JAMES KLINE

SUNY CORTLAND
STUDENT LIFE CENTER
Cortland, NY

The Pennsylvania State University
Dep’t of Architectural Engineering

An Architectural Engineering Study with Special Focus on Lighting and Electrical Design

Lighting & Electrical Option: Spring 2014

Faculty Advisor: Dr. Kevin Houser

STUDENT LIFE CENTER
SUNY CORTLAND
Cortland, NY

General Building Data

Building Name	Student Life Center
Location and Site	SUNY Cortland Campus, Cortland, NY
Building Occupant Name	SUNY Students and Staff
Occupancy or function types	Student Physical Training & Dining, Staff Offices
Size	148,329 SF
Number of stories above grade	2
Dates of Construction	November 2012 – August 2014
Cost information	$51.2 Million Overall Project cost
Project Delivery Method	Design-Bid-Build

Primary project team

Owner	The State University of New York
Architect	H2L2 Architects/Planners LLC
Associate Architects	Hastings + Chivetta Architects, Inc.
Structural and Civil Engineers	KS Engineers
Mechanical, Electrical, Plumbing	WSP Flack + Kurtz
Audio-Visual & Security Engineers	WSP Flack + Kurtz
Lighting Designers	Illumination Arts LLC
Landscape Architect	Trowbridge Wolf Michaels LLP
Storm Water Mngmt Eng.	Fisher Associates
Cost Estimation	The Tocci Group
Kitchen Consultant	Cini Little International, Inc.
Pool Consultant	Aquattica Pools & Water Parks, Inc.
General Contractor	FAHS Construction
Construction Manager	C&S Construction Management

ARCHITECTURE AND SUSTAINABILITY

- Two double-story main wings are connected by a single story entry lobby
- Green roof covers the entry lobby, views from the second story positions, and decreasing solar heat gain to the structure
- Large skylights in the gymnasiums, weight/cardio space, and natatorium bring quality diffuse daylight to these large open spaces
- Spinning room can harvest the energy created by bikers' exercise

LIGHTING SYSTEM

Sources: Flourescent, Metal Halide, LED

Special Design considerations:

- Natatorium lighting had to be designed to withstand environmental factors of the pool air
- Direct glare from sunlight penetrating multiple curtain wall facades was deterred through the use of exterior fins
- Full building management system allows for maximum control of lighting where necessary for daylight harvesting and occupancy purposes

MECHANICAL SYSTEM

Special Design considerations:

- Natatorium air must be handled separately in order to regulate humidity, chlorine, and other chemical senseitive properties
- Full building management system allows for maximum control of the system including occupancy sensing

STRUCTURAL SYSTEM

- Overall structure involves trusses to span large areas such as gymnasiums, weight/cardio space, and natatorium
- Exposed natatorium structure requires specially-ordered galvanized steel
- X-bracing and interior shear walls address lateral loads

JAMES KLINE Lighting/Electrical

Executive Summary

This report is the culmination of all work done on the PSU AE Senior Thesis beginning in June, 2013. This study has been completed using the State University of New York's new Student Life Center at the SUNY, Cortland campus.

There are four main sections to this report after the Building Introduction and Proposal Overview:

1. Lighting Depth
2. Electrical Depth
3. Façade Breadth
4. Mechanical Breadth

The Lighting Depth entails the redesign of the lighting systems for four spaces within the SLC. These spaces are the northeast courtyard; entrance lobby; weight lifting and cardio space; and running track. The criteria for which all design decisions were based on vary for each space, but a common design concept guided the overall lighting design. The energy savings from this lighting design achieved 11 points towards LEED, mainly by providing a lighting power density that was 30% below code.

The Electrical Depth involves the re-evaluation of existing lighting circuits, in order to redesign all panelboards to reflect the new lighting design. A short circuit analysis was completed as part of the electrical depth, along with the design of an energy harvesting system for the spinning room. This system will use power generated by the bikers to run the television at the front of the room. This system will also power indication lighting that will give feedback to all members of the class on how much energy they are producing.

The façade breadth and mechanical breadth are tightly connected, since both involve studies on rain screen façade types. Research was completed initially on rain screen facades, proving that they are advantageous in certain situations. These facades were designed initially to manage water penetration better than other façade types, but provide an advantage in that a lighter, more unique, and potentially cheaper cladding material can be utilized by the architect. They are also very effective thermally, but in the mechanical breadth, energy simulation proved that this makes only a small difference. This was because the majority of the space load was internal to the space used, which is also the case with most other building spaces and climates, so a rain screen façade should certainly not be selected for thermal purposes alone.

Acknowledgements

I would like to thank the following people for their advice, support, and guidance throughout the production of my thesis…

Professors

Dr. Kevin Houser
Dr. Richard Mistrick
Professor Kevin Parfitt
Leslie Beam

Illumination Arts LLC

Faith E. Baum
Ken Douglass
Elizabeth Johnson
Tara White

Architect

H2L2 Architects
Drew Jones

Lumenpulse

Greg Campbell

I would also like to thank my entire family, and all my friends who have given me support and advice throughout my time at Penn State.

Note: All content found in this report is meant for educational use only.

Table of Contents

Section A

Building Overview

General Building Data

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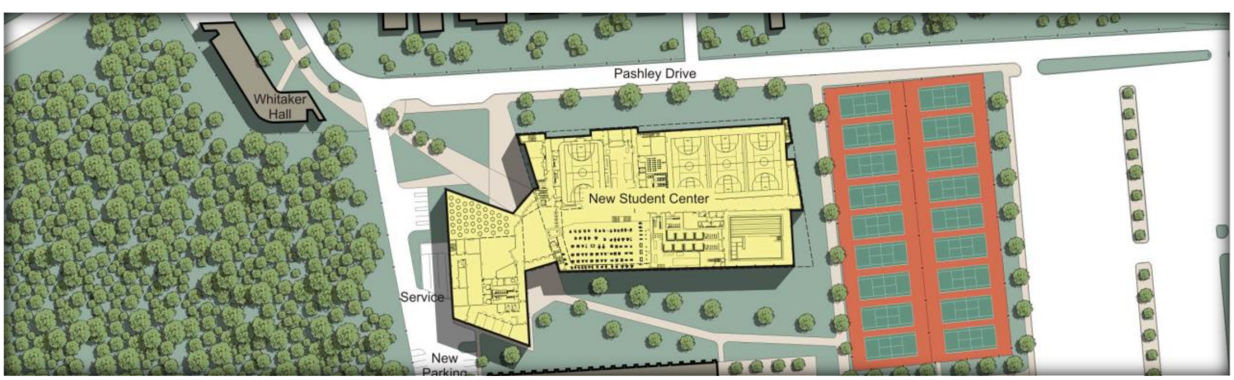
Architect	H2L2 Architects/Planners LLC http://www.h2l2.com/
Associate Architects	Hastings + Chivetta Architects, Inc. http://www.hastingschivetta.com/
Structural and Civil Engineers	KS Engineers http://www.ksengr.com/
Mechanical, Electrical, Plumbing	WSP Flack + Kurtz
Audio-Visual & Security Engineers	WSP Flack + Kurtz http://www.wspgroup.com/en/wsp-usa/
Lighting Designers	Illumination Arts LLC http://www.illuminationarts.com/
Landscape Architect	Trowbridge Wolf Michaels LLP http://www.twla.com/
Storm Water Mngmt Eng.	Fisher Associates http://www.fisherassoc.com/

Cost Estimation	The Tocci Group http://www.tocci.com/
Kitchen Consultant	Cini Little International, Inc. http://www.cinilittle.com/
Pool Consultant	Aquattica Pools & Water Parks, Inc. http://www.aquattica.com/
General Contractor	Waiting for response
Construction Manager	C&S Construction Management

Dates of Construction	November 2012 – August 2014
Cost information	$51.2 Million Overall Project cost
Project Delivery Method	Design-Bid-Build

Architecture

This structure consists of two double story main wings, with a single story connection structure in between. The South wing is the largest, and contains of an fitness center with weight lifting equipment and tread mills, a natatorium, spin room, mind body room, staff offices, large running track, 4 gymnasiums, 2 golf simulators, game room, climbing wall, and 2 cardio rooms in addition to standard amenities such as bathrooms, showers, and locker rooms. The North Wing serves as a dining space, and includes support spaces for food preparation in addition to bathrooms for all occupants and locker rooms for employees. The connection structure is known as the lobby, and also the main entrance to the building from either the East or West side.



Major national model codes:	Building Code of New York State 2010 ADA/FHA Compliant National Electric Code ASHRAE 90.1 2007
Zoning:	N/A: On campus
Historical Requirements:	None

Building Enclosure

Building facades

The Student Life Center utilizes two main types of building façades. On the Southeast corner, the entire façade is a curtain wall consisting of fully-tempered safety glass with type A and type C glass. Both panel types are a total of 1 inch thick, with low-e glazing, but type C has an acid-etched frosted inner panel, and the air space between the inner and outer sheets of both types is filled with Argon. These two specific panel types have a visible light transmittance around 70 percent and a solar heat gain coefficient around .38. U values of both are .29 for the winter night-time condition, and .28 for the summer daytime condition. All exterior glass has a center-of-glass maximum U value of .46, and a minimum e rating of .05.

Façades not utilizing glass utilize a rain screen. The rain screen wall structure is as follows, from interior to exterior:

- Metal Stud
- 5/8" Exterior Sheathing
- Non-permeable air barrier via sealant
- 7" Semi rigid moisture resistant insulation
- Sub-girt
- 2 ½" Metal comp. wall panel (Rain Screen)

Roofing

Roofing mainly consists of a modified bitumen roof membrane with scattered skylights bringing light to areas of emphasis in the fitness wing:

Twelve translucent skylight systems light the gymnasiums, weight training area, cardio loft, and natatorium. The system is comprised of 4” structurally reinforced translucent panels, with self-supporting framing. Panels have a U value of .14 and solar heat gain coefficient of .17.

Sustainability Features

The connection building between the two main wings - the main entrance - has a green roof which is accessible only for maintenance. This green roof is utilized for lowering the building’s heat load, and for aesthetics, since the roof can be seen from multiple locations on the second floor. An energy harvesting system is an option in the spin room. This system would harvest electricity generated by the bikers as they work out and redistribute the energy back into the room to power various elements. A more detailed description of this system can be found in the electrical portion of the report here. Skylights and large exterior curtain walls in combination with daylight harvesting reduce the electric lighting load during the day. The rain screen façade system described above is the final sustainable feature of this building.

Primary Engineering Systems

Construction

The Natatorium needs special construction attention and consultants as well as dedicated mechanical equipment to regulate the environment. Due to the size of the mechanical system needed, a step down section had to be specially dug just to accommodate the height of the system. All exposed steel in the natatorium is galvanized steel in order to prevent corrosion from the pool air.

Access control in the form of turnstiles is located in entry spaces when entering either the South wing or the North wing from the main lobby. Also, the exterior doors security system has the ability to lock exterior doors at predetermined times.

Electrical

The Student Life Center utilizes one 2000 Amp service switchboard at 480/277 Volts: three phase. The switchboard connects to multiple panelboard loads in addition to the dedicated photovoltaic system and lighting relay panels. Lighting relay panels are used in order to activate lighting throughout the building based on occupancy and daylight sensors. Mechanical systems also use these relay panels activated by occupancy sensors in specific areas of the building to conserve energy consumed by the mechanical system. The emergency power system is backed up by a natural gas fired generator via two automatic transfer switches.

Lighting

The lighting system is comprised of fluorescent, metal halide, and LED sources. The full building management system allows for maximum lighting control, daylighting, and occupancy control. Daylight harvesting is implemented in the main cardio and free weight area. Specialized controls in the Mind/Body room allow the instructor to be able to plug his/her iPod into a standard audio outlet, which connects to a lighting control system that will change the LED perimeter cove lighting based on the music. Similar technology allows the climbing and bouldering wall staff to select a variety of pre-programmed, color-changing scenes to be played accent lights. The option is also available to implement a Colorkinetics AuxBox, which would allow the lighting scenes to be triggered by a variety of devices, including motion sensors, time clocks, or temperature sensors.

Mechanical

This building uses multiple air handling units which distribute air to the building as demanded. VAV controllers in each space determine the amount of air that is dispersed into that space at any given moment. One chiller and two boilers are responsible for heating and cooling the air before it is sent to the VAV controllers. Remote air cooled condensers are used to reject heat from the system.

The pool has its own dedicated mechanical system which controls both the natatorium air and pool water. The water filtration system works in tandem with an infrared system to cleanse and treat the pool water. The air unit is specified to work specifically with the high humidity levels present in a natatorium atmosphere.

Electrical and data rooms have their own air conditioning units to help control the higher heat loads involved with the equipment in these spaces, as well as the recommended lower room temperatures for the equipment to operate optimally.

Structural

The second floor is slab on deck supported mainly by W16x45 & W16x26 steel beams shear connected to 12x12 steel columns. One specialized area of the building involves a suspended track which is supported by W10x26 beams connected to exterior columns on one side, and steel hangers on the other. The main roof structure is supported by multiple types of trusses in all large open spaces; the gymnasiums, cardio/weight training space, and natatorium. The architecturally featured circular exterior cut out is supported by a single cantilever beam. Lateral loads are accounted for through shear walls in the elevator shafts and X-bracing in multiple locations throughout the building.

Additional Engineering and Engineering Support Systems

Fire Protection

The Student Life Center is protected by a full building sprinkler system and smoke alarms. Speakers and strobes will activate on all floors and an alphanumeric text message will display on LCD screens in the case of a fire. A signal is transmitted to the campus command center via the campus monitoring system, return fans automatically stop, recirculating air fans stop, and the door releases on all floors activate via communication with the security system. Smoke control fans initiate as a final measure to increase safety for those evacuating the building.

Transportation

The Student Life Center utilizes one main entry building which connects the south wing and the north wing, and serves as the lobby. The building utilizes two elevators; one is located in the main lobby, while the other is located near the middle of the South wing. There are seven separate staircases, most of which are located around the exterior of the building for access to the exterior in case of emergency.

Telecommunications

Extensive telecommunications provide cable TV and campus visual messaging to all LCD TVs in the building. A PA system allows announcements to be made from the main desk and output to speakers located in most rooms throughout the building. Electronic white boards, projectors, and laptop ready stations in multiple rooms are conducive to providing multiple types of instruction. Several spaces have CD, radio, microphone, and iPod connections available for music and speaking.

Special Systems

The Green Roof utilizes an engineered soil-like material designed to retain moisture, manage plant nutrients, and support vigorous growth of the foliage. Included in its design is Electric Field Vector Mapping which is a leak location technique. The assembly will be a multi-course system, consisting of a 3 inch growth media layer installed over a synthetic sheet drain.

Section B

Proposal Overview

This thesis report will include a lighting and electrical depth, as well as the façade and mechanical breadths.

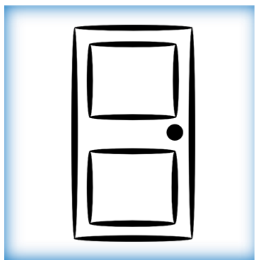
Lighting Depth

The lighting depth involves four spaces within the Student Life Center. These spaces include:

Main Purpose Space

Weight lifting & Cardio Area

Circulation Space



Entrance Lobby

Exterior/Facade

NE Courtyard

Special Purpose Space

Running Track

The lighting design is based off of one central concept which is identified at the beginning of the lighting depth section. The report outlines key design criteria for each space as well as how the criteria were successfully met. Energy efficient fixtures, as well as energy saving control techniques were used to aid in the creation of an overall sustainable design for the Student Life Center.

Electrical Depth

The electrical depth describes the necessary alterations that were made due to lighting system changes, as well as a short circuit analysis. The third section of the electrical depth is schematic design of the spin room. This building's spin room has to option of adding a system that will harvest the power generated by members of the cycling classes. An analysis displays how the system can be designed, the estimated power generation, and proposes a use for the energy harvested.

Breadths

The first breadth is a façade study, which will determine the advantages, disadvantages, and many other details concerning a pressurized rain skin. This façade system is popular and successful in Europe, but not widely adopted in America.

A mechanical study of the spaces in the Student Life Center will be the second breadth. This breadth will use heating and cooling load simulations, as well as a cost analysis to determine whether the façade system researched in the previous breadth is financially feasible for this building and if so, where.

Section C

Lighting Depth

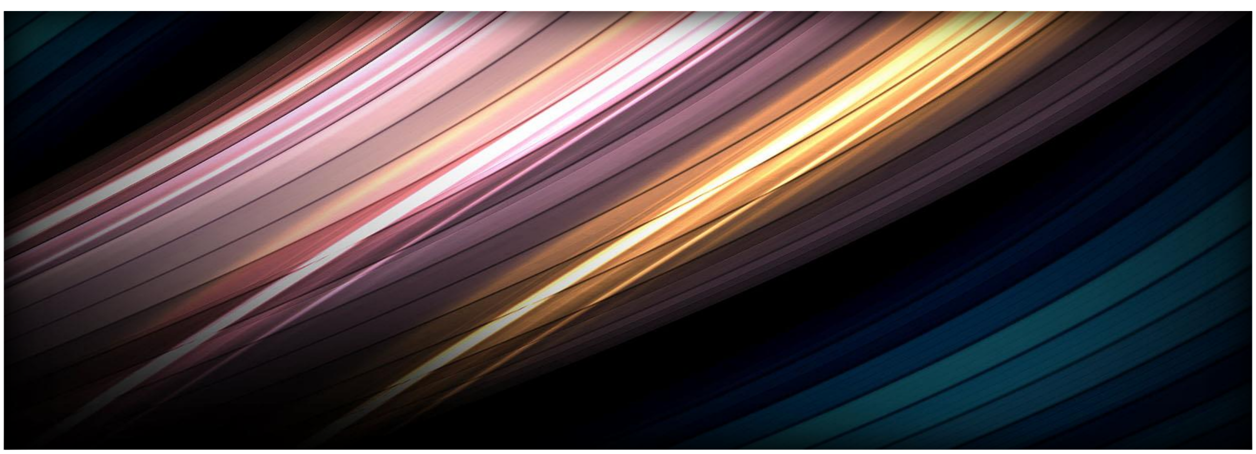
Concept of Design

This building was meant to promote and bring new life the SUNY Cortland campus. One thing that is very representative of life is **motion**. When we observe motion, we subconsciously connect that with life, whether it is a car passing by, a mouse pointer moving on a computer screen, or even leaves rustling across the road, mistaken for a mouse. None of these elements are alive, yet we assume life.

We can even assume motion – and therefore life – without actually seeing something move, as you may notice in these images. While we don't experience motion, we know from past experiences in life and visual clues, that motion is apparent here.

We can achieve the same phenomenon with architecture and light. Often times, including with the Student Life Center, architecture is designed to imply a direction of travel or encourage motion. I plan to do my part and encourage motion through these spaces with light.

My goal is to encourage motion with lighting using brightness, controls, and directional cues.



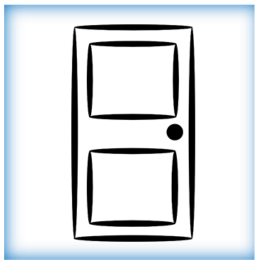
Design Overview

The lighting design involves four spaces as mentioned in the proposal overview. They are located on both the first and second level of this two story building. For clarity they are as follows:

Main Purpose Space

Weight lifting & Cardio Area

Circulation Space



Entrance Lobby

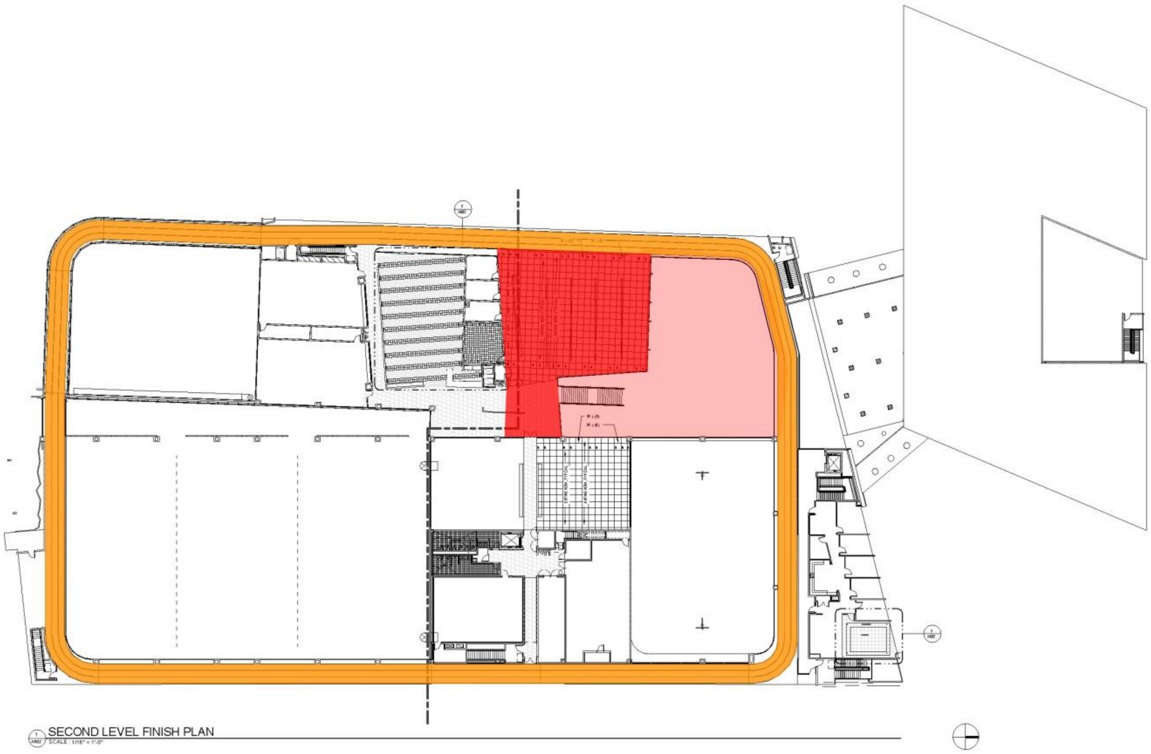
Exterior/Facade

NE Courtyard

Special Purpose Space

Running Track

By color, they are located according to the following two floor plans. Half of the weight lifting space (the south side) is covered by the cardio loft, as can be seen when comparing the first floor plan to the second floor plan – for full size floor plans at higher resolution, you may visit Appendix A.



The running track encompasses the entire second floor of the Southern Wing. When it traverses over the indoor swimming pool, the track is enclosed in a tube that suspends over the pool. This protects the track environment - including the lighting – from being effected by the harsh pool air conditions.

Elements Related to Lighting Included in this Section

- Weight Lifting & Cardio Lighting Design (w/ unique reflection)
- Running Track Lighting Design (w/ individual control system)
- Entrance Lobby Lighting Design
- Exterior Courtyard Lighting Design
- Control System Narrative
- LEED Qualifications
- Lighting Power Densities (by space and by building)
- Light Loss Factors Used

Elements Related to Lighting Included in Appendices

- Fixture Schedule App. C
- Fixture Specification Sheets App. C
- Lighting Drawings (incl. details and elevations) App. B

Weight Lifting and Cardio Area

High Priority Criteria

1. Psychology

   The weight lifting and cardio area was chosen as the space to be designed based on the Flynn mode of "public." In order to convey a public feel in this space, overhead lighting should be the main source of illumination. Other aspects such as vertical surface lighting where possible are also acceptable in order to make the space feel more inviting and spacious.

2. Comfort

   This space will be one of the most utilized spaces in the Student life center. Therefore it should be comfortable, despite its public feel. This can be achieved with accent lighting and vertical surface lighting.

3. Daylighting sensors to provide energy savings.

4. Illuminance values as recommended by the IES.

Quantitative Design Criteria

	Horizontal Illuminance (E_h)			Vertical Illuminance (E_v)	
Space/Task	Average (lux)	Ave:min	CV	Average (lux)	LPD (W/SF)
Weight Training Floor: E_h @ 2.5';E_v @ 5'	150	3:1	N/A	50	.72+.1+.1= .92
Cardio Loft Floor	150	3:1	N/A	50	
Walkway: E_h @ Floor;E_v @ 5'	30 (.2x150)	3:1	N/A	10	

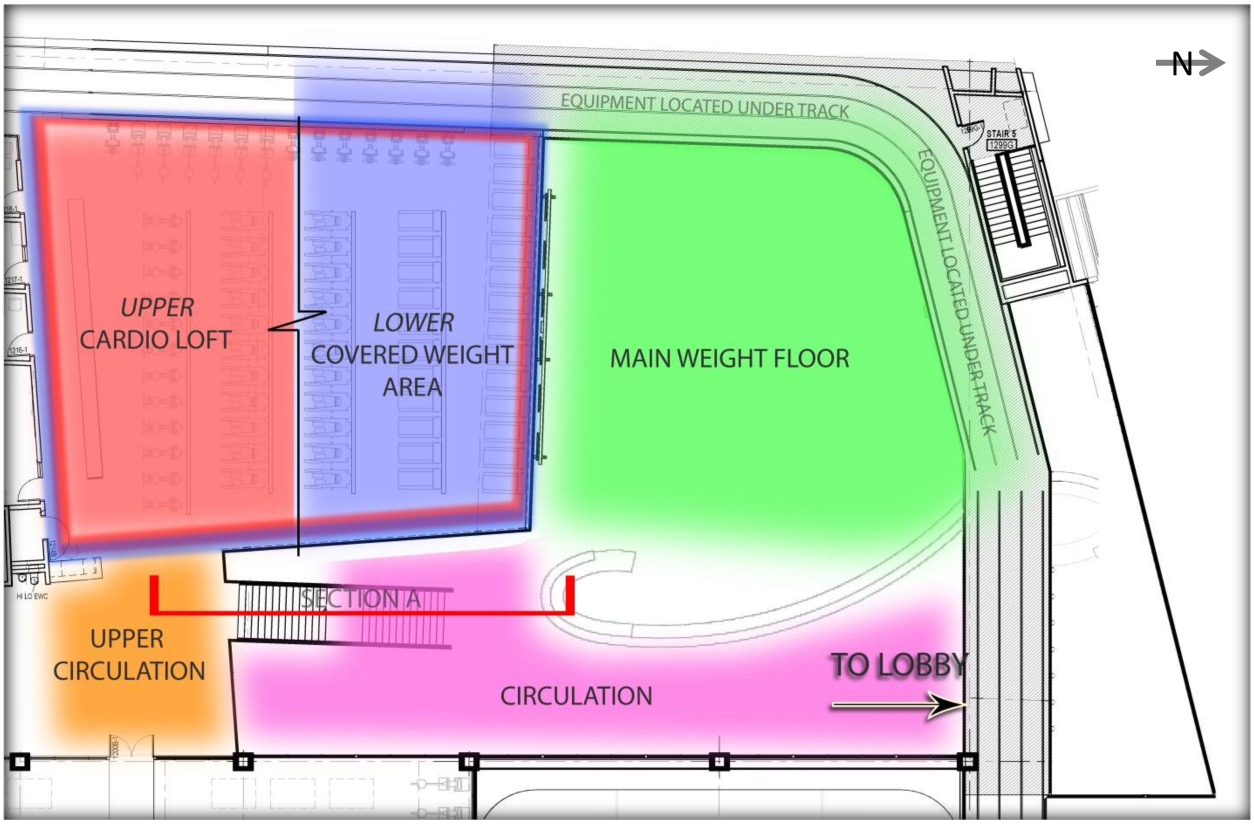
Lighting Plans can be found in Appendix B where the locations of each fixture type as well as daylight sensors can be found.

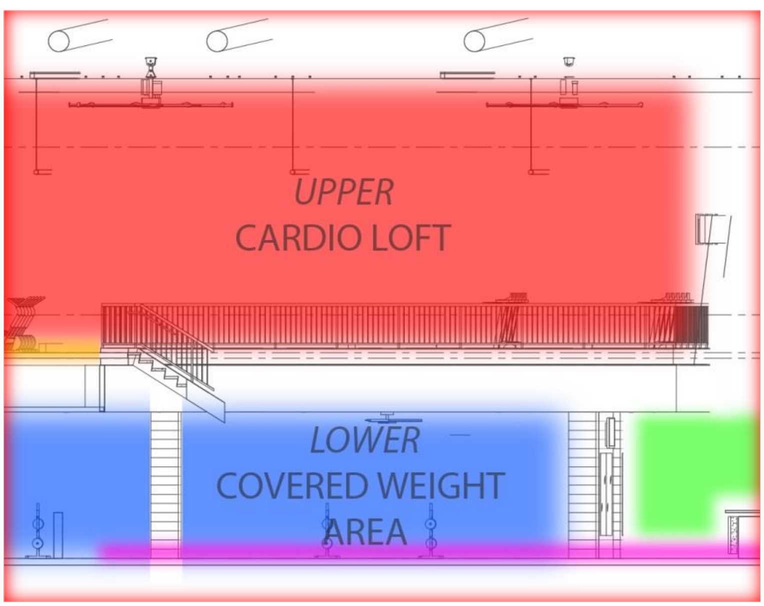
Reference Sheets:

L1 - Lighting Gym - Level 1
L2 - Lighting Gym - Level 2
L6 - Lighting Skylights - Level 2

Lighting Solution

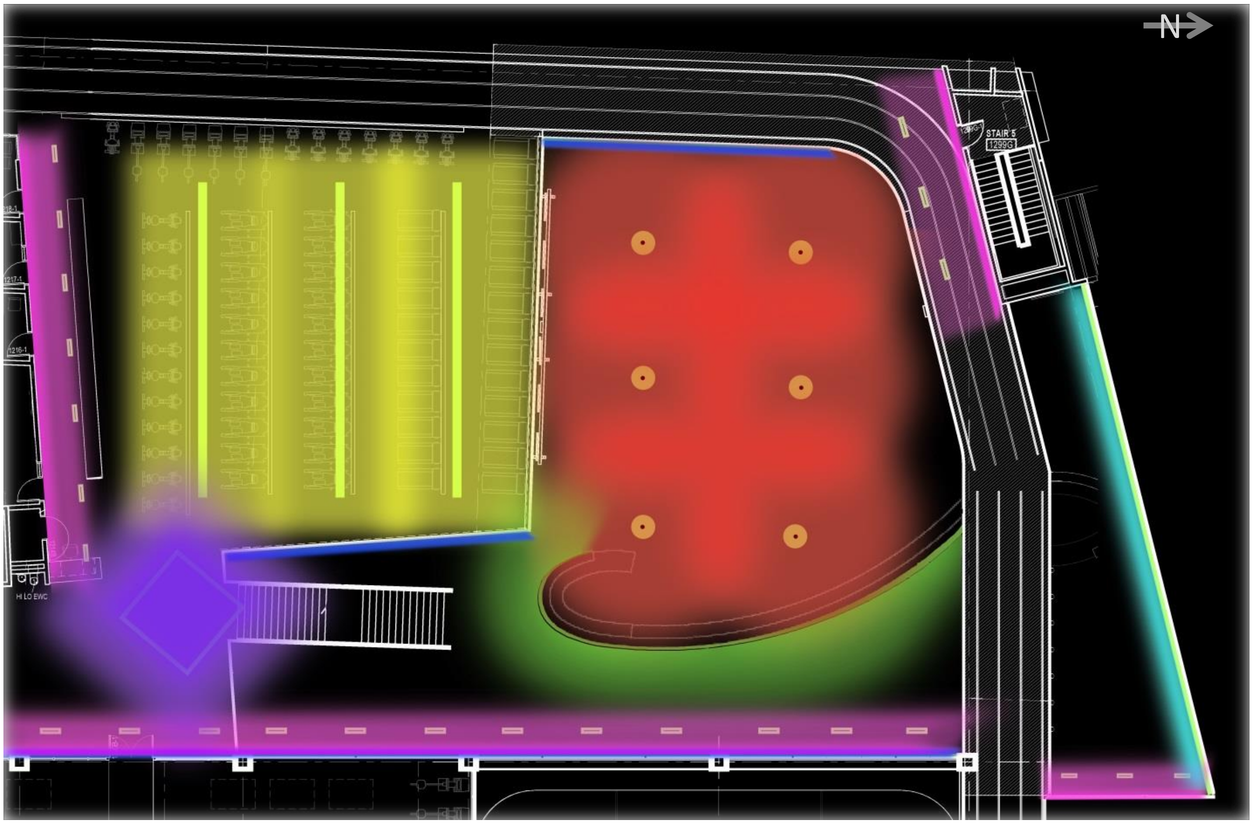
Please use the following image and section to become familiarized with the layout of the space. This is the largest space in the scope of this thesis. Referencing these images will help orient you much better than any written description. The main functions of this space include weight lifting, cardio-based exercise, and circulation to the remainder of the building after entering from the lobby.





SECTION A

Please also use this image for a quick overview of fixture locations, a reference to locate fixtures within the space later, and to get an additional understanding of the space. This image does not include skylight fixtures, or the four LED strip fixtures beneath the cardio loft, all of which will be seen later.



The images below reference the lighting fixture types corresponding by color to the image above.

Weight Lifting Main Floor

The main weight lifting floor is lit using six high bay LED fixtures as the main source of light. After this, vertical illumination via wall washers on the second story vertical walls is used to add reflected light to the space. In addition, lighting from the track supplies reflected – and some direct – light to the weight lifting floor. Four foot recessed LED fixtures are placed on a standard interval around the outside of the space to provide illumination to areas where the high bay pendant lighting would otherwise cast strong shadows onto the first floor (See "Equipment located under track" in first image above). In addition, reflected light from the skylight fixtures apply diffuse light to the weight lifting floor. These fixtures will be seen below in the skylight image. Wall washers will be seen below in the circulation image.

View from Track onto Main Weight Floor

Cardio Loft

The cardio loft is lit using continuous direct indirect LED pendants. These pendants are very similar to the direct recessed fixtures located throughout the rest of the building. And again, semi-recessed wall washers light the back wall of the cardio loft to prevent this large vertical surface from going dark. Reflecting light off of this wall, the ceiling, and the skylights above all provide very adequate vertical illumination to this section of the overall space. This is important since there will be a large quantity of treadmills, bikes, ellipticals, and other equipment here.

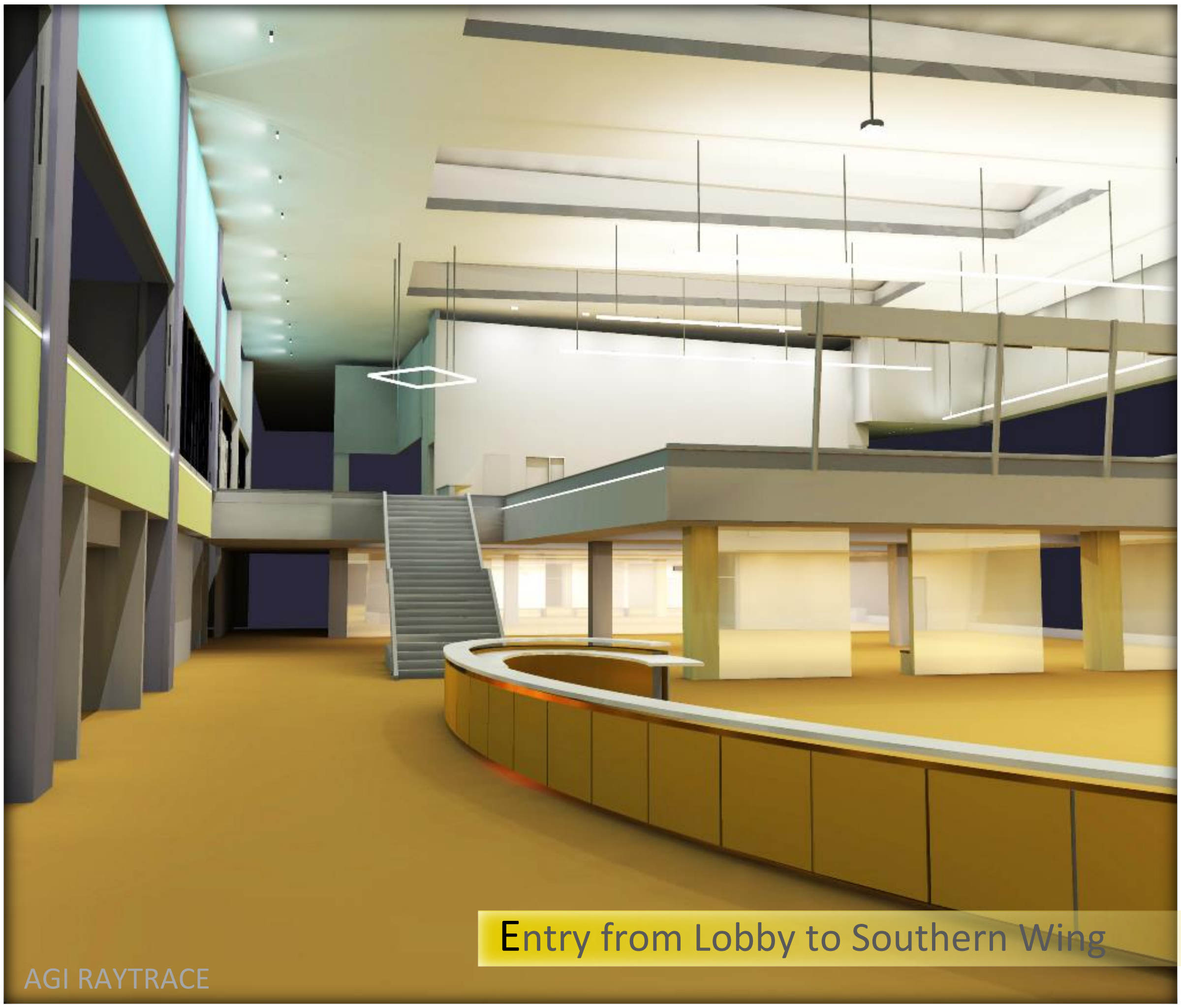
Weight Lifting Secondary Floor

In the second area of the weight floor – where the cardio loft covers it – continuous linear LED fixtures are recessed into the ceiling to provide general illumination and avoid glare. Since there are large amounts of glass and mirrors in this area specifically, avoiding glare is of the utmost importance. The below image is a clear indication of how glare has been reduced; only one continuous fixture is visible despite the fact that there are four total continuous fixtures in the space. One is out of view to the left, and the other two are hidden in the other recessed ceiling cavity further across the space.

Weight Training Space beneath Cardio Loft

Circulation

Above the circulation area of this space, metal halide wall washers provide vertical illumination to the brightly colored vertical surfaces. These fixtures prevent the upper and outer portions of this very tall space from going dark, in addition to adding reflected light for general illumination.



Entry from Lobby to Southern Wing

One key pendant is positioned at the top of the stairs to draw people through the space, both visually and physically. This luminaire acts as a key focal point, since it is at the top of the only staircase in the room, and in the general line of sight when looking down the passageway through the space. It distributes light not only down, but sideways. The lens on this linear fixture wraps up the sides of the luminaire, along the entire length of the fixture. This helps supply vertical illumination and facial rendering of students traveling up the steps and standing near the top of the stairs.

Open Cavity

A cove light along the length of the large curtain wall adds a bit of light as accent to this otherwise dark portion of the space. It also ties in with the overall concept to encourage motion since it is in the direction of travel of students running on the track. A linear strip mounted to the wall above the track adds accent to the space, and helps to reinforce the upward size of the space. This image is somewhat deceiving because the lobby lighting will actually reflect a moderate amount of light up into the cavity as well. This will also slightly reduce the contrast between the bright track and the darker lobby floor on the other side of the track.

Skylights

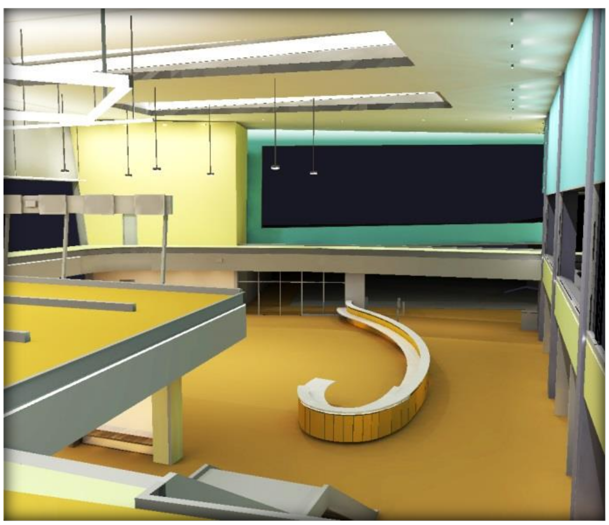
There are four skylights placed in the ceiling of this space. These skylights are actually made of a very reflective material; Kalwall. Light transmission is less than 20%. This allows us to bounce light off of the material, creating a very iconic image from the exterior, and also a very diffuse light source for the space below. Continuous indirect LED fixtures are mounted along the length of each skylight on just the Northern side.

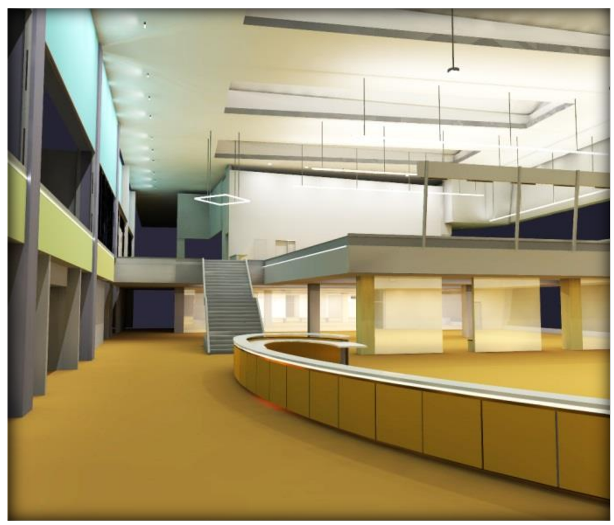
Keep in mind that this space is surrounded on many sides by glass, as can be seen in the perspective views of the space. Light from the surrounding spaces will likely increase the amount of light experienced in areas of the weight lifting and cardio area bordering these curtain walls. Specifically, the circulation area will receive a substantial amount of reflected light from the open gyms, since these spaces will be required to be lit very heavily. Also, the area near the lobby will receive additional reflected light from the lobby. Calculations did not include these sources of light, which is why it can be expected that values in these specific areas will be slightly greater in the constructed design.

Special Reflection

This space is extremely unique, and feels even more unique when seen at multiple angles. Simply by flipping through the images above, this is clear. The lighting solution has supported this phenomenon. Please review these images quickly, and you will see that different views will cause certain lighting elements to practically appear from nowhere. For example, since the skylights are lit from only one side, the aesthetics of the ceiling are completely different when looking into the space *from* the lobby compared to looking *towards* the lobby. Also, if an occupant simply walks from the lobby, through the circulation space, and into a deeper part of the building, they may never even notice the vertical accent strip above the track that is seen by weight lifters and cardio equipment users. Even a runner on the track may never see this strip either since they will be running counterclockwise.

This is an interesting connection; the more a student widens their experience physically, the more they are able to experience the exceptionality of this space.



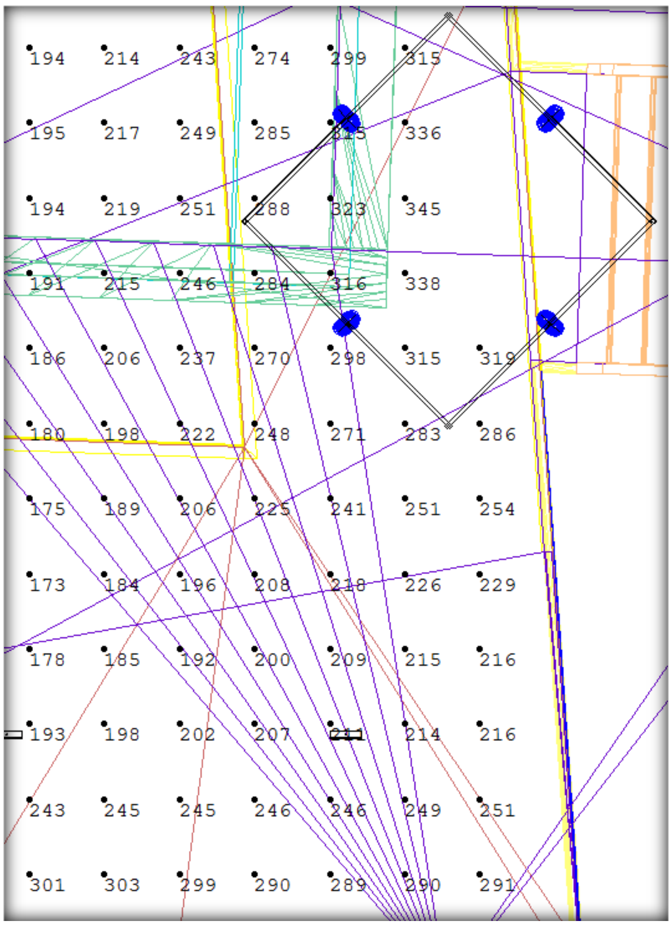


Overall, the lighting design for the weight training floor utilizes a large quantity of direct light, as well as some indirect light to make the space feel public. In addition, the weight training floor has one distinct advantage; it is bordered by an open circulation space. This circulation space can be darker than the rest of the room. This is advantageous because it does two things:

1. Makes students on the weight lifting floor feel as though they are "on stage" compared to the rest of the room. Psychologically, this is beneficial for athletes.
2. Subconsciously draws passing students towards the brighter area of the gym (physically and mentally), encouraging them to take part in physical exercise, regardless of whether they decide to take part at that moment, or another.

Quantitative Criteria and Calculations

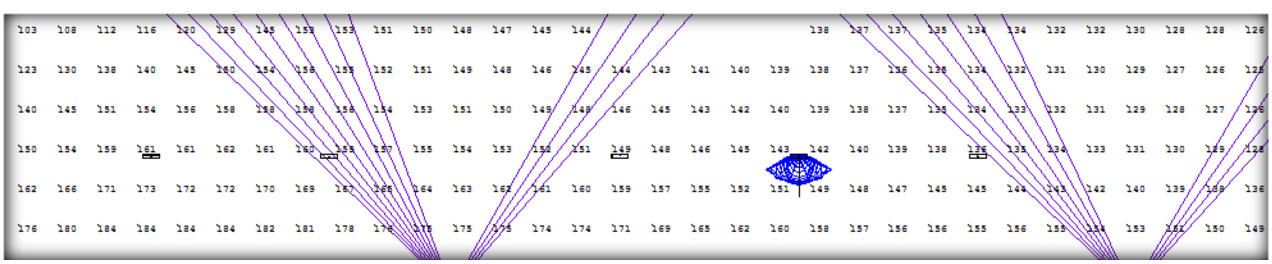
Quantitative Design Criteria					
	Horizontal Illuminance (E_h)			Vertical Illuminance (E_v)	
Space/Task	Average (lux)	Ave:min	CV	Average (lux)	LPD (W/SF)
Weight Training Floor: E_h @ 2.5';E_v @ 5'	218	1.75	N/A	128	
Cardio Loft Floor	294	1.53	N/A	213	.73
Walkway: E_h @ Floor;E_v @ 5'	138	1.90	N/A	83	

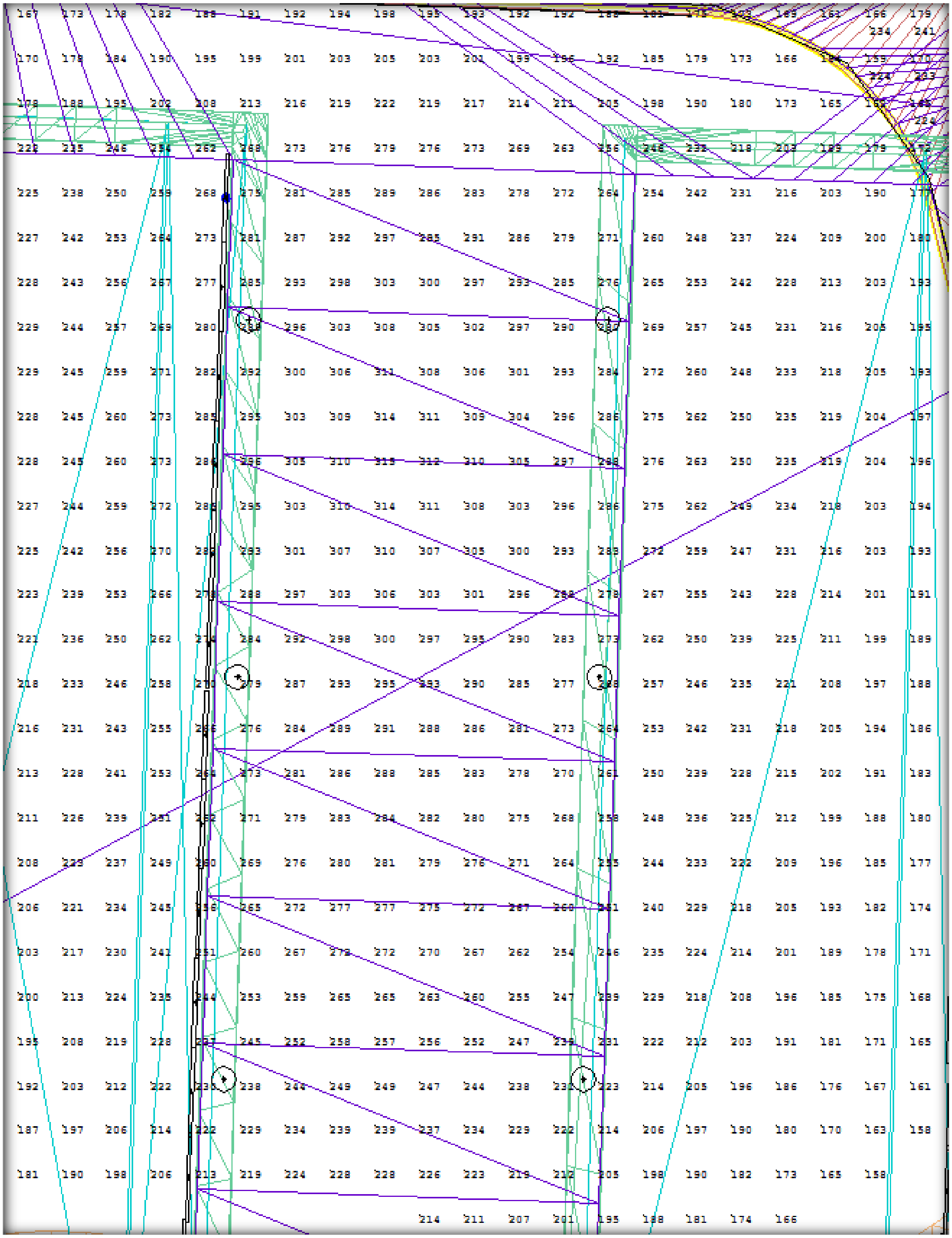


Left: Top of stairs illuminance values. The square pendant can be seen at the top right of the image, and one of the wall washers lighting the high blue walls can be seen near the bottom of the image.

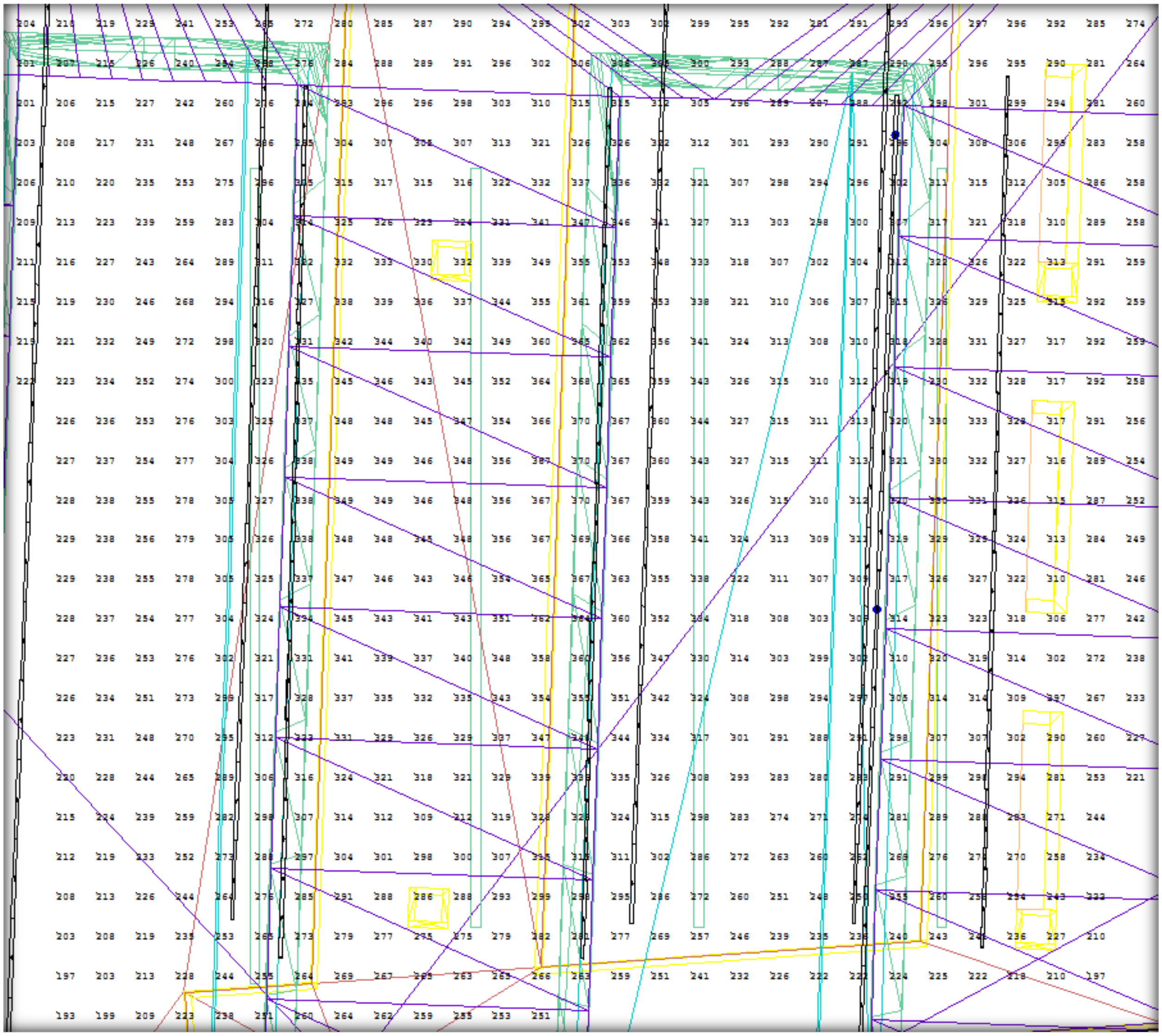
Note: Illuminance values are greater than recommended in all spaces. This is intentional because the floor surface of this room is very dark. At only 150 lux, the room would feel much darker than it actually is. Also, 150 lux is the bare minimum to begin with, since this is the recommendation based on 50% or more occupants being under the age of 25.

Bottom: Illumination values for the circulation area on the East side of the space (bottom of plan view) as identified above.





Illuminance values for the main weight lifting area. The six high bay pendants hung from the ceiling, but not under the skylights above can be seen in this image as circles.



Illuminance values for the cardio loft space. This image is not a good representation of fixture positions; it shows both the first level fixtures which are lighting the weight lifting space underneath the loft, in addition to the cardio loft fixtures. Reference the colored floor plan at the start of the Weight Lifting and Cardio section above to see fixture positions of the loft lighting. Reference the documented lighting plans in Appendix B for fixture positions of the weight lifting space underneath.

Running Track

High Priority Criteria

1. Control System

   The running track needs a high quality control system in order provide the pacing system via the lighting.

2. Glare

   Since runners will be traveling at high speeds on the track, glare and the strobe effect that could be experienced should be eliminated at all costs.

3. Illuminance values as recommended by the IES.

Quantitative Design Criteria						
	E_h			E_v		LPD
Space/Task	Average (lux)	Max:min	CV	Average (lux)	Max/min	(W/SF)
Running Track: 3' above Floor	150	3:1	.25	N/A	N/A	.82

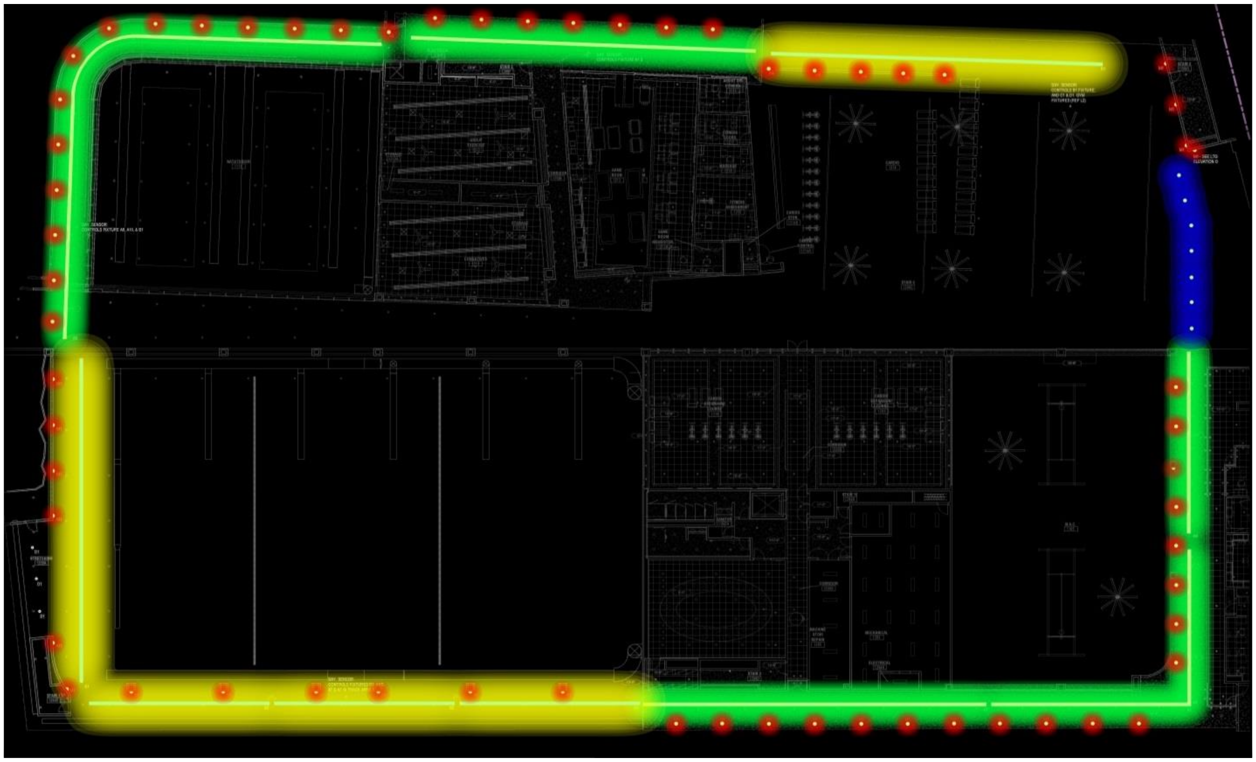
Lighting Plans can be found in Appendix B where the locations of each fixture type as well as daylight sensors can be found.

Reference Sheets:

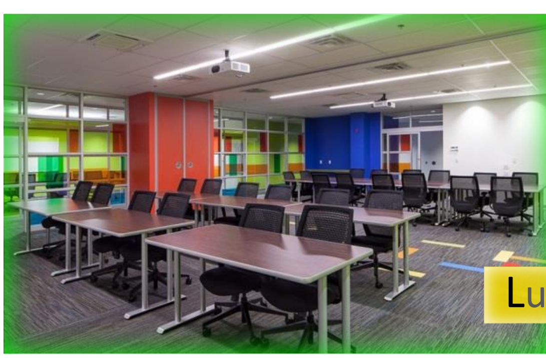
L4 - Lighting Track - Area A
L5 - Lighting Track - Area B

Lighting Solution

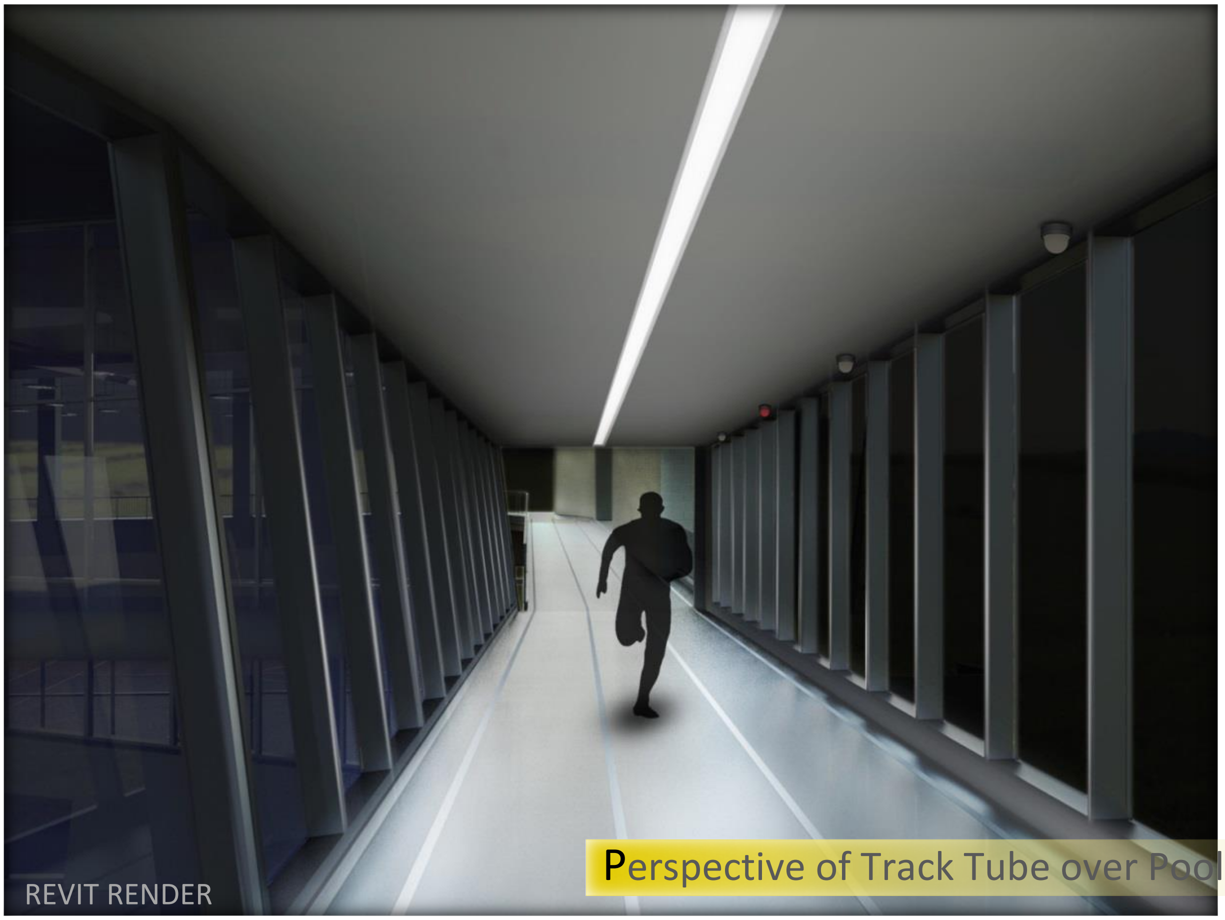
Please use the following image for a reference to locate fixtures within the space, as well as to get an overall understanding of the space.



The below images reference the lighting fixture types corresponding by color to the image above.



Luminaires



Perspective of Track Tube over Pool

Perspective of Track with Recessed Strip

In order to prevent the strobe effect from glare on the track, continuous recessed LED strips were mounted where gypsum ceilings provided proper ceiling heights.

In addition, half spherically lensed LED fixtures are mounted at a set interval around the track. The majority of the times, these fixtures are surface mounted to the ceiling, but at times, the architecture provides interesting places to mount these fixtures, such as to the side of columns, or to the side of walls. The next page explains the function of these fixtures.

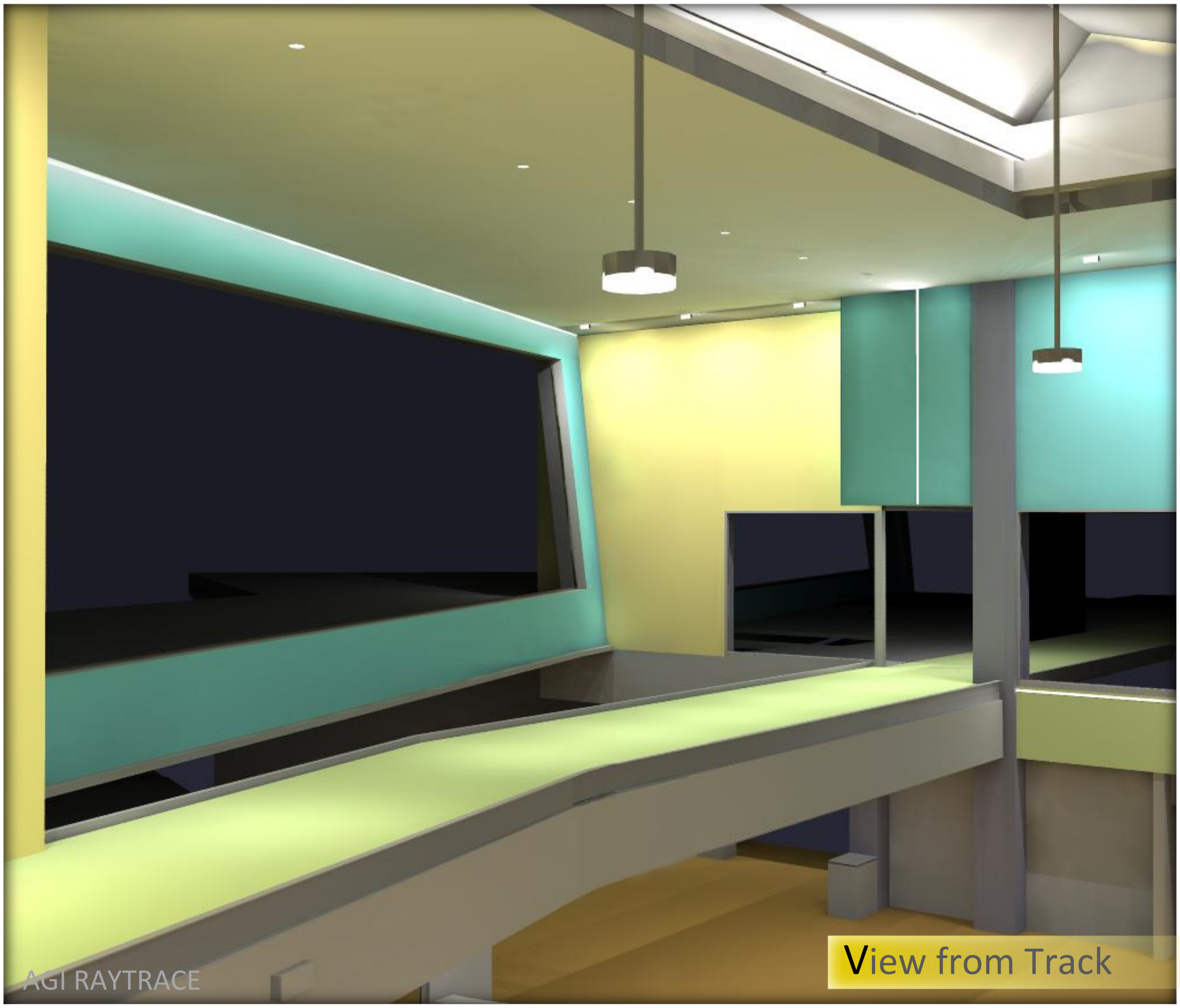
Lumentouch control system (track only)

These fixtures will be programmed using the Lumenpulse Lumentouch control system to light up by color in a pattern around the track. By corresponding with a Lumenpulse representative, it has been determined that this is the most user-friendly and most applicable control system for this situation since the Lumentouch control has a real time clock built in. This will allow each color to be programmed to correspond to a certain 1 mile pace. For example, the control system would turn on fixture 1 in the color red, then turn fixture 1 off and turn on fixture 2 , then turn 2 off and 3 on, and so on. It would do this in real time so that if one were to follow the dots around the track exactly alongside the red dot, he or she would run a nine minute mile. This can be repeated, but for different colors at different paces, and all be programmed into one scene. This allows the receptionist to simply activate "Scene 1" and the pacing scene will begin, turning on all of the colored pace indicators. Keeping all colors on at one time will prevent different scenes from having to be triggered, which would restart the system and interrupt someone who is running on the track already. The Lumentouch system is very versatile, so other schemes could be programmed just to provide interest to the building if desired. For example, since these fixtures will be visible from the pool, they could be programmed to pulse red and white for the SUNY Cortland school colors. The opportunities for this system or endless, and it can be programmed at any time, allowing extreme versatility for the system.

Lumentouch Touchpad Controller

In areas where ceiling heights were too great, direct indirect continuous linear pendants were suspended above the track. This image, seen before in the weight lifting and cardio section, shows the direct indirect lighting on the right side of the image.

Where the track travels over the weighting lifting space, tight beam downlights were used in order to avoid suspending luminaires and breaking up the view above the track in this location. These downlights supplement the reflected light already present in the space to provide adequate illuminance values. This change in lighting also helps to identify this section of track as special for the runner since it is the only section that is open on both the left and right side, seemingly floating over the space below.



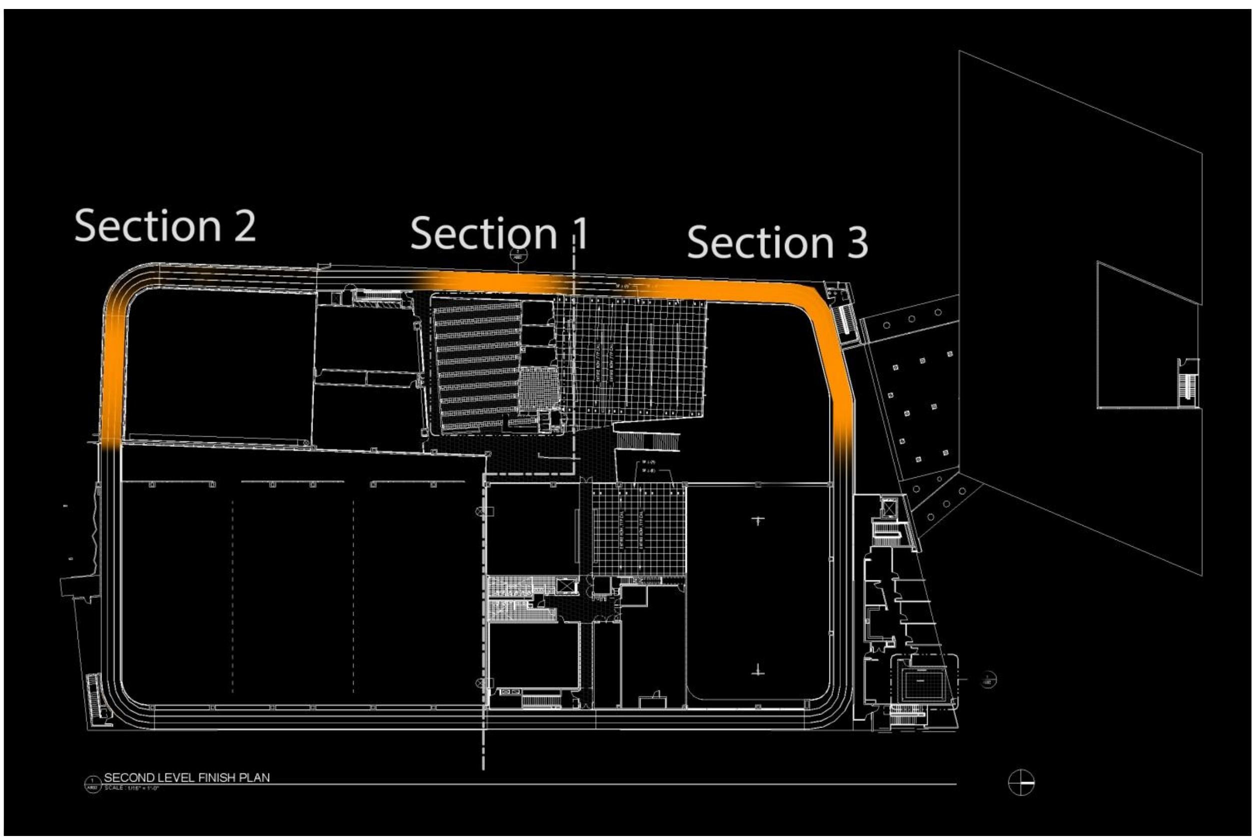
View from Track

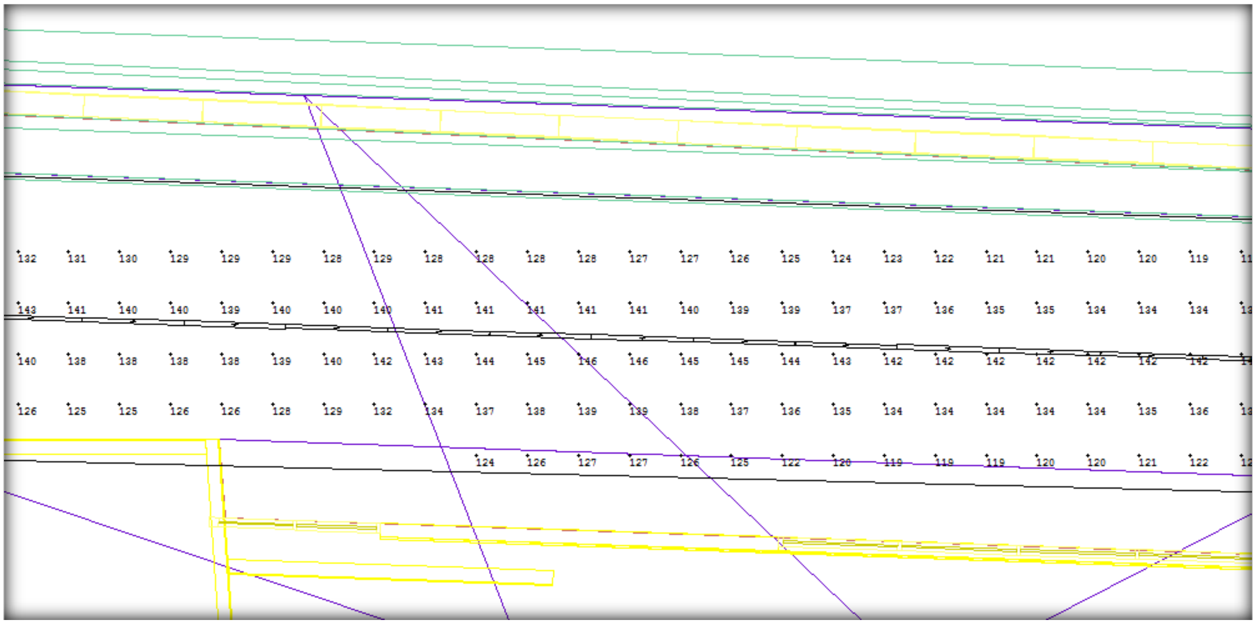
As mentioned in the weight lifting and cardio section, the track has a relatively high amount of contrast when compared to the floor below and the luminance of surrounding surfaces. This is not a negative thing, but rather a positive one, since it will heighten the sense that the runner and the track are floating.

Quantitative Criteria and Calculations

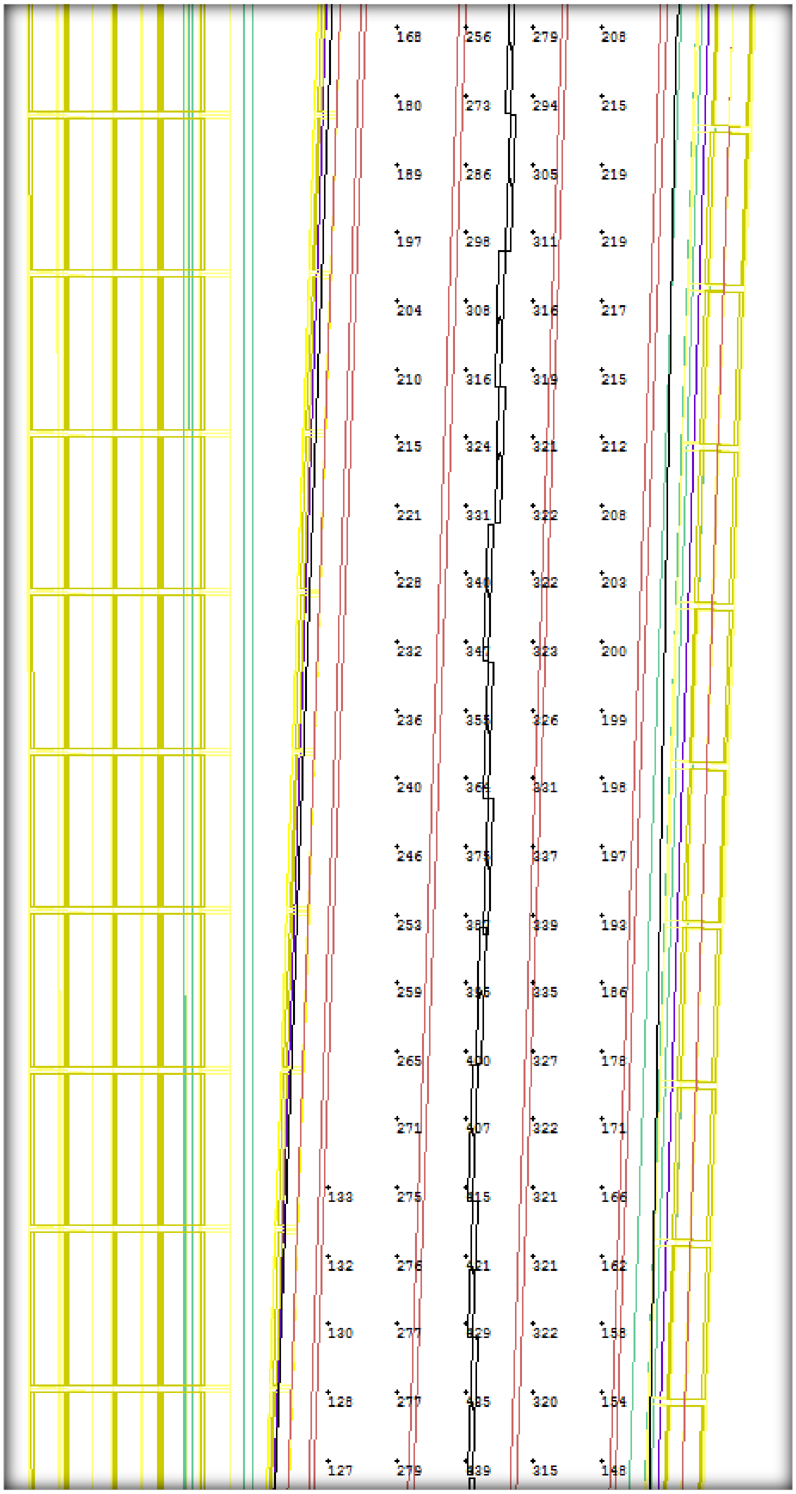
Quantitative Design Criteria: Dependent on Section of Track						
	E_h			E_v		LPD (W/SF)
Space/Task	Average (lux)	Max:min	CV	Average (lux)	Max/min	
Running Track: 3' above Floor Section 1	134	1.3	.06	N/A	N/A	.75
Running Track: 3' above Floor Section 2	137	3.1	.32	N/A	N/A	
Running Track: 3' above Floor Section 3	259	2.1	.13	N/A	N/A	

The following image shows the regions for which calculations were completed for the track. These calculations were done with no lighting placed in the surrounding spaces (except for section 3), even though the track is open on one or more sides the majority of the time. Since reflected light from surrounding spaces will spill on to the track surface, the illuminance values will be greater in the constructed space of various amounts depending on location. This is acceptable in this scenario, because the base illuminance for this design is only 150 lux. In addition, this change in illuminance by space will help the runner identify their current position on their adventure around the track.

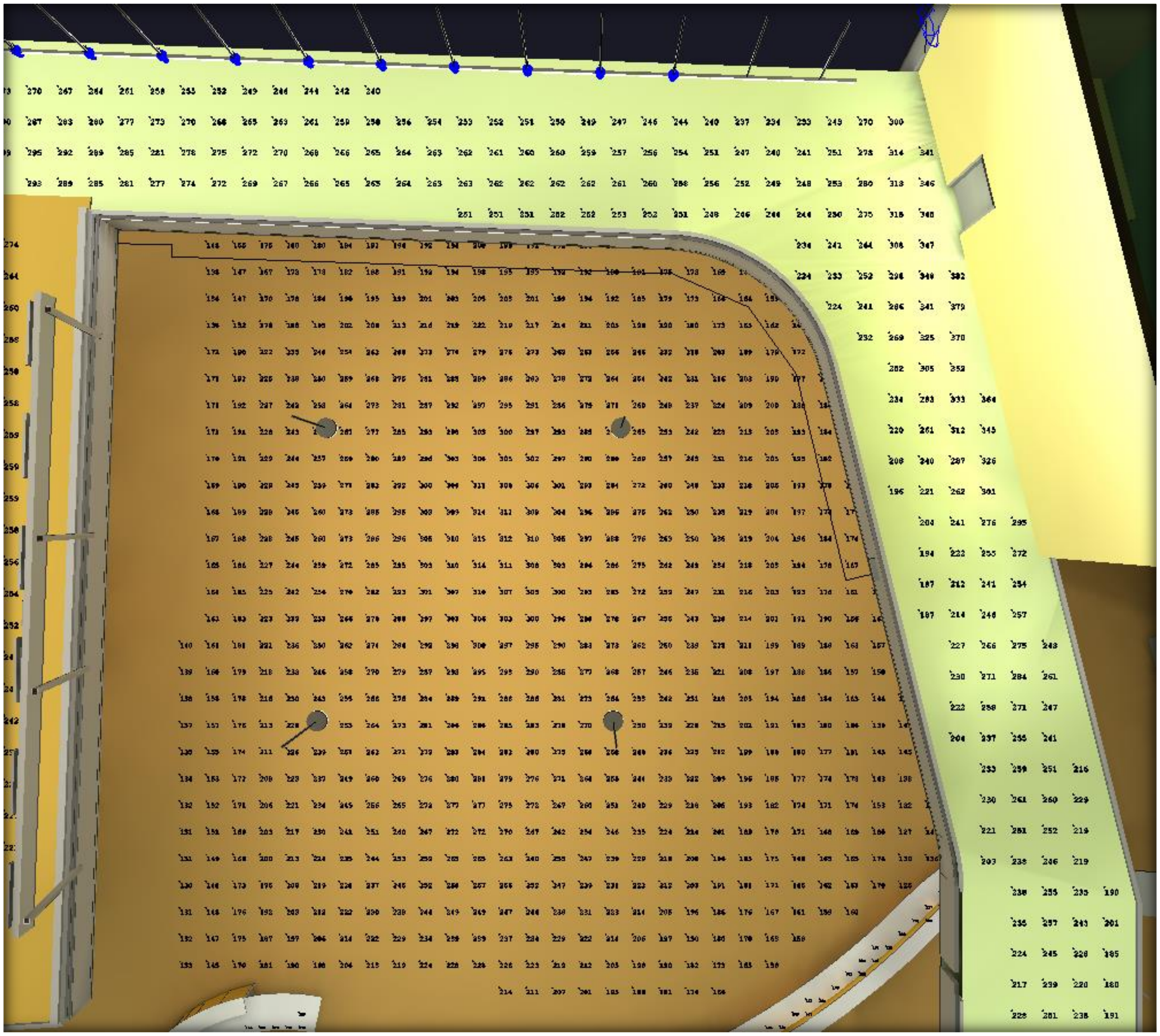




This calculation is for section 1 of the track. This is typical of multiple locations around the track where recessed LED continuous strips are used.



This calculation is for section 2 of the track. This section is unique since it is the only section fully enclosed by the track tube because it is suspended above the pool. This specific section of track has illuminance values that are too high (274 lux) since it is fully enclosed. Because of this, the control system will be commissioned to place a high end trim of 50% on these fixtures.



This calculation is for section 3 of the track (green athletic material). This section is unique because it is not enclose on any side, and is actually part of the weight lifting and cardio space. Direct indirect pendants suspended above the track can be seen near the top of this image. Also, the yellow painted wall on the right side of the image is lit using three wall washers, which reflect light down onto the track below. Finally, the bottom right section of the track shown is lit with tight beam downlights as mentioned in the rendering description above.

Entrance Lobby

High Priority Criteria

1. Concept

   While the concept should be felt throughout the design as a whole, this space should reflect the concept as much as possible, since this is the space that all occupants must pass through to get to the rest of the building. By encouraging motion, and utilizing a streamline modern lighting design, the feeling of life should inherently present itself here.

2. Focal points

   The main focus point of the entrance lobby is the control desk. The control desk should be a unique feature that grabs the attention of an occupant. It can also help guide the eye toward the southern wing.

3. Illuminance values as recommended by the IES.

Quantitative Design Criteria					
	E_h			E_v	
Space/Task	Average (lux)	Ave:min	CV	Average (lux)	LPD (W/SF)
Lobby Floor Night **E_h @ Floor;E_v @ 5'**	25	3:1	N/A	10	
Lobby Floor Day **E_h @ Floor;E_v @ 5'**	50	3:1	N/A	25	
Control Desk	150	2:1	N/A	50	.45
Casual Seating Area	20	2:1	N/A	7.5	
Vestibules Night: **Medium Activity Level** **E_h @ Floor;E_v @ 5'**	25	2:1	N/A	15	

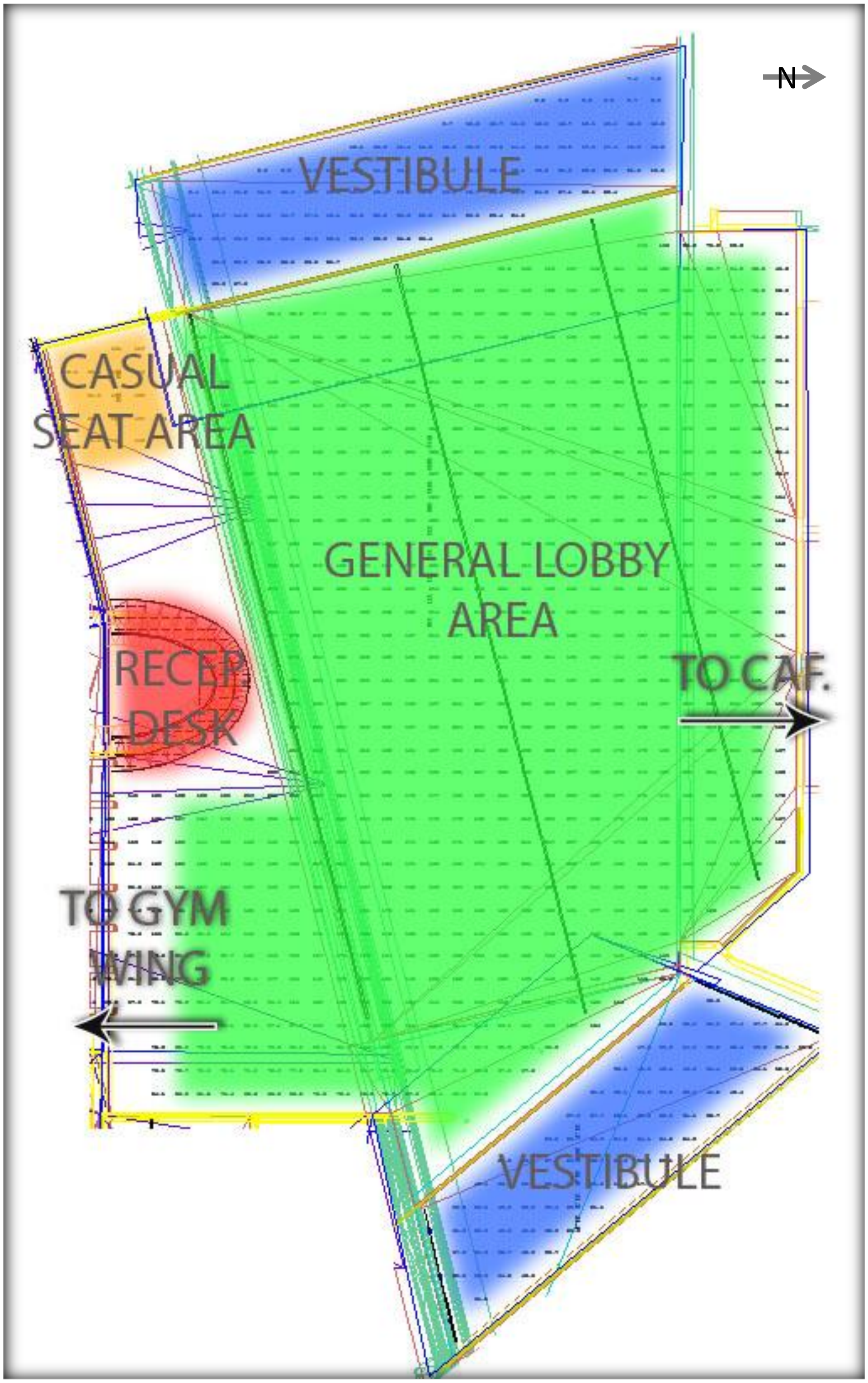
Lighting Plans can be found in Appendix B where the locations of each fixture type can be found.

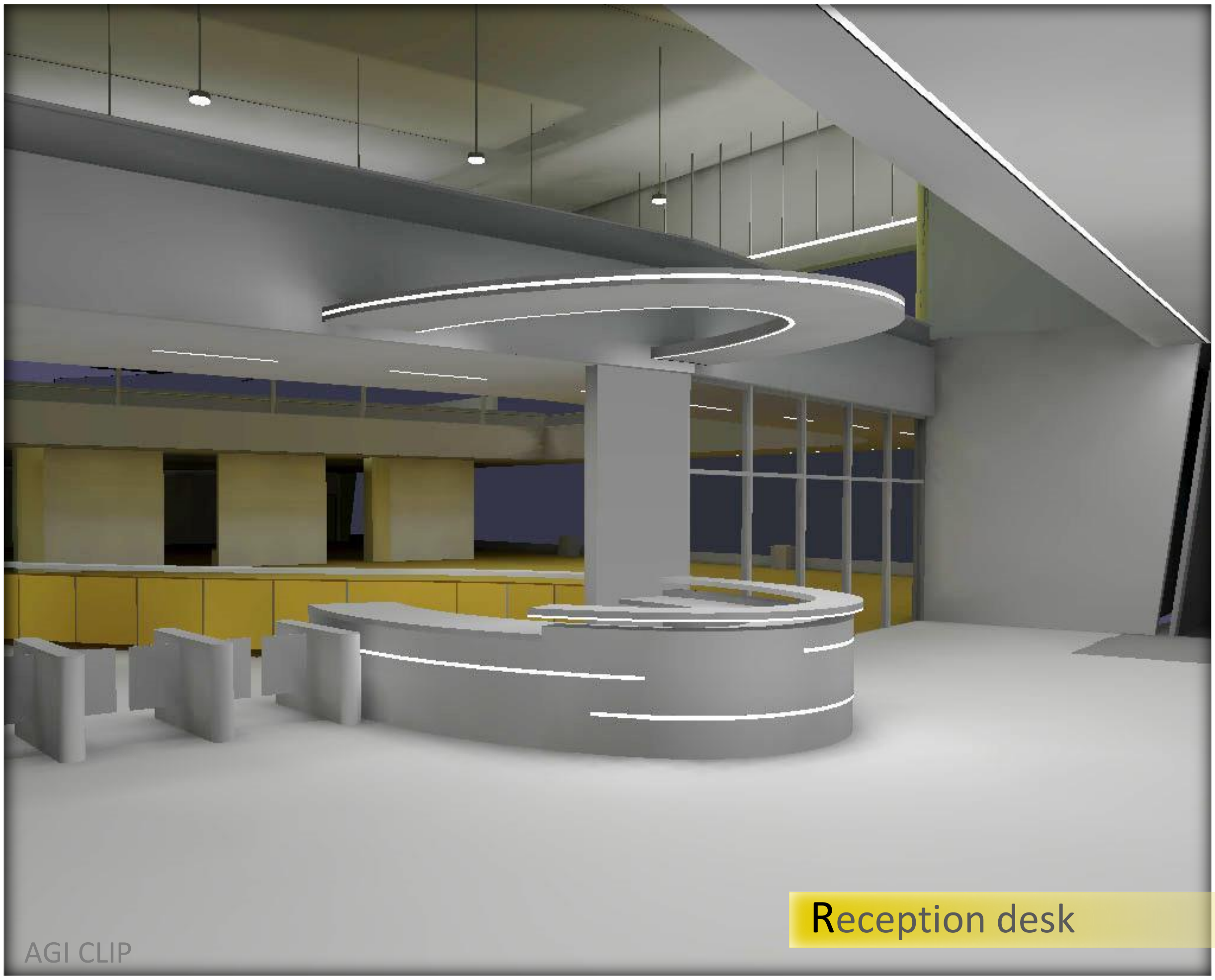
Reference Sheets:

L3 - Lighting Lobby

Lighting Solution

Please use the image below to orient yourself to the overall layout of the entrance lobby before proceeding.





Reception desk

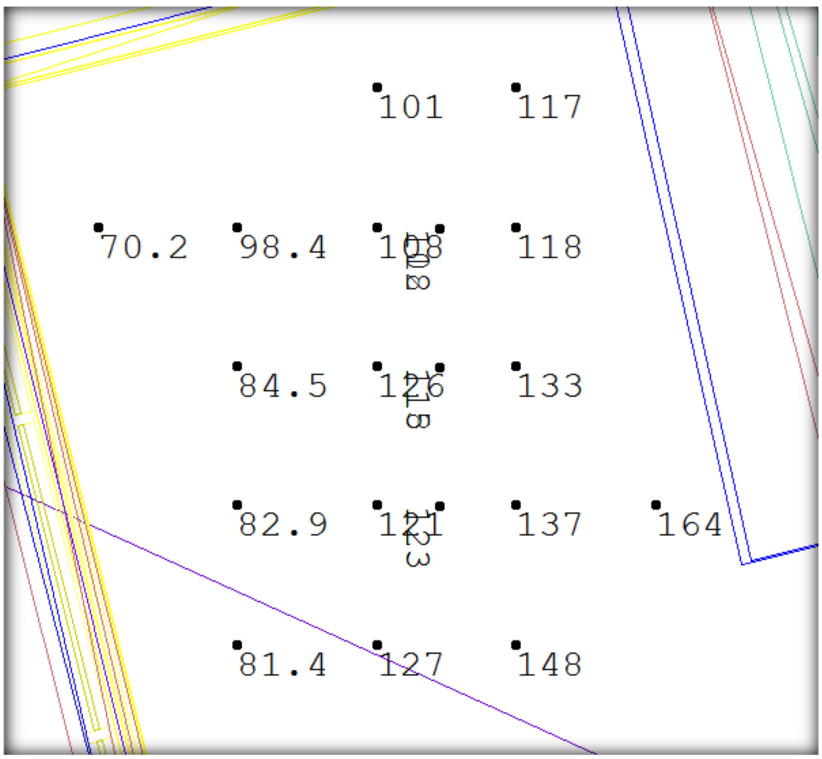
Vestibule Wall

The entrance lobby contains the main reception desk for the entire building. Since this is the main focal point of the space, is the brightest and most eye-catching element of the lobby. Most of the light illuminating the surface of the desk actually comes from the recessed LED general lighting strips in the main lobby area; especially the southernmost strip, which can be seen in the top right of the above image. The curved strip which is recessed into the underside of the drywall arch also provides task lighting to the desk. The curved strip which is recessed vertically into the outside of the same arch acts mainly as accent lighting, but also provides vertical illuminance to the surrounding areas. The recessed strips recessed vertically into the desk structure provide similar functions and help guide the eye into the main exercise area. For the vestibules, cove lighting along both side walls provide general illumination to the space, in addition to the spill light that passes through the lobby glass. This also helps support the concept since they are arranged in the direction of motion through the vestibule.

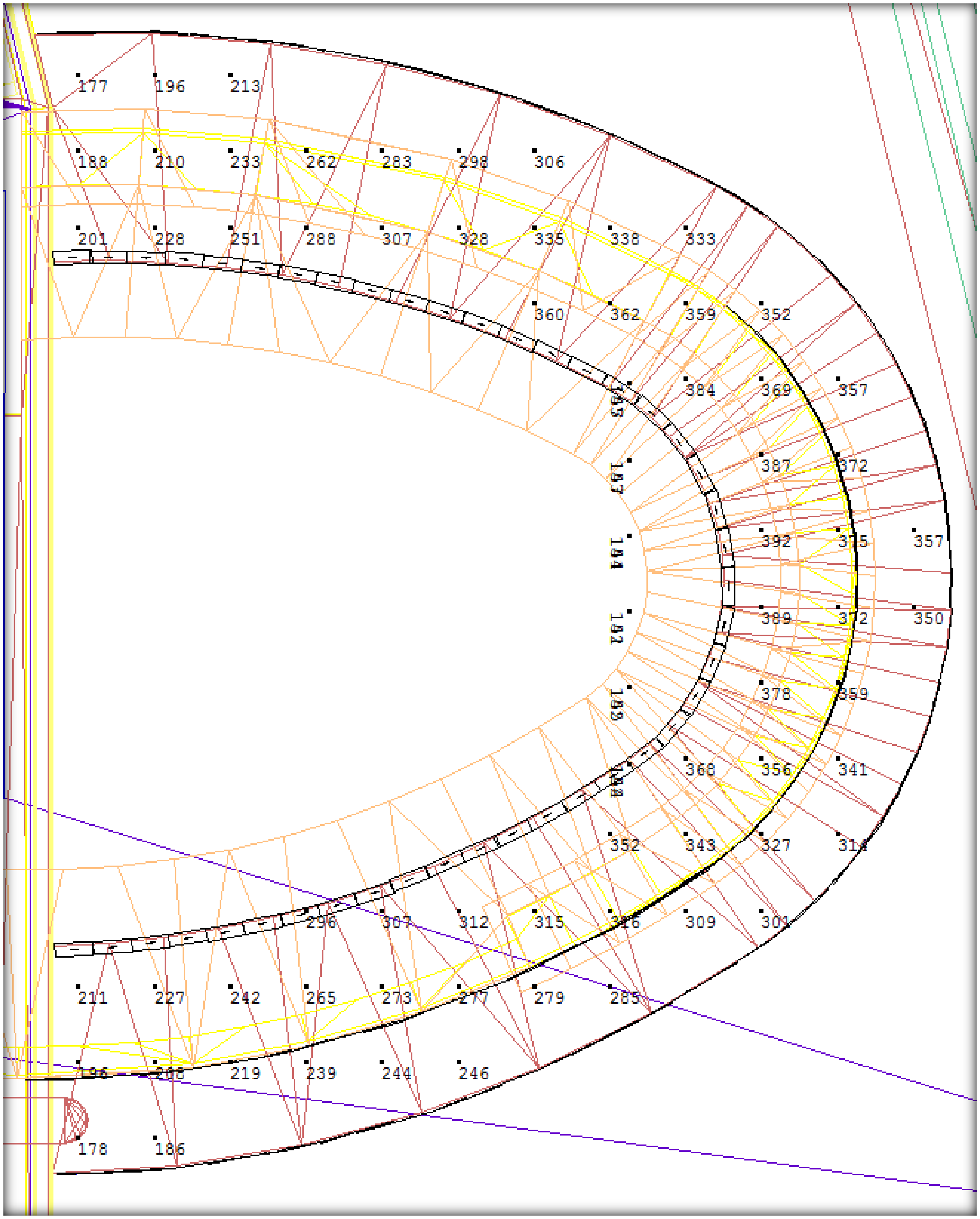
Continuous strips encourage motion from one side of the lobby to the other. This is important because this space will be used for passage from one side of campus to the other, not just as an entry point for the building. These LED strips provide general illumination to the space while keeping the total wattage low. This very uniform aesthetic draws the eye through the space as experienced in the above image. While we want occupants to pass through the space, we also want them to be drawn towards the reception desk, which is why the reception desk is brighter and is accented more. In order to compare the brightness of different elements in lobby, see the Pseudo Color Overlay below.

Quantitative Criteria and Calculations

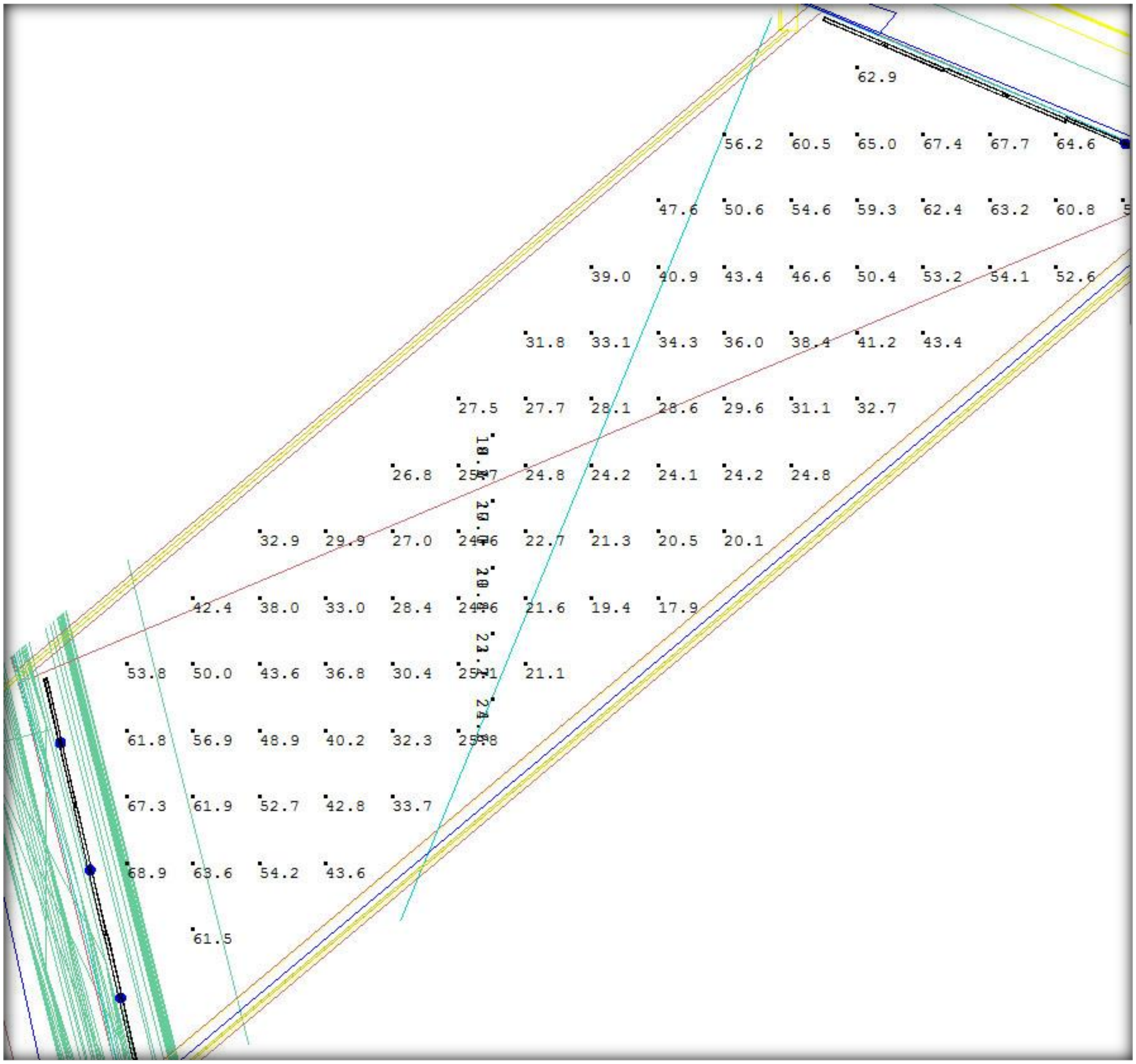
Quantitative Design Criteria					
	E_h			E_v	LPD (W/SF)
Space/Task	Average (lux)	Ave:min	CV	Average (lux)	
Lobby Floor **E_h @ Floor;E_v @ 5'**	160	3:1	N/A	118	
Control Desk	300	2:1	N/A	148	
Casual Seating Area	114	2:1	N/A	116	.9
Vestibules Night: **Medium Activity Level** **E_h @ Floor;E_v @ 5'**	41	2:1	N/A	21	



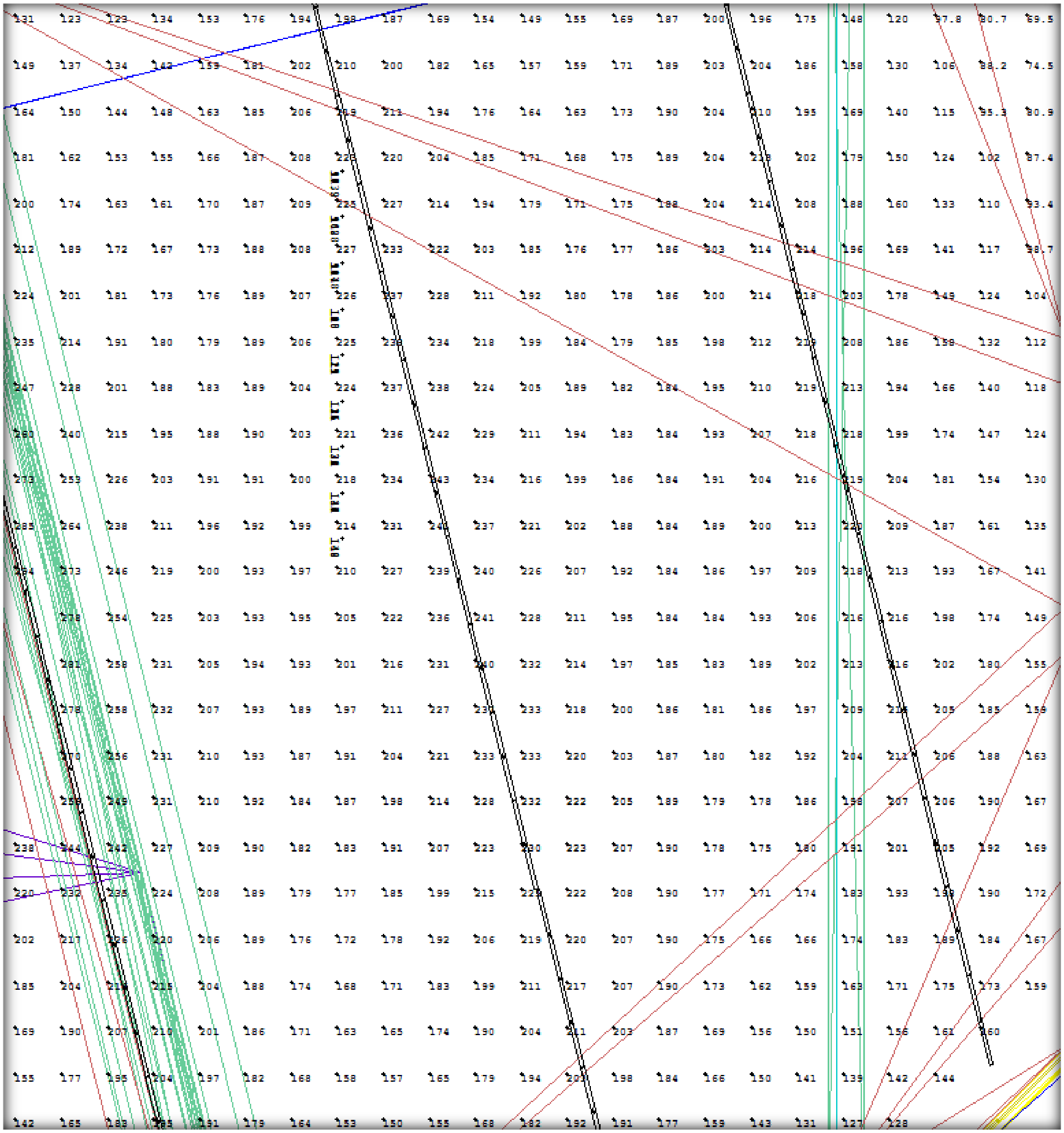
Illuminance values at the casual seating area.



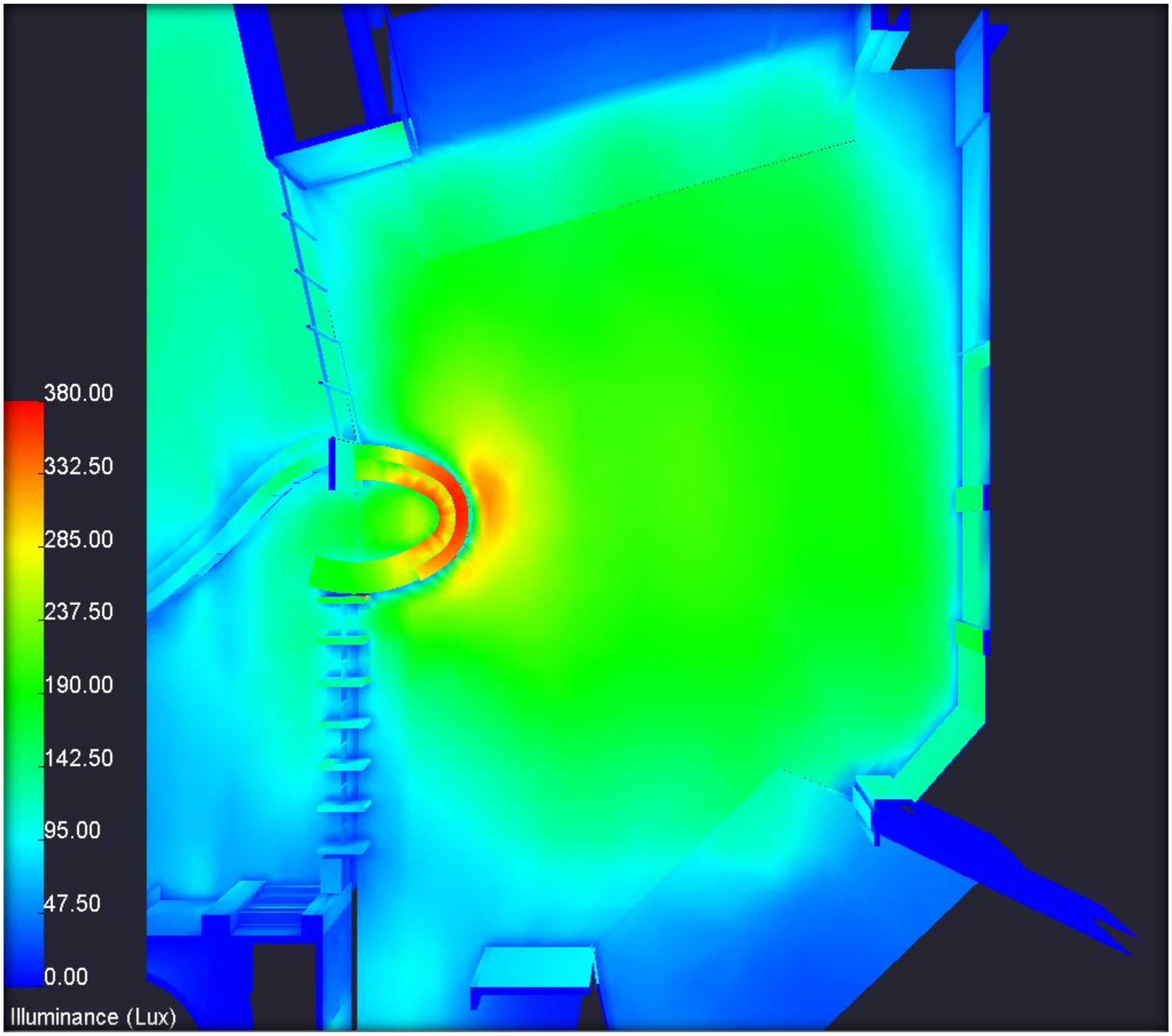
Reception Desk Illuminance values



Illuminance values typical of both vestibules.



Illuminance values across the main lobby floor.



Plan view in Pseudo Color overlay showing Illuminance values across the entire lobby. This image helps show that the desk is indeed the brightest and most important aspect of the space.

Exterior

High Priority Criteria

1. Psychology

   The most important aspect of the Northeast courtyard is how the students and faculty will be drawn to the space. The lighting should provide visual cues to help identify the pathways leading to the entrance, but not take away from the entrance itself, which will be glowing from inside.

2. Safety

   Lighting should provide students and faculty with safety as they pass through the courtyard.

3. Illuminance values as recommended by the IES.

Quantitative Design Criteria

	E_h			E_v	LPD (W/SF)
Space/Task	Average (lux)	Max:min	CV	Average (lux)	
Sidewalks	10	2:1	N/A	2	.1
Landscaping	N/A	N/A	N/A	N/A	0

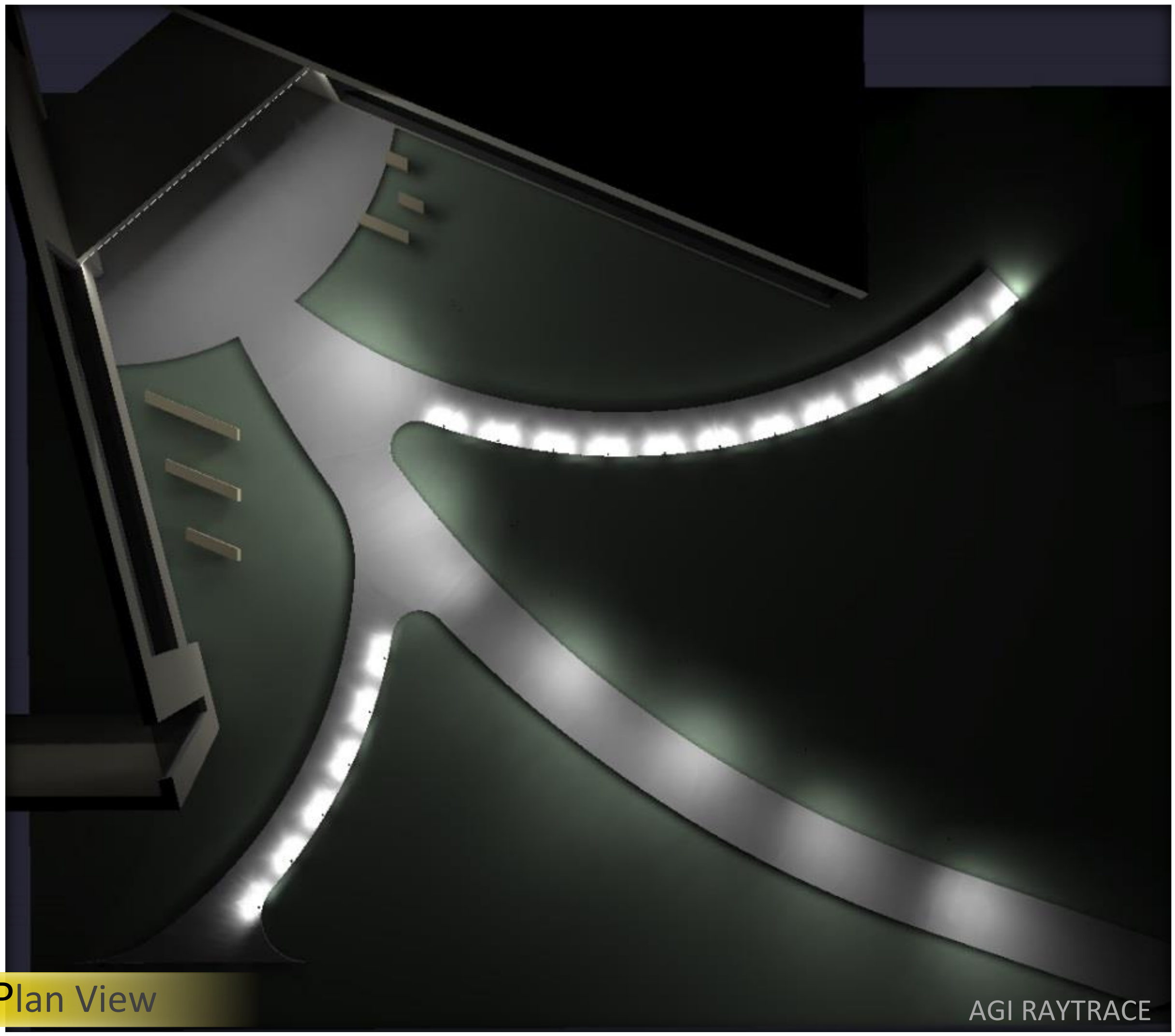
Lighting Plans can be found in Appendix B where the locations of each fixture type as well as daylight sensors can be found.

Reference Sheets:

L7 - Lighting Exterior

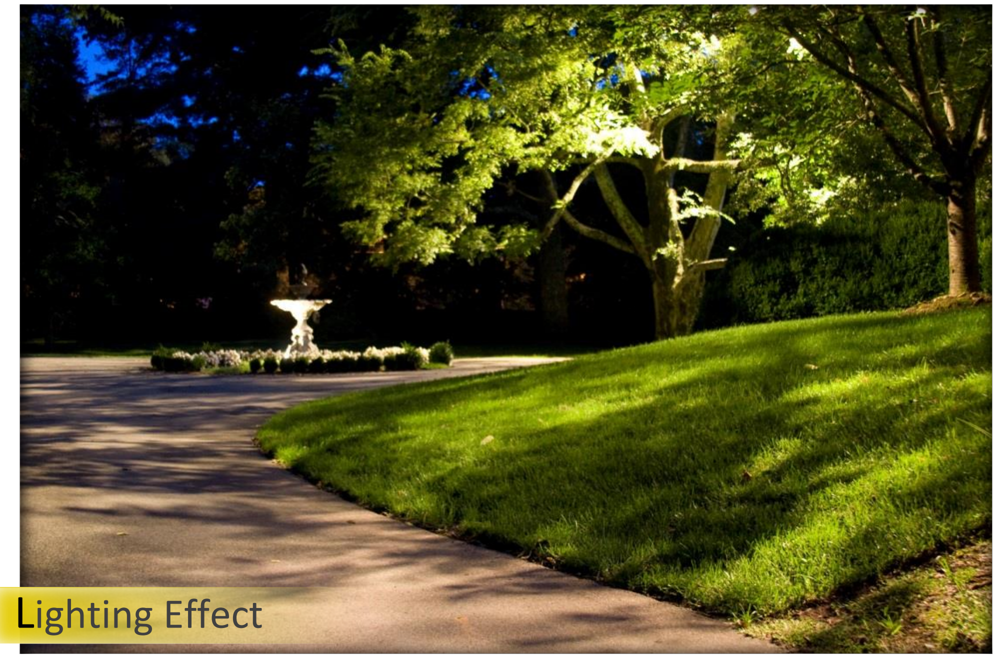
Lighting Solution

First, most of the façade bordering the courtyard is a curtain wall, so a moderate amount of light will be spilling out of the building to provide ambient lighting to the courtyard. This has not been displayed in renderings or accounted for in calculations since there will be times that the interior lighting will be off while the exterior is on.



Plan View

Bollards at ten foot spacing were used to light the two flanking pathways which converge into the central pathway. These 21 inch tall bollards provide adequate light levels while directing all light downward, reducing light pollution and glare. The central pathway is lit with Lumascape LED fixtures which use mini O-Clamps (image on the next page) to mount to tree branches along the path. The lighting plan shows where all trees are located in the exterior courtyard, and which trees these fixtures attach to. If placed where indicated, the fixtures can be aimed to create a relatively uniform – but interesting – pattern on the central walkway while providing adequate light.



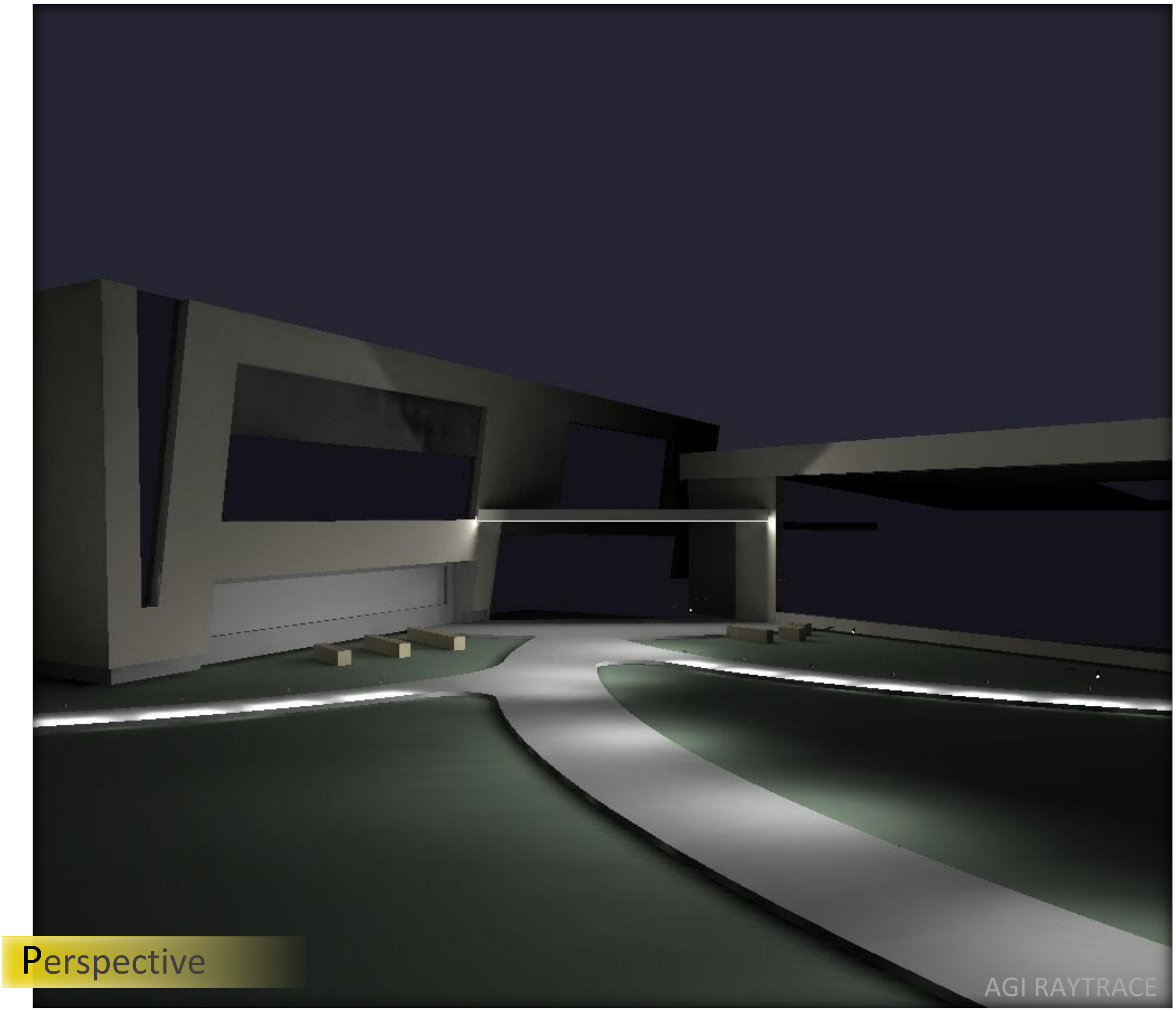
Lighting Effect

This is the type of effect that can be expected by attaching lighting to the tree branches. This creates a very unique and organic pattern on the pathway while avoiding uplighting in order to reduce light pollution. The only light will travel upward is what bounces off of the pathway. This is also important because it will reduce glare. There are several homes which have a view of the Student Life Center, so avoiding glare for these residences is a specific goal of the campus.

This pattern will create small dark spots on the pathway. This will result in a max/min ratio of greater than 2:1 for this space. Although this is outside of the recommendations by the IES, I believe it is acceptable in this scenario in order to achieve the effect seen above as well as some intentional visual patterns.

Mini-O-Clamp

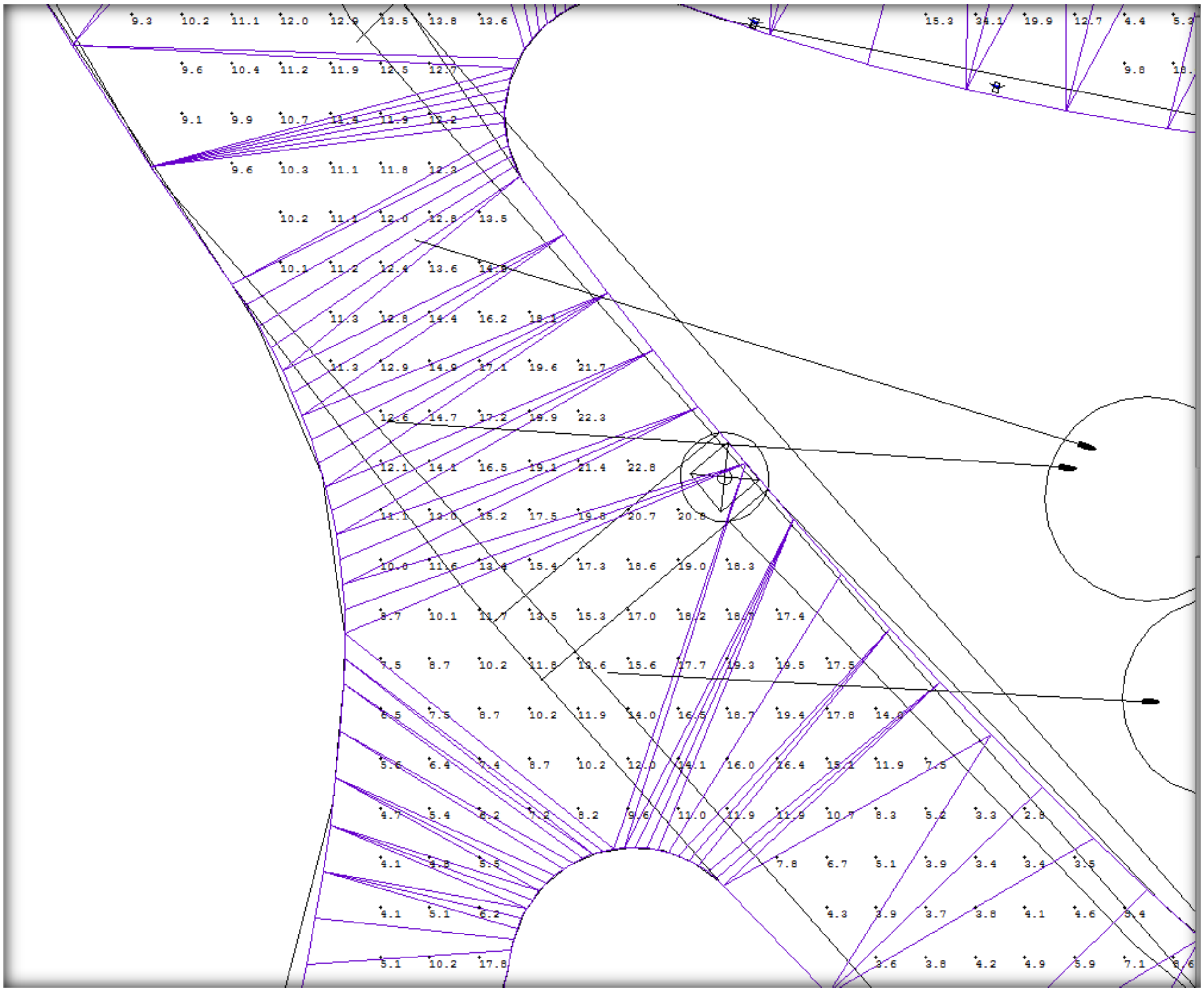
A small continuous LED strip attached to the underside of the entrance overhang provides interest and introduces this common theme that is seen throughout the rest of the interior lighting design. It provides a moderate amount of light onto the entrance patio, while adding a bit of visual flare.



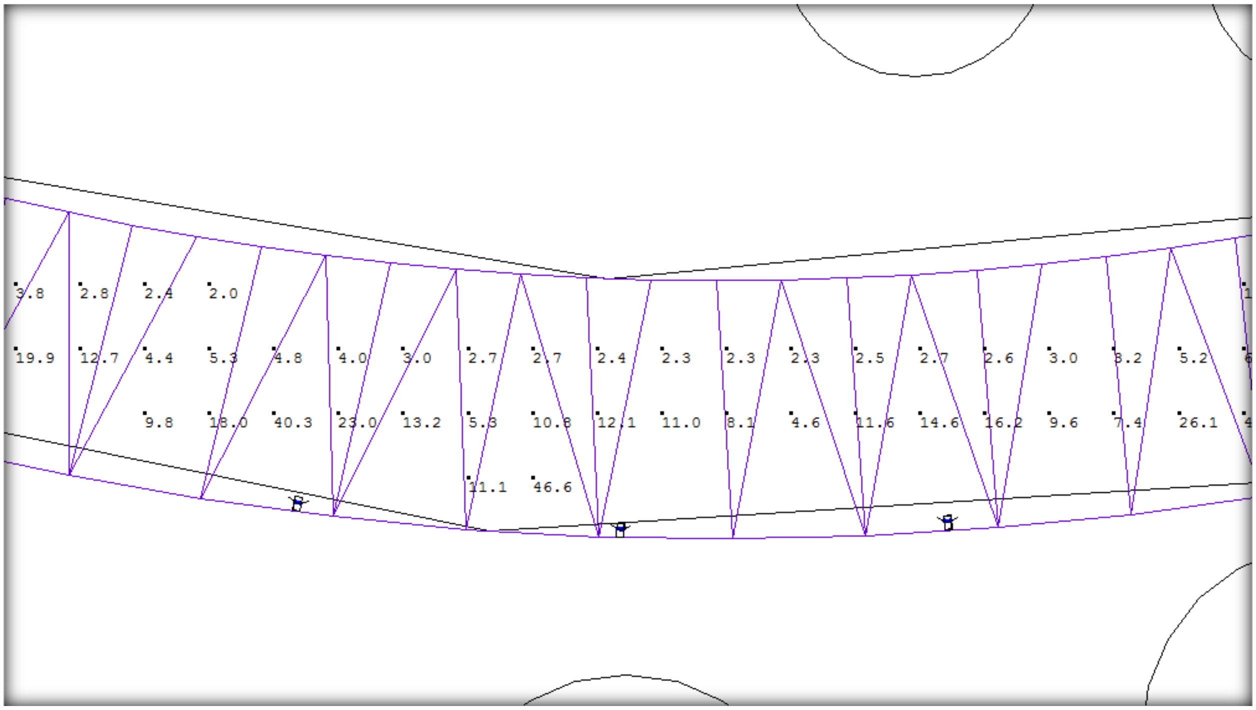
It may seem as though more lighting could have been applied to this space, but in order to achieve LEED requirements, no façade lighting or uplighting was used. Also, in order to conserve as much energy as possible, this scheme was kept very minimal: using only the strip, lighting effects, and landscaping to create an interesting space.

Quantitative Criteria and Calculations

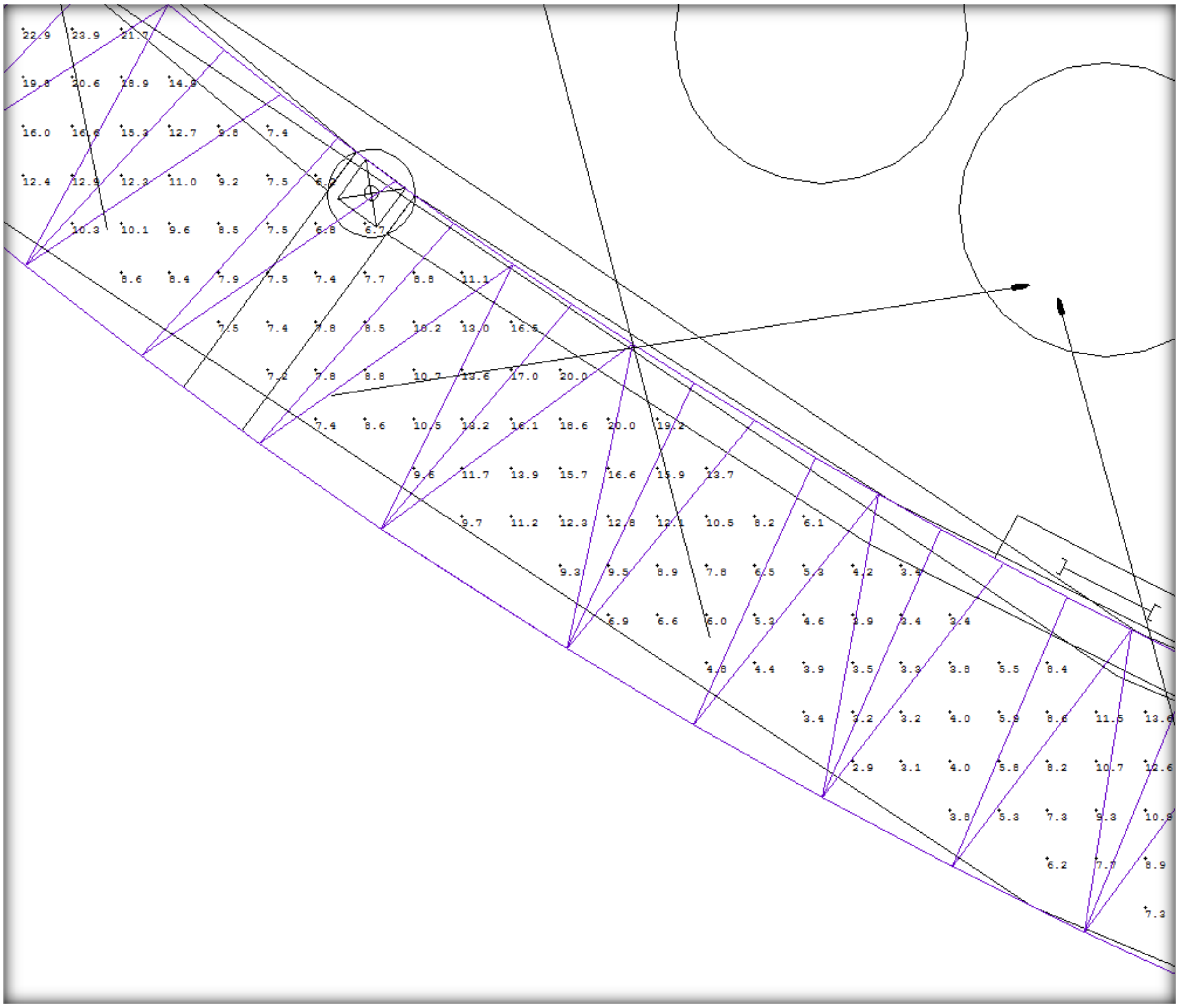
Quantitative Criteria : As Designed				
	E_h			E_v
Space/Task	Average (lux)	Max:min	CV	Average (lux)
Sidewalks	13.2	>2:1	N/A	2
Landscaping	N/A	N/A	N/A	N/A



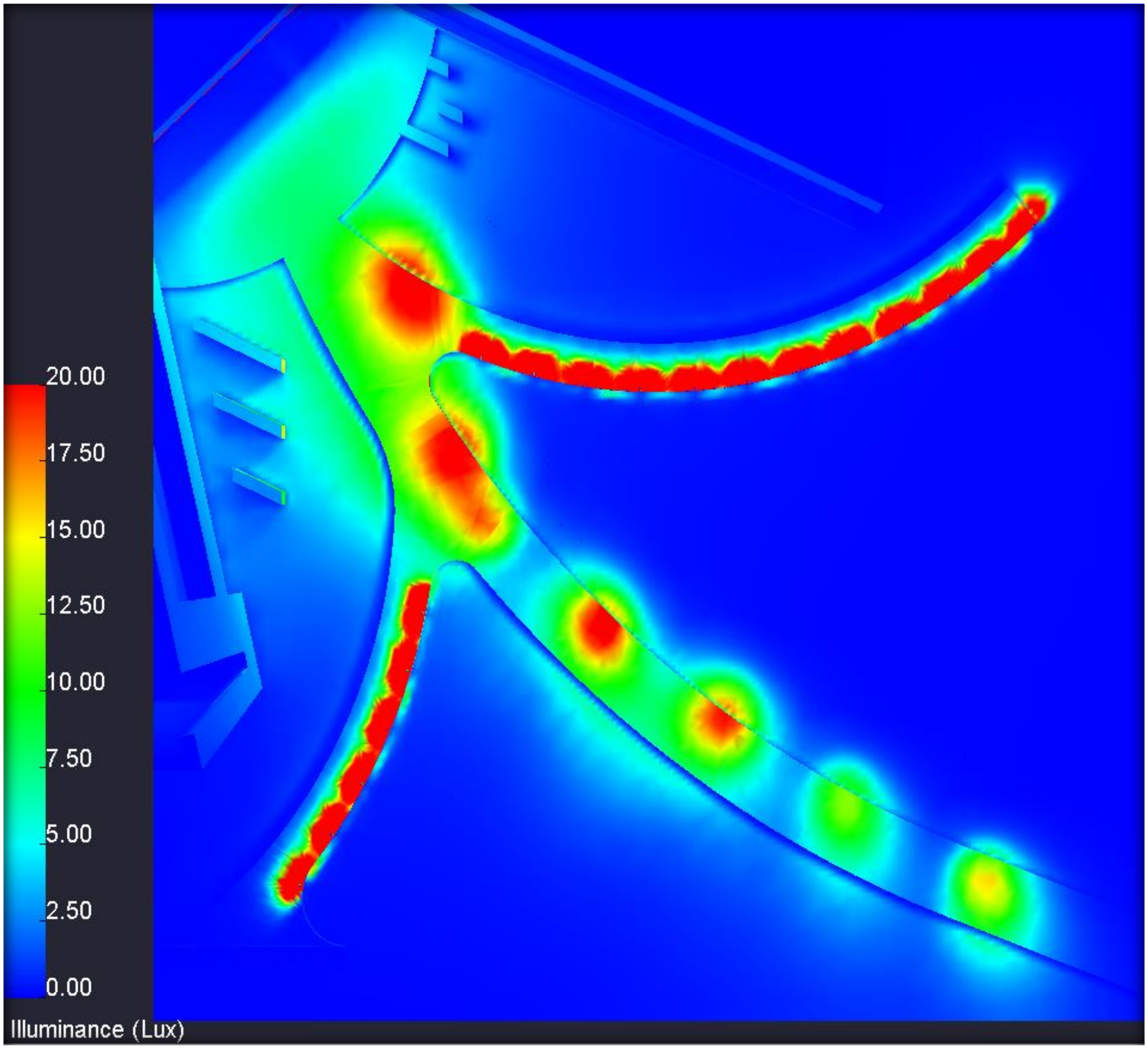
Illuminance values where the left flanking path converges into the middle pathway.



Typical distribution of bollard Illuminance values on the flanking pathways.



Typical distribution of illuminance values along the center pathway from tree mounted fixtures.



Plan view in Pseudo Color overlay showing Illuminance values across the entire area. As you can see, the lighting in general gets brighter as you move closer to the building. This helps draw people towards the building entrance.

Control System Narrative

The current control system for the SUNY Cortland Student Life Center uses Greenmax Relay cabinets which gathers and sends all data to and from fixtures, occupancy sensors, vacancy sensors, photosensors, control stations, wall switches, and even mechanical equipment. Thus, the overall control scheme for the building will remain the same. The existing equipment details and specific schemes can be found here.

The new control scheme though, will need to reflect lighting fixture changes. In addition, one system – the track pacing system – will need to be on an independent stand-alone system to ease software conflicts and user control.

Please refer to the Lighting Drawings to locate daylight sensors throughout the weight lifting/cardio space, and running track. The lobby will not utilize daylighting controls. On these drawings, notes identify which fixtures are controlled by which sensors, but here is a short list of new zones:

Weight Lifting/Cardio

1. C1 and D1 fixtures
2. B2 Fixtures
3. A6 Fixtures as noted

Running Track

1. Fixture B1 (West side, above weight lifting space)
2. Fixture A7 & A8 (West side)
3. Fixture A8, A10, B1 (South side)
4. B3 Fixtures (East side)
5. Fixture A1 & A7 (East side)

The building will close between 12:00AM and 5:00AM. A time clock setting should be set to shut off the lighting throughout the building between 12:30AM and 4:30AM. This will allow employees to enter and exit safely since they will likely be leaving after hours and returning early. Manual override switches will be available at control desks for employees to turn lighting on if necessary for early arrival, late nights, or cleaning.

For a description of the track pacing control system, please refer to the running track section where the system is already described here.

Finally, fixtures A8 (2) and A10, located in the track tube that suspends over the swimming pool will be commissioned with a 50% high end trim. The facilities personnel at the SUNY Cortland campus, according to the project team, are more than capable of increasing this trim later in the building's life if desired.

Lighting Power Densities (by space & by building)

Project: SUNY Cortland SLC

Date: 1/20/2014
Revised: 4/4/2014

Space	Design Wattage	SF or LF	LPD by Code	Watts Allowed	Design LPD
Lobby	2,435.7	5,469	0.90	4922.1	0.45
Gym	12,301.0	16,856	0.92	15507.52	0.73
Track	9,847.0	13,132	0.82	10768.24	0.75
Exterior Sidewalks	567.0	5,437	0.80	4349.6	0.10
Exterior Landscaping	0.0	17,070	0.05	853.5	0
Totals	25150.7	57,964.00	0.63	36,400.96	0.43
				% BETTER/WORSE THAN CODE*	30.91%

LEED Qualifications

There are three sets of requirements that could be achieved in LEED for this proposal.

- SS Credit 8: Light Pollution Reduction
- EA Credit 1: Optimize Energy Performance
- IEQ Credit 6.1: Controllability of systems — Lighting

Total points expected to through this design: 11

Break Down by Section:

SS Credit 8: Light Pollution Reduction ✓

Requirements:

Design exterior lighting so that all site and building mounted luminaires produce a maximum initial illuminance value no greater than 0.20 horizontal and vertical footcandles at the site boundary and no greater than 0.01 horizontal footcandles 15 feet beyond the site. Document that no more than 5% of the total initial designed fixture lumens are emitted at an angle of 90 degrees or higher from nadir (straight down).

Were they met?

This building was zoned LZ2 for the purposes of this design:
LZ2 – Low (primarily residential zones, neighborhood business districts, light industrial areas with limited nighttime use and residential mixed-use areas)

The site boundary is technically the edge of the SUNY Cortland campus, so site boundary conditions were certainly met. Also, no more than 5% of initial designed fixture lumens were emitted at an angle of 90 degrees or higher from nadir.

EA Credit 1: Optimize Energy Performance ✓

Requirements:

EA Credit 1: Optimize Energy Performance

1–19 Points

Intent

To achieve increasing levels of energy performance beyond the prerequisite standard to reduce environmental and economic impacts associated with excessive energy use.

Requirements

Select 1 of the 3 compliance path options described below. Project teams documenting achievement using any of the 3 options are assumed to be in compliance with EA Prerequisite 2: Minimum Energy Performance.

OPTION 1. Whole Building Energy Simulation (1–19 points)

Demonstrate a percentage improvement in the proposed building performance rating compared with the baseline building performance rating. Calculate the baseline building performance according to Appendix G of ANSI/ASHRAE/IESNA Standard 90.1-2007 (with errata but without addenda[1]) using a computer simulation model for the whole building project. The minimum energy cost savings percentage for each point threshold is as follows:

New Buildings	Existing Building Renovations	Points
12%	8%	1
14%	10%	2
16%	12%	3
18%	14%	4
20%	16%	5
22%	18%	6
24%	20%	7
26%	22%	8
28%	24%	9
30%	26%	10
32%	28%	11
34%	30%	12
36%	32%	13
38%	34%	14
40%	36%	15
42%	38%	16
44%	40%	17
46%	42%	18
48%	44%	19

Were they met?

If a similar approach used for the lighting design of these four spaces was used for remainder of the building, lighting would achieve 10 of the energy performance points based on the lighting power densities calculated above.

IEQ Credit 6.1 Controllability of systems — Lighting ×

Requirements:

Provide individual lighting controls for 90% or more of the building occupants to enable adjustments to suit individual task needs and preferences.

Provide lighting system controls for all shared multi-occupant spaces to enable adjustments that meet group needs and preferences.

Were they met?

The majority of the spaces designed for this proposal are very public spaces. Though, most of these spaces will be preprogrammed to operate without user interruption unless absolutely necessary, so this will not meet the requirement. While the track does house a very user involved system, the other spaces do not.

Light Loss Factors

Only two sources were used for this project, LED and Metal Halide. All products specified except one included drivers in their report; therefore no additional Light Loss Factors (LLF's) had to be added to account for new drivers. The only product that did not was an LED accent strip. This strip had such a minimal output that applying LLF's would be negligible in its effect on the space.

LLD = Lamp Lumen Depreciation
LDD = Lamp Dirt Depreciation
BF = Ballast Factor

Light Loss Factors			
Source	**LLD**	**LDD**	**BF**
LED	0.8	0.9	Drivers included
Metal Halide	0.7	0.9	1
LED Accent Strip	Not used: strip is low output - LLFs negligible and output is negligible to space		

Section D

Electrical Depth

Introduction

The Electrical Depth consists of three parts:

1. Recircuiting of panel boards to address changes in the lighting design as explained in the Lighting Depth.
2. Short Circuit Analysis
3. Spin Room Schematic

1. Recircuiting of Panelboards

Overall, the total lighting load for the areas that were redesigned was only slightly less than the original design. In order to simplify the circuitry, one or two circuits were added to the Panelboards, and the names of some circuits were renamed from their previous identification. Also, some circuits were eliminated in the process. Emergency lighting circuitry was redone and the new loads were calculated as can be seen in the panelboards below. The following Panelboards had changes made to them:

1. HV-1-1
2. HV-1-2
3. HV-1-3
4. HV-2-1
5. HV-2-2
6. LV-1-2
7. EM-1-2
8. EM-1-3
9. EM-2-1

The following images, up until part 2, are the new panelboards. Altered circuits are highlighted and the new loads are placed into their proper column.

BRANCH CIRCUIT PANELBOARD SCHEDULE

PNL: HV-1-1	MOUNTING:	SURFACE	X	MAIN LUGS ONLY	x	MAIN BREAKER:	125A
480Y/277, 3 PHASE, 4 WIRE		FLUSH		SHUNT TRIP MAIN		Main Lugs Only: A	
14 ,000MIN A.I.C. SYM		IN MCC		FEED THRU LUG		GROUND BUS:	X
NEUTRAL: 100%				NUMBER OF POLES:	42	ISOLATED GROUND BUS:	

CKT No.	LOAD	TRIP (AMP)	KVA / PHASE A	KVA / PHASE B	KVA / PHASE C	KVA / PHASE A	KVA / PHASE B	KVA / PHASE C	TRIP (AMP)	LOAD	CKT No.
1	RESTROOM/CLASSROOM	20	2.95			2.41			20	MER ROOM	2
3	STORAGE/LOBBY/CORR.	20		2.50			3.56		20	EQMPT. STORAGE	4
5	CIRCUIT/FREE WEIGHTS	20			3.96			1.91	20	GOLF SIM./CORRIDOR	6
7	45 KVA TRANSFORMER	70	15.00			.57			20	GYMNASIUM	8
9				15.00			0.00		20	SITE LIGHTING	10
11		3			15.00			1.30	20	SITE LIGHTING	12
13	SITE LIGHTING	20	1.07			1.04			20	SITE LIGHTING	14
15	SITE LIGHTING	20		1.22					20	LIGTHING (SPINNING RM)	16
17	SITE LIGHTING	20			1.15				20	SPARE	18
19	SPARE	20							20	SPARE	20
21	SPARE	20							20	SPARE	22
23	SPARE	20							20	SPARE	24

BRANCH CIRCUIT PANELBOARD SCHEDULE

PNL: HV-1-2	MOUNTING:	SURFACE	X	MAIN LUGS ONLY	x	MAIN BREAKER:	100A
480Y/277, 3 PHASE, 4 WIRE		FLUSH		SHUNT TRIP MAIN		Main Lugs Only: A	
14 ,000MIN A.I.C. SYM		IN MCC		FEED THRU LUG		GROUND BUS:	X
NEUTRAL: 100%				NUMBER OF POLES:	18	ISOLATED GROUND BUS:	

CKT No.	LOAD	TRIP (AMP)	KVA / PHASE A	KVA / PHASE B	KVA / PHASE C	KVA / PHASE A	KVA / PHASE B	KVA / PHASE C	TRIP (AMP)	LOAD	CKT No.
1	CORRIDOR/POOL AREA	20	1.91			3.56			20	SHOWERS/FAM. CHG.	2
3	MECHANICAL ROOM	20		1.01			1.68		20	BOULDERING/NATATORIUM LTG	4
5	LOCKERS	20			3.23			1.29	20	CONCOURSE	6
7	45 KVA TRANSFORMER	70	15.00						20		8
9				15.00					20		10
11		3			15.00				20		12
13		20							20		14
15		20							20		16
17		20							20		18

BRANCH CIRCUIT PANELBOARD SCHEDULE

PNL: HV-1-3	MOUNTING:	SURFACE	X	MAIN LUGS ONLY	x	MAIN BREAKER:	75A
480Y/277, 3 PHASE, 4 WIRE		FLUSH		SHUNT TRIP MAIN		Main Lugs Only: A	
14 ,000MIN A.I.C. SYM		IN MCC		FEED THRU LUG		GROUND BUS:	X
NEUTRAL: 100%				NUMBER OF POLES:	18	ISOLATED GROUND BUS:	

CKT No.	LOAD	TRIP (AMP)	KVA / PHASE A	B	C	KVA / PHASE A	B	C	TRIP (AMP)	LOAD	CKT No.
1	LOBBY LTG.	20	2.00			1.79			20	LOCKERS / IT / BATH.	2
3	SEATING AREA	20		1.56			1.84		20	CLASS./OFFICES/SERV.	4
5	SEATING AREA	20			2.94			1.30	20	STORAGE/REPAIRS/BIKE	6
7	30 KVA TRANSFORMER	50	10.00			0.50			20	EXTERIOR LTG (10 FK-6A)	8
9				10.00					20		10
11		3			10.00				20		12
13	LOBBY LTG.	20	.49						20		14
15		20							20		16
17		20							20		18

BRANCH CIRCUIT PANELBOARD SCHEDULE

PNL: HV-2-1	MOUNTING:	SURFACE	X	MAIN LUGS ONLY	x	MAIN BREAKER:	
480Y/277, 3 PHASE, 4 WIRE		FLUSH		SHUNT TRIP MAIN		Main Lugs Only: 200 A	
14 ,000MIN A.I.C. SYM		IN MCC		FEED THRU LUG		GROUND BUS:	X
NEUTRAL: 100%				NUMBER OF POLES:	30	ISOLATED GROUND BUS:	

CKT No.	LOAD	TRIP (AMP)	KVA / PHASE A	B	C	KVA / PHASE A	B	C	TRIP (AMP)	LOAD	CKT No.
1	MIND/BODY, CARDIO EXP.	20	3.20			3.20			20	OFFICES	2
3	MER/MAC ROOMS	20		2.52			1.48		20	ELEVATED TRACK LTG	4
5	CONCOURSE/RESTROOM	20			3.50			4.21	20	CARDIO	6
7	SPARE	20				4.15			20	CARDIO	8
9	CARDIO	20		4.33			1.51		20	TRACK LTG	10
11	CARDIO	20			3.06			2.88	20	GYMNASIUM	12
13	45 KVA TRANSFORMER	70	15.00			2.88			20	GYMNASIUM	14
15				15.00			3.11		20	GYMNASIUM	16
17		3			15.00			2.39	20	MAC	18
19	GYMNASIUM	20	3.11			2.39			20	MAC	20
21	GYMNASIUM	20		3.11			0.10		20	MIND BODY	22
23	GYMNASIUM	20			2.88			1.23	20	MIND BOBY	24
25	SPARE	20				1.96			20	TRACK LTG	26
27	SPARE	20							20	SPARE	28
29	SPARE	20							20	SPARE	30

BRANCH CIRCUIT PANELBOARD SCHEDULE

PNL: HV-2-2	MOUNTING:	SURFACE	X	MAIN LUGS ONLY	x	MAIN BREAKER: 150A
480Y/277, 3 PHASE, 4 WIRE		FLUSH		SHUNT TRIP MAIN		Main Lugs Only: 200 A
14 ,000MIN A.I.C. SYM		IN MCC		FEED THRU LUG		GROUND BUS: X
NEUTRAL: 100%				NUMBER OF POLES:	24	ISOLATED GROUND BUS:

CKT No.	LOAD	TRIP (AMP)	KVA / PHASE A	KVA / PHASE B	KVA / PHASE C		KVA / PHASE A	KVA / PHASE B	KVA / PHASE C	TRIP (AMP)	LOAD	CKT No.
1	FREE WT/CARDIO LTG	20	1.63				1.66			20	FREE WT/CARDIO LTG	2
3	FREE WT/CARDIO LTG	20		1.63				2.11		20	ELEVATED TRACK LTG	4
5	ELEVATED TRACK LTG	20			2.50				2.42	20	FREE WT/CARDIO LTG	6
7	COMBATIVES	20	2.93				2.59			20	GAME ROOM	8
9	GROUP EXERCISE	20		2.99				2.69		20	GAME ROOM	10
11	CLAMP FIXTURES	20			1.25					20	SPARE	12
13	MAC RMS.	20	0.40				15.00			70		14
15		20						15.00			45 KVA TRANSFORMER	16
17		20							15.00	3		18
19		20								20		20
21		20								20		22
23		20								20		24

BRANCH CIRCUIT PANELBOARD SCHEDULE

PNL: LV-1-2 SECT 2	MOUNTING:	SURFACE	X	MAIN LUGS ONLY	x	MAIN BREAKER: 100A
208Y/120, 3 PHASE, 4 WIRE		FLUSH		SHUNT TRIP MAIN		Main Lugs Only: A
10 ,000MIN A.I.C. SYM		IN MCC		FEED THRU LUG		GROUND BUS: X
NEUTRAL: 100%				NUMBER OF POLES:	24	ISOLATED GROUND BUS:

CKT No.	LOAD	TRIP (AMP)	KVA / PHASE A	KVA / PHASE B	KVA / PHASE C		KVA / PHASE A	KVA / PHASE B	KVA / PHASE C	TRIP (AMP)	LOAD	CKT No.
25	CONV. RECEPT.	20	1.26				1.44			20	conv recept	26
27	AV RECEPT.	20		1.00				0.36		20	conv recept	28
29	AV RECEPT.	20			1.00				1.50	20	SIGNAGE	30
31	CONV. RECEPT.	20	0.72				1.50			20	SIGNAGE	32
33	TV RECEPT.	20		1.20				0.80		20	TV RECEPT.	34
35	RECEPT.	20			1.08				1.08	20	RECEPT.	36
37	QUAD RECEPT. (2)	20	1.20				1.44			20	RECEPT.	38
39	ahu ltg	20		1.00				1.20		20	QUAD RECEPT. (2)	40
41	EF-1-3	20			0.67				1.40	20	CUH-1-5	42
43	CUH-1-18	20	1.40				1.40			20	CUH-1-6	44
45	CUH-1-19	20		1.40				1.40		20	CUH-1-7	46
47		20								20	SPARE	48

BRANCH CIRCUIT PANELBOARD SCHEDULE

PNL: HV-EM-1-2	MOUNTING: SURFACE	X	MAIN LUGS ONLY	x	MAIN BREAKER:
480Y/277, 3 PHASE, 4 WIRE	FLUSH		SHUNT TRIP MAIN		Main Lugs Only: 200 A
14 ,000MIN A.I.C. SYM	IN MCC		FEED THRU LUG		GROUND BUS: X
NEUTRAL: 100%			NUMBER OF POLES:	12	ISOLATED GROUND BUS:

CKT No.	LOAD	TRIP (AMP)	KVA / PHASE A	B	C			KVA / PHASE A	B	C	TRIP (AMP)	LOAD	CKT No.
1	LOCKERROOM LTG	20	2.26					0.45			20	EXT.LTG	2
3	STAIR 5	20		0.45							20		4
5	CIRCUIT FREE WEIGHTS	20			0.90						20		6
7	15 KVA TRANSFORMER	30	5.00								20		8
9				5.00							20		10
11		3			5.00						20		12

BRANCH CIRCUIT PANELBOARD SCHEDULE

PNL: HV-EM-1-3	MOUNTING: SURFACE	X	MAIN LUGS ONLY	x	MAIN BREAKER:
480Y/277, 3 PHASE, 4 WIRE	FLUSH		SHUNT TRIP MAIN		Main Lugs Only: A
14 ,000MIN A.I.C. SYM	IN MCC		FEED THRU LUG		GROUND BUS: X
NEUTRAL: 100%			NUMBER OF POLES:	18	ISOLATED GROUND BUS:

CKT No.	LOAD	TRIP (AMP)	KVA / PHASE A	B	C			KVA / PHASE A	B	C	TRIP (AMP)	LOAD	CKT No.
1	LOBBY	20	.53					0.45			20	EXT. LTG	2
3	SERV/TOILETS/SEATING	20		2.00					0.87		20	STAIR 8, MECH. RM	4
5	LIGHTING	20			2.02					2.10	20		6
7	15KVA TRANSFORMER	30	5.00					2.10				KX-R-4	8
9				5.00					2.10		20		10
11		3			5.00						20	SPARE	12
13		20	3.75								20	SPARE	14
15	KX-R-1,-3, -5			3.75							20	SPARE	16
17		3			3.75						20	SPARE	18

BRANCH CIRCUIT PANELBOARD SCHEDULE														
PNL: HV-EM-2-1		MOUNTING:		SURFACE		X		MAIN LUGS ONLY			X	MAIN BREAKER:		
480Y/277, 3 PHASE, 4 WIRE				FLUSH				SHUNT TRIP MAIN				Main Lugs Only: A		
14	,000MIN A.I.C. SYM			IN MCC				FEED THRU LUG				GROUND BUS:		X
NEUTRAL: 100%								NUMBER OF POLES:			12	ISOLATED GROUND BUS:		
CKT	LOAD	TRIP	KVA / PHASE					KVA / PHASE			TRIP	LOAD	CKT	
No.		(AMP)	A	B	C			A	B	C	(AMP)		No.	
1	GYMNASIUM EM LTG.	20	2.78					3.22			20	RESTROOMS, STAIRS, CA	2	
3	EMERGENCY LTG (A SECT	20		2.44					0.30		20	EXITS	4	
5	TRACK, MER, OFFICE & CO	20			2.58					3.30	20	STAIR Z	6	
7	9 KVA TRANSFORMER	20	3.00					1.48			20	LTG-CARDIO/GAME RM	8	
9				3.00					.293		20	LIGHTING- TRACK	10	
11		3			3.00					1.30	20	LTG-FREE WT/CARDIO	12	
13	SPARE	20									20	SPARE	14	
15	SPACE											SPACE	16	
17	SPACE											SPACE	18	

2. Short Circuit Analysis

Short Circuit Analysis

Leg 1: Transformer into Switchboard

$I_{F.L.A} = \frac{1,500*1,000}{480*1.732} = 1804A$

$Multiplier = \frac{100}{3.5} = 28.571$

$I_{S.C.} = 1804 * 28.571 = 51540A$

$f = \frac{1.732*10*51540}{134200*6*480} = .0023$

$M = \frac{1}{1+.0023} = .9977$

$I_{S.C.symRMS} = 51540 * .9977 = 51,421A$

Leg 2: Switchboard to Kitchen Transformer

$f = \frac{1.732*370*51421}{15082*6*480} = .758$

$M = \frac{1}{1+.758} = .569$

$I_{S.C.symRMS} = 51421 * .569 = 29,239A$

Leg 3: Kitchen Transformer to Kitchen Dist. Panel

$f = \frac{1.732*5*29239}{20566*480} = .026$

$M = \frac{1}{1+.026} = .975$

$I_{S.C.symRMS} = 29239 * .975 = 28,508A$

Leg 4: Kitchen Dist. Panel to LV KIT 1A

$f = \frac{1.732*5*28508}{15082*480} = .034$

$M = \frac{1}{1+.026} = .967$

$I_{S.C.symRMS} = 28508 * .967 = 27,570A$

3. Spin Room Schematic

This section explains the schematic that has been developed to install an energy harvesting system for the cycles in the spin room. This type of cycles has been used in multiple "green gyms" across the country including Energia Fitness, and Steve Nash's personal gym. The University of Massachusetts has also installed a retrofit system to a single existing cycle of theirs as part of study to use the energy for lighting a greenhouse.

The normal friction resistance mechanism installed on typical spinning bikes is replaced with a motor, that when run in reverse, produces electricity. The rider can have a handheld device attached to the cycle similar to the one seen in Figure D3.1 that will allow him or her to increase the resistance level of the motor, as well as see how much energy they are producing in Watts at any given moment. The greater the resistance and/or the harder the cyclist pedals, the more energy is produced. This handheld device is optional since the bikes can still have a manual crank that will increase or decrease resistance.

Figure D3.1: Handheld device for increasing resistance and monitoring energy output of biker.

While personal monitoring devices per bike can be used, I propose the use of a single wattage display located at the front of the room that will display the total wattage of the group instead. This will help members of the class to feel part of a larger purpose and part of a team, which is very beneficial in group exercise environments. Being part of a team gives you a sense responsibility to do your part as to not let the other members of the team down.

This single metric of wattage will also allow groups who attend regularly to set exact goals of how much energy they would like produce each workout, since it is directly correlated with how hard the group is working as a whole.

As you can see, the benefits of this system can reach beyond just the production of energy.

All necessary equipment that would be needed for the system has been identified and should include:

1. Energy Harvesting Spin Bike or Retrofit System
    a. Similar to bike or retrofit developed by the Green Revolution found here.
2. DC to AC Inverter
3. Programmable Automatic Transfer Switch (2)
4. Wattage Display (digital numerical)
5. All connection pieces and wiring as needed

Optional Equipment

1. Handheld Resistance Device

This schematic diagram outlines how the system should be set up (figure D3.2):

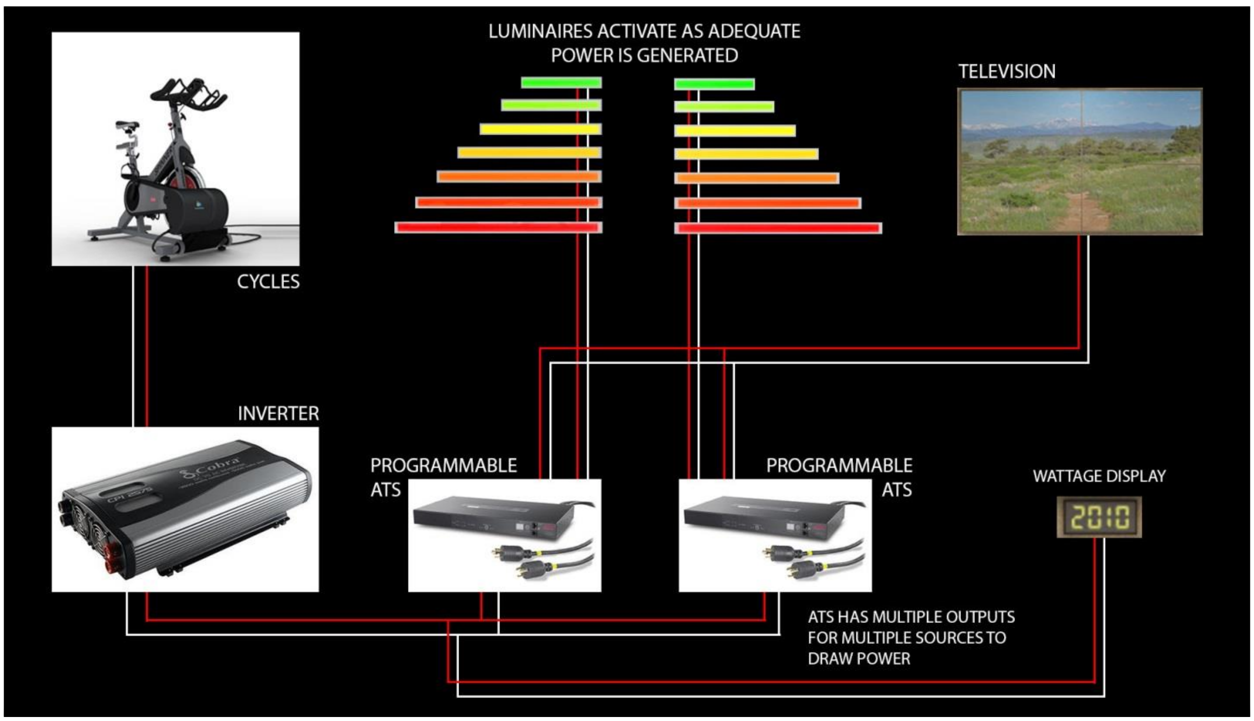


Figure D3.2: Spin Room Energy Harvesting Schematic Diagram.

The luminaires identified in the diagram should be color changing LED strips, recessed into the front wall of the room as shown in figure D3.3.

The television is already part of the current room design, and should be the first thing to turn on before the luminaires. This will allow for there to be no power from the main grid to be drawn for the television, and no need for instructors to turn the television on and off; it will simply turn on once the group provides it with enough power to do so.

<u>Figure D3.3</u>: Spin Room with signaling luminaires, television, and wattage meter shown as identified in Figure D3.1.

According to data gathered by Energia Fitness centers, the average biker produces approximately 110 Watts of energy in a 50 minute workout. With 25 bikes in this room, this tells us that there will certainly be enough energy to power the television and luminaires as the bikers exercise.

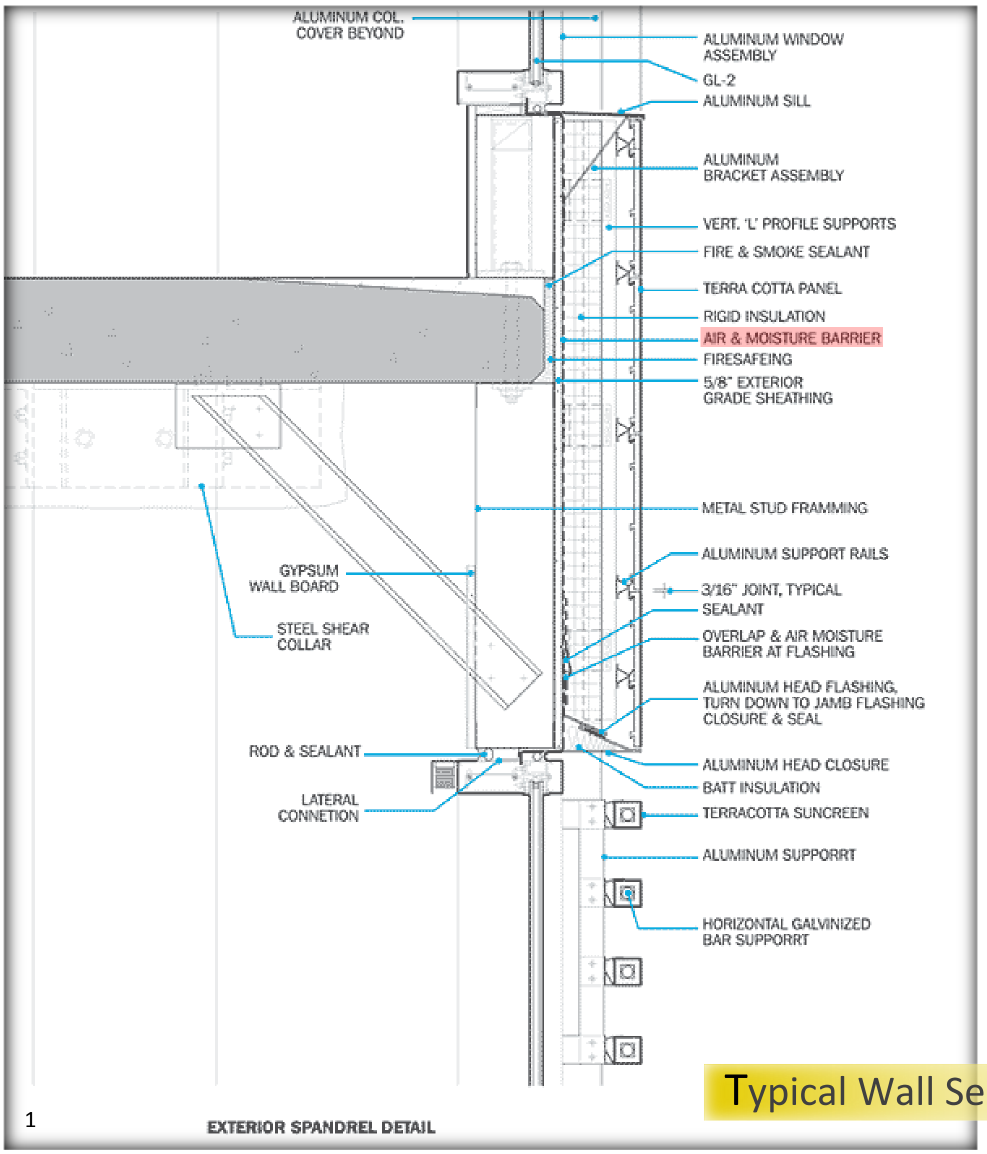
Section E

Façade Breadth

Rain Screen Façade Overview

<u>Main purposes:</u>

1. Prevent water from penetrating facades during construction
2. Create a façade clad with almost any material
3. Decrease total building energy usage
4. Create a more effective thermal barrier



Typical Wall Section

<u>What it is</u>:

A façade system using a specially designed flashed and drained cavity outside of a weather resistant barrier to wick water away from the building – a masonry w all could technically be considered a rain screen – but rain screens do not need to be made of masonry anymore.

The concept of rain screens are being used to create more unique facades out of materials such as terracotta, metal, and even fabric.

Study: Comparing Standard versus Pressure-Equalized Rain Screens

Water Management

"According to a more narrow definition, a rain-screen wall is one designed to neutralize wind currents on the inside and outside surfaces of cladding so that pressure differences do not drive water through gaps or flaws in an assembly and into a building interior."[1] These systems are also called or referred to as 'pressurized or pressure-equalized rain screens.'

The National Research Council Canada recommends that the air cavity behind the cladding material (this cavity is what defines a rain screen) should be compartmentalized in order to best react to pressure changes due to wind. By introducing compartments, the movement of air from high pressure regions to low pressure regions in the air gap behind the façade will not occur. Without compartments, this phenomenon pulls moisture with it. When moisture is forced in varying directions against the façade, it can cause water to seep into the structure and damage interior elements of the wall, structural components, and even as far in as finishes. For this exact reason, an air and moisture barrier is absolutely necessary on the inside of the air cavity: this layer is highlighted in the section above. As an additional note, these compartments should be sized smaller at locations where large pressure variations can occur; parapets and corners. The larger – more-so taller – a building is, compartmentalization becomes more and more of an issue.

Conclusion 1:

> Pressure-equalized rain screens are better in the category of water management because they are more effective at protecting the inner layers of the façade by avoiding water movement due to pressure changes across the façade. Furthermore, compartmentalized pressure-equalized rain screens are even better at achieving this than a single cavity.

Thermal Properties

Rain screens have been utilized also for their thermal abilities. Using a rain screen on both new construction and renovation projects allows buildings to increase their insulation's effectiveness by varying amounts. This is due to the fact that the insulation is no longer broken by studs; it is placed directly on the exterior grade sheathing, after the air and moisture barrier. This creates on large continuous thermal break from interior to exterior. In a renovation done on a 32,000 square foot office building in Denver, the new façade –utilizing a rain screen – "increased the [building] insulation's effectiveness by about 30 percent."[2] This was a compartmentalized system, which used fins between the aluminum panels to prevent air flow in the cavity behind these panels.

1

[1] Gonchar, Joann. "Rain-Screen Facades Are More than Skin Deep." Architectural Record. McGraw Hill Financial, n.d. Web. 3 Apr. 2014. p. 2
[2] Ibid., p. 3

The 30% mentioned here is not the overall increase in effectiveness of the façade. The air cavity behind the aluminum panels would further increase thermal efficiency. In addition, compartmentalization would further increase the efficiency, since less airflow would reduce the effect of convection inside the cavity across the insulation.

Conclusion 2:

> In general, rain screen facades are much more efficient, thermally, than many standard façade types. Pressure-equalized rain screens are better than non-pressure-equalized rain screens because convection from air moving from side to side, bottom to top, or even top to bottom due to pressure changes from wind is reduced. Furthermore, highly compartmentalized pressure-equalized rain screens will be even better at achieving this.

Structural Weight

Rain screens have been utilized in many cases where structural issues do not allow heavy facades to be use; the outermost material of a rain screen is completely interchangeable for a lightweight material. This allows architects to specify lighter materials, to reduce the structural support needed, or to accommodate weaker existing structural systems. Although, the difference in weight between pressure-equalized rain screens and non-pressure-equalized rain screens will not be significant enough to claim that one is better than the other. Of course, compartmentalization will indeed be heavier, but in comparison to the exterior material, this compartmentalization will – in most cases – be insignificant. Times when this weight will be significant would be when extraordinarily light materials are used for the outermost layer since this layer is usually the heaviest.

Conclusion 3:

> In general, the difference in weight between pressure-equalized rain screens and non-pressure-equalized rain screens is not significant enough to claim that one is better than the other in this category. Overall though, rain screens are an effective choice to reduce the weight of a façade in any case.

Constructability and Cost

Rain screens are becoming more popular as the façade of choice, but the constructability and cost of the two types are not equal. Generally, all rain screen façades have one distinct advantage during construction; since the "architectural envelope is divorced from the weather barrier, quick erection of the building's enclosure is possible"[3] as quoted from John Starr in the Architectural Record article. This is especially true for buildings with minimal window openings such as museums. When comparing pressure equalized to non-pressure equalized rain screens, non-pressurized are easier to construct since there are less components, and one less step of coordination is needed all the way from the architect to

[3] Ibid., p. 4

the subcontractors. Less detailing and attention to these specific details will save time and money during the project when constructing non pressurized rain screens. This is apparent since less American structures are built using pressure equalized rain screens in comparison to Europe. Subcontractors in Europe have already mastered this system, while subcontractors in the United States are not as effective at constructing this type of system. For residential projects, rain screen have been reported to add 30% to the wall cost of a siding project.

Conclusion 4:

> Pressure-equalized rain screens take more coordination, time, detailing, and ultimately money than non-pressure-equalized rain screens due a decreased constructability. Whether this is significant enough to choose one over the other shall be up to the architect on the project.

Summary

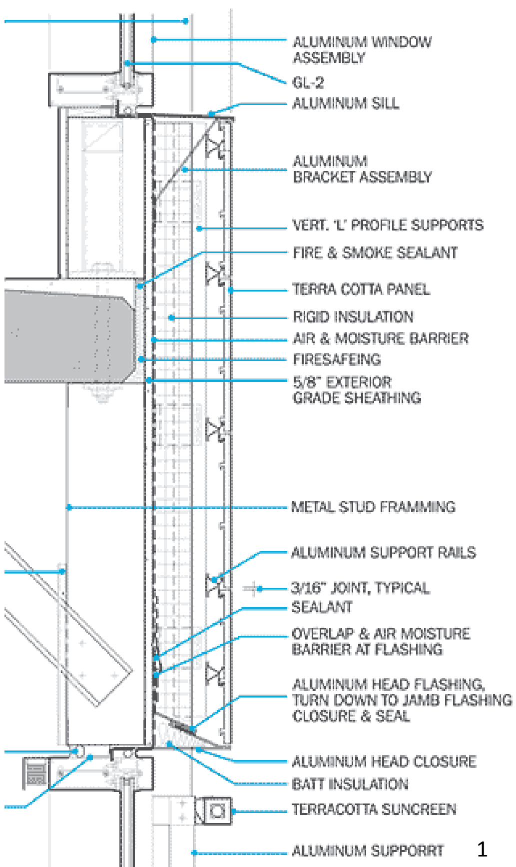
In conclusion, rain screen façades help protect a building from water penetration, increase the thermal efficiency, provide construction benefits, and even lower structural loads. In comparison, pressure equalized rain screens are slightly more expensive, but when needed, offer great benefits compared to non-pressure equalized rain screens. These benefits include greater thermal efficiency, and better water management. This results in a reduced load on the mechanical system of the building, and better preservation of the building materials over the lifetime of the structure.

Section F

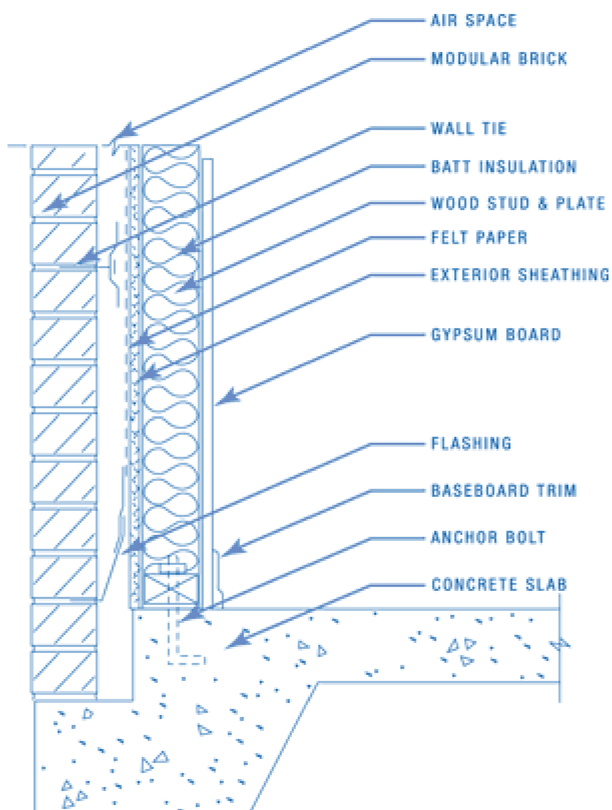
Mechanical Breadth

Introduction: Scope of Mechanical Breadth

This breadth involves an energy simulation which has been used to determine the thermal efficiency of a rain screen façade against another typical building façade type. A model was constructed in the simulation program TRACE, of which the geometry and orientation was based off of the 3-court gymnasium in the SUNY Cortland Student Life Center. This model was first created using a typical brick on metal stud wall construction (Alternate 1). This detail can be seen below as a comparison. This model was then duplicated and the exterior wall type was changed to reflect the characteristics of a rain screen façade with terra cotta cladding as seen in the section detail in the façade breadth above (Alt. 2). For quick reference, this wall section can be seen again below. All other aspects of the models were kept constant other than the exterior wall structure changes, and the U-values associated with them.



1



[4]

Rain Screen Section

Brick on Metal Stud Section

[4] "Cost Comparison for Common Commercial Wall Systems." *Brick the Solid Investment*. Brick Industry, n.d. Web. 4 Apr. 2014.

Documentation of TRACE Model, Methods, and Results

The 3-court gymnasium used for this simulation had the following dimensions and attributes input into the program:

Width	106’
Length	178’
Height	24’
Glass	30%
Exterior Walls	East and South
Interior Walls	West and North

For the two different wall types (Alternate 1 and Alternate 2), U-values were calculated using typical values of materials and the wall details above.

U-value comparison of Terra-cotta Rain Screen to Standard Wall				
Rain Screen			**Brick on M. Stud**	
Material	**R-value**		**Material**	**R-value**
Terre-cotta	12		Brick	0.8
Air Space	1		Air Space	1
R-19 Insulation	19		Exterior Sheathing	1.32
Exterior Sheathing	1.32		*	7.1
Metal Stud	0.005		GWB	0.56
GWB	0.56			
R-Value	33.885		**R-Value**	10.78
U-Value	0.0295		**U-Value**	0.0928

*R-19 Mineral Fiber Ins. with 2x6 metal studs @ 16" OC

As this chart shows, the two U-values were significantly different, but the simulation results showed that this made only a small change in the annual building load.

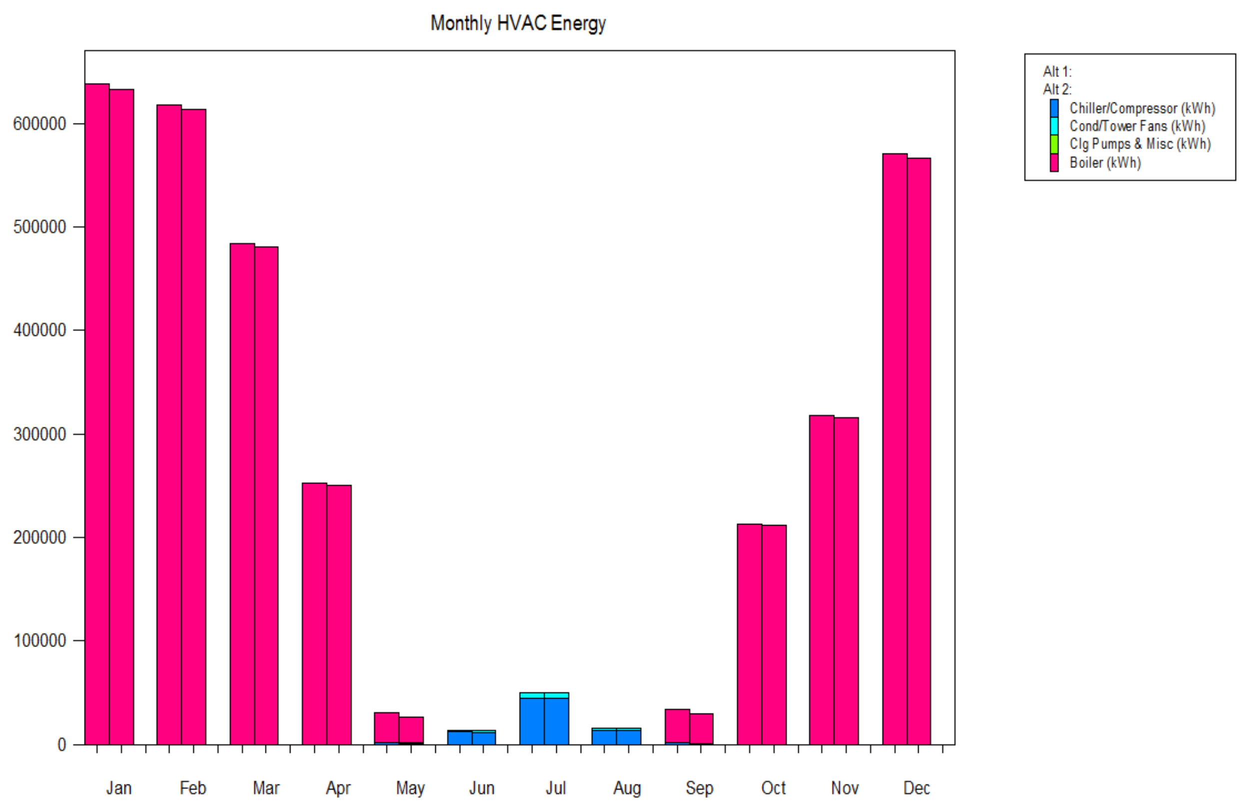
In addition, the infiltration rate was changed from one scenario to the other in an attempt to account for a tighter façade in the case of the rain screen. The infiltration rate was changed from .038 CFM/SF to .025 CFM/SF.

The actual results from the simulation can be found attached in Appendix D. In summary though, the total building energy load (kBtu/yr) was reduced from 11,670,187 to 11,549,675. This is a 1.03% change. Based on values interpolated by TRACE, this would also cause a decrease in the annual cost to run the system. The change here is from $45,684 to $45,171. This is a savings of $513, or 1.12%.

Conclusions

After running calculations for both wall types, it was determined that the rain screen façade system helped lower the mechanical load on the building – as expected. What was not expected is that this change in efficiency only resulted in a 1 percent difference. This is due to the simple fact that the majority of the load on the space comes from internal loads rather than external loads. Loads such as people and lighting mainly contributed to the amount of energy needed to heat and cool the space, rather than load from the outside temperature.

The following graph shows the change from one analysis to the next. The bars on the left of the two stack groups represent the load using the brick and metal stud façade, while the bars on the right represent results from the rain screen façade.



As you can see, the two sets of data are nearly equal, only resulting in approximately a 1 percent reduction in load. Fortunately, energy efficiency is not the only driving factor for selecting a rain screen façade, as you can see in the previous breadth discussion. While energy usage reduction does occur, there are many more reasons to choose a rain screen façade.

Summary & Conclusion

The Student Life Center is a structure meant to promote activity and new life for the students at the State University of New York Cortland campus. Its enticing architecture and intriguing shapes surely demand attention from both the interior and exterior. The entrance lobby provides a key focal point for the building both during the day and at night. A “streamline” lighting design is seen throughout all interior spaces, but is especially apparent here. Simple but strong lines provide adequate illumination, while also providing accent lighting at the reception desk. Through an interior curtain wall, occupants can observe others exercising in the main fitness area; the cardio loft and weight floor.

Vertical fins mounted on the structure’s façade provide captivating lighting formations on the weight floor during the day, while creative lighting transforms the space at night. Vertical illumination high in the space illuminates expressive paint colors while creating a comfortable space. A combination of direct and indirect lighting provide a space psychologically conducive to public activity. Accent lighting and a diamond shape pendant thoughtfully located encourage motion through the space and into deeper expanses of the building. Controls provide energy savings by dimming fixtures based on the current daylight conditions.

The runner will experience the entirety of this building, receiving a very diverse and thorough understanding of the building as they traverse around its perimeter. Different combinations of direct and indirect lighting provide a varied experience depending on where the runner is located at that moment. Specialized integrated controls provide a unique visual pacing system with one set of luminaires while dimming others based on daylight conditions.

The exterior has been designed with a minimal approach in order to save energy and avoid glare to residences within view of the Student Life Center. Tree mounted fixtures and bollards provide pathway lighting while a single LED strip defines the overhang over the entrance to the lobby. The energy savings from this space – in addition to others – has resulted in a design achieving 11 points towards LEED.

An energy harvesting system has been added to the spin room, which will power the television and indicator lighting at the front of the room. This indication system will help members of the class to feel part of a larger purpose and part of a team; a beneficial element in group exercise environments, since all members will be working toward a common cause. The added wattage meter also introduces a new metric to this type of exercise: Wattage, which is measuring the exact amount of energy that the group is exerting.

Research done on rain screen facades proved that they are advantageous in certain situations, especially those where lighter, more unique, and potentially cheaper cladding is desired by the architect. These facades have also been proven to manage water penetration better than most other façade types. They are also very effective thermally, but in the energy simulation completed, this proved to make little difference for a gymnasium since the majority of the space load is internal to begin with. This is also the case with most other building spaces and climates, so a rain screen façade should certainly not be selected for thermal purposes only.

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