2019 International Radiance Workshop // NYC August 21-23

DEMANDS OF THE RADIANCE POWER IN A NON-ORTHOGONAL WORLD

Eduardo Pintos

Project Team: George Loisos, Alan deMarche, Ibone Santiago, Abe Shameson
House Intro

.....yes, this is a house, not a flying saucer.
House Intro

Aerial view rendering with site context

- pottery studio
- gym
- event space with art collection
- 1,400 sf closet
- 10 car garage
- pool
- underground movie theater
- lots of cylindrical skylights
- 54 KW photovoltaic array
- 1,400 sf closet
This House vs. Other House Type We Normally Work On

Just to name a few challenges:
- curved vertical glass facades facing southeast and southwest
- double curvature walls and ceilings
- daylight sensitive art collection
- large size round skylights with clear glass
- wide open site with no shading from context
Design Phases

CONCEPT DESIGN > SCHEMATIC DESIGN > DESIGN DEVELOPMENT > CONSTRUCTION DOCUMENTS

SCHEMATIC DESIGN

exterior rendering

DESIGN DEVELOPMENT

interior 180° rendering with finishes

CONSTRUCTION DOCUMENTS

section drawing
Weather Data // Sky Conditions

Annual Global Horizontal Illuminance

- June Clear 12:00 noon
- Dec. Overcast noon

Annual Sky Cover

- Clear
- Intermediate
- Overcast
Schematic Design
Schematic Design

Solar Convergence Studies // animation
Solar Convergence Studies

“12,384 watts/m²” in a given horizontal spot of the outdoor patio.

Some references:
11,000w/m²: burst into flames
1,000 w/m²: clear sky_desert
750 w/m²: clear sky_urban
Schematic Design

Proposed Solutions

Flat glass in segmented curve

Peak reduction:
From 12,384 to 1,268 watts/m²

Glass shading alternative 1

Glass shading alternative 2

Glass Specifications: SunGuard SNX 60/28

<table>
<thead>
<tr>
<th>Visible light</th>
<th>Solar energy</th>
<th>Solar factor (g)</th>
<th>U-value (EN 673)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transmission [%]</td>
<td>Reflection outside [%]</td>
<td>Reflection inside [%]</td>
<td>Colour rendering index</td>
</tr>
<tr>
<td>Double Glazing: 6-16-4, SunGuard® High Selective on #2</td>
<td>60</td>
<td>12</td>
<td>14</td>
</tr>
<tr>
<td>Triple Glazing: 6-12-4-12-4, SunGuard® High Selective on #2 + ClimaGuard® Premium on #5</td>
<td>53</td>
<td>14</td>
<td>17</td>
</tr>
</tbody>
</table>

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Schematic Design

Direct Sun Penetration Animation

December 22nd, clear skies, 11:30am
Schematic Design

Direct Sun Penetration

3D model meshing not quite refined yet

PROBLEM! Direct sun on painting

PROBLEM!
Getting blind while using the treadmill

December
Clear skies 12:00 noon

PROBLEM!
Direct sun on painting

Gaps and light leaks to be fixed

Basic materials for early studies (final finishes still TBD)
Schematic Design

Daylight Availability
Design Development
Design Development

Monthly Summary // Cumulative Solar Radiation (over one day)

January 21st
February 21st
March 21st
April 21st
May 21st
June 21st
July 21st
August 21st
September 21st
October 21st
November 21st
December 21st
Radiant System Zoning

The goal of this analysis was to determine the solar loads that the radiant system would need to absorb and suggest zoning for such systems to support their optimized performance. When the sun enters the building and hits the floor, the radiant system needs to cool down that surface to keep the operative temperature in the space within the target setpoints. If a zone for the radiant system is not defined to do so in an efficient manner, the floor will likely overheat in the areas where the solar radiation enters the building, or overcool in the other areas included in the same zone but remain in the shade.

To create sample zoning diagrams, included in pages 4 and 5, we first found typical zone size range based on the following assumptions for two different zone sizes:

**Small zone:**
- 3/8” PEX tubing spaced at 6” OC
- Total circuit length: 200’
- Assumed capacity at 0.3 GPM: ~26 BTU/ft²/hr
- Total Area: 100 ft²
- Capacity: 2,600 BTU/hr

**Large zone:**
- 3/4” PEX tubing spaced at 12” OC
- Total circuit length: 500’
- Assumed capacity at 1.2 GPM: ~22 BTU/ft²/hr
- Total Area: 500 ft²
- Capacity: 11,000 BTU/hr

Based on our simulation results (summarized on page 13), typical peak radiation incident upon the floor is 150 W/m², or about 48 BTU/ft²/hr. This is greater than the capacity of each zone, meaning that some heat will need to be stored in the mass so the load can be shifted later. In the small zone, the excess is 22 BTU/ft²/hr, and in the large zone, the excess is 26 BTU/ft²/hr. There are two ways the system can shift this load: first, the mass of the floor itself can limit the temperature rise so that the heat can be stored at a comfortable temperature. Second, heat can be transferred via the hydronic loop to mass that is not in the sun.

This leads to the following guidelines, which we have deployed in our sample zoning layouts:

- When parts of a zone are expected to be in sun, the zone should be drawn to include areas that will be shaded at least as often.
- Piping should deliver chilled water first to the section of the zone where solar loads are anticipated (most often at the perimeter as described in the diagram on the right), and it should be returned from the section of the zone where no solar loads are expected.
- The topping slab should be heavyweight concrete to provide additional thermal mass.

Using the cumulative loads (as shown on pages 7 for the whole year and page 13 for one day per month), and capacity limitations described above, we defined the areas and location of each zone, considering also occasional patterns as described in the seasonal peak load images included in page 13.
Design Development

Annual Cumulative Hours of Direct Sun
**Hours of Direct Solar Radiation**

Cumulative With No Shades

With Shades (Blackout) only on West CW

**Observations:**
Total of 250 hours per year of direct sun (over 400Fc), maximum of 775 hrs on the whole wall.
Sun comes from west facing curtain wall.
Direct sun from west facing curtain wall happens in the afternoon from 2pm to 4pm until sunset, during the whole year.

**Instantaneous Light Levels**

Overcast - No Shades

Clear Sky - No Shades

Clear Sky - Shades (4% Openess on West CW)
Recommendation:
It is possible to display the following colored materials:

- **NO SENSITIVITY**
  - No limit
  - Metals, stone, glass, most ceramics, enamal, most minerals.

- **LOW SENSITIVITY**
  - Limit: 60,000 Fc/hr (20Fc)
  - Oil and tempera fresco, undiluted leather and wood, horn, lacquer, some plastics

- **MEDIUM SENSITIVITY**
  - Limit: 5,000 Fc/hr (20Fc)
  - Costumes, watercolors, pastels, prints, manuscripts, paintings in distemper media, wall paper gauche, wood, fur, leathers

- **HIGH SENSITIVITY**
  - Limit: 1,500 Fc/hr (5Fc)
  - Silk, newspaper, felt tip pen, fugitive dyes, pristine art never exposed to light.

**Direct Solar Radiation**

- JAN
- FEB
- MAR
- APR
- MAY
- JUN
- JUL
- AUG
- SEP
- OCT
- NOV
- DEC

**Anticipated Electric Lighting Effect**
- Wall wash, ceiling recessed
Construction Documents

Refinement of daylighting and electric lighting design
Construction Documents

Lighting Design
Snake Deco Specifications

**Luminaires**
- Sustainable design
- Radius, minimum 12.36" (314mm)
- Diffused line of light
- IP67, UL STD 1598, wet location, walkover rated 1000 lb
- Clear borosilicate glass 1.2" (30mm) thick
- Anti glare system
- Aluminum construction, with diffused tempered glass
- ABS installation housing, direct concrete pour
- Snap in installation with no exposed hardware
- 3.3' (1m) feed cable standard

**Size**
- 5" x 3.5" H (124mm x 90mm)

**Power**
- H = 2.5W, 3000K, 225 lm

**Color Temperature**
- 30 = 3000K
- 35 = 3500K
- 40 = 4000K
- CRI: > 85

**Optics**
- SP = spot - 17º
- FL = flood - 31º

**Voltage**
- 24 = 24VDC fixture voltage

**Options**
- C1 = 10' (3m) feed cable
- C2 = 20' (6m) feed cable
- C3 = 30' (9m) feed cable
- CX = specify length

**Ordering Information**
- (Minimum order quantity 9pcs)
  - Model: F SND 5 H
  - Length: 30, 35, 40
  - Power: SP, FL
  - Voltage: 24
  - Options: C1, C2, C3, CX
  - Housing: SNC

**Power Supply**
- Non-Dim: D-520-24007: Osram 96W, 24VDC, 120-277VAC
- Dim: D-520-24006: Osram 10% 0-10V dimming, 96W, 24VDC, 120-277VAC
- IL-JB-LED-24003-120V-DFPN: Lutron LTE 1% Forward Phase (with neutral) dimming, 5-40W, 24VDC, 120VAC, Case K, dry location enclosure
- IL-JB-LED-24010-UNV-D3W: Lutron L3D 1% 3-wire dimming, 5-40W, 24VDC, 120-277VAC, Case K, dry location enclosure
- IL-JB-LED-24010-UNV-DES: Lutron L3D 1% EcoSystem dimming, 5-40W, 24VDC, 120-277VAC, Case K, supplied in a dry location enclosure

**Notes**
- See power supply pages for details. No enclosure, unless stated. lm80 values shown.
Construction Documents

Lighting Design
Construction Documents

Lighting Design
Construction Documents

Day-Night Transition
Lighting Design

Iguzzini Light-Up Orb (shown here within 3” Ø stainless steel tube)
Qtran Qcap D1
Stainless steel zee
3/4” conduit (to be confirmed)

Section detail through grating panel
Construction Documents

Lighting Design
Construction Documents

Lighting Design
Construction Documents

Lighting Design
Lighting Design

thanks Greg!
Under construction
Thank you