



CIRCADIAN CURTAIN WALL

ADVOCATING INTEGRATED DESIGN
John Neary AIA LEED AP, HOK Facades
Elliot Glassman AIA NCARB LEED AP CPHD,
WSP Built Ecology

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CIRCADIAN CURTAIN WALL





John Neary, HOK Facades

Facades architect at HOK, Frank Seta & Associates and Arup. Project Designer, focus on envelope and special structures at Gensler, Perkins Eastman, Pei Cobb Freed & Partners. My interest in the building enclosure is a basis for advocating integration of the conceptual and technical aspects of design. MArch Rice University. BA Vassar College. AIA, LEED AP, NCARB Certified.

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Associate and high performance building consultant. Expertise in daylighting, passive design, and using computational design for building performance optimization. Masters of Design Studies in Sustainable Design from the Harvard Graduate School of Design. BArch from New Jersey Institute of Technology. Licensed Architect, LEED AP, NCARB Certified, and Certified Passive House Designer.

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Project Team

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Zhenhuan Xu, HOK

Blake Kurasek, HOK

Marie Achabalun, HOK

Mario Claussnitzer, HOK Façade Engineering

Matt Breidenthal, HOK Structural Engineering

Matthew Payne, WSP Built Ecology

Elliot Glassman, WSP Built Ecology

with extra help from:

Apoorv Goyal, Sustainability Specialist at HOK

Victoria Ereskina, Façade designer at HOK



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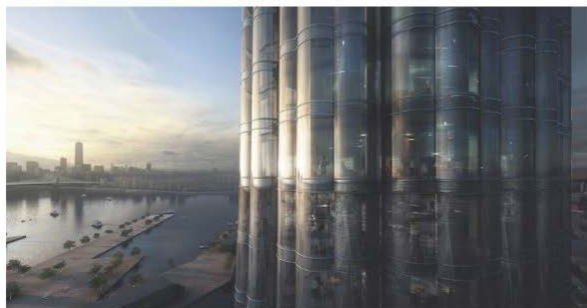
HOT TOPICS:

2018 GIANTS 300 REPORT: RANKING THE NATION'S LARGEST ARCHITECTURE AND CONSTRUCTION FIRMS

Curtain walls go circadian

Catering to our natural circadian rhythm is a task designers are taking to heart.

GREAT SOLUTIONS | SEPTEMBER 17, 2018 | DAVID MALONE, ASSOCIATE EDITOR



HOK's Circadian Curtain Wall concept employs curved, bubbled glass to maximize daylight, minimize solar heat gain, and provide external shading. Courtesy HOK

New research by interior landscaping firm Ambius (bit.ly/2MPpiy3) found that the typical office worker spends less



THOUGHT LEADERSHIP
Circadian Curtain Wall concept employs **biophilic design** to capture **natural light** and **reduce energy use**.

中文 60+ Years of Design + Innovation DESIGN THOUGHT LEADERSHIP HOK PEOPLE

THOUGHT LEADERSHIP

INNOVATION

HOK's Circadian Curtain Wall Connects Office Workers to Outdoors, Reduces Energy



View of a proposed Brooklyn high-rise sheathed in HOK's Circadian Curtain Wall concept

A finalist in **Metals in Construction's 2018 Design Challenge**, HOK's Circadian Curtain Wall concept draws on **biophilic design** to offer building occupants abundant natural light while minimizing solar heat gain.

How can facade systems play a more important role in improving employee health and well-being? That was the crux of Metals in Construction's 2018 Design Challenge, and it got HOK facade specialist **John Neary**, AIA, LEED AP, thinking about an idea.

For the past two years Neary and his colleagues in HOK's New York studio had been working on a concept for a load-bearing facade for high-rise buildings. That design, **Structural Aluminor Enclosure**, replaced much of the aluminum found in modern curtain walls with steel, giving the facade additional strength to serve as part of the building's overall framing and, because steel requires one-third the amount of carbon to produce as aluminum, reducing its embodied energy.

More recently, Neary had been trying with a further evolution of the concept. What if curved glass could also reduce the use of aluminum while giving the



SKINS

SKINS is back, refreshed, renewed and better than ever! Kille Gould has delivered us a visual upgrade and we have a new crop of contributors to this and upcoming issues. Given SKINS four-month hiatus, there is more institute news than usual, but also new voices and old friends are included in this issue. There are many threads to this intricate dialogue, and room for many hands to weave this flowing tapestry of buildings, building skins and urban fabric. Join the conversation; **submit your contributions to SKINS**. Join the action, support the Institute's many initiatives by **becoming a member** and engaging with one of our committees or working groups, or by running for one of our elected leadership positions. We have a tremendous amount to do, and we invite you to join us in our mission to transform the built environment through the medium of the building skin.

Mc Patterson
 Ambassador of Innovation & Collaboration
 The Facade Technics Institute



PROFILE

HOK Thought Leadership and John Neary's Circadian Curtain Wall
 HOK has a rich history of research, innovation and knowledge sharing. Facade expert John Neary shares his novel concept for a building-integrated facade system that reaches beyond considerations of operational carbon to the critical importance of embodied carbon in pursuit of carbon neutral architecture. [Read more \(HOK\)](#)

MIC'S MUSINGS

the dialogue; act now!
<https://facadetechnics.org/journal/2018/07/SAC-Recruitment.pdf>

FACADETECTONICS.ORG
facadetechnics.org

Like Comment Share

Kille Gould and Ahmad Ahmed like this.

Facade Technics
 July 13

HOK Architects Corporation has a rich history of research, innovation and knowledge sharing. Facade expert John Neary shares his novel concept for a building-integrated facade system that reaches beyond considerations of operational carbon to the critical importance of embodied carbon in pursuit of carbon-neutral architecture.

Connects Office Workers to Outdoors, Reduces Energy

Like Comment

HOK
 128,738 followers
 4mo

Our Circadian Curtain Wall concept employs biophilic design to capture natural light and cut energy use. <http://bit.ly/2LoIDpJ>

265 Likes 10 Comments

Like Comment Share

Add a comment...

Cheryl Carr · 3rd
 Accounting Assistant with Expressworks International LLC
 To not only decrease the amount of materials used in support of a conventional curtain wall, plus increasing interior daylighting, for the interior health of the people working within, saving energy, and also positively affecting the bottom line for companies/business within. LOVE this concept and would love to see it come to fruition! 🍌
 Like Reply

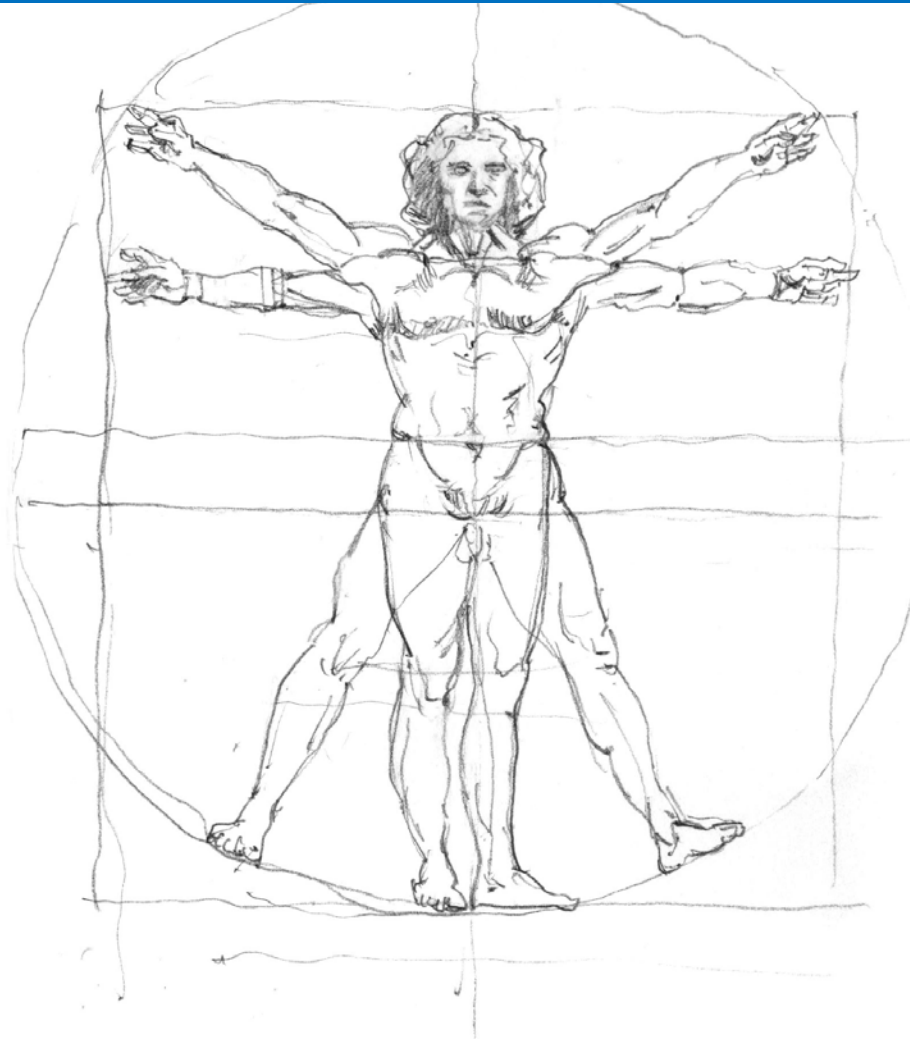
Yiejing LIU · 2nd
 sustainable building engineer at ECADI
 amazing concept
 Like Reply

Load more comments

Wellness

Connections between:

- Mind and Body
- Emotional and Intellectual
- Functional and Formal
- Quantitative and Qualitative
- Environmental and architectural:
- Thermal, texture, air, water, light, sound.
- Interior and exterior



Integrated Design

Connections between:

- Form and Performance
- Aesthetic and Technical aspects of Architecture
- Form and Spatial Order
- Elimination of unnecessary material
- Following natural principles of structure

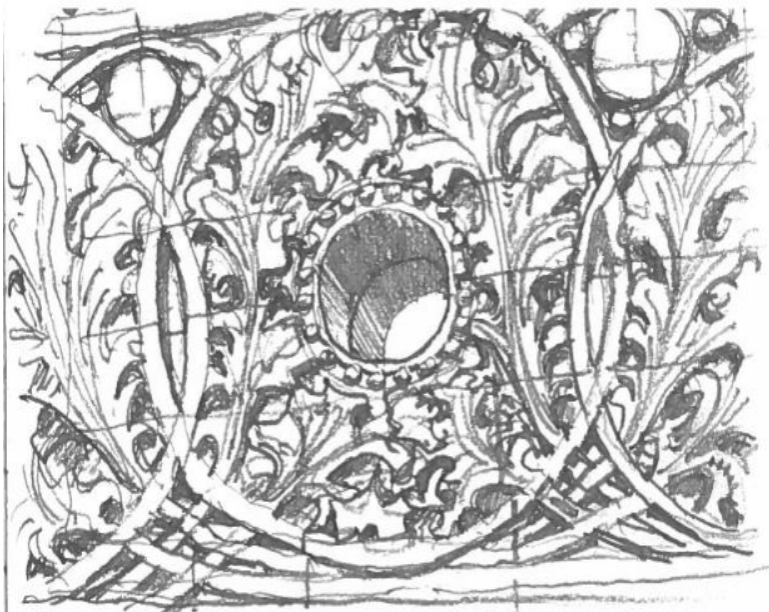
Through our proposal, we are advocating integration of aesthetic, experience-related objectives and the technical, performance-related objectives in design.



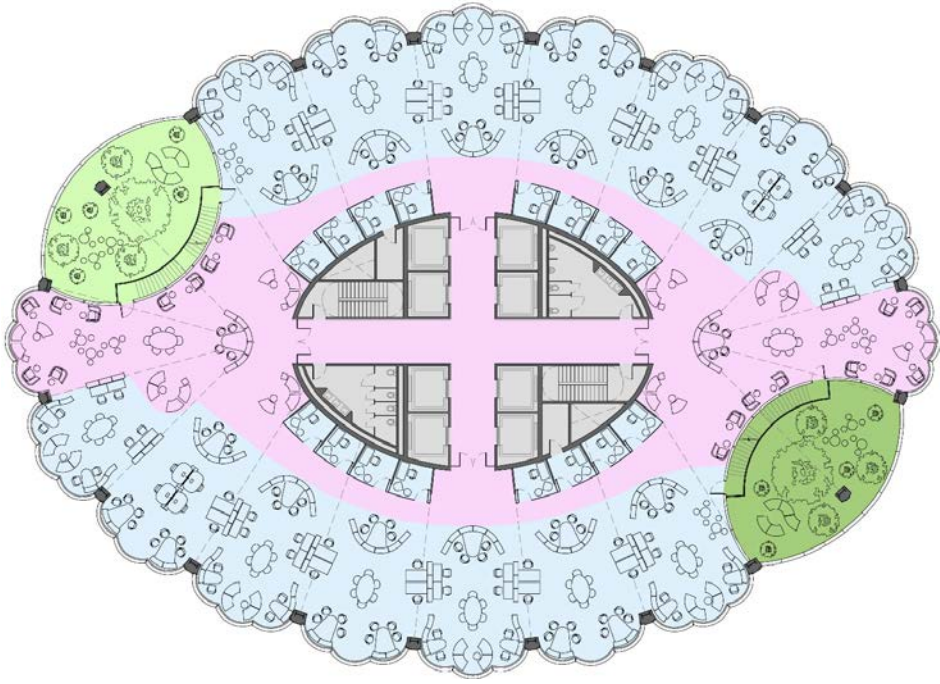
Organic Design

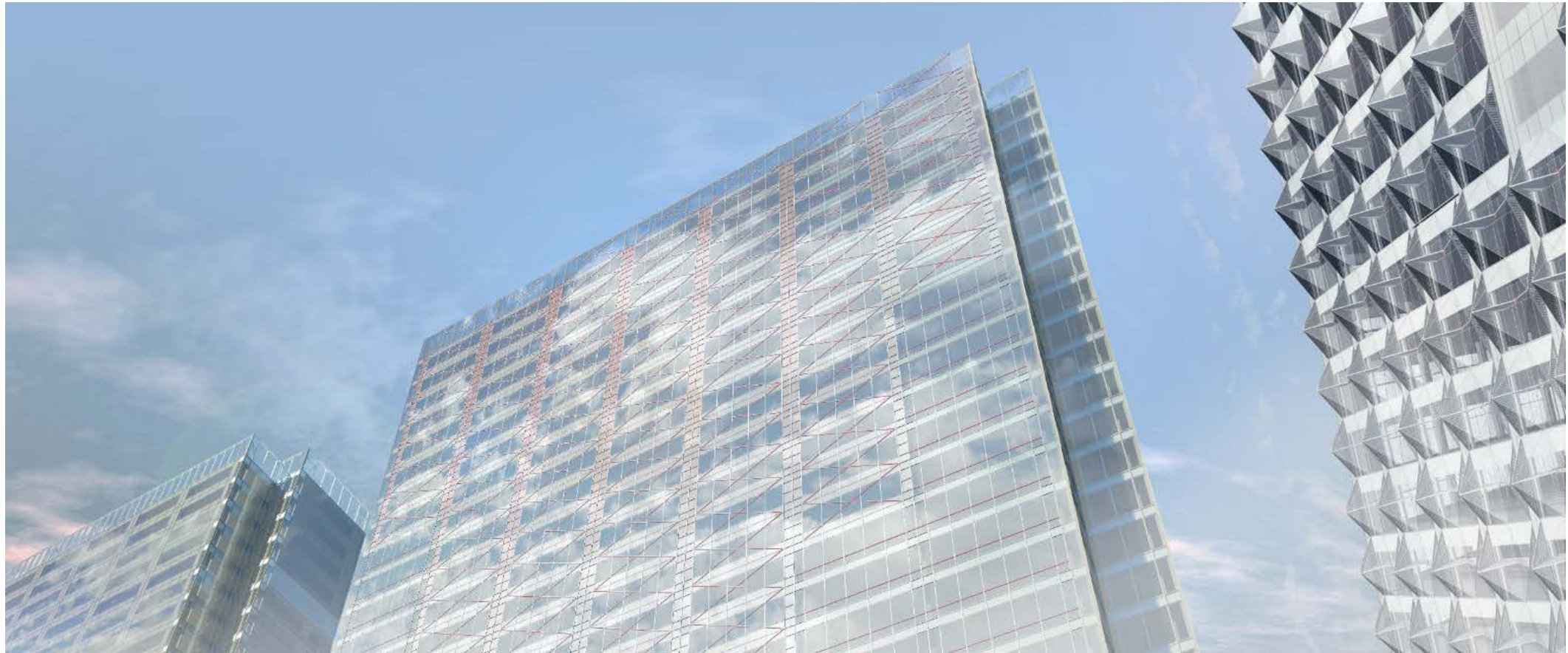
Connections between:

- Architecture and Nature
- Building and Human Scale
- Themes that define early modernist work from Sullivan and Wright to the Bauhaus and Mies.
- The shading and articulation of the floor plate design resulted in a biomorphic lobed geometry that resembles an organic form.



Sullivan - Wright - Cornice Windows 9104-17

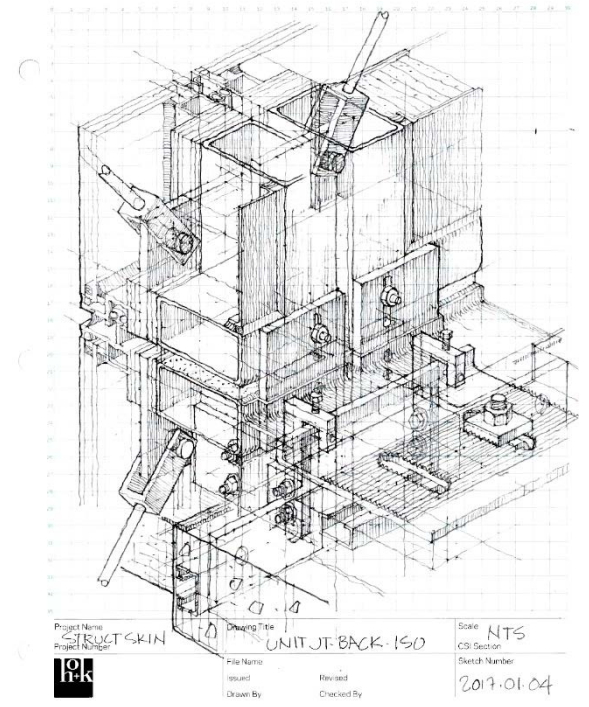
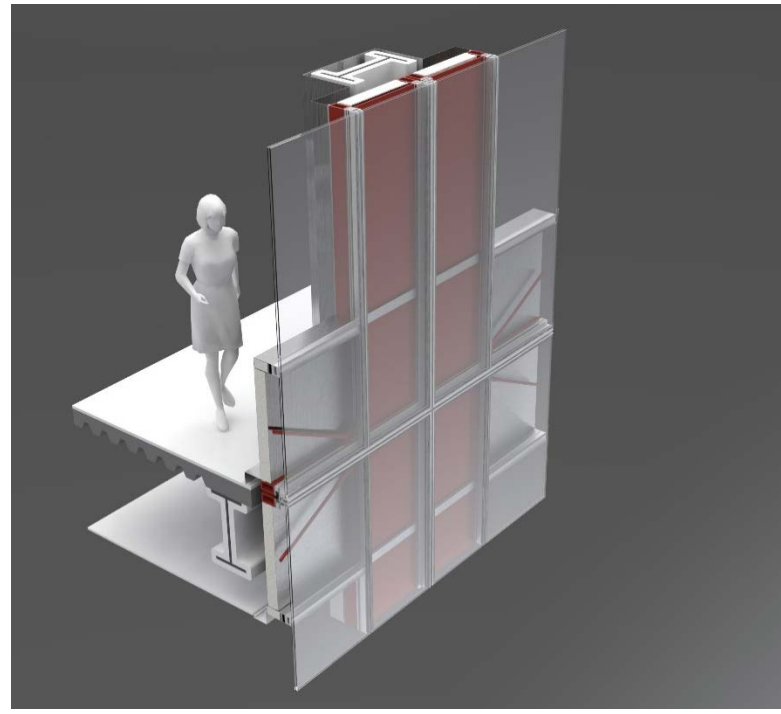
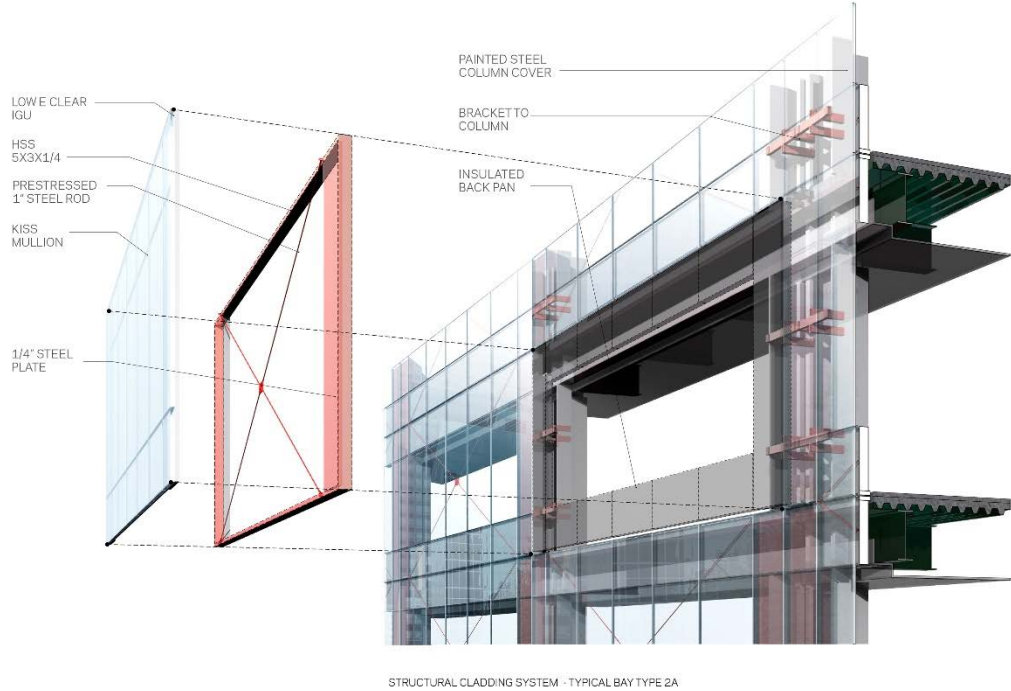




Structural eXterior Enclosure
2017 Metals In Construction Competition-
Reimagine Structure
Finalist

- Mega-panel steel frame with diagonal bracing contributes wind-stiffness to the primary structure.
- Mullions are minimized by bracing glazing against diagonals
- Embodied CO2 is reduced in frame and cladding

CURRENT

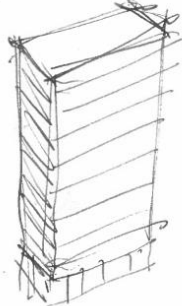


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THE WALL
OR THE UNVENTILATED OFFICE BUILDING FACADE
IS FLAT.

OUTSIDE:



FUNCTION:

- BACK FACE OF THE PERFORATED 'BOX' IS BARRIER EXPOSURE TO SUN/SOLAR GAIN/CLARE OR NOT

Form:

- WALL OF RELIEF, SCALE, GENERATING UNUSUALNESS
- FIXED PROJECTIONS SHADOWS FROM OUTSIDE OF THE WALL WORK FOR COOLING TIME OF DAY/SEASON
- COOLING TIME, PROTECTS INTERIOR FROM HEAT

INSIDE:



- SHADOWS MOVE UP OR DOWN TO PREVENT SOLAR GAIN/CLARE.
- SHADOWS BLOCK VIEW, BUT NATURAL LIGHT
- FIXED PROJECTIONS SHADOWS FROM VIEW OF SKY/FIELD

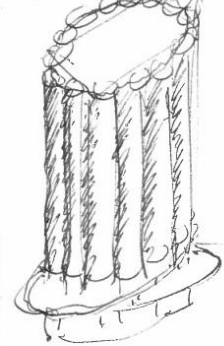
Form: INTERIOR

- FLAT PICTURE-PLANE VIEW CREATES SEPARATION

OCCUPANTS DO NOT HAVE A HEALTHY SENSE OF CONNECTION TO OUTSIDE SURROUNDINGS.

EXPERIENCE THE CONNECTION BETWEEN INSIDE & OUTSIDE THROUGH THE MOST-COMPLICATED CASEY-COLUMBIA SMART FACADE INTEGRATED TUBULAR STRUCTURE

OUTSIDE: IN THE ROUND



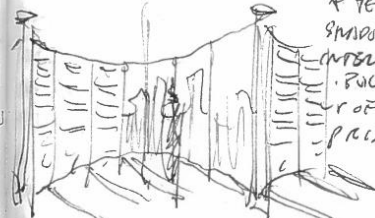
FUNCTION:

- ROUNDED OVER FRAME - PLATE AVOIDS SUN OR NORTH/SOLAR RECOGNITION
- TUBULAR FACADE CREATES PROJECTING 'BOX' WINDOWS WHICH ARE PARTLY SELF-SHADOWED/ORIENTED TO INDIRECT LIGHT AT ANY POINT IN TIME.
- THIS REDUCES SOLAR GAIN/CLARE

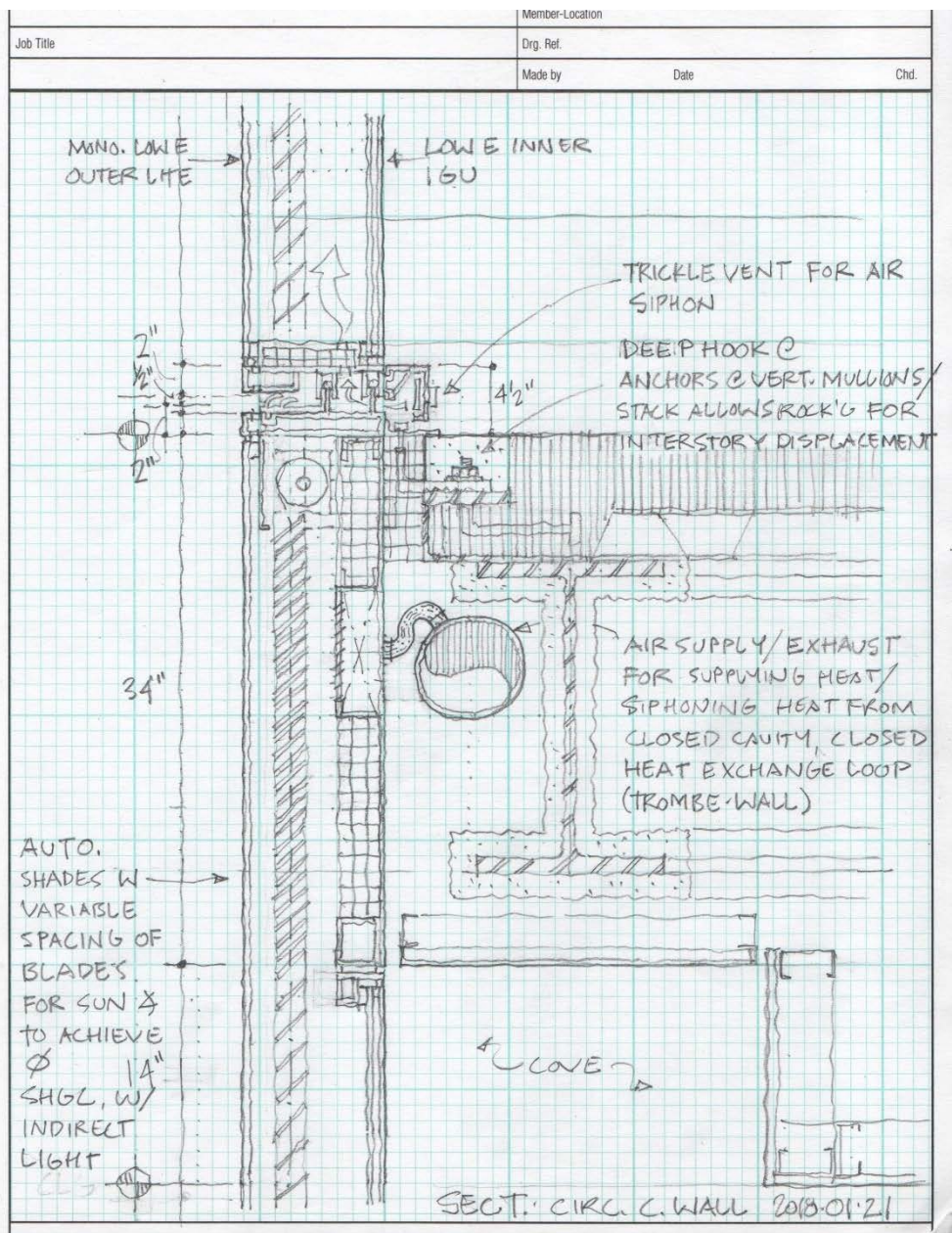
Form:

- 'SHADOW' BOXES CREATE A TEXTURE & SCALE, PROVIDE SHADOW/RELIEF, UNUSUAL INTERIORITY.
- BUILDING IS A 'WHOLE' MORE OF PARTS, NOT AN ISOLATED PRISMATIC OBJECT.

INSIDE:



RENEWED/BUILDING OCCUPANTS

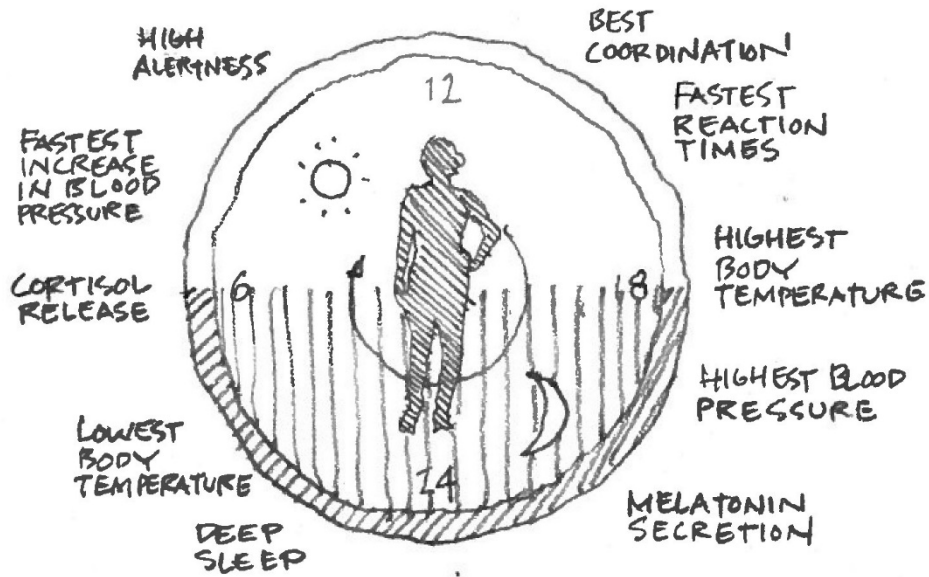


HOK Facades Group

Advocacy of integrating aesthetic/experiential and performance/technical aspects of design throughout the process.



The *Metals in Construction* magazine 2018 Design Challenge is a competition to generate ideas for a facade system that can play a major role in enhancing employee health and well-being. This ideas competition is based on the philosophy that the 21st century facade needs to be adaptive and responsive to human needs, especially in the workplace. With researchers probing beyond workplace aesthetics to examine holistic factors, we are learning that air and water quality, thermal control, and especially visual access to outdoor environments can directly improve employee well-being.



“Life on Earth is adapted to the rotation of our planet. For many years we have known that living organisms, including humans, have an internal biological clock that helps them anticipate and adapt to the regular rhythm of the day”

source: www.nobelprize.org

Circadian Rhythm

The cycle/circle of Life

- The 2017 Nobel Prize in Medicine was awarded for research into the science of Circadian Rhythm.
- A critical subject for defining how buildings relate to environment.



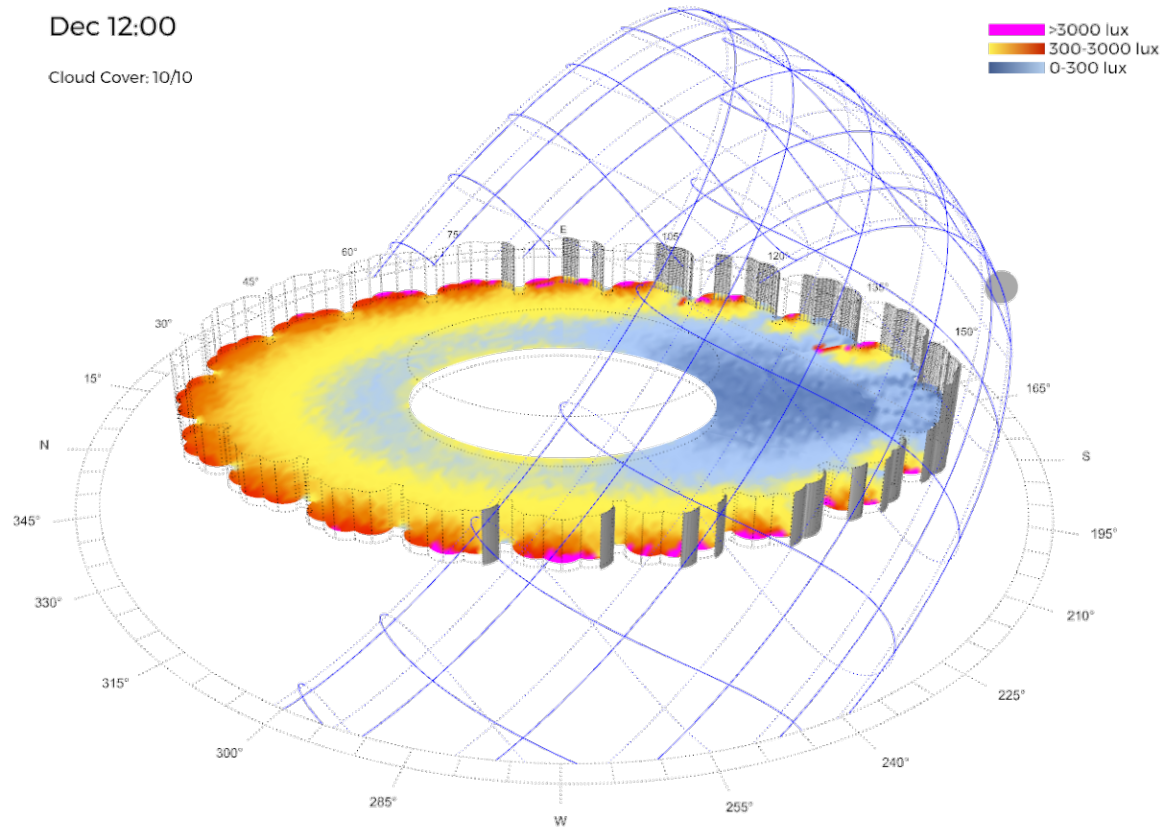
“Research shows that to a large extent employee well-being is a result of connecting the occupants of spaces within a building with the world outside.”

source: [www. metalsinconstruction.org/design-brief/](http://www.metalsinconstruction.org/design-brief/)

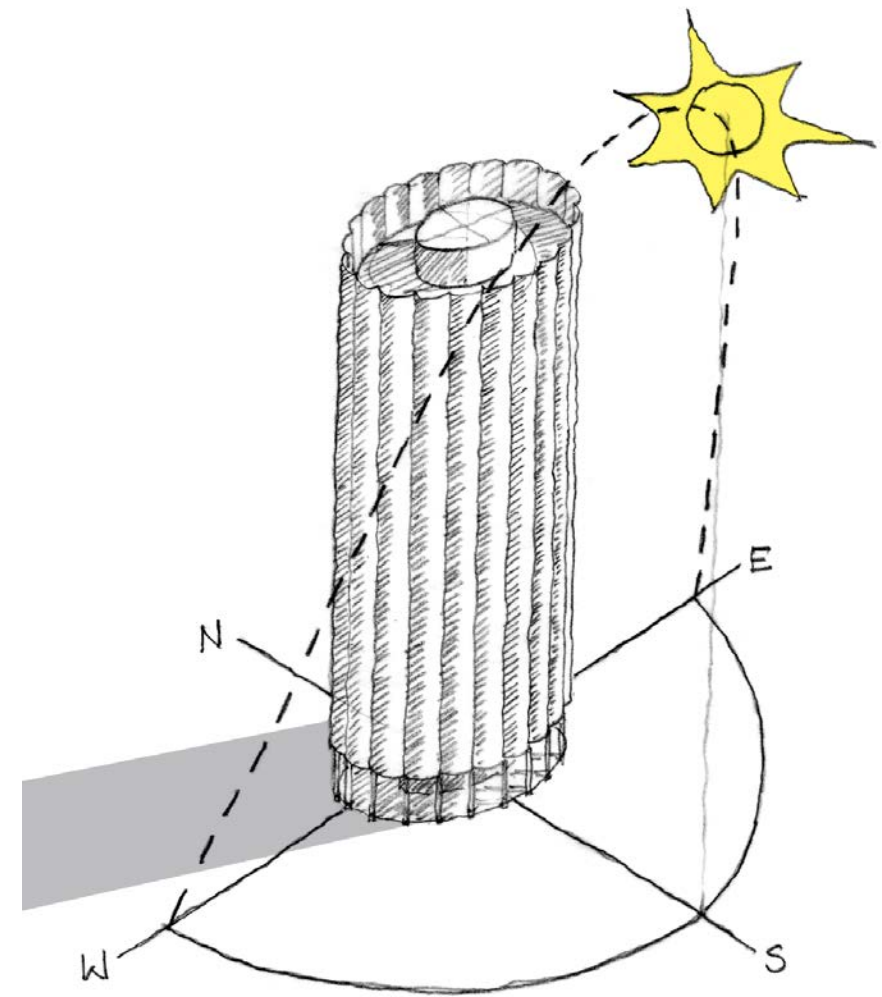


Dec 12:00

Cloud Cover: 10/10



Solar exposure– North-South orientation

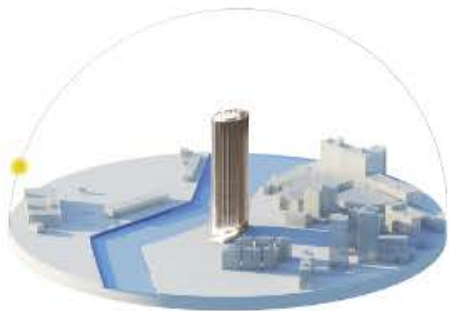


Arc of the Sun– study of West-East orientation

Symbol of Time

The symbol, the essence, of the circadian, daily cycle is the arc of the sun across the sky-- the yin-and-yang of day followed by night.

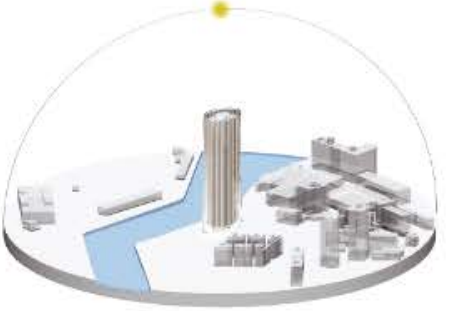




6 pm



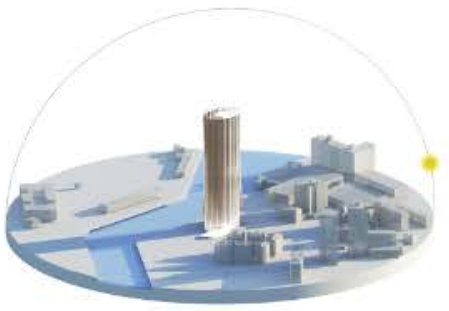
3 pm



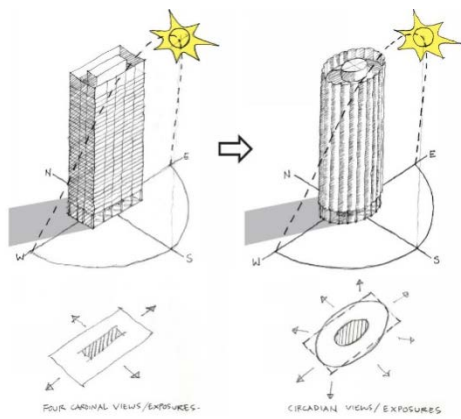
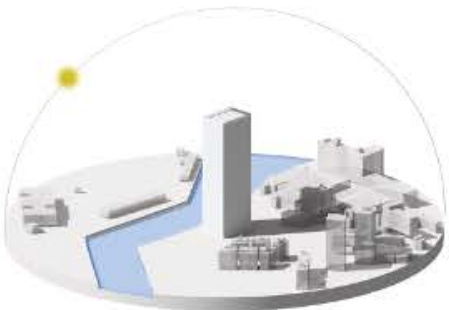
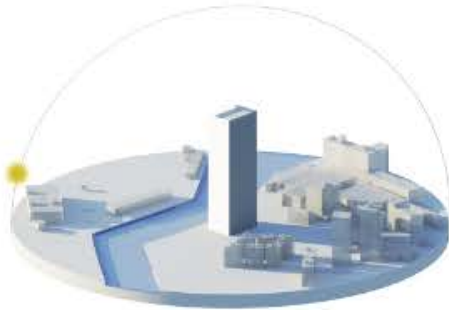
noon



9 am



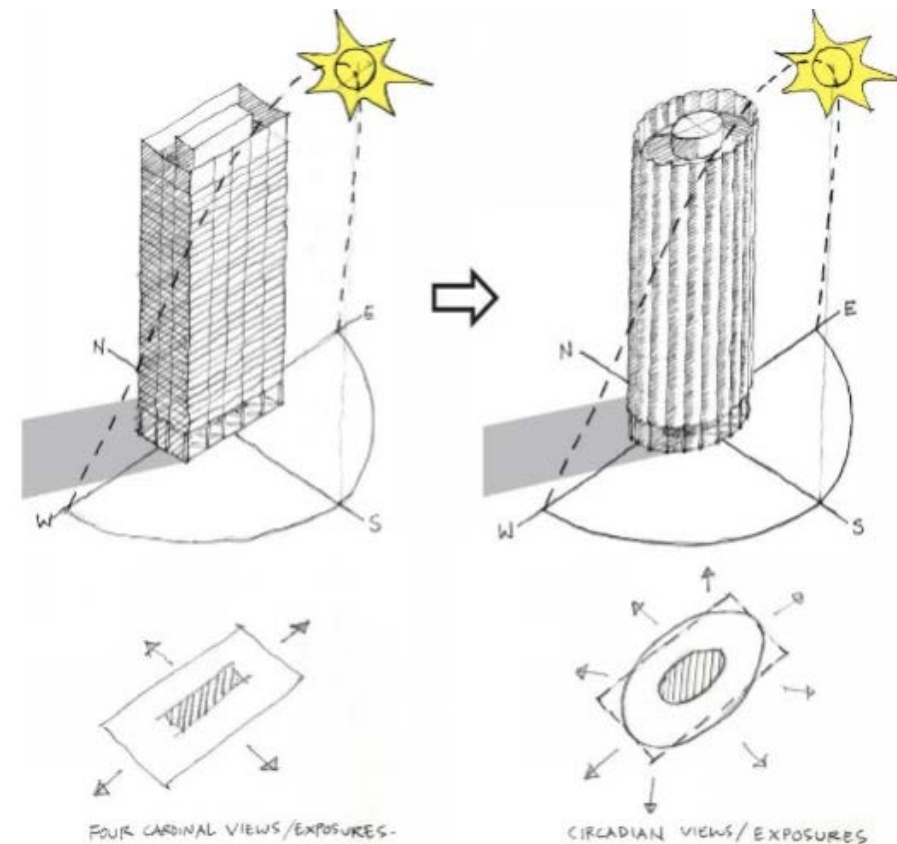
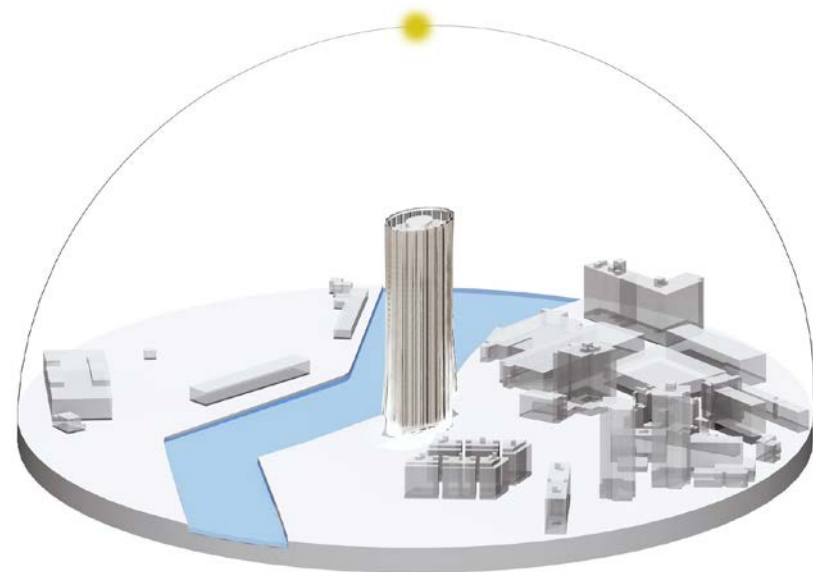
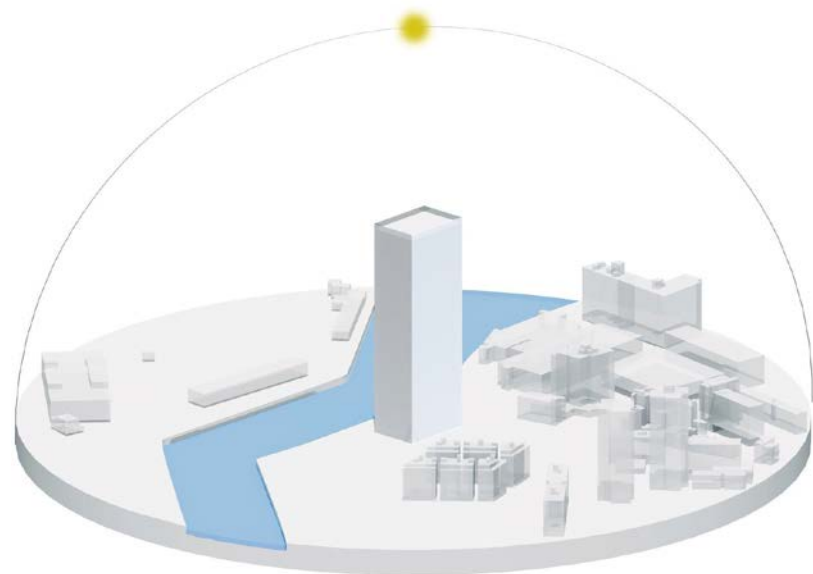
6 am



Circadian Rhythm

The fine-grain fluting of the Circadian façade produces a constantly changing pattern of light and shade.

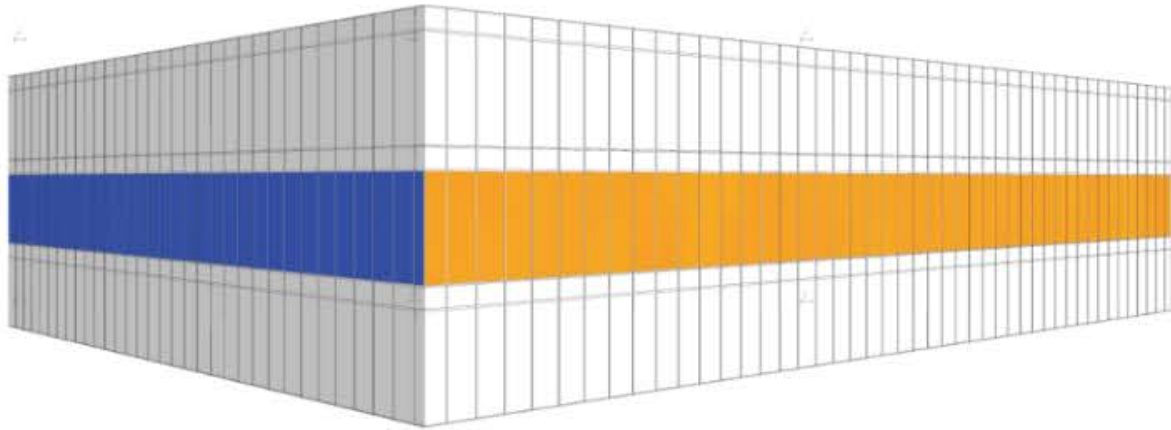
The conventional rectangular building's facades are either in direct sun or in shade, essentially. The building is visually static from the outside.



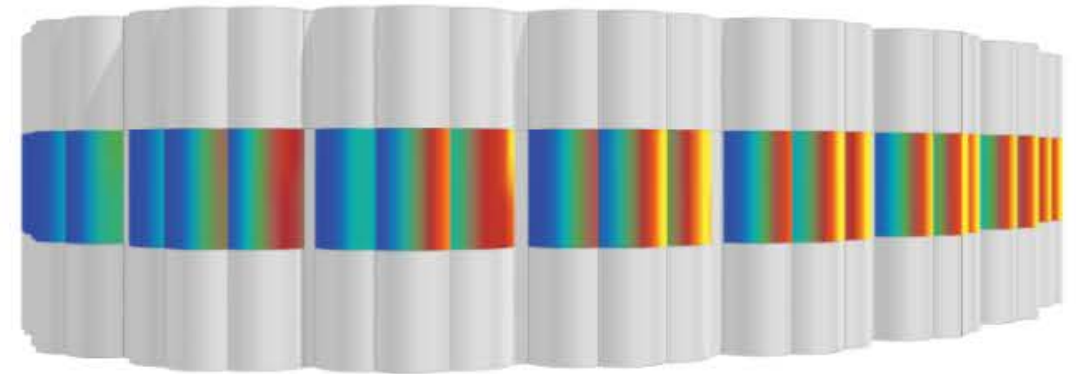
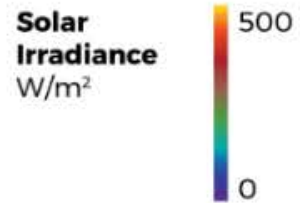
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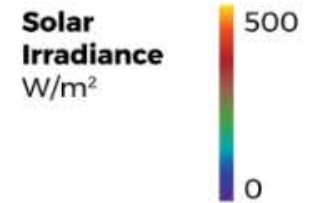
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Aug 21 11:00-12:00
Average Irradiance: 255 W/m²
Total Irradiance: 173,343 W

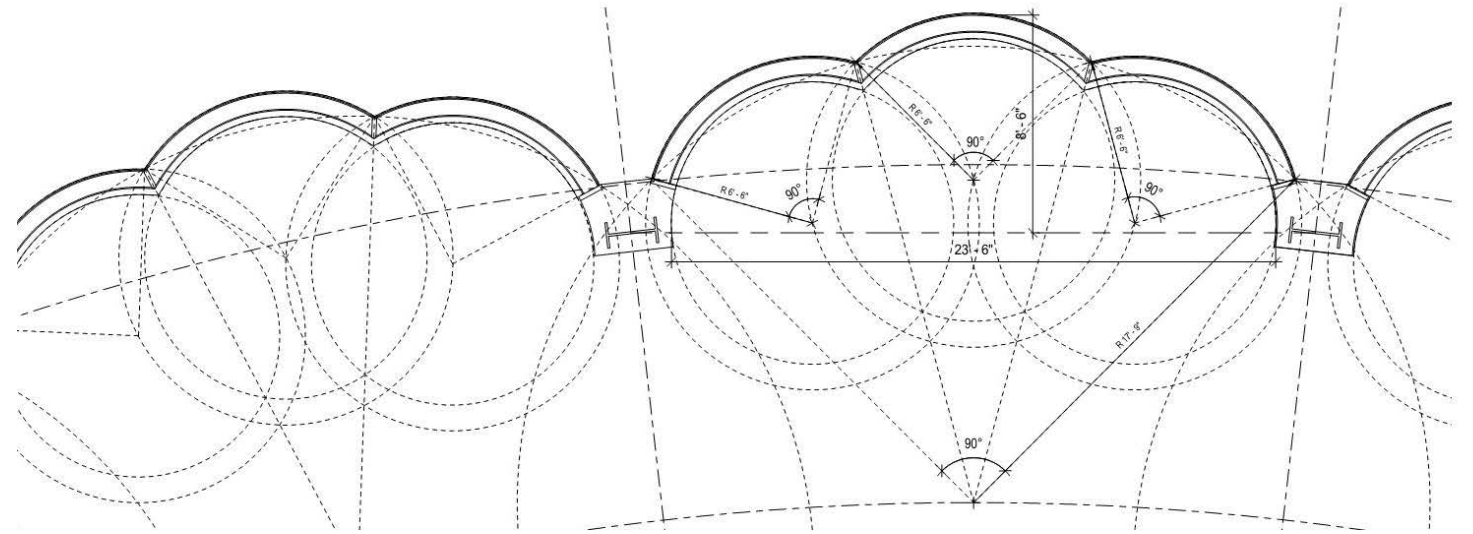


Aug 21 11:00-12:00
Average Irradiance: 234 W/m²
Total Irradiance: 168,325 W

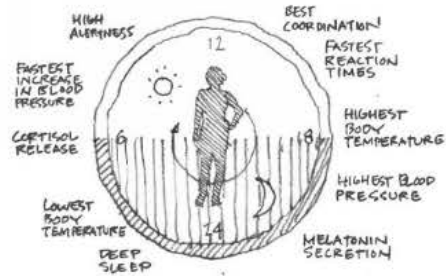




RESILIENCE BLOG
 2017.12.02
 - Modelled, Deep Surface
 - Curvatures, projects into
 Surroundly Space.



Circadian, latin *circa* + *dies* day



source: www.nobelprize.org

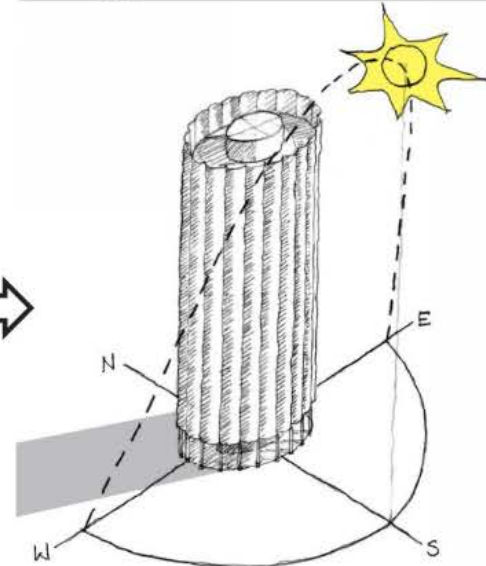
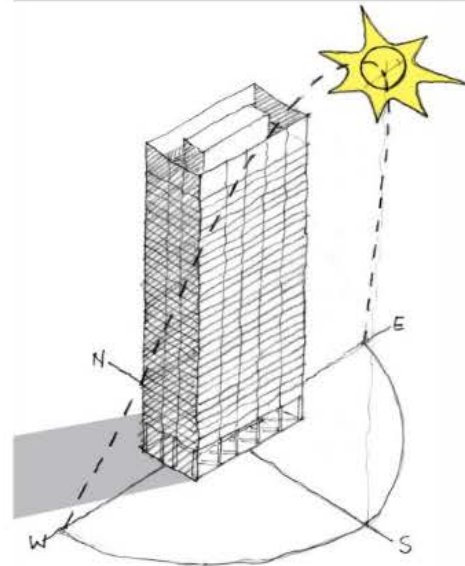


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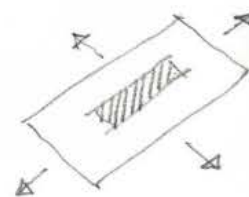
PROBLEM:

- Flat 'picture plane' view creates a separation between inside and outside, and limited field of view.
- Base case building is 120' x 180'. The program calls for 30 floors. Surface area is 270k sf.
- At any moment, the box is 50% self-shaded, but faces receiving direct sun require complete shading to control solar gain and glare.

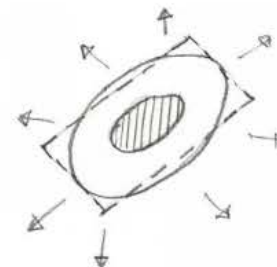


SOLUTION:

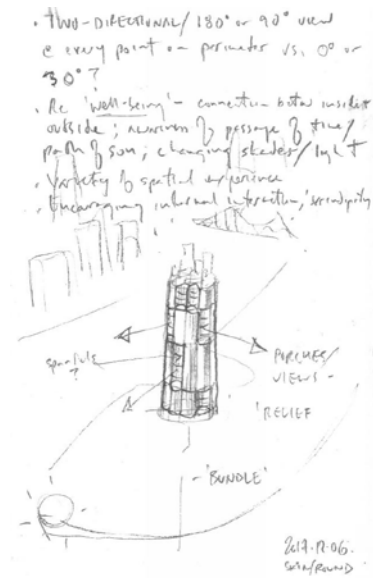
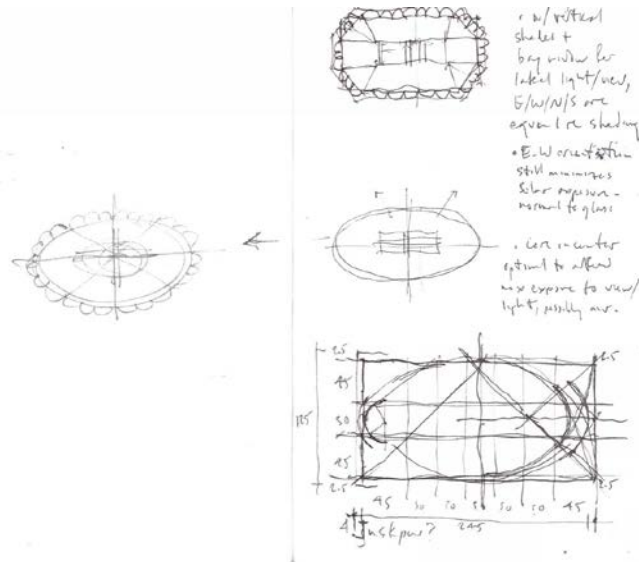
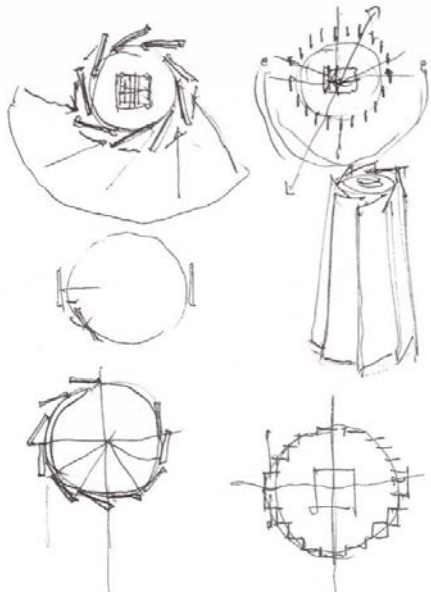
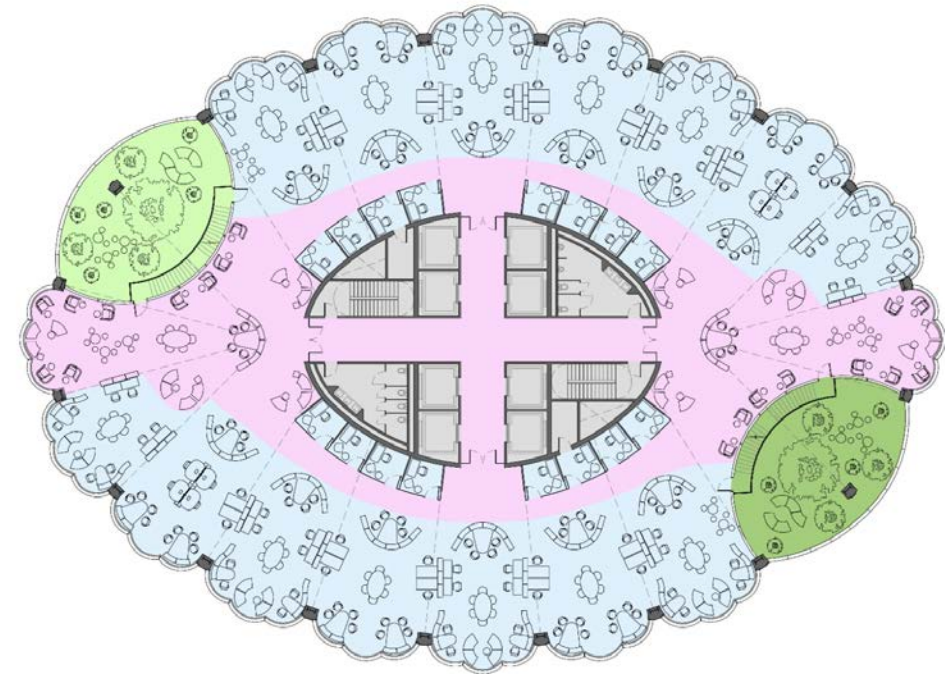
- Projecting bay windows create feeling of connection between inside and outside.
- Circadian Tower floor plate is ovoid with 153' x 212' limiting dimensions. Surface area is almost 290k sf.
- Curved bay windows are self-shading, creating shadow and relief on the building surface. At any moment, the tower is approximately 75% self-shaded. In each bay some glass may be unshaded to allow view and natural light without heat gain and glare.



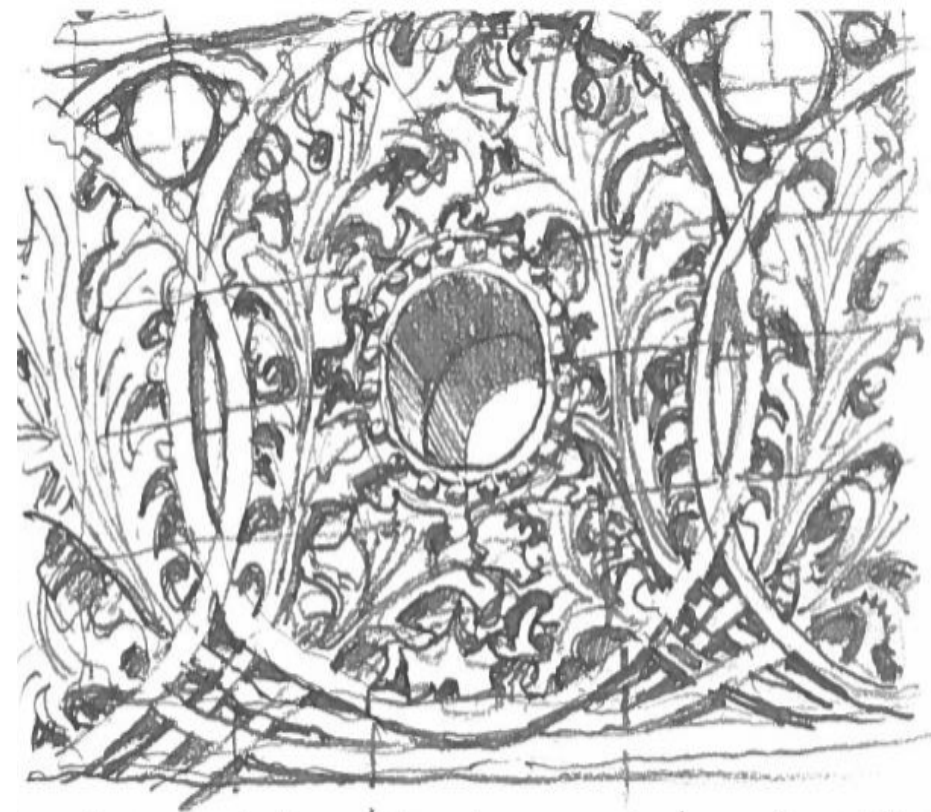
FOUR CARDINAL VIEWS/EXPOSURES-



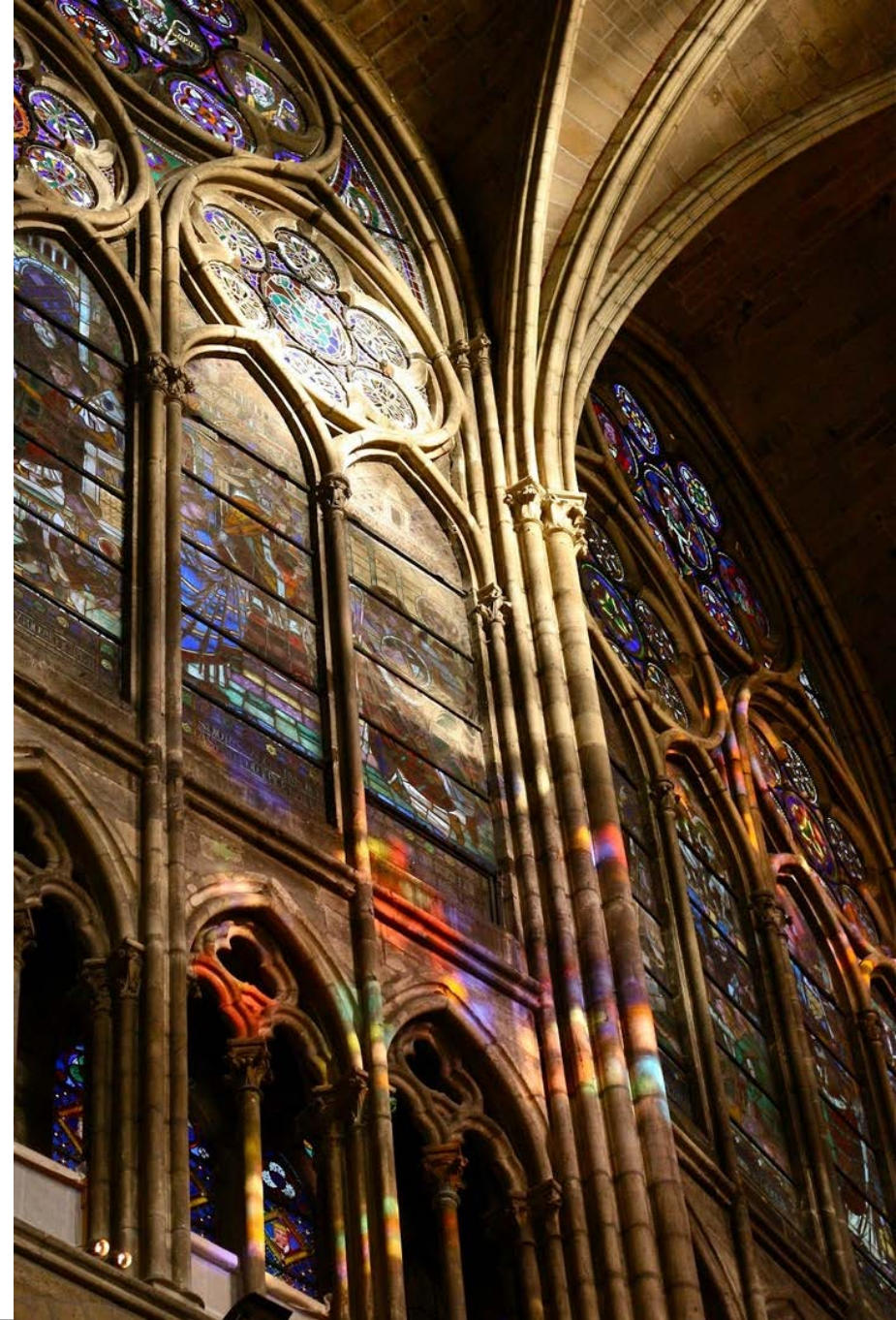
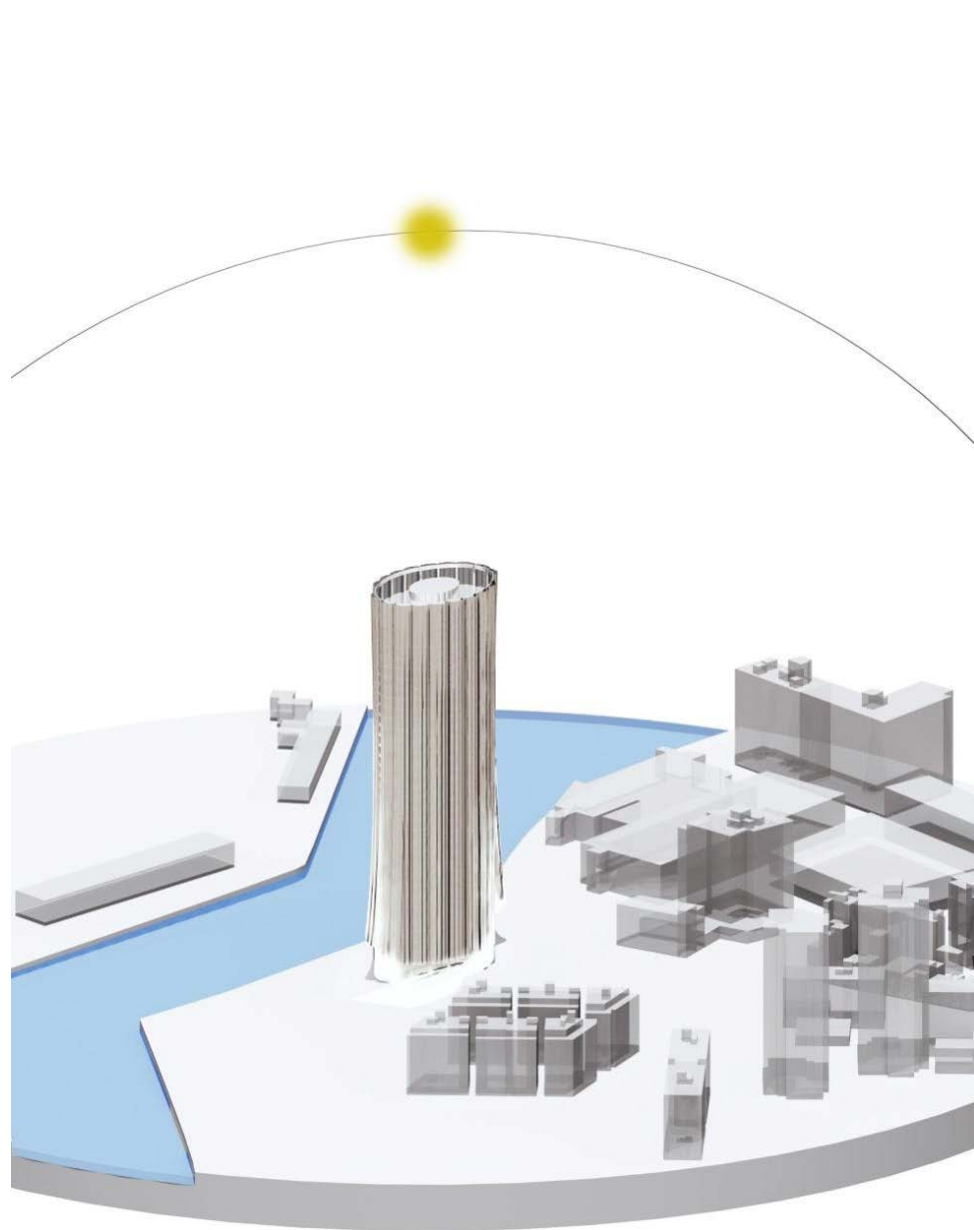
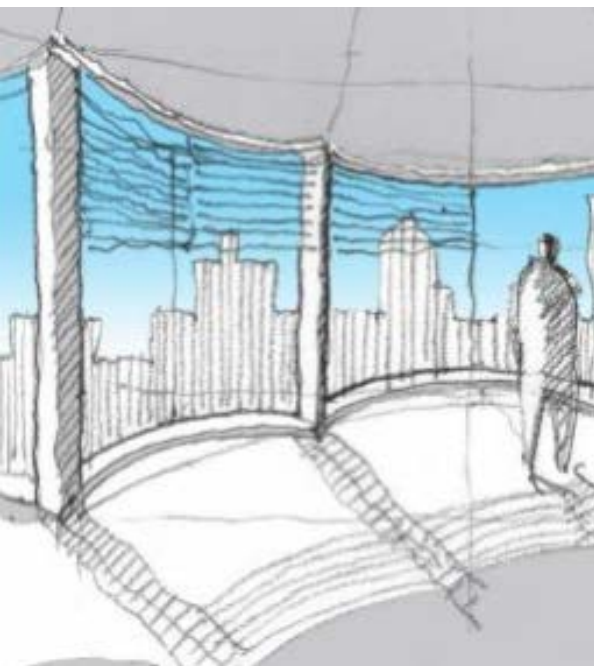
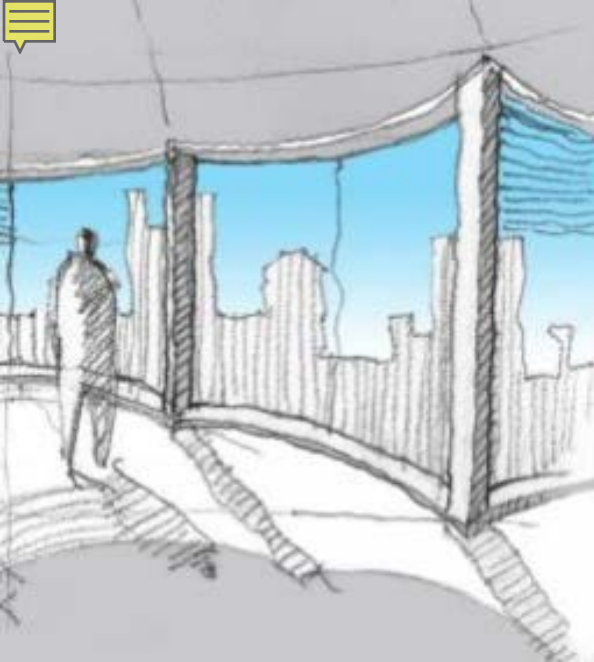
CIRCADIAN VIEWS/EXPOSURES

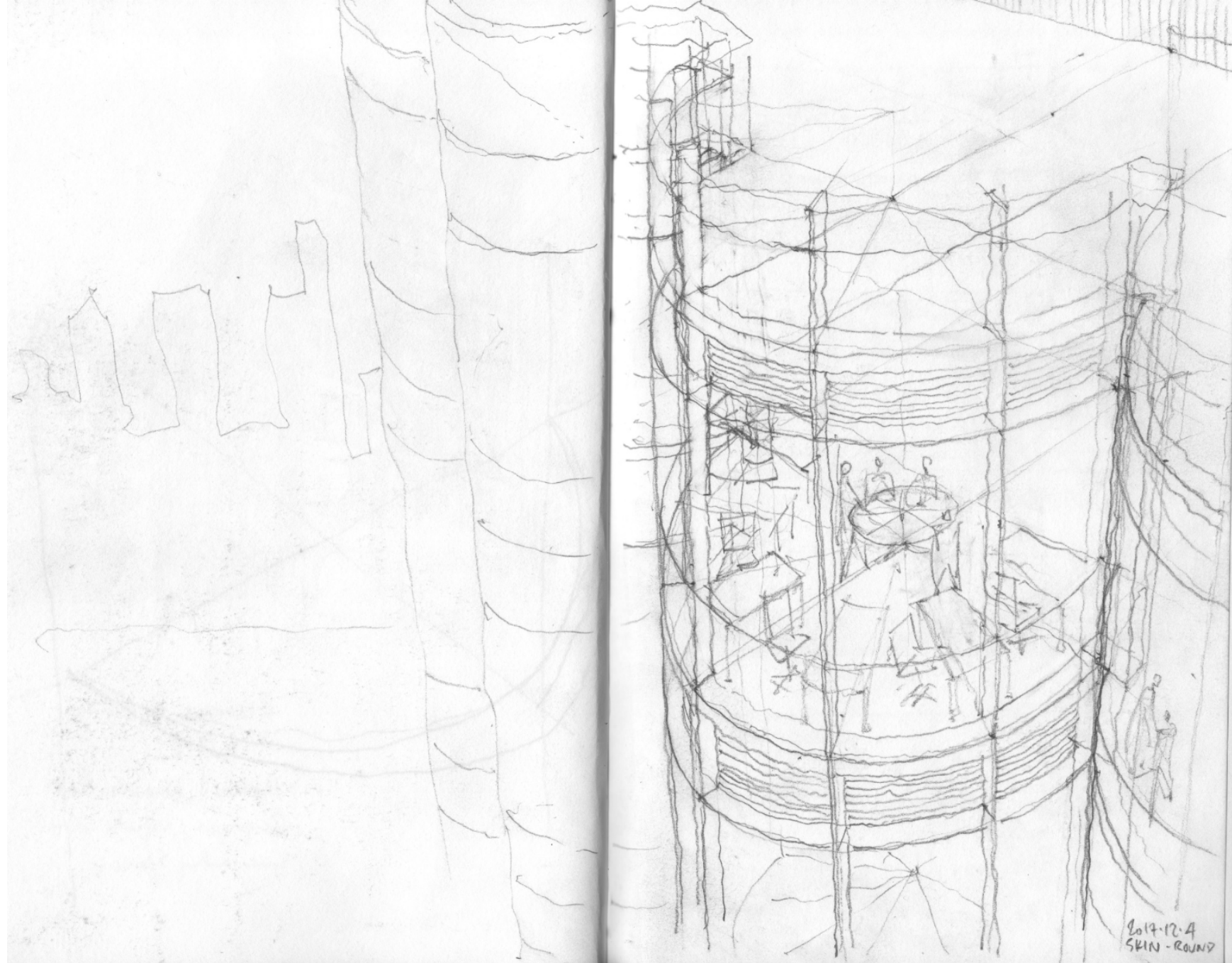


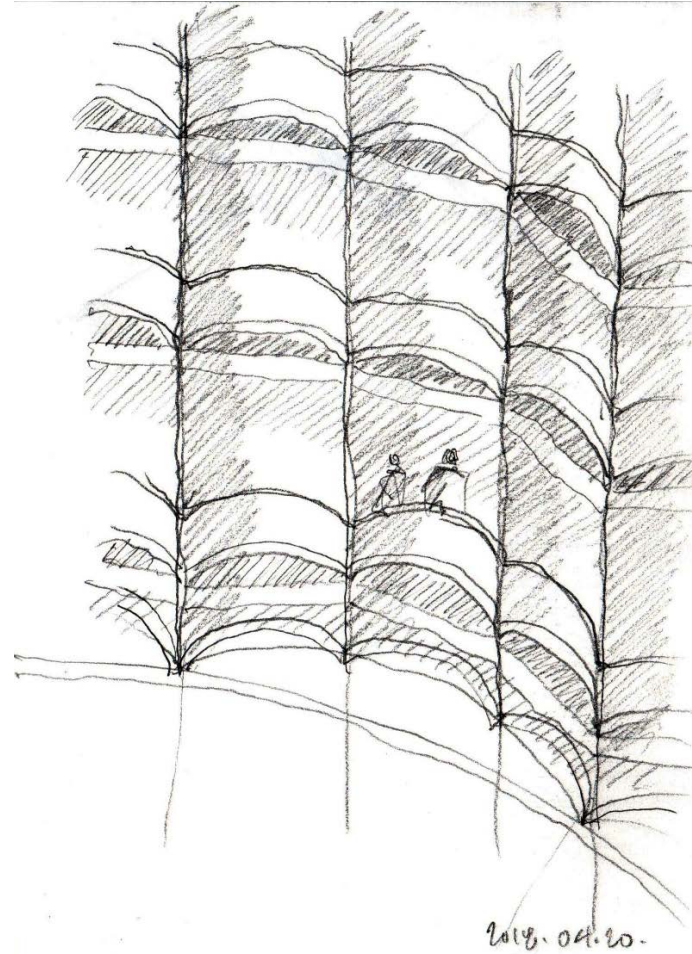
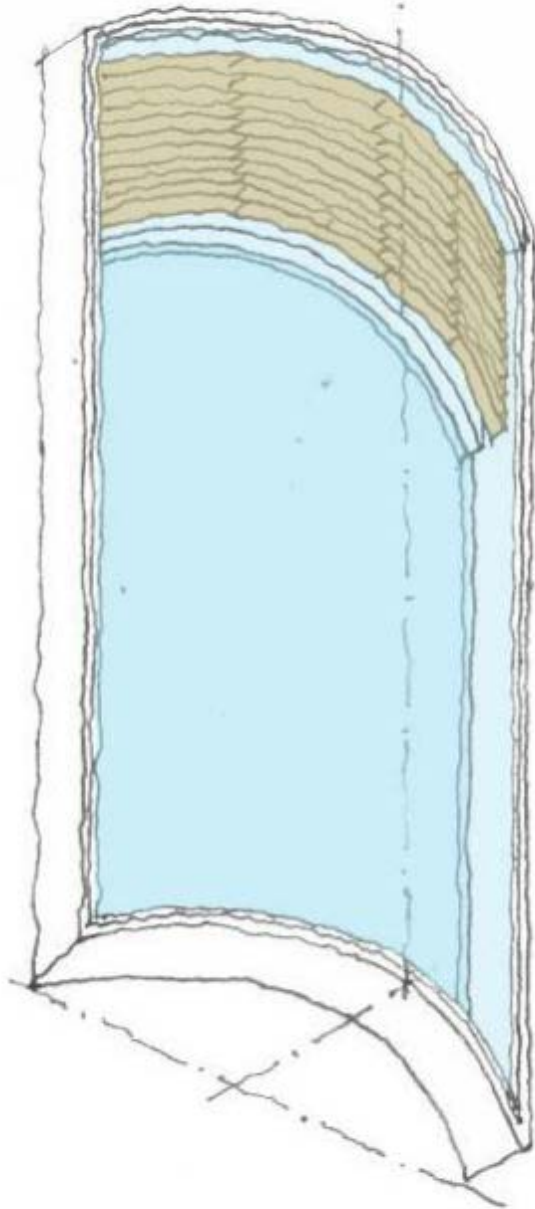
Development of the circular/rounded floor plate with petals or lobes creating a shaded facade.



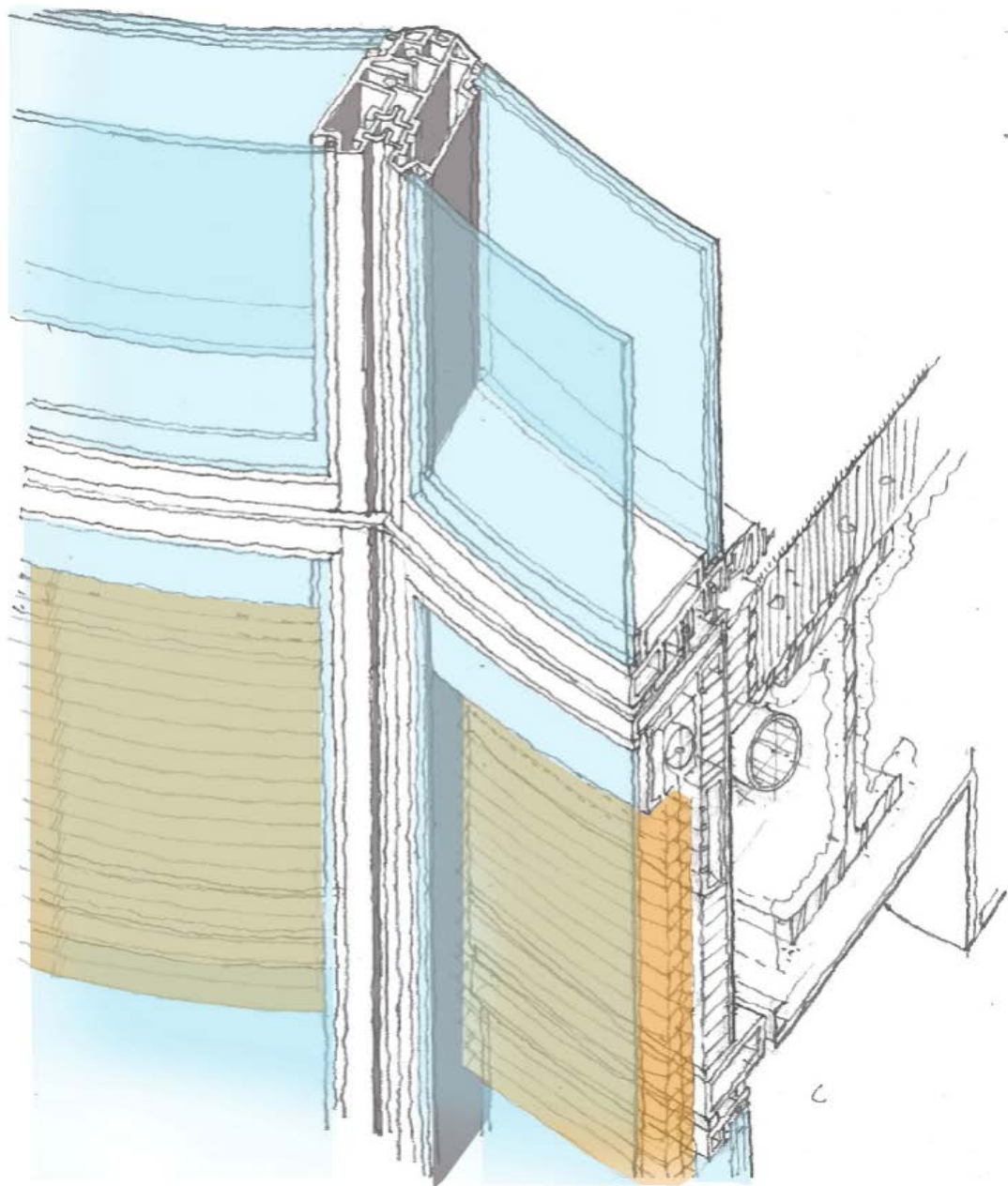
Sullivan - Wright - Cornice Windows 9104-'17





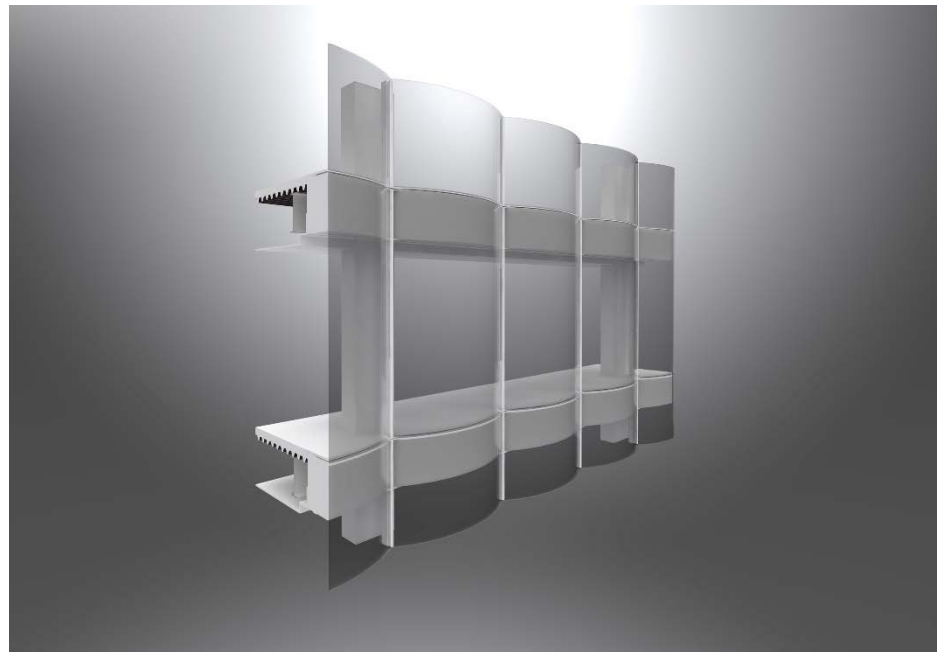
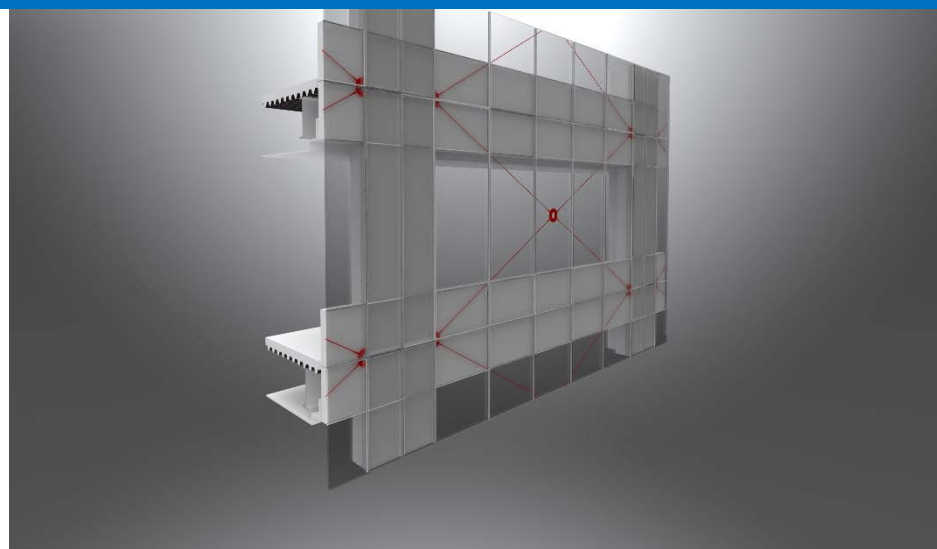


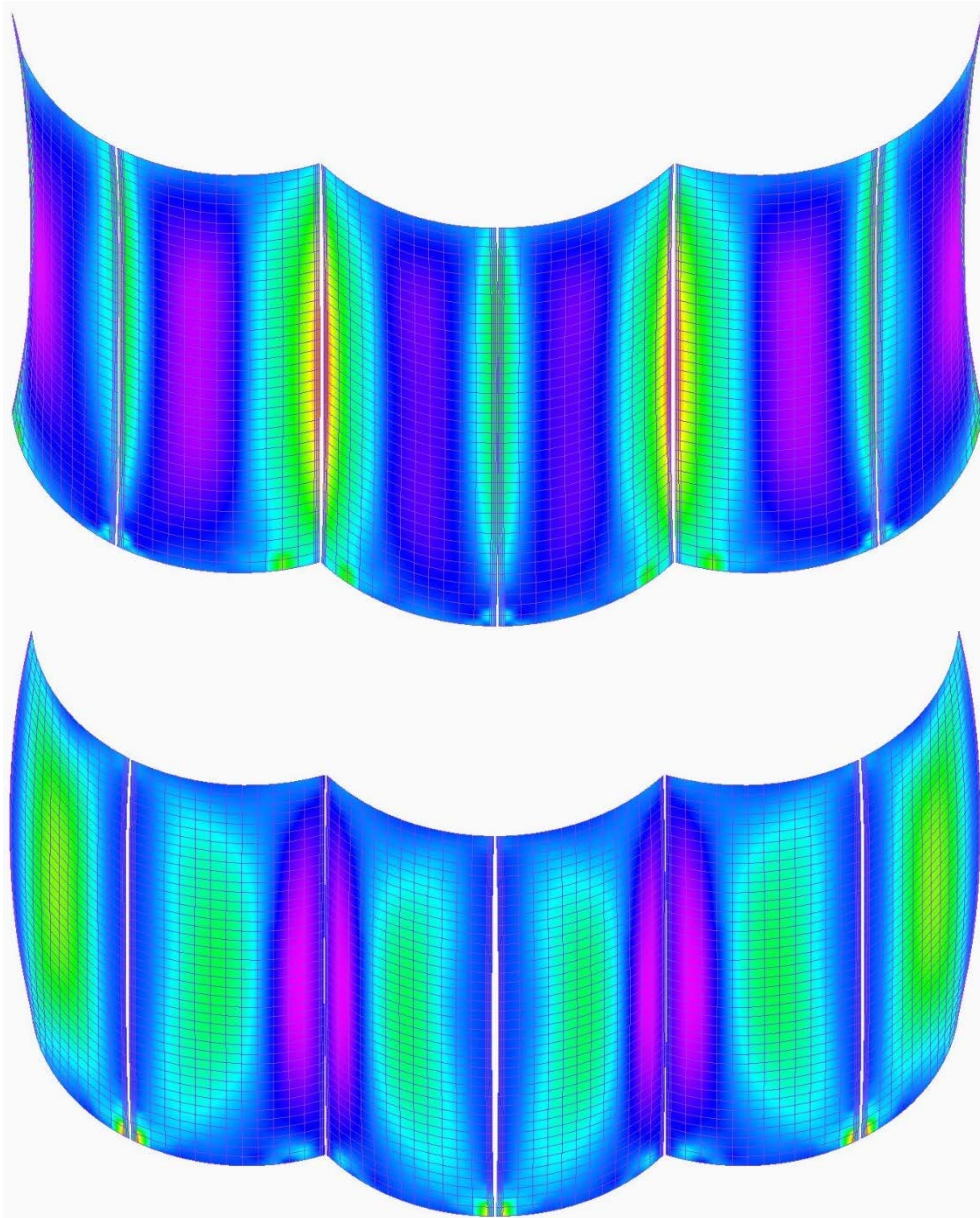
The energy required to operate the shades is much less than can be saved by reducing heat load from sun and from artificial lighting required when shades are down.



The closed cavity protects the automatic shades from dirt and breezes. The supply and return of heated air has practical challenges which explain the absence of this feature in closed cavity systems currently in use, but these seem solvable with development.

EMBODIED ENERGY/ TROMBE WALL HEAT RECYCLING





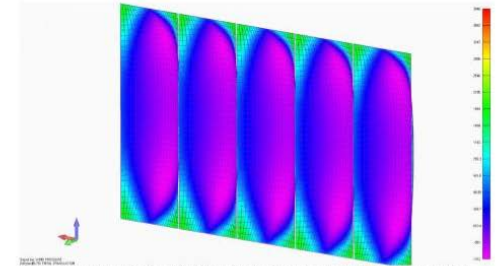
REDUCED EMBODIED ENERGY

Ultimately, Wellness depends on the health and ecology of our environment, and the experiential features of the Circadian facade must be governed by concern for material economy and minimizing embodied energy.

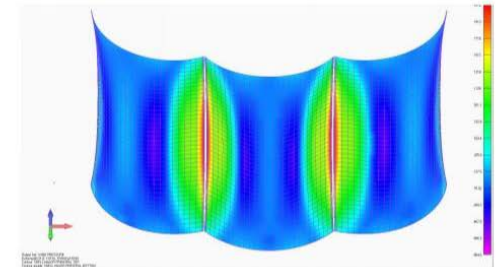
- The conventional curtain wall is made up of 5' wide x floor-height aluminum frames with glass infill. Mullions take wind load to the floors, requiring appr. 5 psf of aluminum.
- The Circadian Curtain Wall curved glass acts as a beam spanning floor-to-floor, leaving the unit frame as a chassis for weather seals, connections to the mechanical systems and firesafing. This tower has a surface area of approximately 300K sf. If aluminum is cut in half by use of the curved glass it saves almost 400 tons of aluminum. This is a significant amount of embodied CO2 equivalent.
- Structural savings is offset by the curved glass and shading controls and mechanical couplings for the filtered air. But these, combined with the self-shading form of the building generated by the bay-window, effectively eliminate solar gain through the facade, and allow indirect light which reduces heat load and energy use for artificial lighting throughout the day.
- Reduced carbon footprint and connection between the building occupant and the circadian rhythms of shades and lights synced to the time of day all contribute to occupant well-being.

Curved glass acts as a beam, allowing fewer, thinner mullions & savings of 400 tons of aluminum in the tower skin.

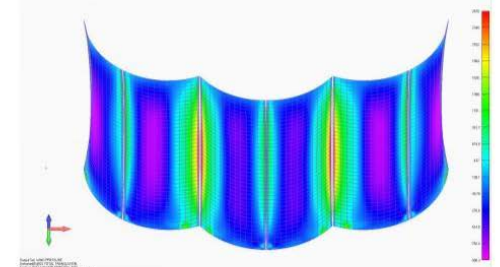
The curved bay windows are self-shading, allowing some shades to be up at all times on most bays and reducing reliance on artificial light.



- Structural analysis of 50 psf windload on conventional 5' x 15' units shows mullions are required to take wind load in order to limit deflection to acceptable maximum.

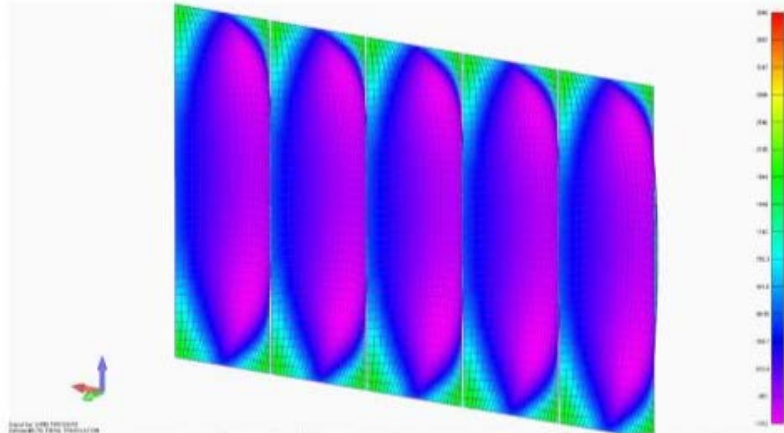


- Structural analysis of 50 psf windload on 10' x 15' curved lites in Circadian Curtain Wall units shows no mullions are necessary for structural purposes if glass is connected by structural silicone. Aluminum frames are included to provide housing for automated shades, and chassis for anchors and gaskets.

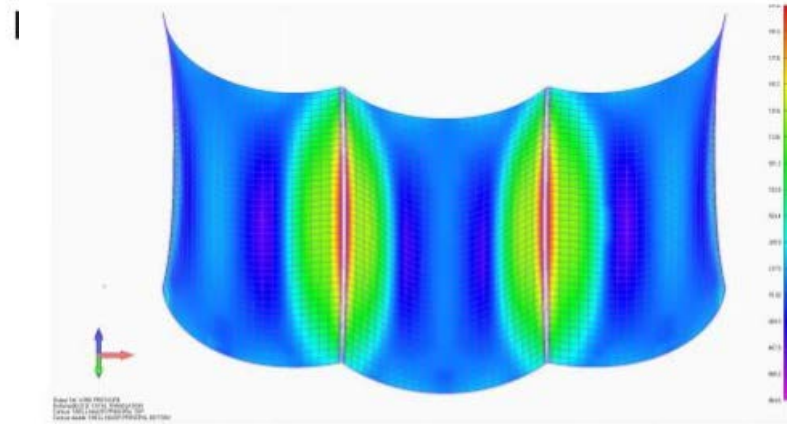


- Structural analysis of 50 psf windload on 5' x 15' curved lites in Circadian Curtain Wall units shows no mullions are necessary for structural purposes if glass is connected by structural silicone. The smaller glass is more economical, but there are more joints and seals.

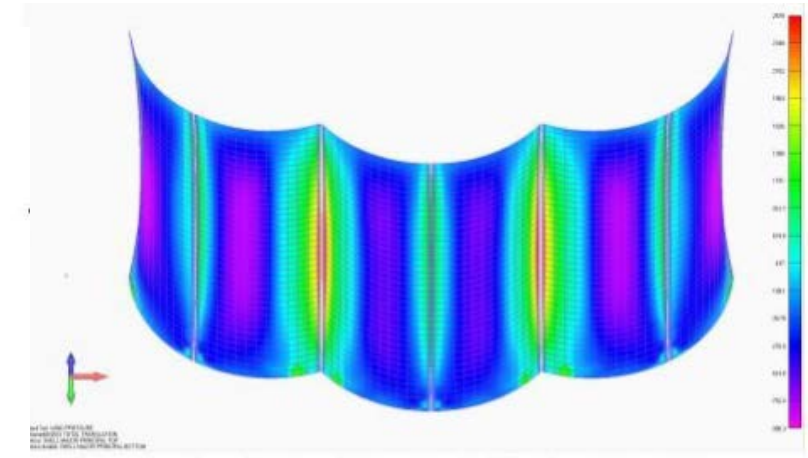
EMBODIED ENERGY/ TROMBE WALL HEAT RECYCLING



Structural analysis of 50 psf windload on conventional 5' x 15' units shows mullions are required to take wind load in order to limit deflection to acceptable maximum.



Structural analysis of 50 psf windload on 10' x 15' curved lites in Circadian Curtain Wall units shows no mullions are necessary for structural purposes if glass is connected by structural silicone. Aluminum frames are included to provide housing for automated shades, and chassis for anchors and gaskets.



- Structural analysis of 50 psf windload on 5' x 15' curved lites in Circadian Curtain Wall units shows no mullions are necessary for structural purposes if glass is connected by structural silicone. The smaller glass is more economical, but there are more joints and seals.

The elimination of 50% of the aluminum, offset by the addition of one layer of glass for the laminated lites, adds up to a savings, for approximately 300K sf of skin, of 3,645 tons of embodied CO₂.



Embodied CO₂

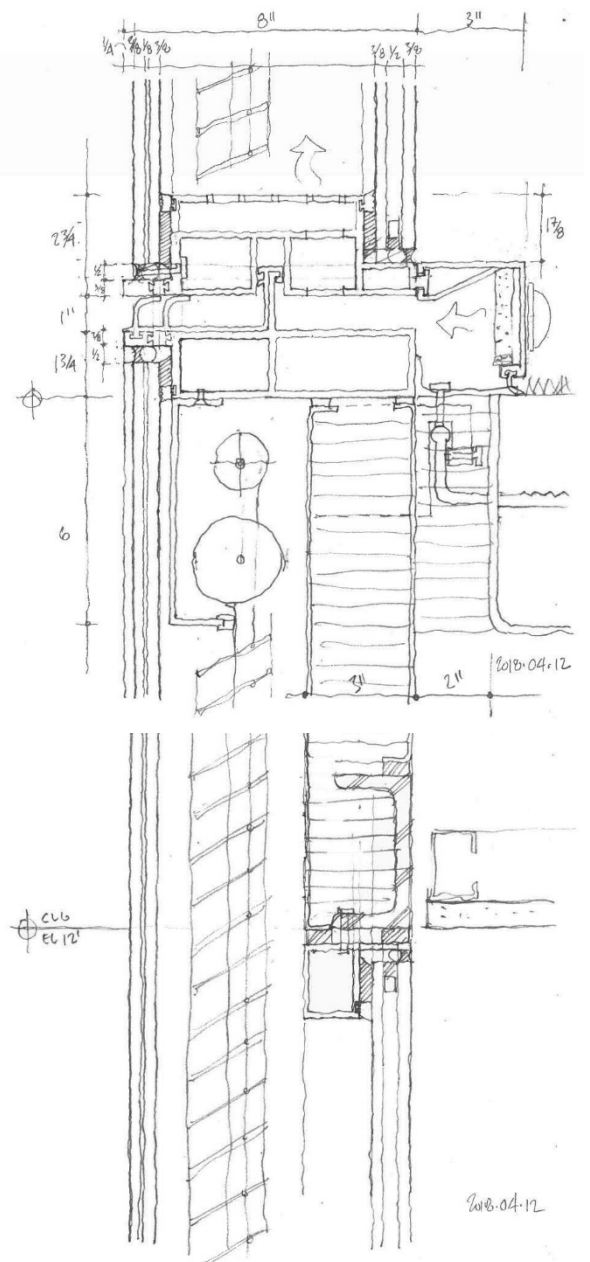
Saving **3,600** tons of embodied CO₂ equals:

- the output of burning 1260 tons of coal, **enough to heat about 300 homes** for a year
- Taking **760 cars off the road** for a year
- The amount of CO₂ that **17,490 trees** absorb in a year

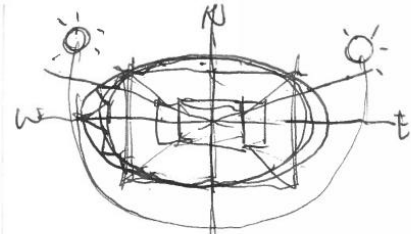
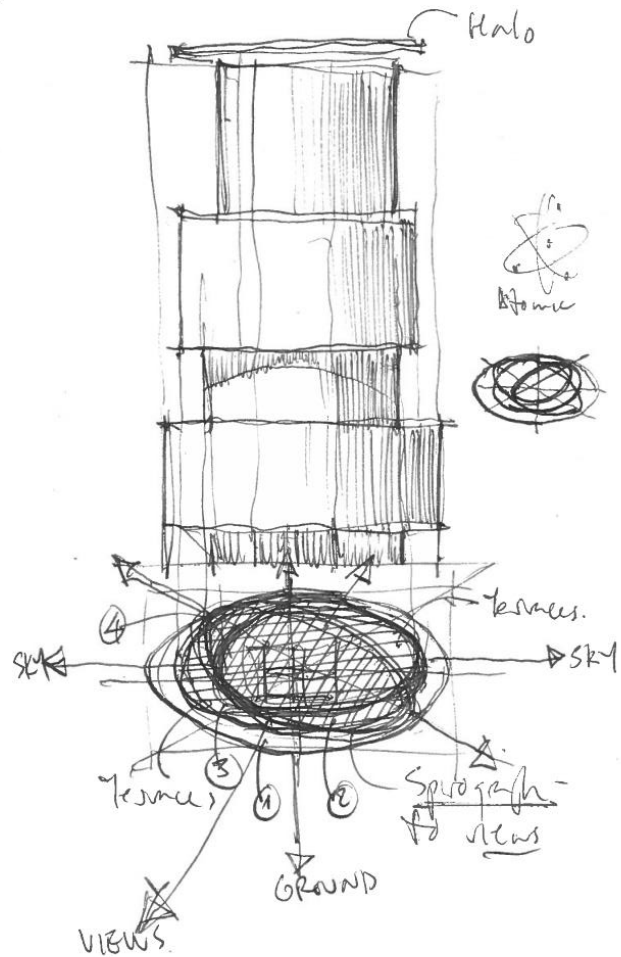
A given square-foot of average exterior then saves approximately 3 pounds of aluminum and costs 3 pounds of glass. On a per-ton basis, Glass costs .9 tons of CO₂ equivalent compared to 9 tons for Aluminum.

With approximately 300K sf of skin, this tower then could save appr. 3500 tons of embodied energy in CO₂ equivalent compared to the base case building.

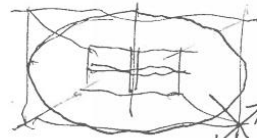
(300K x 3 x 9= 8,100,000 lbs CO saved, minus 300K x 3 x .9 = 810,000 lbs CO added, ttl= 7,290,000 lbs CO₂ saved (3,645 tons embodied CO₂). Source- ICE Database, U. of Bath.



I

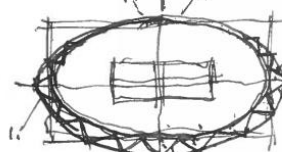


1. Maximize Southern Exp. for shading,
Minimize W/E -



MAX. PERIPHERAL
VIEW - BLOG IN THE POND

2. BLIND DEEP CORNER AREAS FOR DAYLIGHTING



'perimeter zone'
'range of views,
changing temp.'
1. light stained s/n

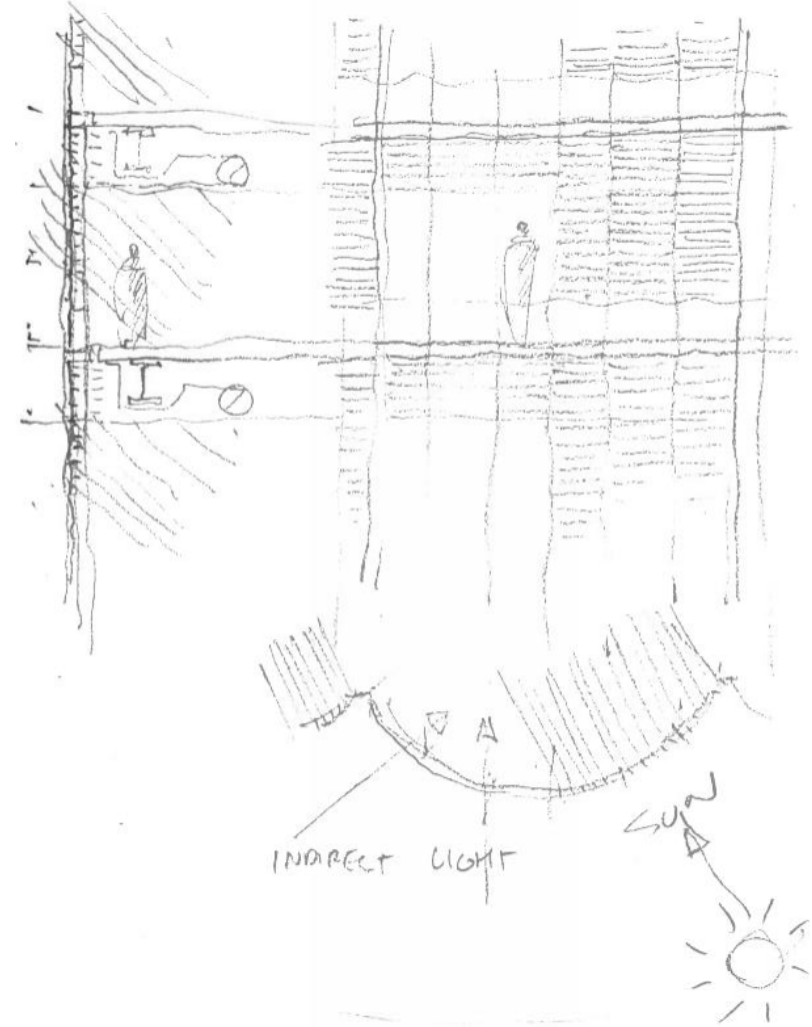
3. SHADING ZONE

2. Glass shaded
by overhang.



2017-11-09

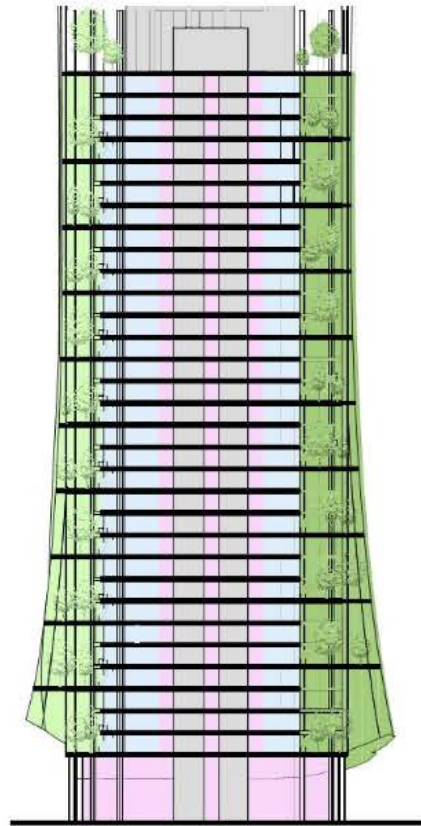
4. BOWL WINDOWS - INSIDE/OUTSIDE - MULTIPLE FLOOR



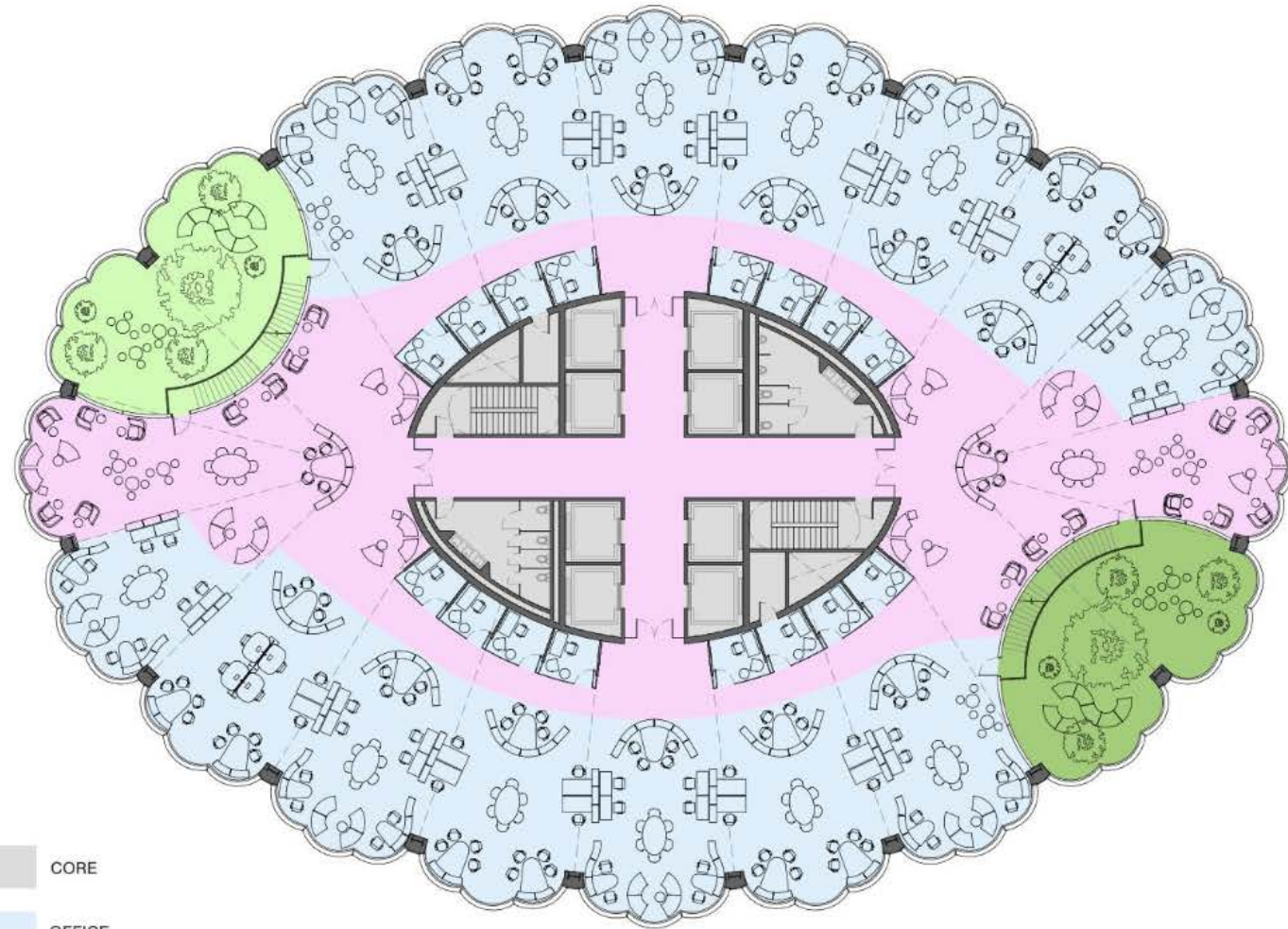
PLAN & SECTION

The 3-lobe cluster defines a space scaled to the most effective group size for creative collaboration. Almost every point on the floor can see the two atria, providing polar orientation.

The North and South Atria bring the outside inward. The Atria provide gardens connecting to the roof, with rejuvenating plants, fresh air and water features.

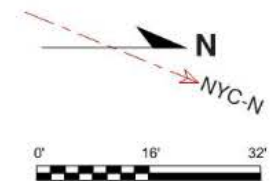


S-N SECTION



- CORE
- OFFICE
- CIRCULATION/
BREAKOUT SPACE
- SOUTH ATRIUM
- NORTH ATRIUM

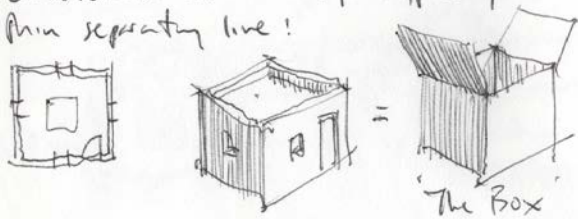
TYPICAL FLOOR PLAN



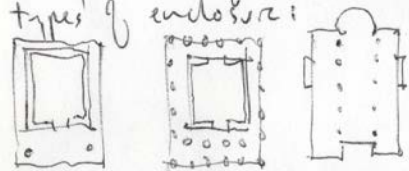
I Inside/Outside -

2017.11.09/9

• Enclosure in modern bldgs typically a thin separating line!



• Historical/Vernacular Architecture provides many models of more integrative, gradual types of enclosure:



Megaron

Peristyle

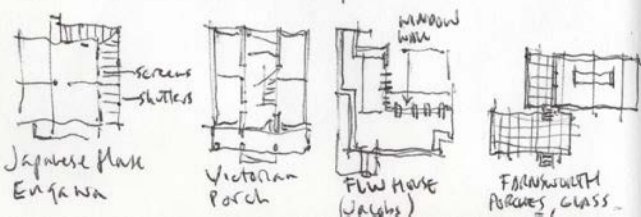
Basilica

Gothic Cathedral

- transitions are interior

- deep walls/piers/buttresses
- dissolve

• Markers: entrances, windows, porches.



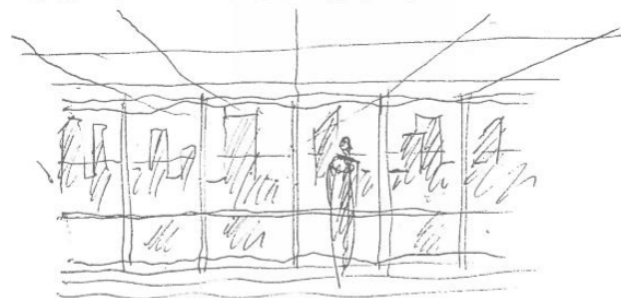
Japanese Mark Enjama

Victorian Porch

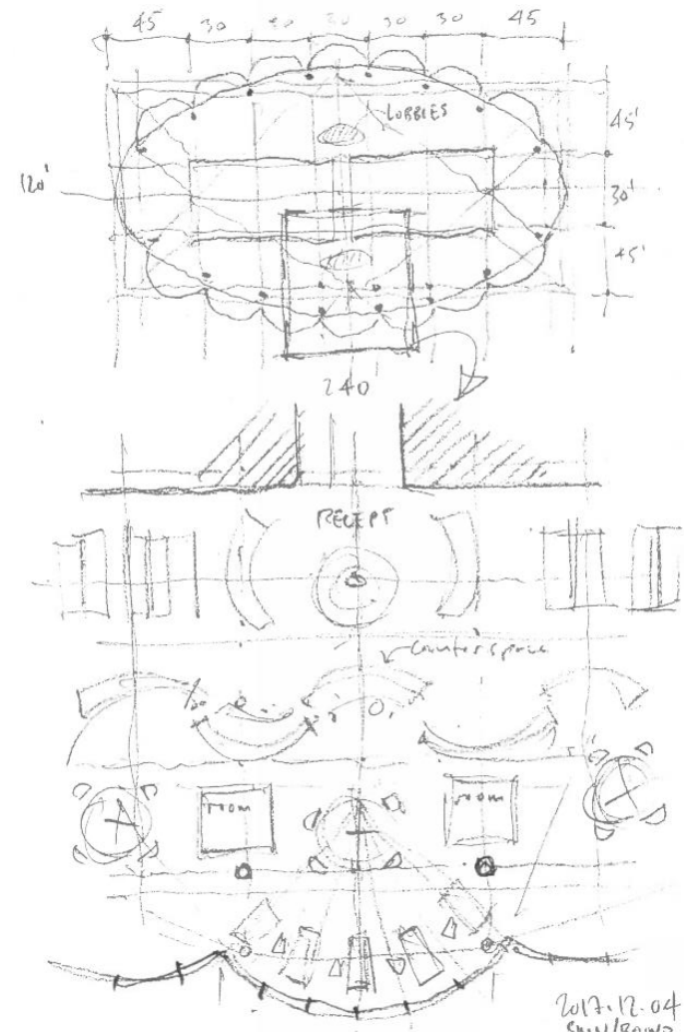
Fluv Home (Watches)

Fluv Home with Porches, Glass

• Conventional FLAT FACADE

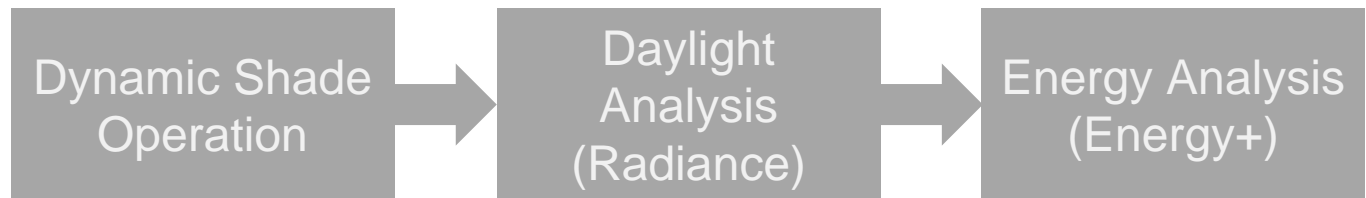
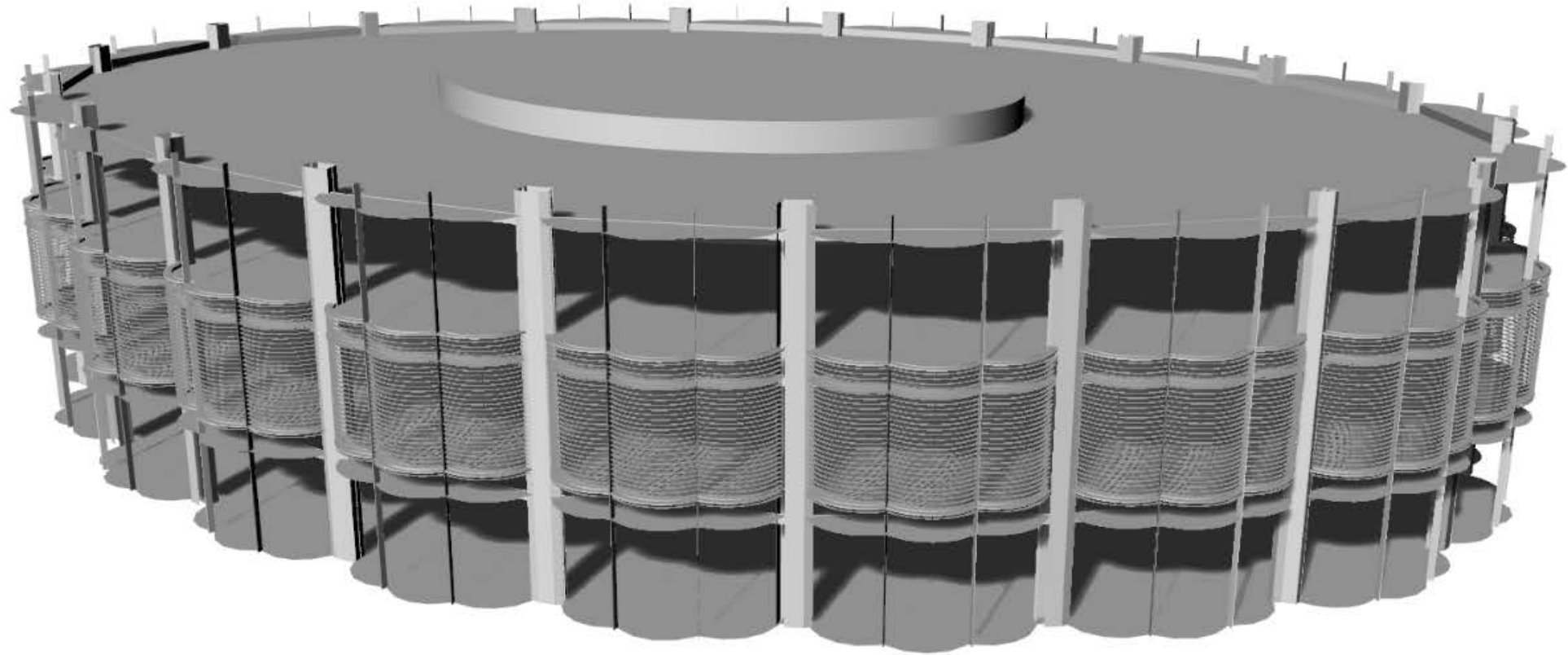


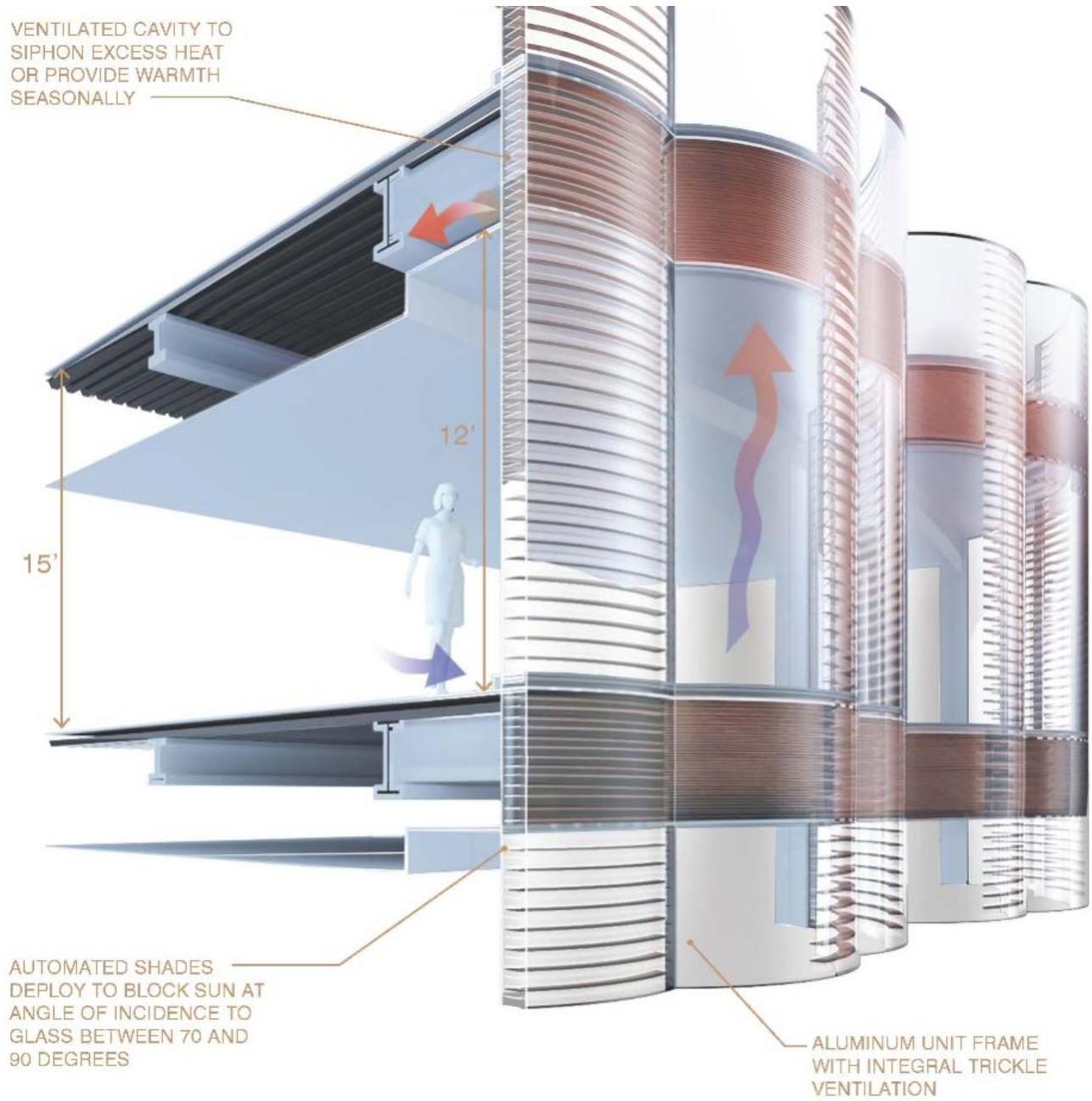
• View is defined by the Picture Plane of the Curtain Wall, and by the Mullion
• SHADE EITHER ALL OR NOTHING
• First High Rise buildings seemed to recognize this, incorporating the Box Window of the Chicago School



2017.12.04
Chris Brown





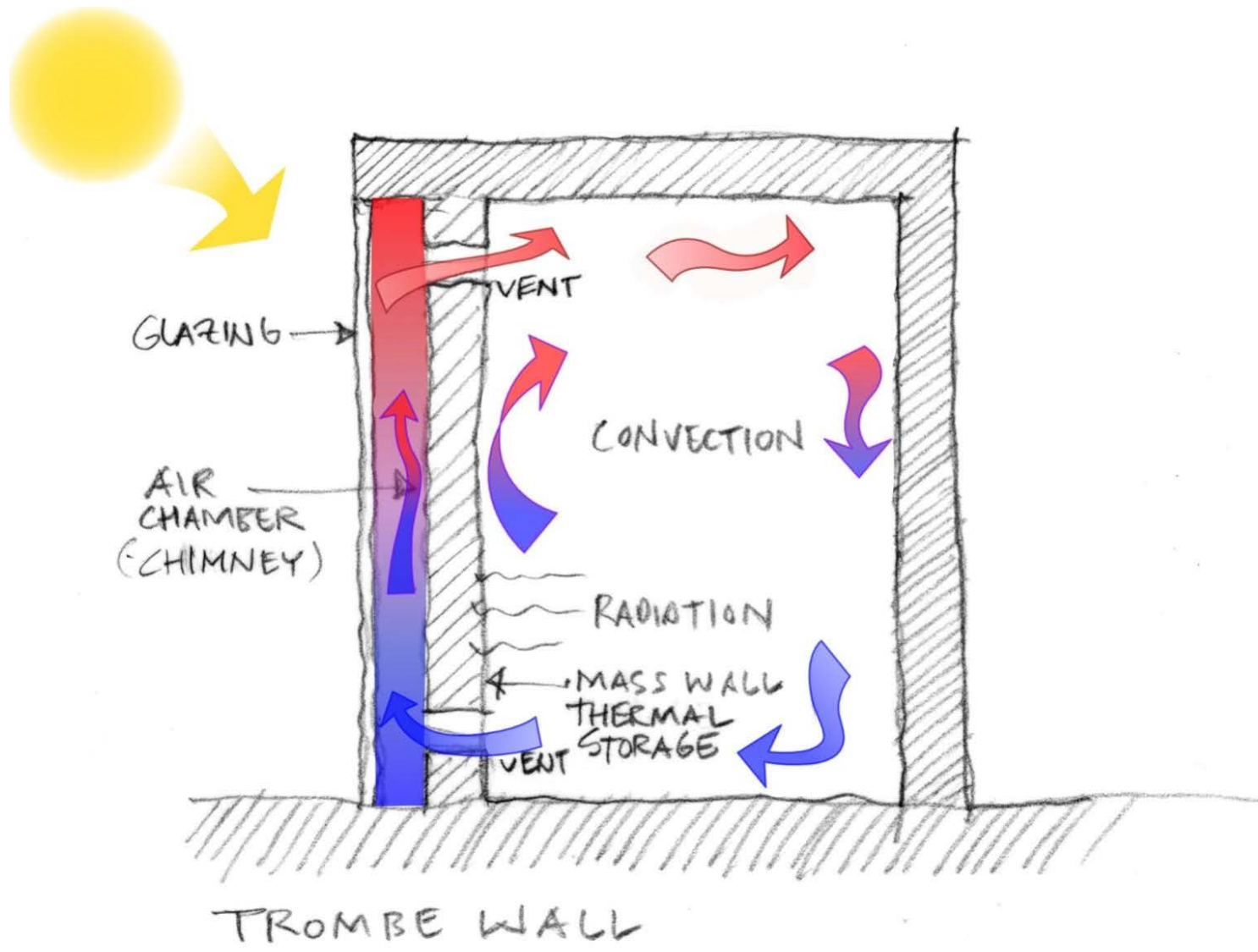


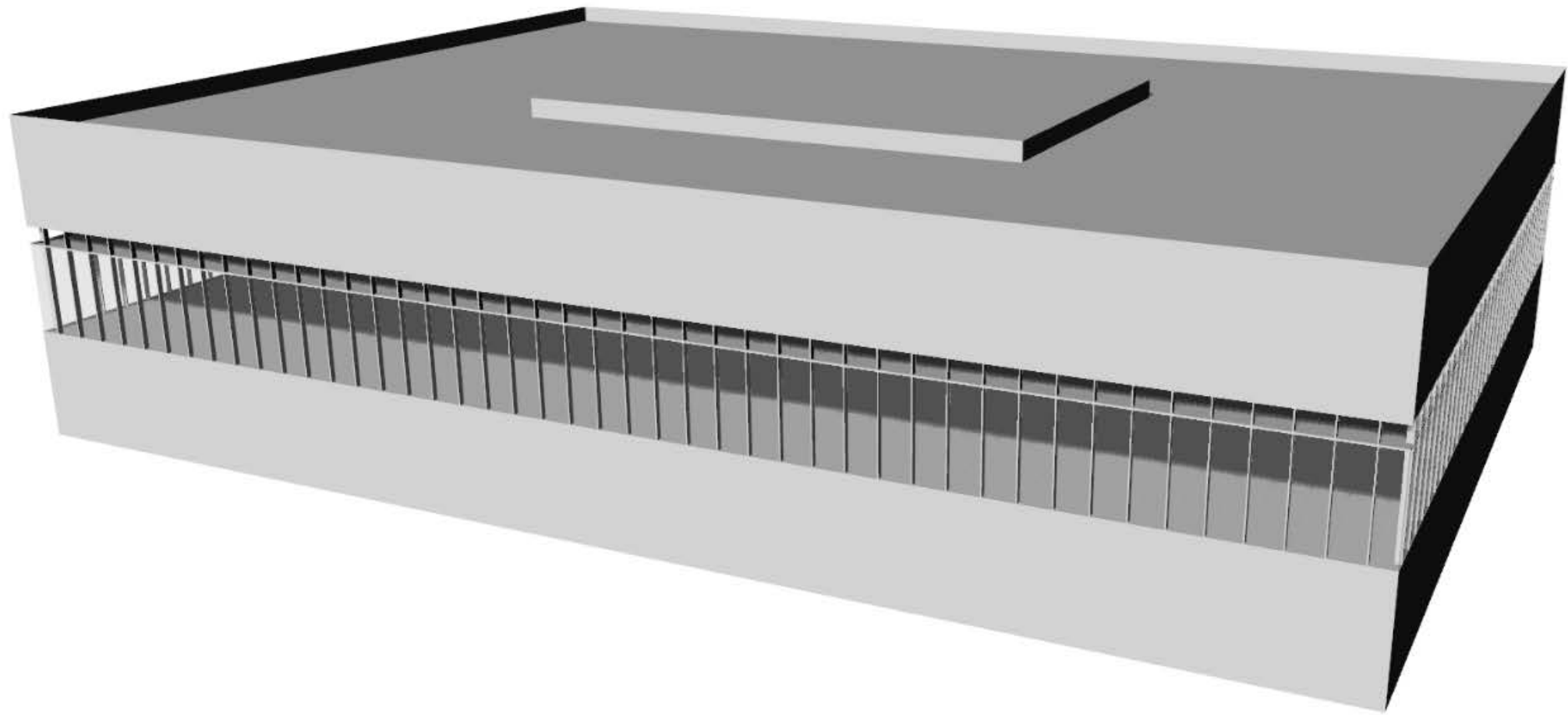
VENTILATED CAVITY TO SIPHON EXCESS HEAT OR PROVIDE WARMTH SEASONALLY

12'
15'

AUTOMATED SHADES DEPLOY TO BLOCK SUN AT ANGLE OF INCIDENCE TO GLASS BETWEEN 70 AND 90 DEGREES

ALUMINUM UNIT FRAME WITH INTEGRAL TRICKLE VENTILATION







RHINO

- Model Geometry
- Zoning and Lighting Groups



GRASSHOPPER

- Thermal and Optical Parameters
- Dynamic Blind Operation
- Post Processing, Results, and Visualization



DIVA

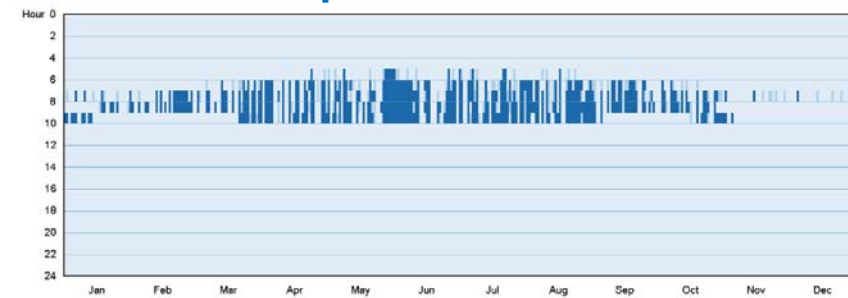
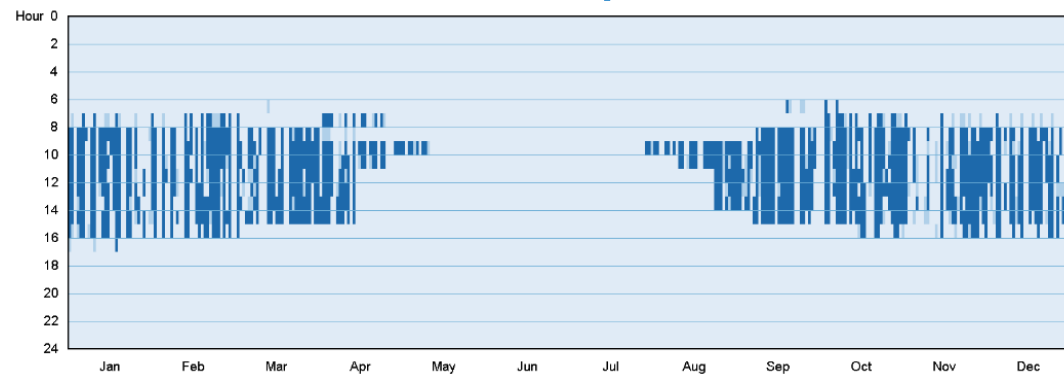
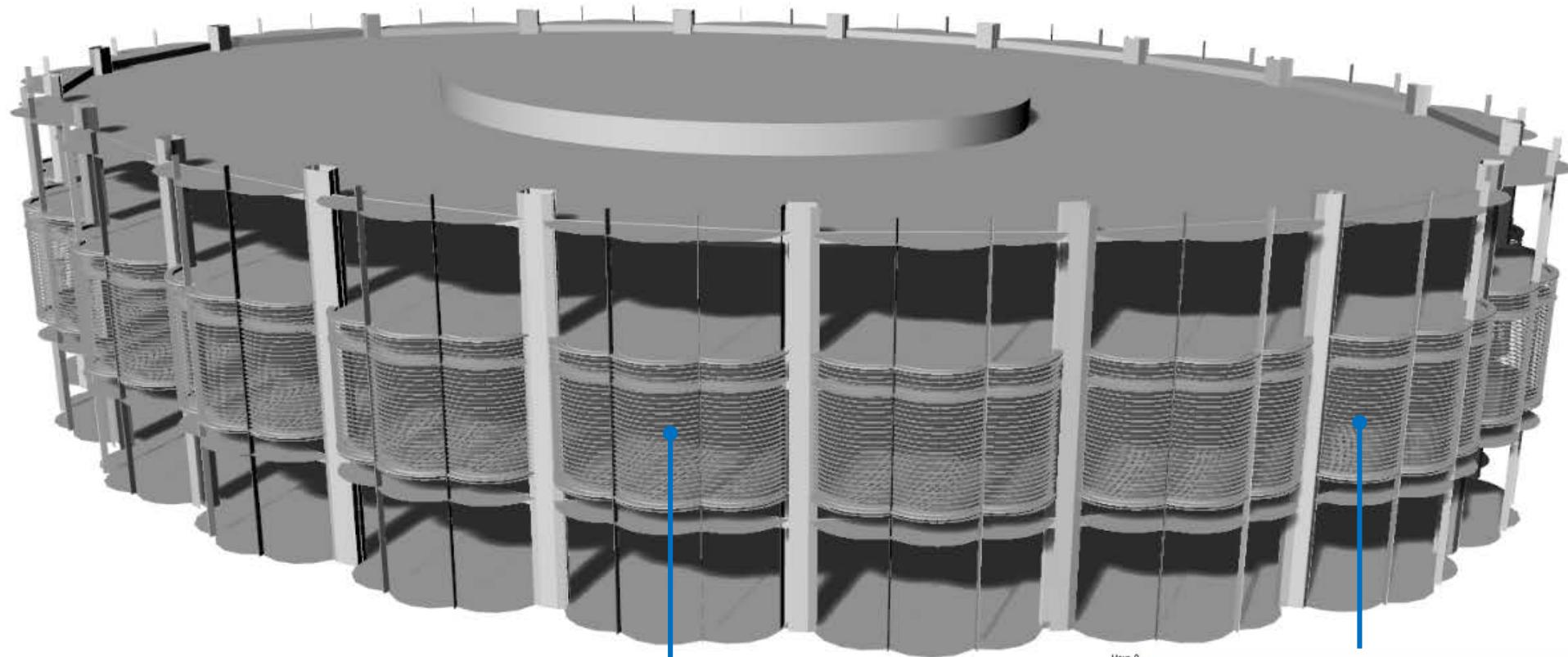
- Annual Daylight Simulation



HONEYBEE

- Energy/Hourly Load Simulation

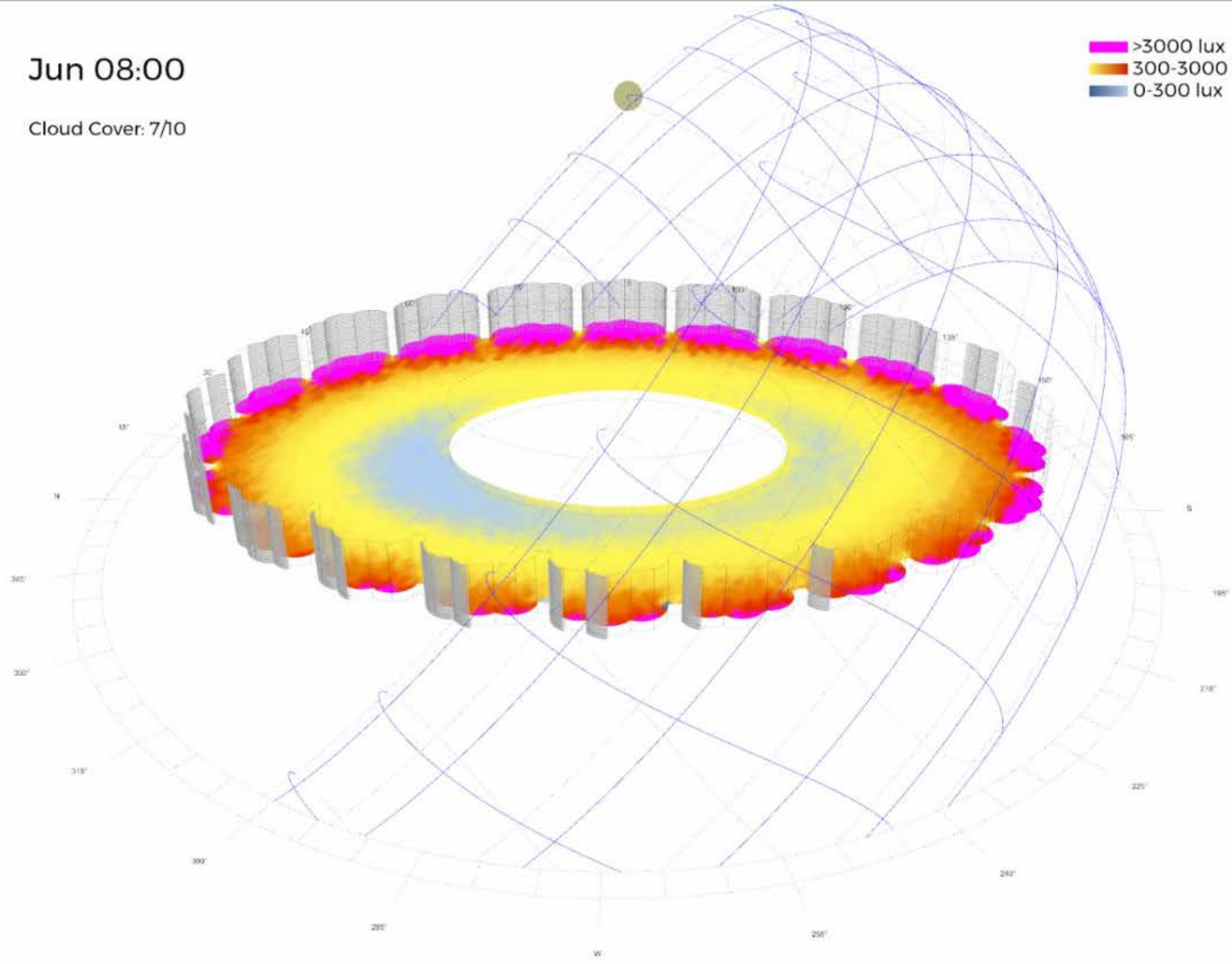




Jun 08:00

Cloud Cover: 7/10

>3000 lux
300-3000 lux
0-300 lux

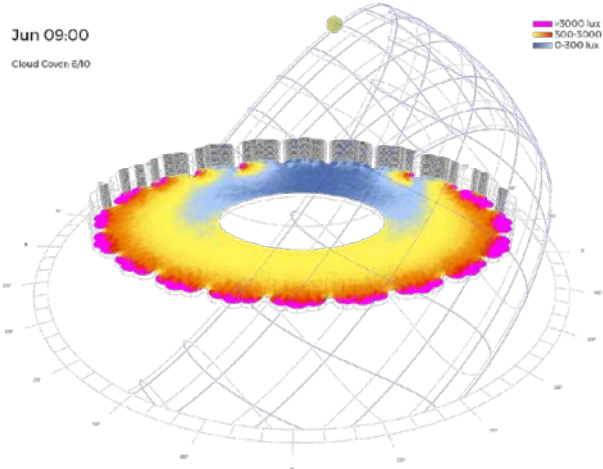




Jun 09:00

Cloud Cover: 6/10

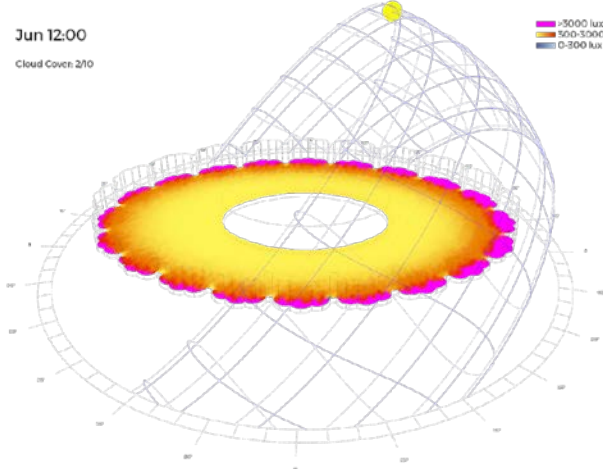
>5000 lux
500-5000 lux
0-500 lux



Jun 12:00

Cloud Cover: 2/10

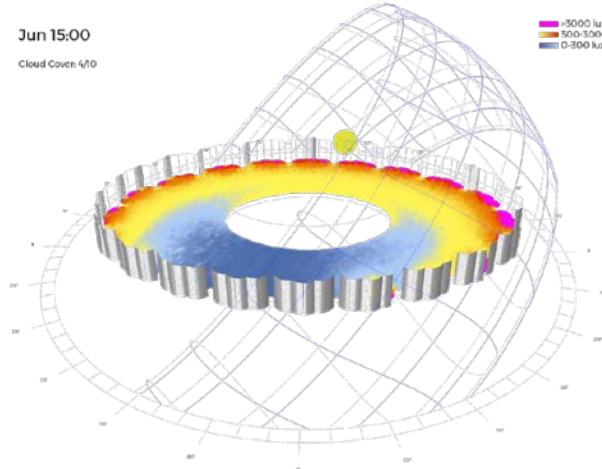
>5000 lux
500-5000 lux
0-500 lux



Jun 15:00

Cloud Cover: 4/10

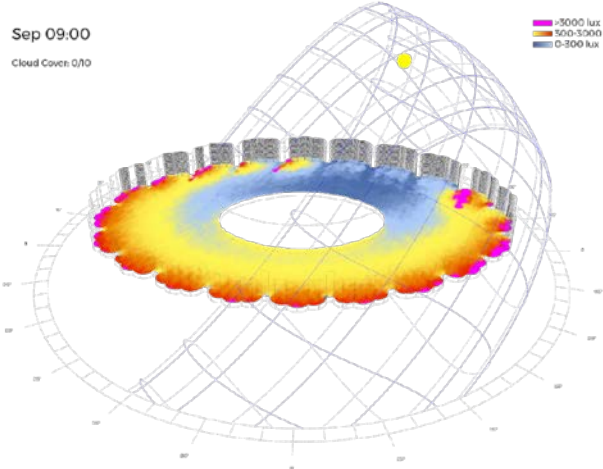
>5000 lux
500-5000 lux
0-500 lux



Sep 09:00

Cloud Cover: 0/10

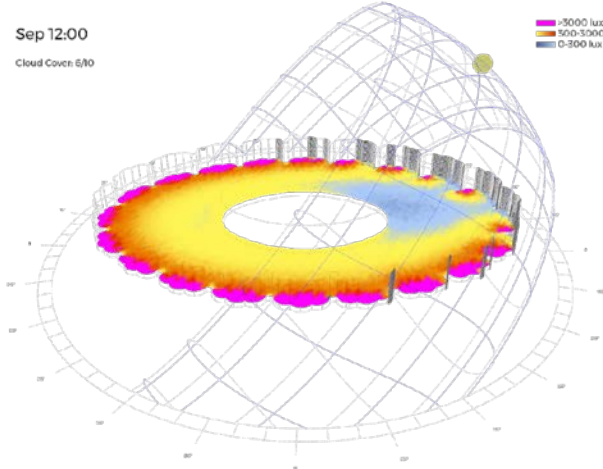
>5000 lux
500-5000 lux
0-500 lux



Sep 12:00

Cloud Cover: 6/10

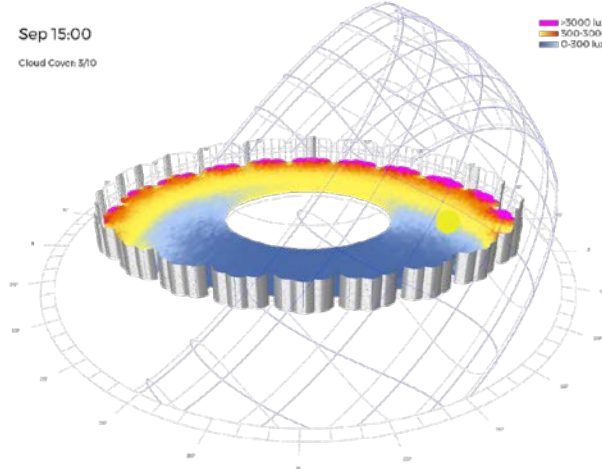
>5000 lux
500-5000 lux
0-500 lux



Sep 15:00

Cloud Cover: 3/10

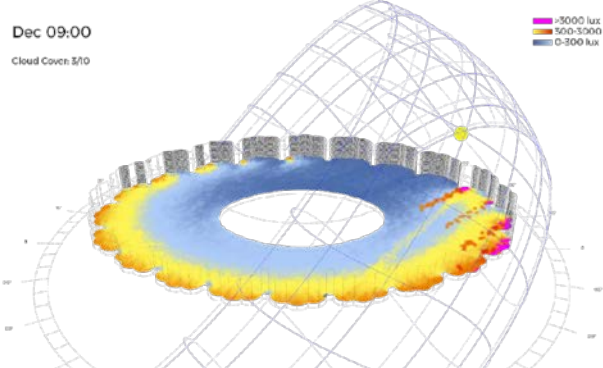
>5000 lux
500-5000 lux
0-500 lux



Dec 09:00

Cloud Cover: 3/10

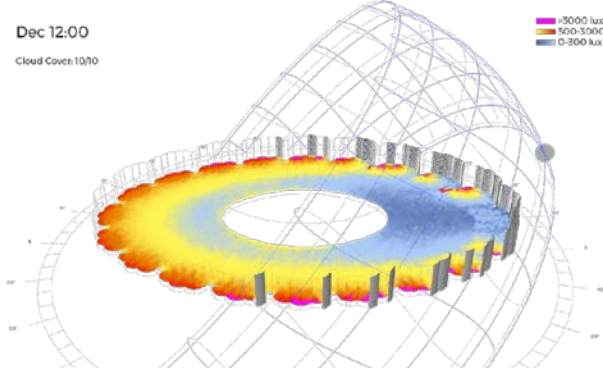
>5000 lux
500-5000 lux
0-500 lux



Dec 12:00

Cloud Cover: 10/10

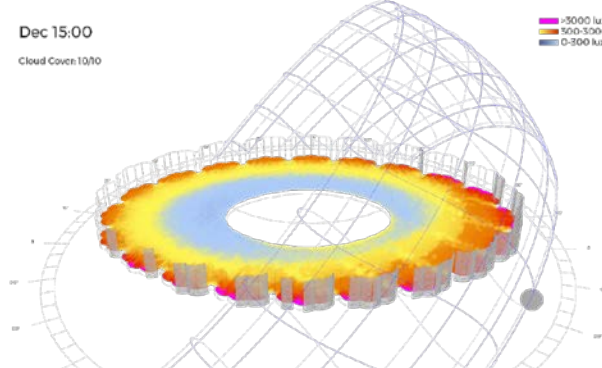
>5000 lux
500-5000 lux
0-500 lux

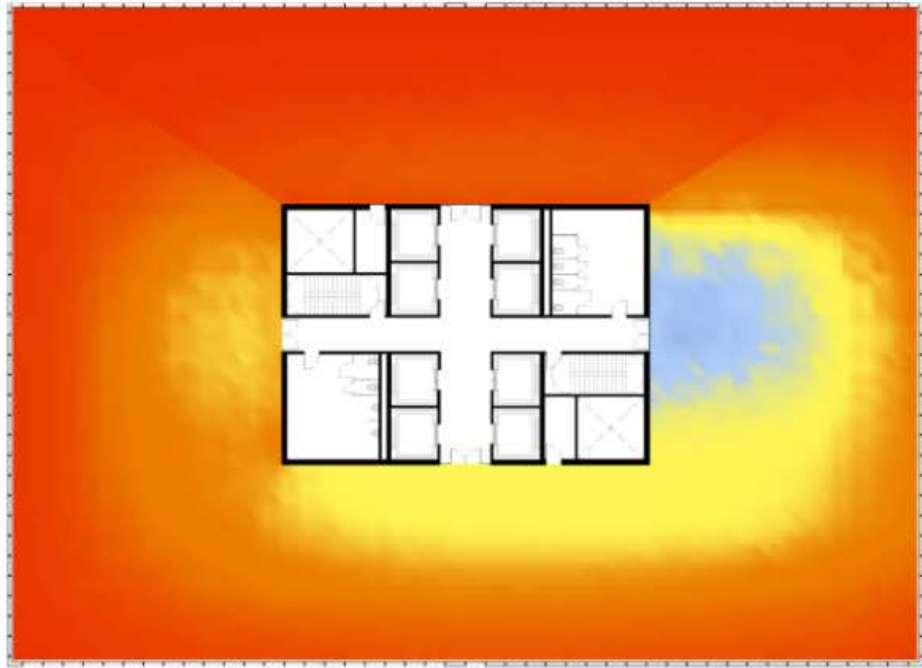


Dec 15:00

Cloud Cover: 10/10

>5000 lux
500-5000 lux
0-500 lux

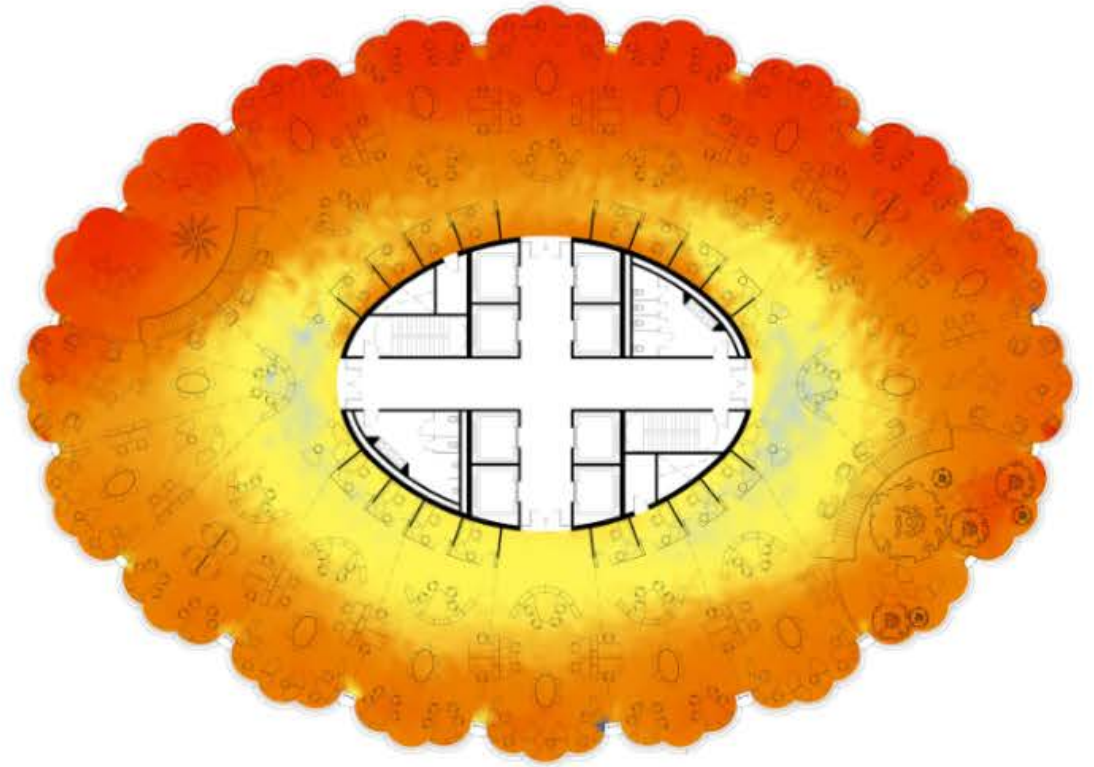




sDA: 88.88%
ASE: 42.2%



**Daylight
Autonomy**
>300 lux

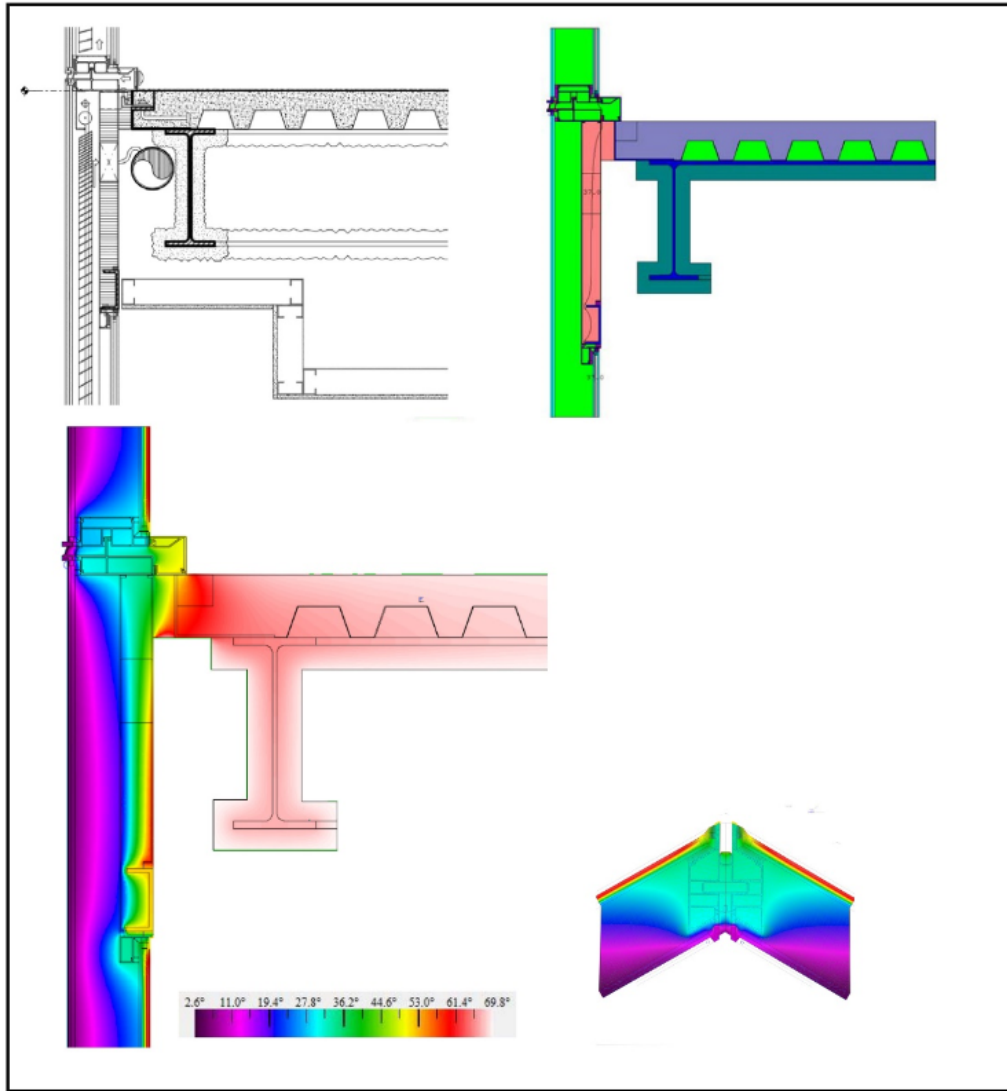


sDA: 89.7%
ASE: N/A (Automatic Blinds)



**Daylight
Autonomy**
>300 lux





- Material assumptions:**
1. Aluminum (Oxidized, Mill Finish) - Aluminum Mullion Sections
 2. Silicone (All silicone fillings, gaskets and structural silicone)
 3. Polyethylene (Low Density) - Backer Rod
 4. Polyamide with 25% Glass Fiber - Thermal Break
 5. Stainless Steel (Buffed) with silica gel (dessicant) glass spacer.PIB layers at the edges.
 6. Mineral Wool - Insulation

- Boundary Conditions:**
1. NFRC 100-2000 Exterior - All glass exterior and frame exterior (Approx. 0 deg F)
 2. Window 7.4 generated Inside U-value film - Glass Interior (70 deg F)
43 Interior Thermally Broken Frame (Convection only) - Frame Interior (70 deg F)

Glass Construction (using Window 7.4):
 1/4" (6mm) Solarban 72 on Starphire #2
 1/2" (13.2mm) airspace Argon Gas Filled
 1/4" (6mm) Starphire

Dew Point:
37 Deg F

Area Calculations		
A	Assembly Height (center line dimensions)	12.00 ft
B	Assembly Width (center line dimensions)	10.00 ft
C	Total Assembly Area (A*B)	120.00 sq.ft
D	Frame Width(Edge of glass to center line)	0.25 ft
E	Vertical Frame Length (A - D)	11.75 ft
F	Horizontal Frame Length (B - D)	9.75 ft
G	Vertical Frame Area (2*E*D)	5.88 sq. ft.
H	Horizontal Frame Area (2*F*D)	4.88 sq. ft.
I	Total Glazing Height (A-2*D)	11.50 ft
J	Total Glazing Width (B-2*D)	9.50 ft
K	Edge of Glass Width	0.21 ft
L	Vertical Edge of Glass Length (I - K)	11.29 ft
M	Horizontal Edge of Glass Length (J - K)	9.29 ft
N	Vertical Edge Area (2*L*K)	4.74 sq. ft.
O	Horizontal Edge Area (2*M*K)	3.90 sq. ft.
P	Core Glass Height (I - 2*K)	11.08 ft
Q	Core Glass Width (J - 2*K)	9.08 ft
R	Core Glass Area(P*Q)	100.61 sq. ft.

U-Value Calculations		
a	Center of Glass	0.24 Btu/hr-ft2-F
b	Vertical Edge of Glass Panel	0.26 Btu/hr-ft2-F
c	Horizontal Edge of Glass Panel	0.25 Btu/hr-ft2-F
d	Vertical Frame	0.45 Btu/hr-ft2-F
e	Horizontal Frame	0.45 Btu/hr-ft2-F

$$U_{Assembly} = \frac{[(R*a) + \{(N*b)+(O*c)\} + \{(G*d) + (H*e)\}]}{C}$$

$$U_{Assembly} = 0.27 \text{ BTU/hr-ft2-F}$$

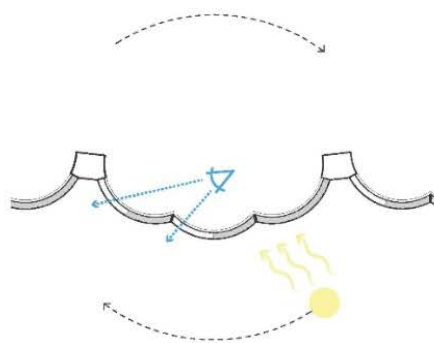
● Therm model of 10' wide unit, overall U of .27 is about 25% lower than typical well-performing unitized curtain wall.



16%
ENERGY SAVINGS OVER
CONVENTIONAL BASELINE
BUILDING WITH FLAT SINGLE
LAYER IGU FACADE

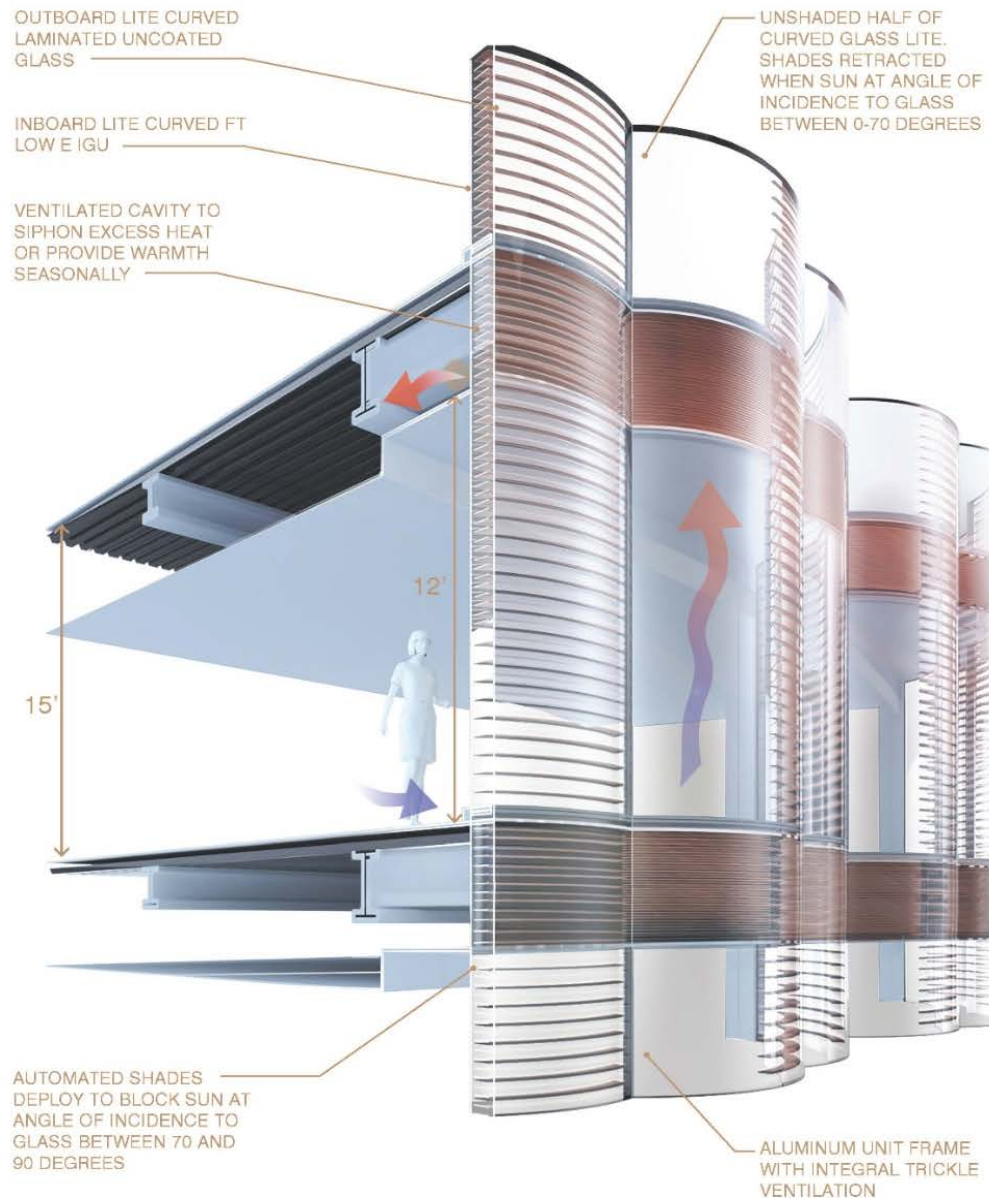
24%
PEAK COOLING LOAD REDUCTION

27%
PEAK HEATING LOAD REDUCTION



PLAN - TYPICAL BAY

SHADES DEPLOY AUTOMATICALLY
WITH SUN. CLEAR VISION
THROUGH NON-SHADED
WINDOWS.

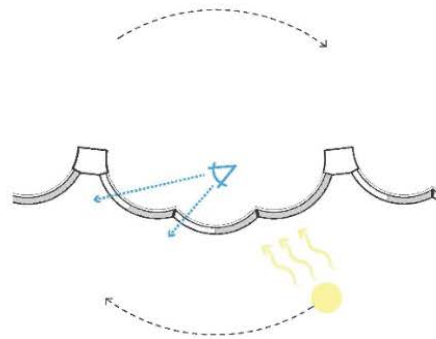


NEXT STEPS

16%
ENERGY SAVINGS OVER
CONVENTIONAL BASELINE
BUILDING WITH FLAT SINGLE
LAYER IGU FACADE

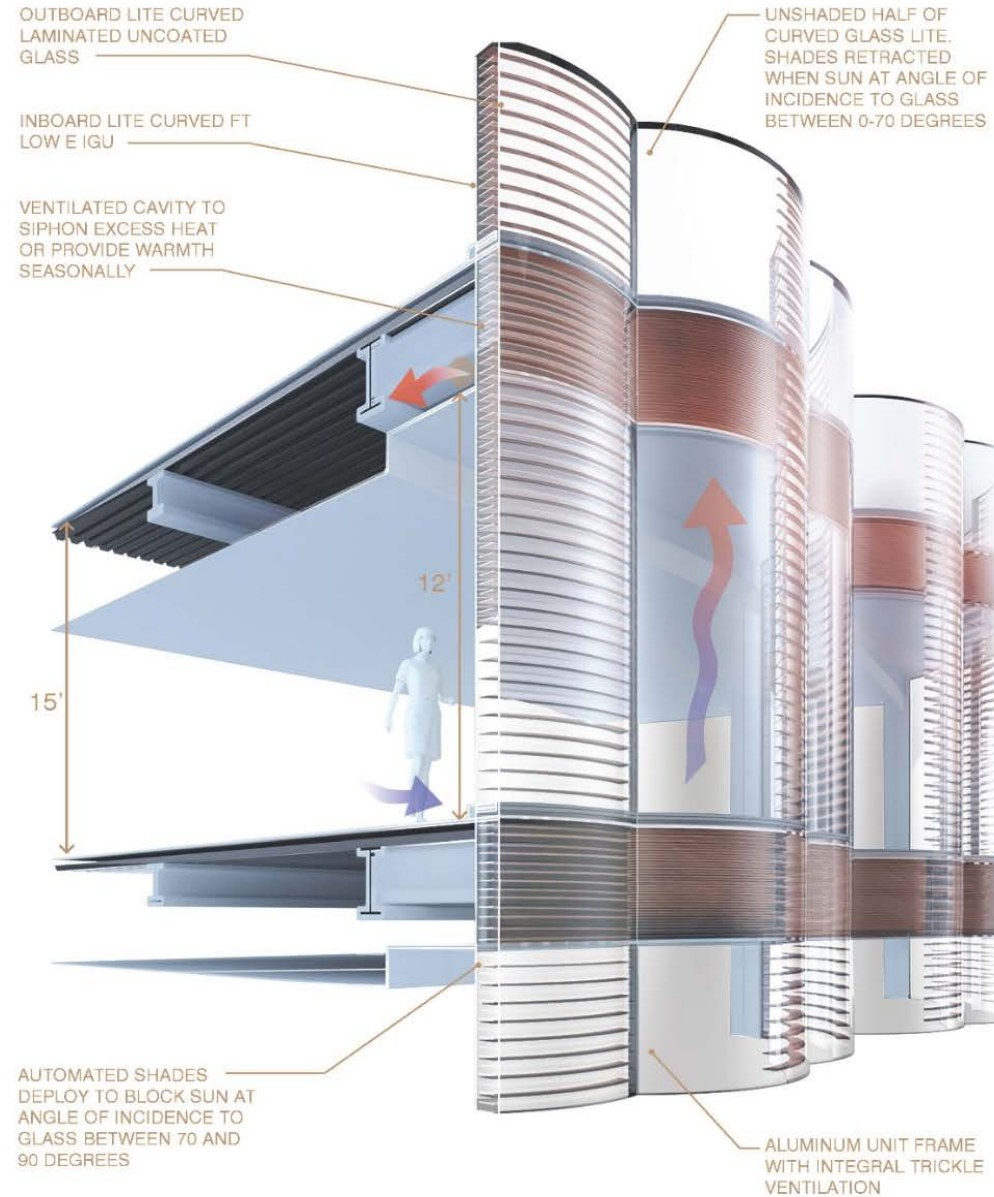
24%
PEAK COOLING LOAD REDUCTION

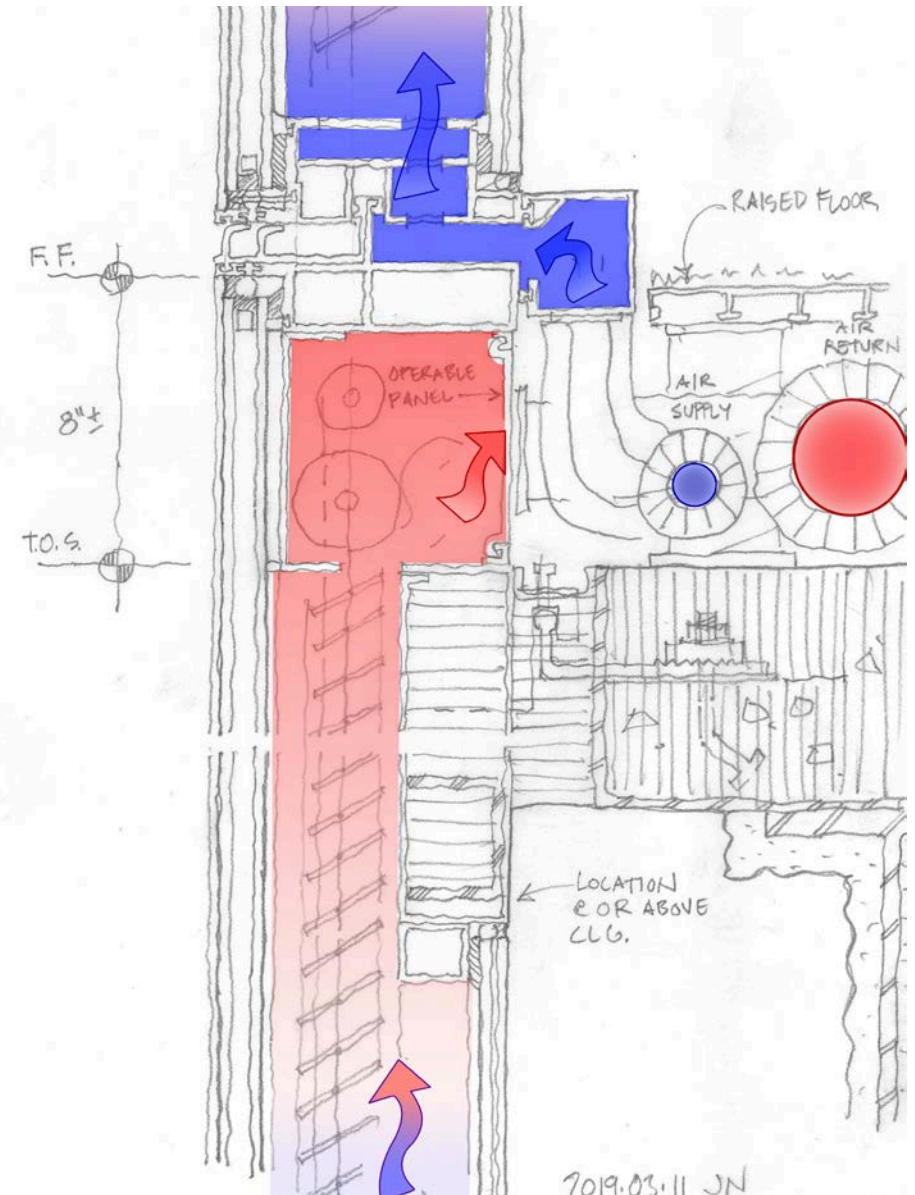
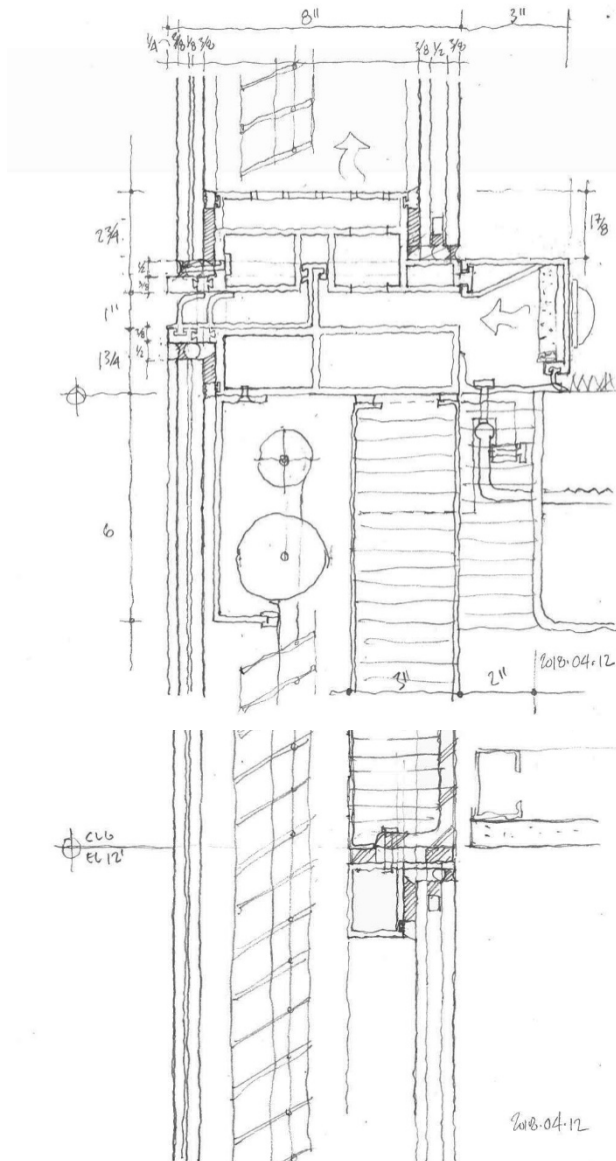
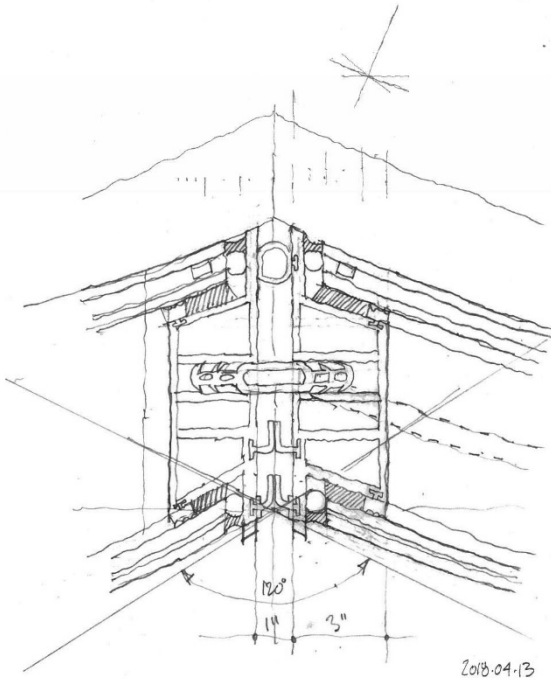
27%
PEAK HEATING LOAD REDUCTION



PLAN - TYPICAL BAY

SHADES DEPLOY AUTOMATICALLY
WITH SUN. CLEAR VISION
THROUGH NON-SHADED
WINDOWS.





- First pass details: Air circulation from occupied space, filtered. Access to shades an issue.

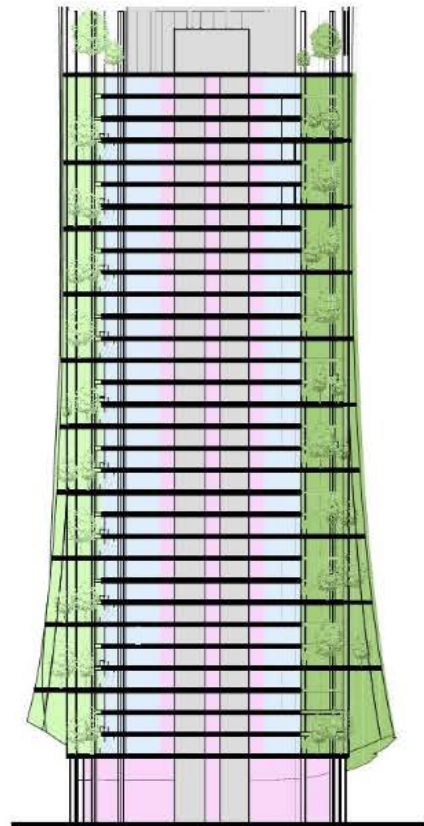
- Second pass details: Raising stack joint allows for above-floor connections to closed circuit of supply and return air, either in fin-tube-like cover or under raised floor. IGU outboard.

CIRCADIAN CURTAIN WALL

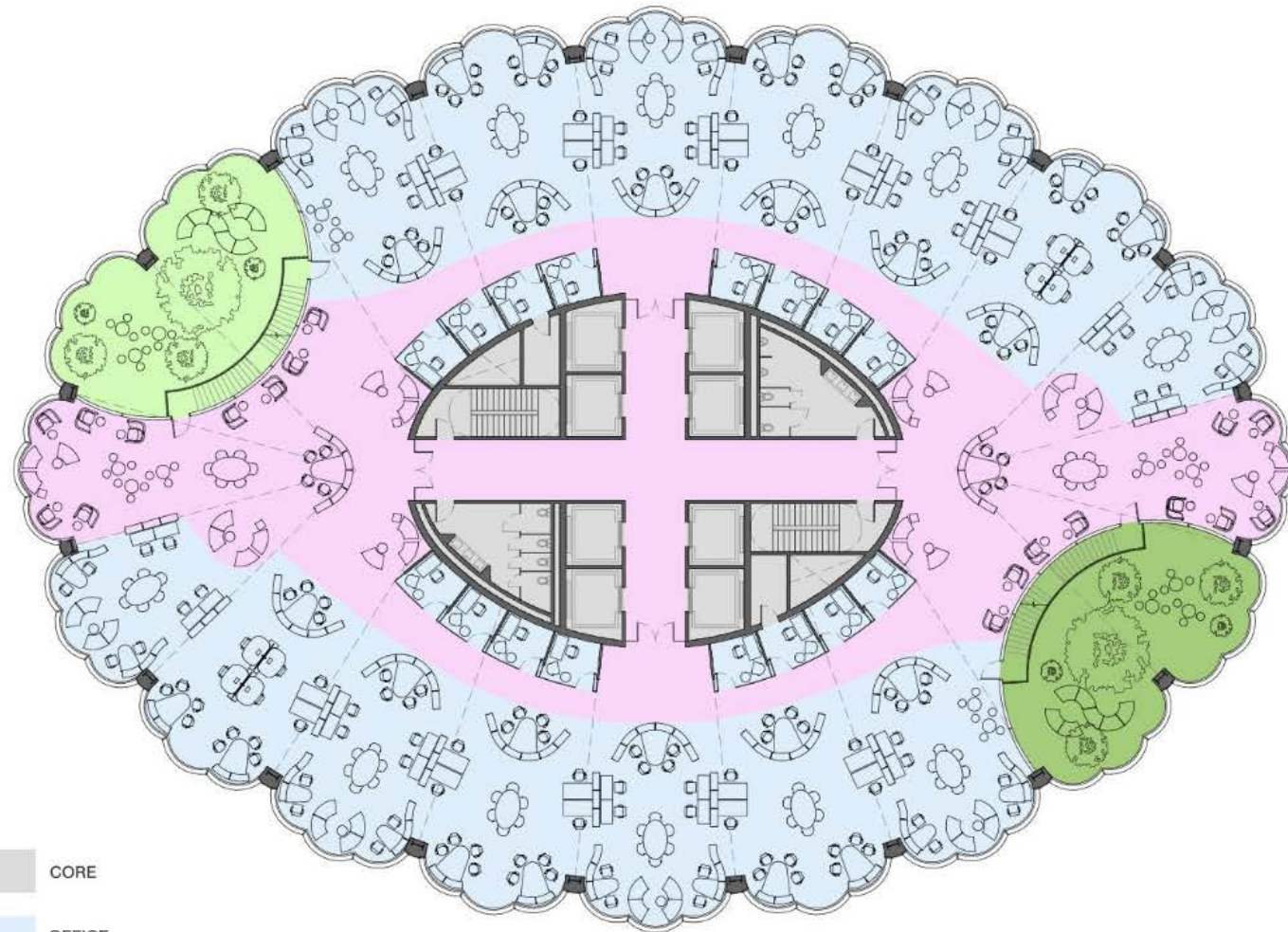
PLAN & SECTION

The 3-lobe cluster defines a space scaled to the most effective group size for creative collaboration. Almost every point on the floor can see the two atria, providing polar orientation.

The North and South Atria bring the outside inward. The Atria provide gardens connecting to the roof, with rejuvenating plants, fresh air and water features.

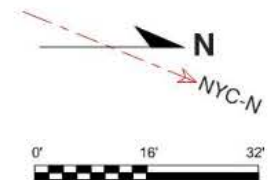


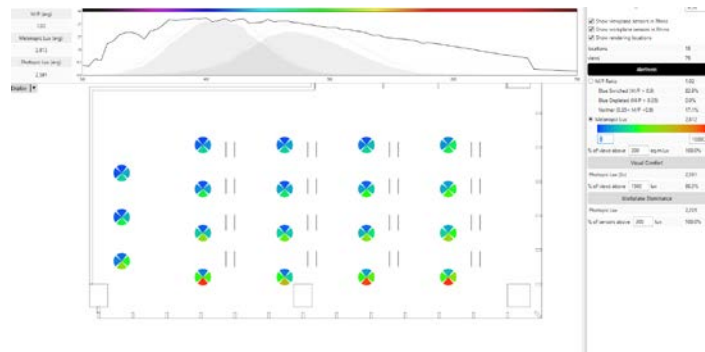
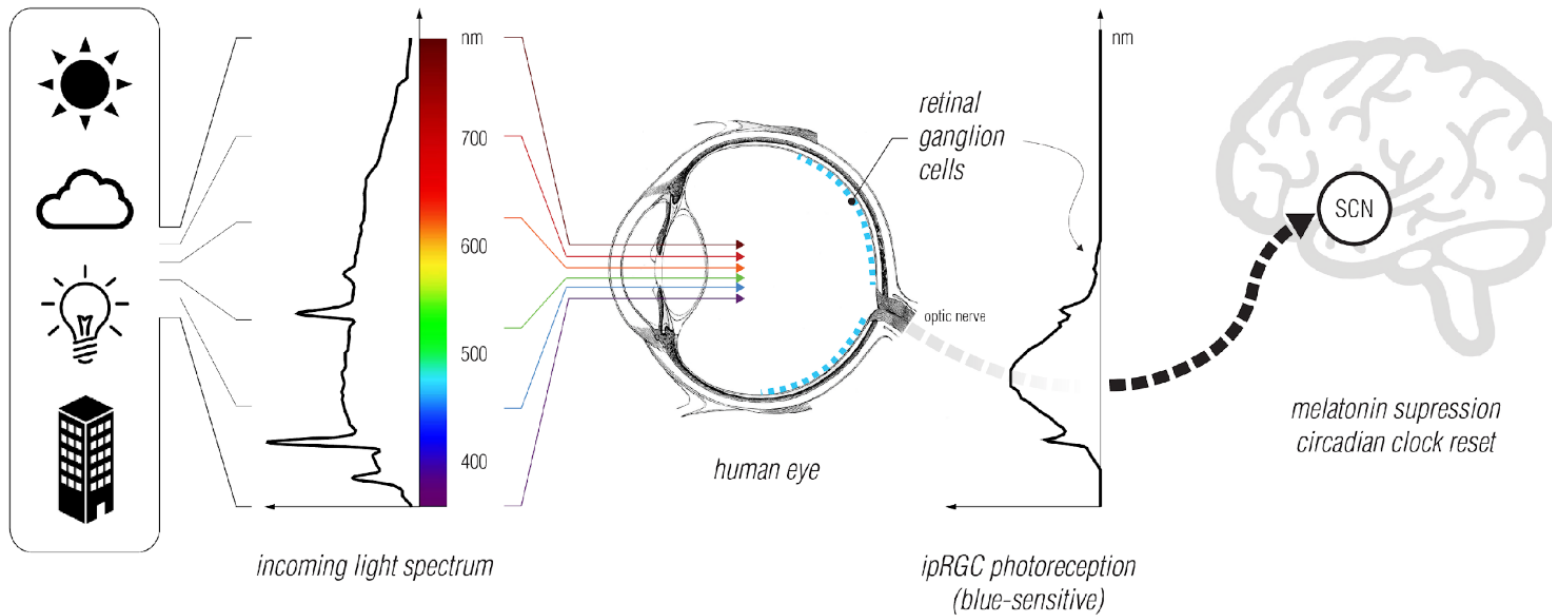
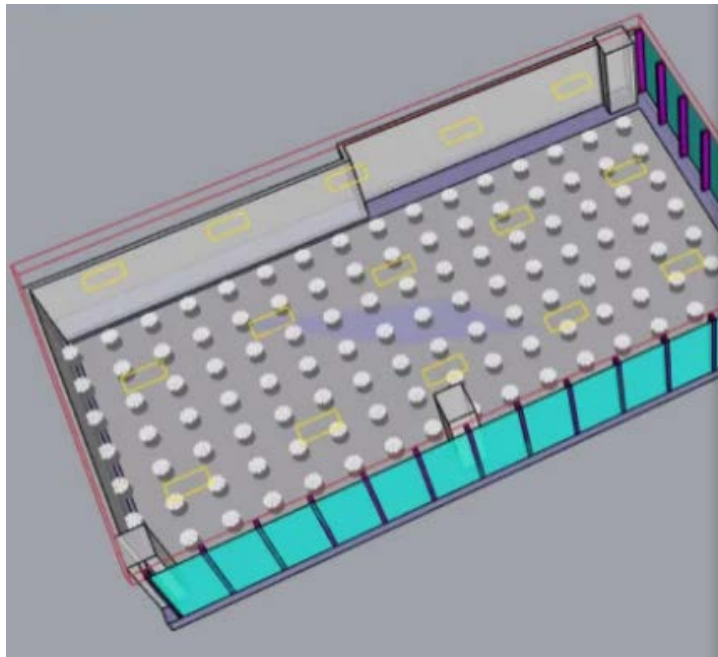
S-N SECTION



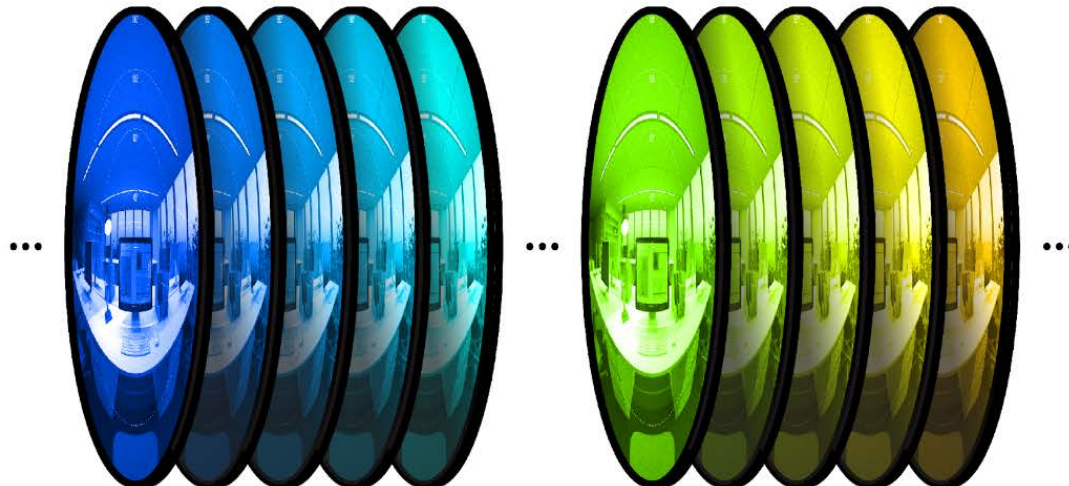
- CORE
- OFFICE
- CIRCULATION/
BREAKOUT SPACE
- SOUTH ATRIUM
- NORTH ATRIUM

TYPICAL FLOOR PLAN





81-COLOR-CHANNEL FISHEYE



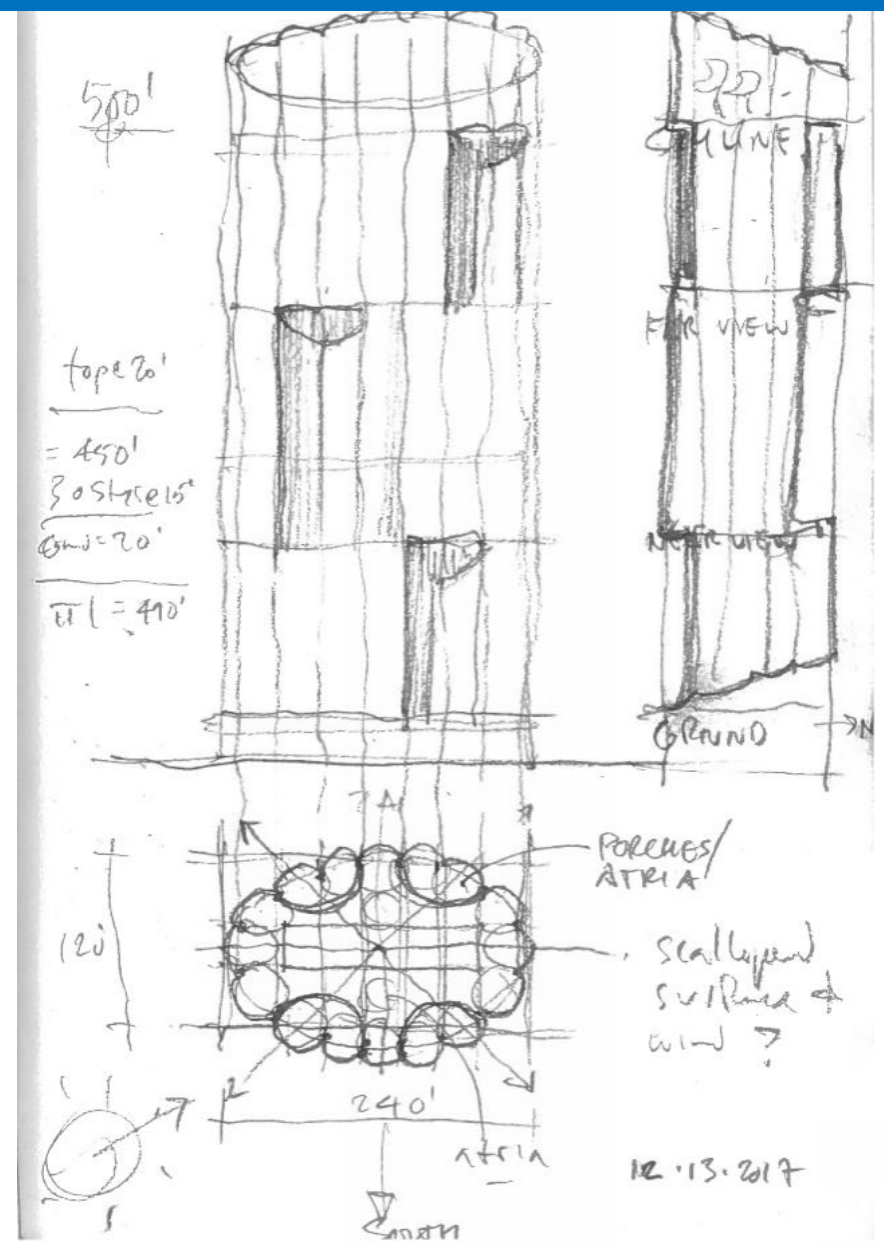
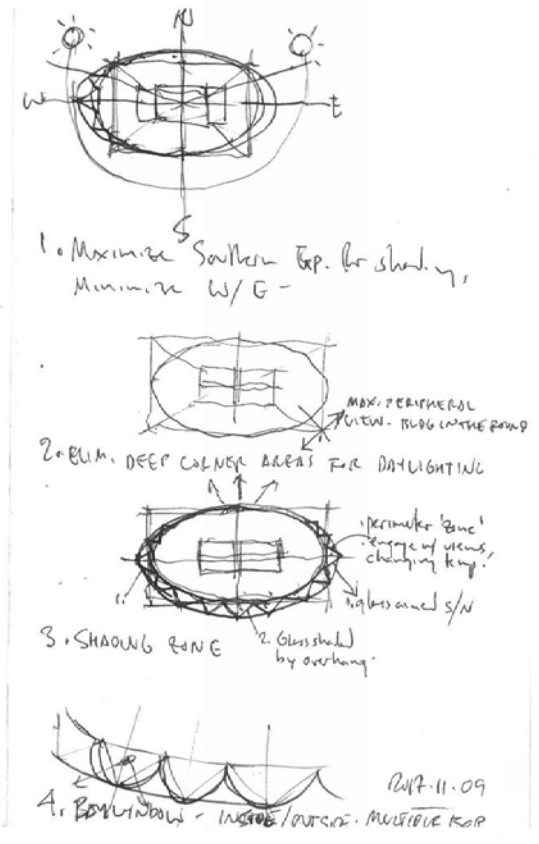
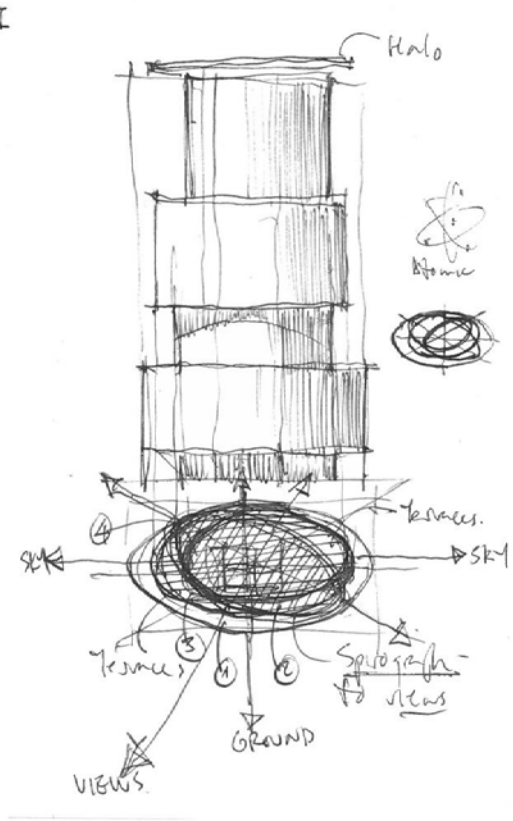
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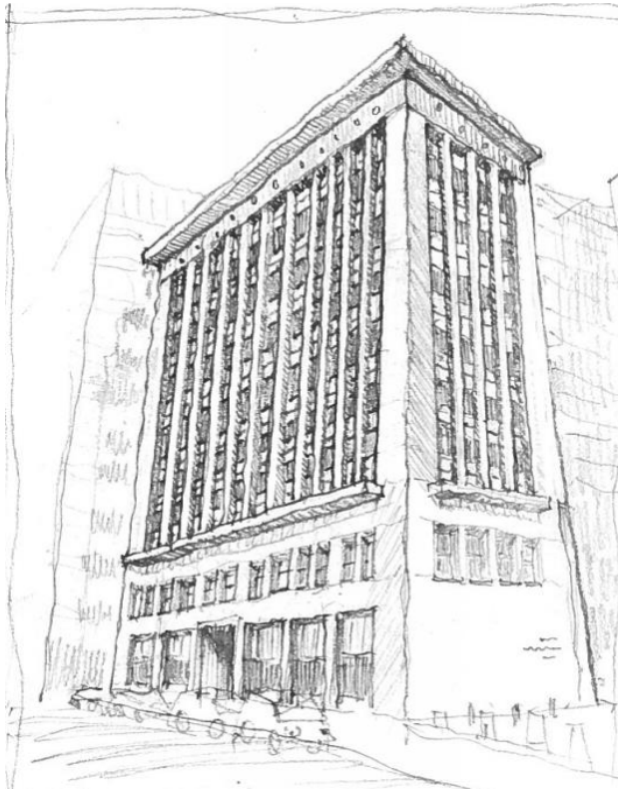
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Images Source: Solemma LLC

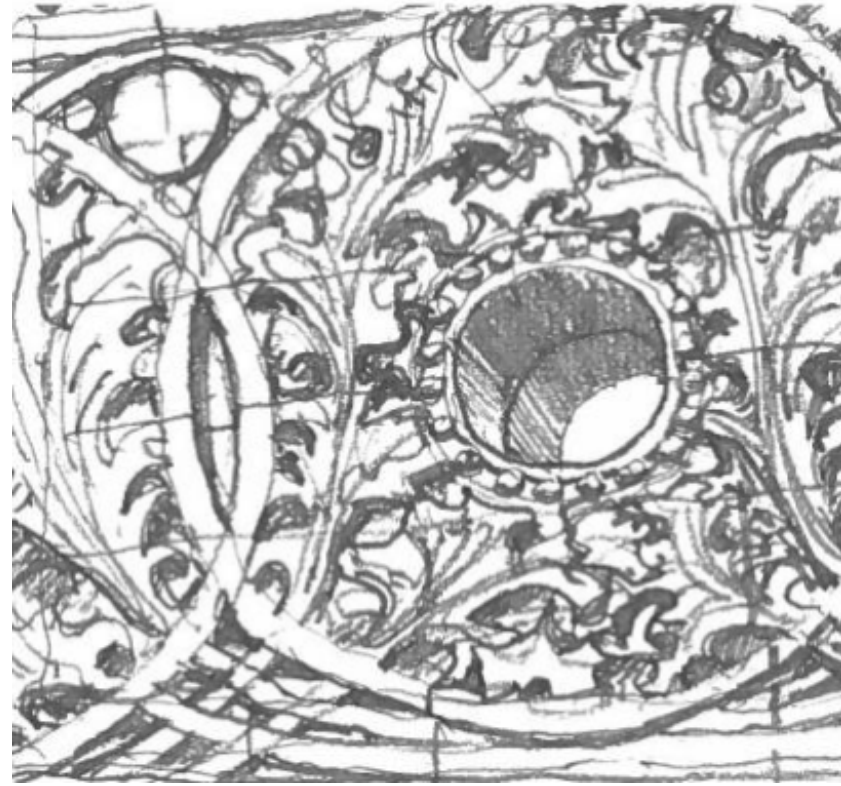


CONCLUSION





Wainwright Building, L. Sullivan, 1891



Wainwright Building, L. Sullivan, 1891- Detail



Reliance Building, D. Burnham, 1895



VICTOR OLGYAY




IAN McHARG



KEN YEANG





The organic approach to architecture emphasises the relationship of buildings to climate and site, seeking to emulate natural habitat in finding strategies for tempering the extremes of natural conditions.