Designing with Daylight

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Credit: 1 AIA LU; 0.1 IACET CEU
Course Number: K1709B

Stephen Selkowitz is a senior advisor for building science and the group leader of the Windows and Envelope Materials group in the Building Technology and Urban Systems division. As an internationally recognized expert on window technologies, facade systems, and daylighting, he collaborates with R&D teams worldwide. Selkowitz is a frequently invited speaker to industrial and professional groups on many aspects of building technologies and commercial building energy efficiency, and he is the author/co-author of more than 170 publications, three books, and holds two patents. He is the principal investigator for the new LBNL program to design and build FLEXLAB, the Facility for Low Energy Experiments in Buildings. Selkowitz holds a BA in physics from Harvard College and an MFA in environmental design from California Institute of the Arts.

Nikolas Dando-Haenisch, AIA, LEED, has played an instrumental role in the practice's large-scale North American urban core and transportation projects, including Fulton Center, Via Verde , and NYU's 2031 Strategic Master Plan, since joining Grimshaw in 2003. He has taken a leadership role particularly on Grimshaw's California-based transit work, leading such projects as the LAX Airport Metro Connector and the Los Angeles Union Station Master Plan. Prior, Nikolas led teams for the Pier 70 Redevelopment Master Plan in San Francisco and the reconstruction of Fordham Plaza in the Bronx, New York City. He has extensive experience not only in designing transformational civic spaces but also in managing them to realization through collaboration with city agencies, community groups, and stakeholders.

Matt Noblett, AIA, NCARB, is partner of Behnisch Architekten in Boston. With more than 20 years of experience, he has led and directed many large-scale, highly complex projects in a variety of market sectors. As resident architect for Rafael Vinoly Architects' Boston Convention and Exhibition Center, Matt spent six years designing and delivering the 2-million-square-foot, $535-million facility from concept design through occupancy. Upon joining Behnisch Architekten in 2007, he directed the firm's work on the Harvard University Science Complex, a 1-million-square-foot, $1-billion research campus, and the LEED Platinum John and Frances Angelos Law Center at the University of Baltimore, a 192,000-square-foot, $115-million project. Matt teaches at Boston institutions of higher education and lectures extensively worldwide on sustainable architecture and design excellence.

Credit earned on completion of this course will be reported to AIA CES for AIA members.

To receive a certificate of completion you must complete and pass the 10-question quiz following this presentation with an 80% or higher, then a certificate of completion will be available for immediate download.

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Questions related to specific materials, methods, and services will be addressed at the conclusion of this presentation.

Learning Objectives

At the end of the this course, you should be able to:

1. Define the aesthetic and energy-saving benefits of designing with daylight, as well as ways in which occupant well-being, safety, and productivity can be optimized.
2. Describe several innovative daylighting design strategies employed in two high-profile projects.
3. Discuss architectural considerations of incorporating daylighting design elements into modern buildings.
4. Explain the basic focus of the overall design and construction process behind the highlighted projects.

Effective Daylighting in Buildings:
Design Solutions for People and the Planet

The New York Times building

Path for Smart Shading and Daylight Dimming to Cost-Effective, Standard Practice

Stephen Selkowitz
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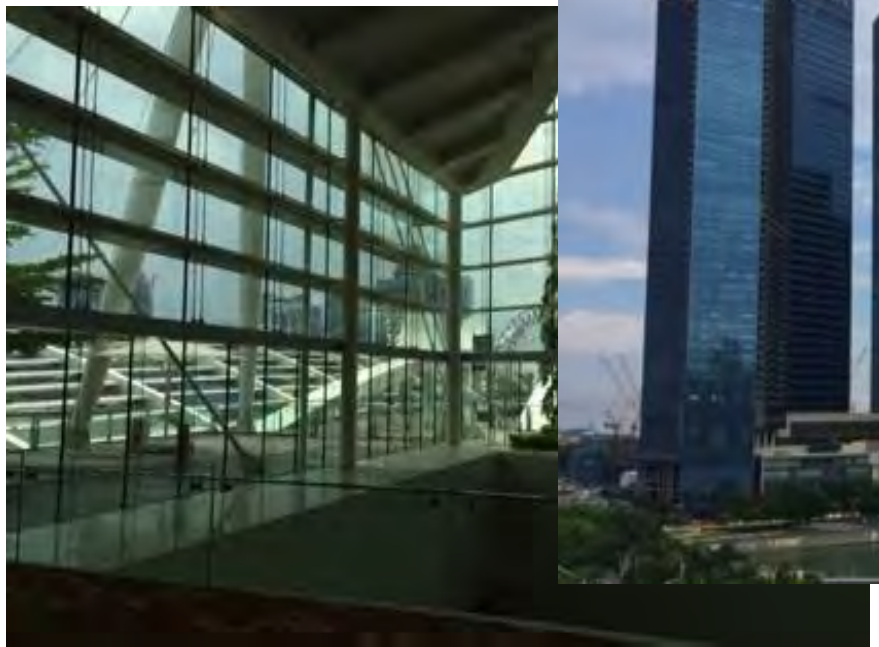
U.S. Annual Energy Cost of “Glass”: ~$50B

Vision for Facades: Convert Net Loss -> Neutral -> Net Positive

Goal: Zero Net Energy Facades w/ Comfortable, Effective Work Environments

Role of Glass and Daylight?

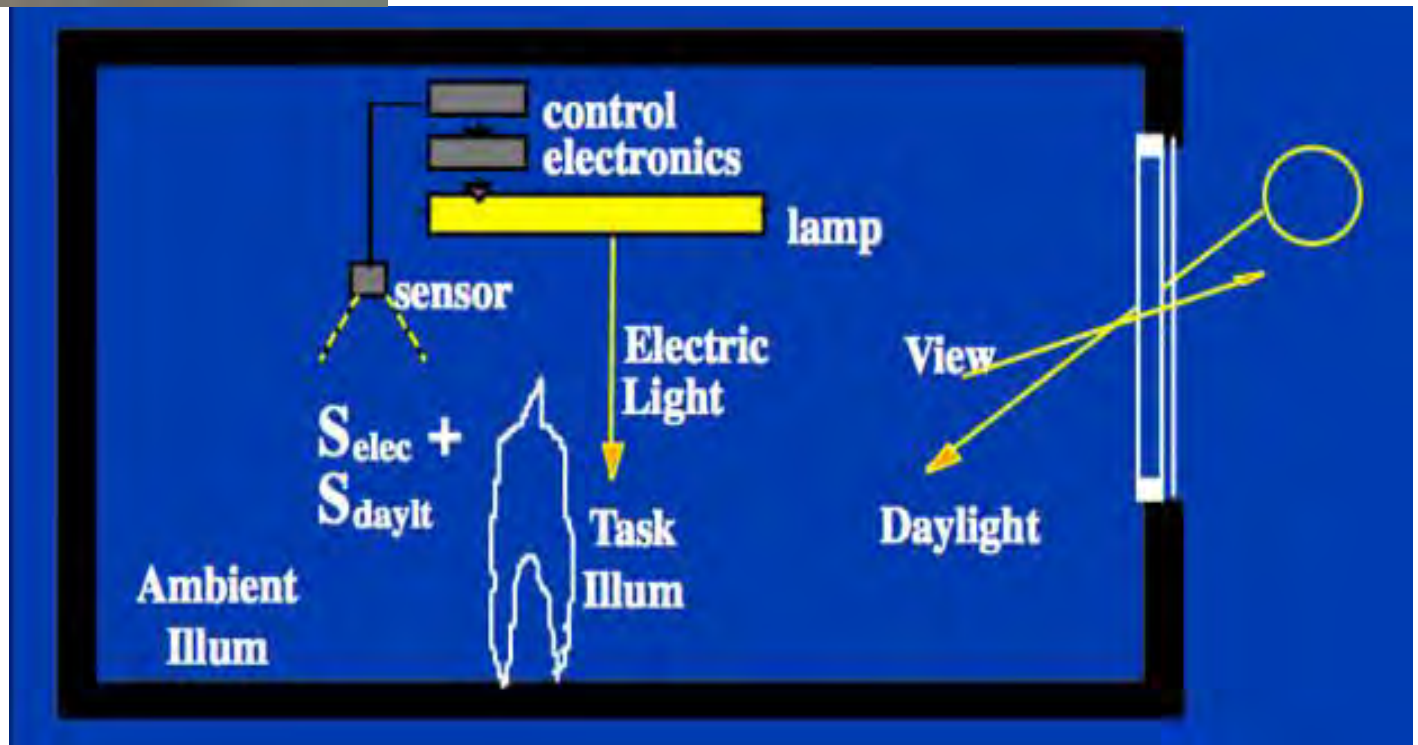


Characteristics of Successful Daylighting Systems

- **Designed as Integrated Building System**
  - Envelope <-> Lighting <-> HVAC
- **Provide Daylight Control**
  - Spectral control to reduce cooling loads- coated glass
  - Dynamic control of intensity and direction- shades
- **Support changing Occupant Needs:**
  - performance, comfort, satisfaction, health
- **Decision support tools for Architects, Engineers**,...
  - design/analysis across life cycle
- **Link Design --> Commissioning --> Operations and Maintenance**

"Daylight" Remains a Defining Architectural Feature of Many Building Spaces

Daylighted Spaces vs (Day)Lighting Control Elements



PEOPLE are the Most Costly “Building Component”

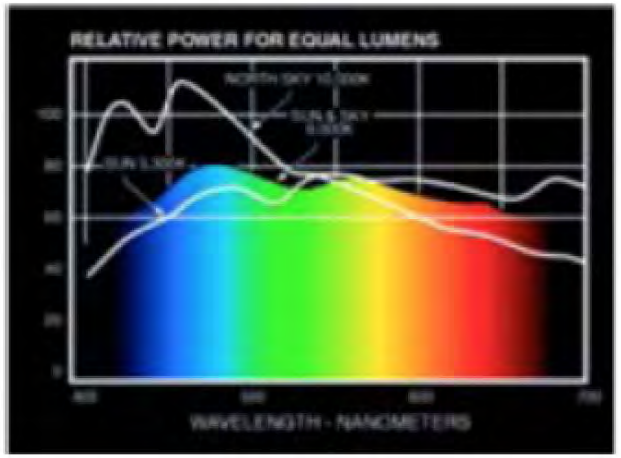
Occupancy Costs = 100 x Energy Cost

Smart Integrated Building Systems will Improve Satisfaction, Comfort and Productivity

Cost / Sq. Ft. Floor -Year

- Energy Cost: $4.00
- Rent: $40.00
- “Productivity” $400.00+

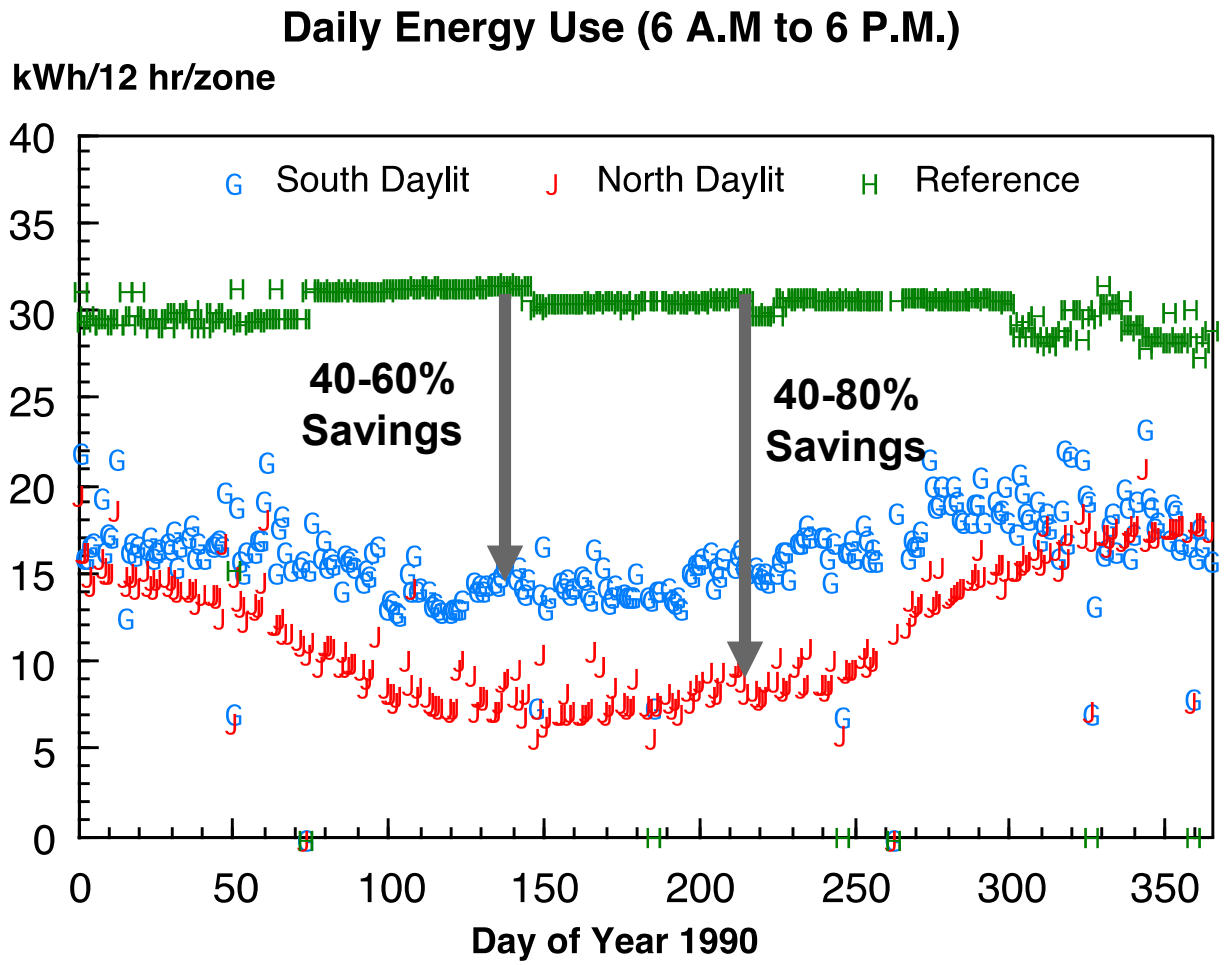
Daylight: What's New?
Human Factors/Wellness



Daylight

- Glare and Visual Comfort
- Access to View (Building Footprint, Floorplate)
- Biophilic Effects
- Circadian Rhythm: Sleep, Alertness
- Health Effects
- Impact on Performance and Productivity
- Challenge: Very difficult to attribute a measurable impact to a design variable

Good Shading and Daylight Dimming Work! (1990)



Data from advanced lighting controls demonstration in Emeryville, CA (1990) ← **!!!**

Energy Use before retrofit:

After retrofit:
South zone:
North zone:

Dimming is 3% of lighting sales

Daylighting Basics: Site to Details

- **Climate, Latitude**
- **Site, Orientation, Adjacent Shading**

- **Floorplate**
- **Facade – Glazing Area and Type, Dynamic Glass**
- **External Shading – Fixed, Operable- Manual/Automated**
- **Internal Shading – Fixed, Operable- Manual/Automated**

- **Ceiling design**
- **Office design, Furniture type and layout**
- **Dimmable Lighting System and Controls, Task Lights**

The New York Times HQ Building (2003)

https://windows.lbl.gov/comm_perf/nyt_overview.html

Owners program:

- Highly glazed facade gives workers views and allows the city to see “news” at work
- But control glare, cooling

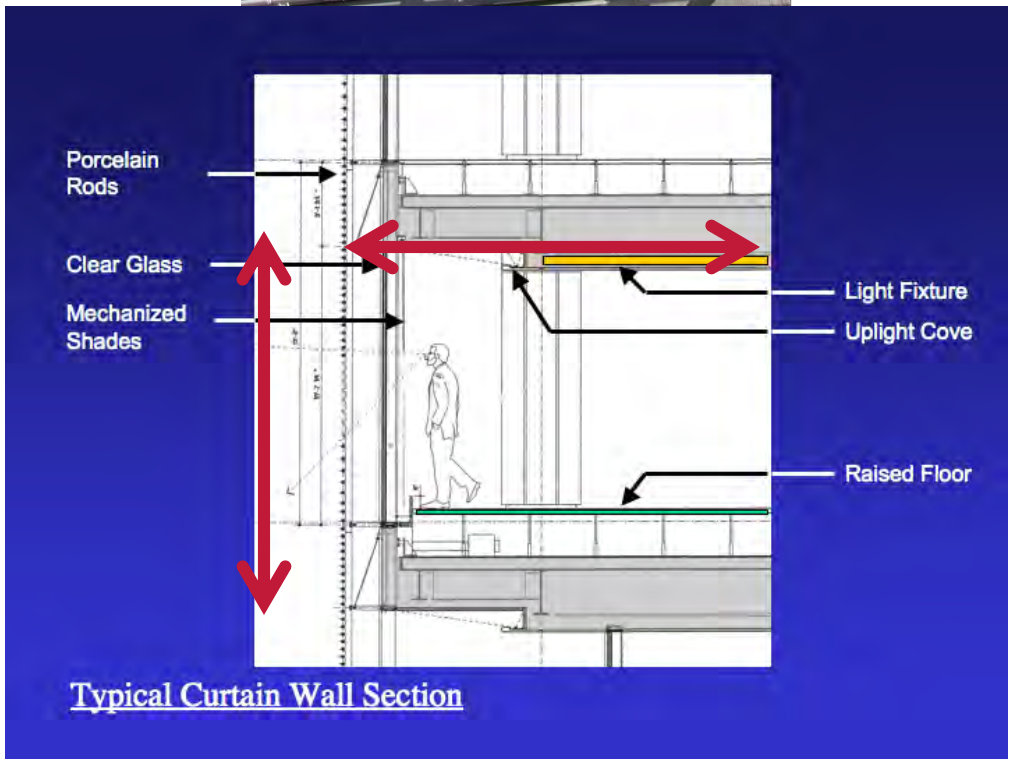
Project Goal:

- Develop integrated , automated shading and dimmable lighting system
  - — Affordable, reliable and robust
- Transform the market- push these solutions toward widespread use

Challenge:

- How to develop a workable, affordable integrated hardware/software solution
- How to “guarantee” that such a solution will work in practice

Renzo Piano/ Fox & Fowle/ Gensler/ Flack+Kurtz/ Susan Brady Lighting



Façade Layers

External layer: Fixed
-- Shading, light diffusion

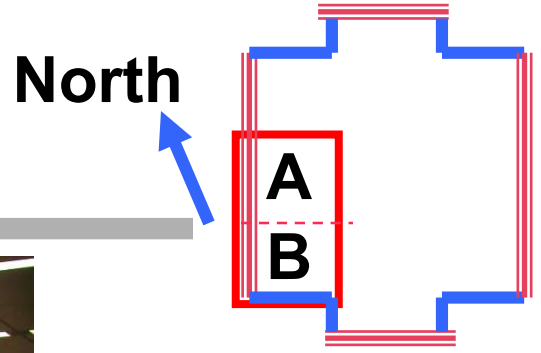
Glazing layer: Fixed
-- Low-E, spectrally selective
- thermal control
- solar gain control

-- Frit - solar, glare control

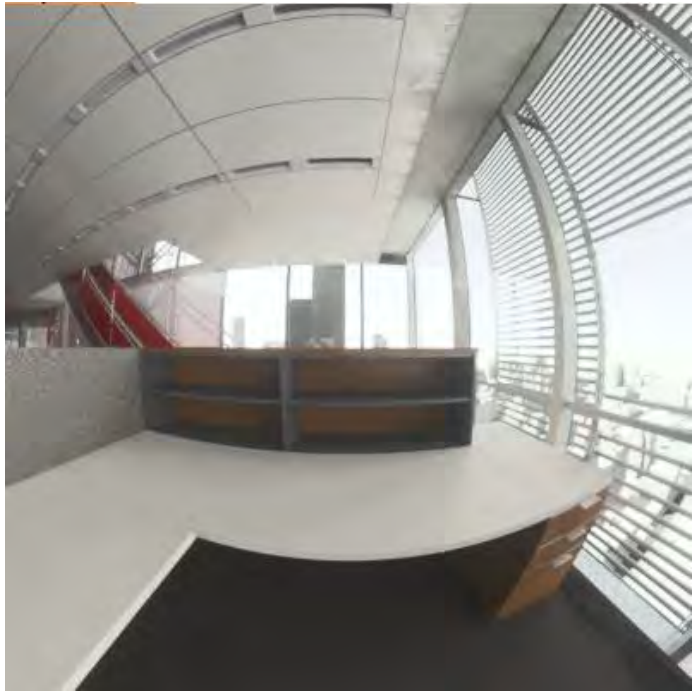
Internal layer: Dynamic
-- Motorized Shade system
-- Solar control
-- Glare control

Façade Layers: Floor to Floor
floor to desk
desk to head
head to ceiling
plenum

Approach: Test Performance in a Full-Scale 4500 sf Mockup

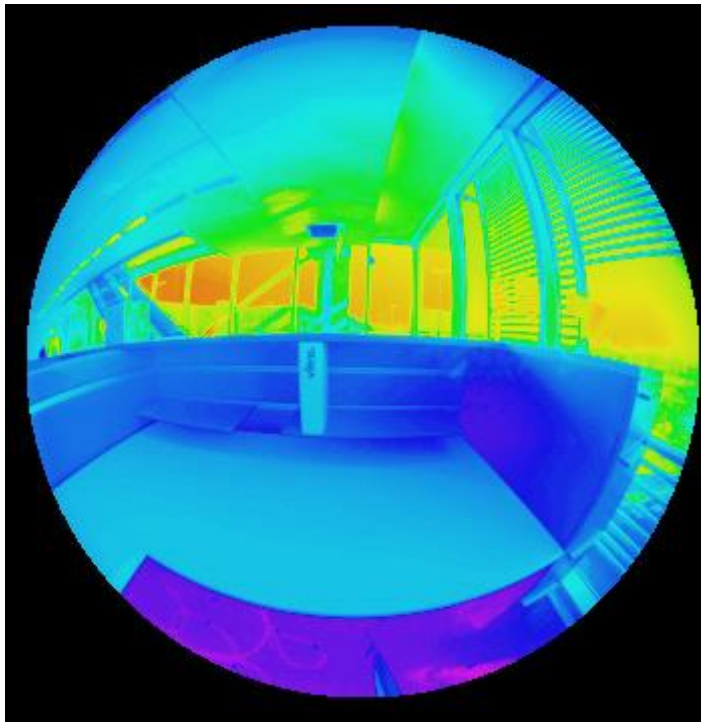


- Shading, daylighting, employee feedback and constructability
- Concerns with glass facade:
  - Window glare (Tv=0.75)
  - Control of solar gain/cooling
  - Daylight harvesting potential
- Real sun and sky conditions near construction site, 12-month monitored period



Managing Discomfort Glare with Automated Shades

- **Shade controlled for direct sun, and sky glare.**
  - **Shade Fabric: 3% openness factor, light gray interior surface.**

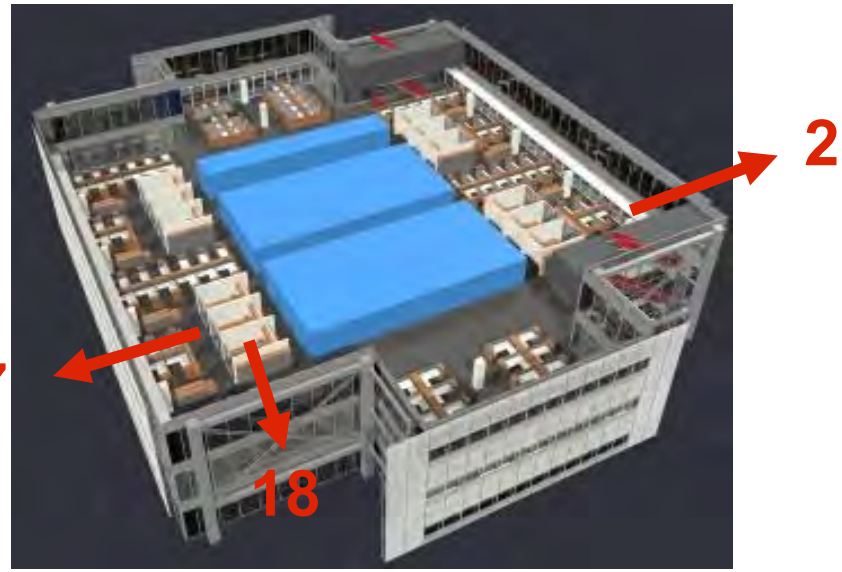


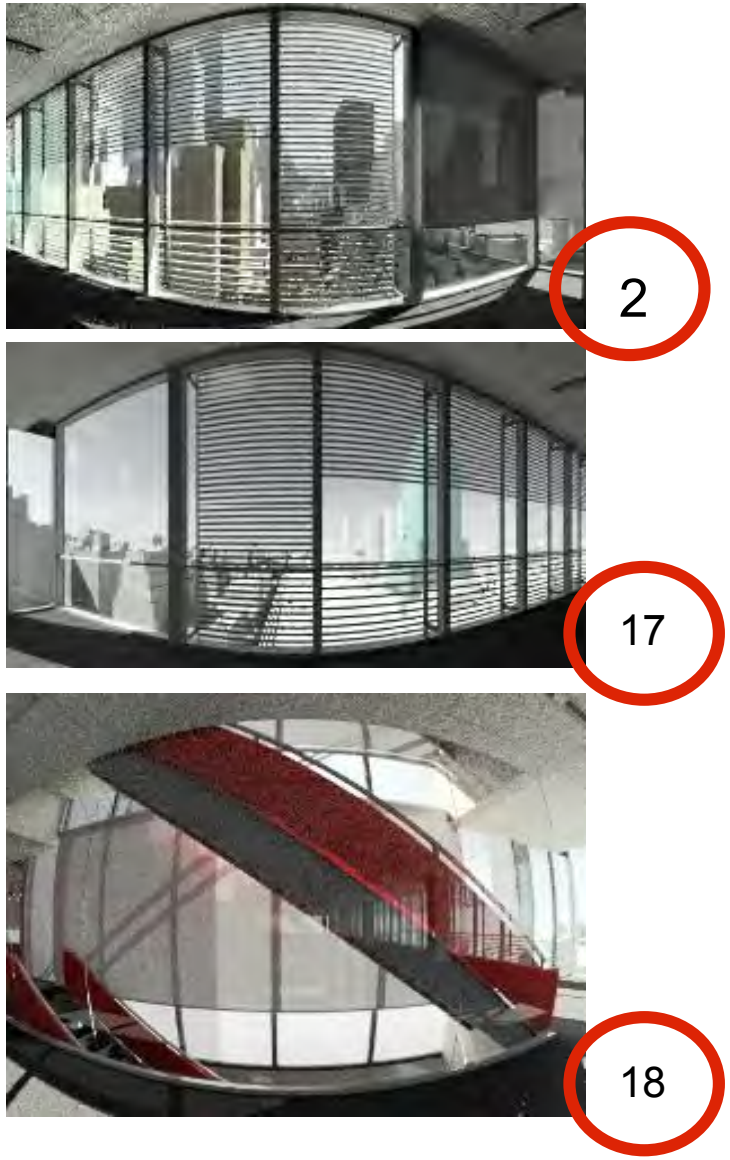
- **Daylight glare index (DGI) was relatively low:**
  - **Why? Eye is adapted to the bright environment near the windows**

Explored Shade Control Strategies for Motorized Shades using Simulation

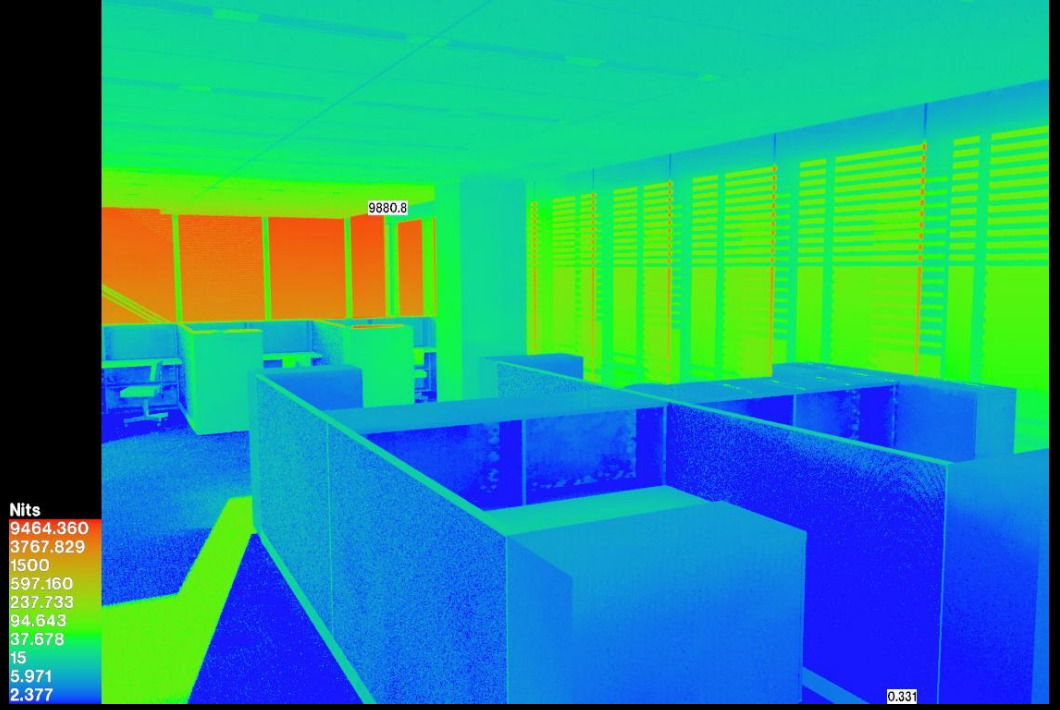
- Each shade system has its own sensor and motors
- Performance will vary with floor elevation, view out, and neighboring buildings.

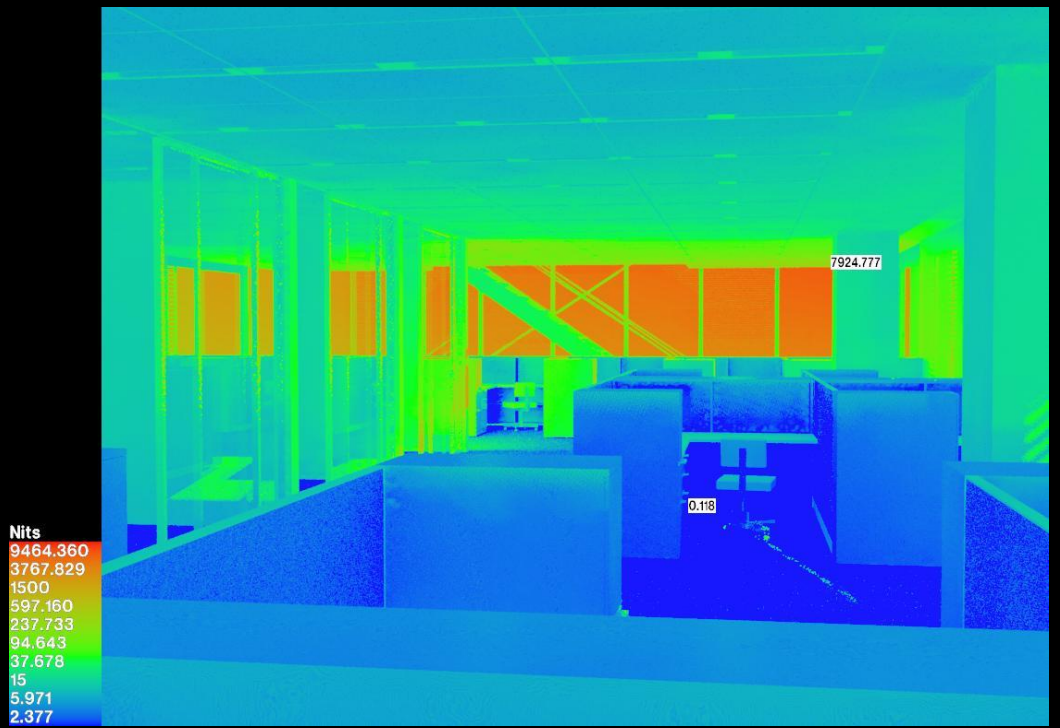
- Build a virtual model of the building in its urban context using hourly weather data to simulate performance





Simulated Views from 3 of 22 view positions


Nits
9464.360
3767.829
1500
597.160
237.733
94.643
37.678
15
5.971
2.377
9880.8
0.331


Nits
9464.360
3767.829
1500
597.160
237.733
94.643
37.678
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5.971
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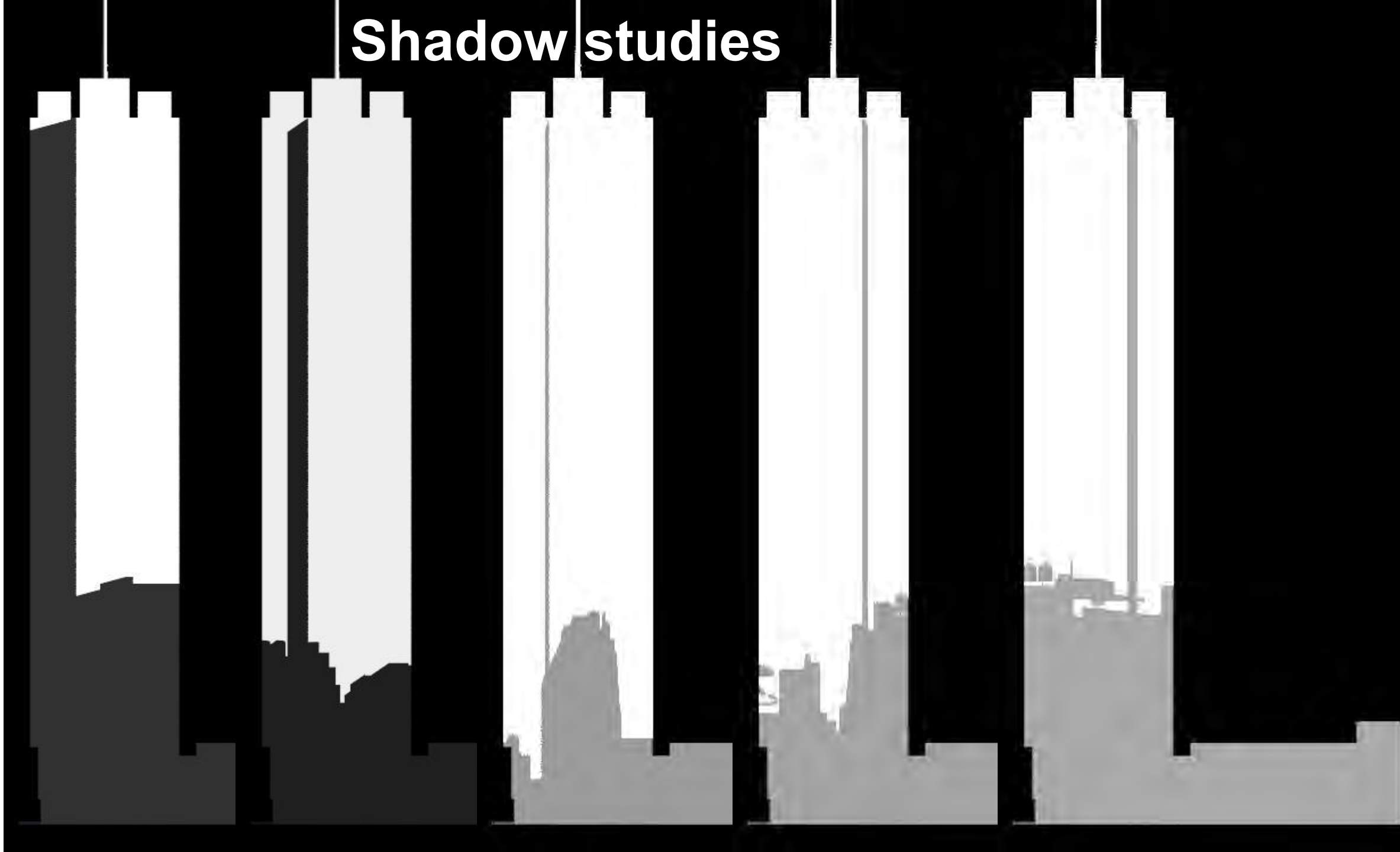
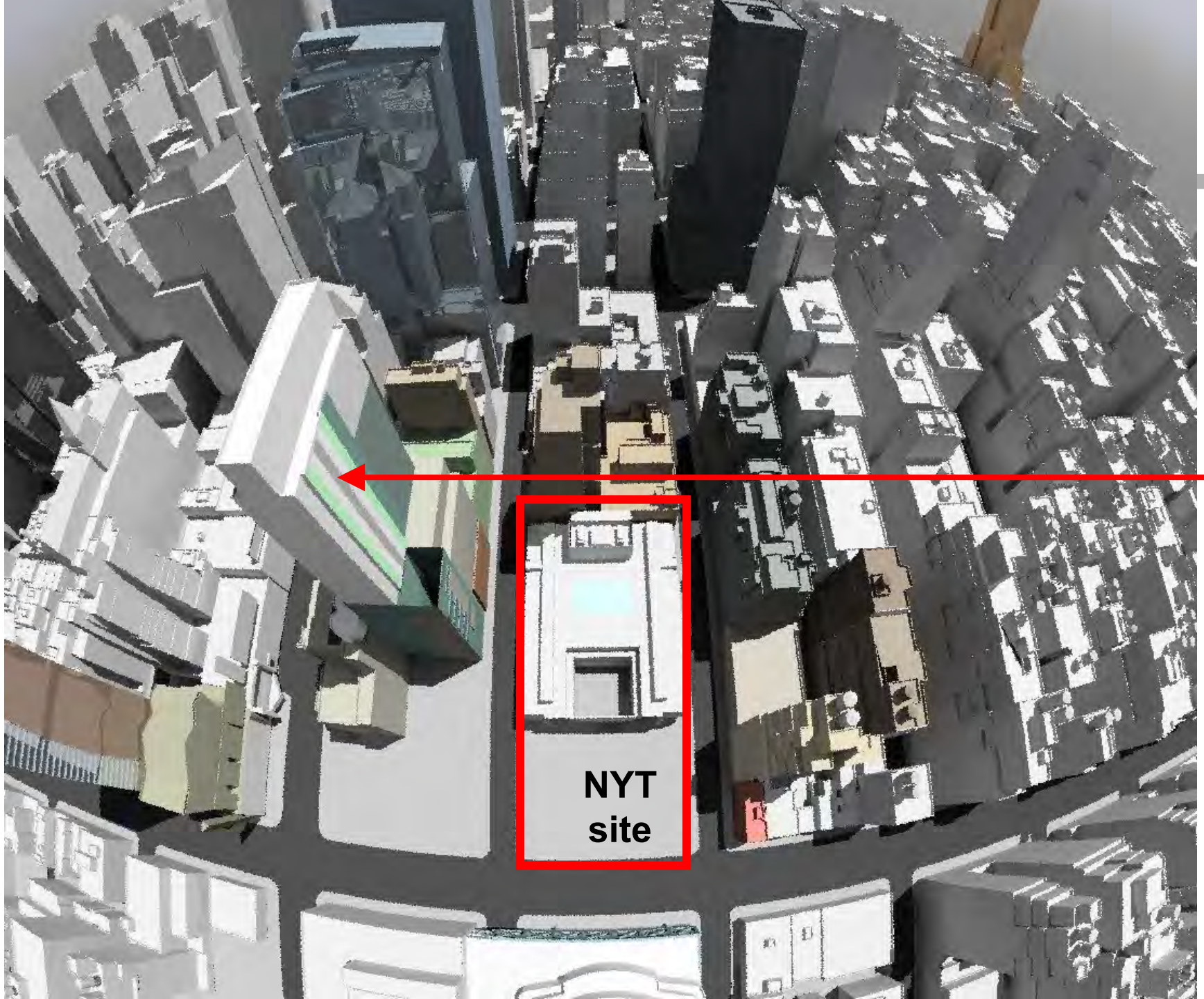
7924.777
0.118

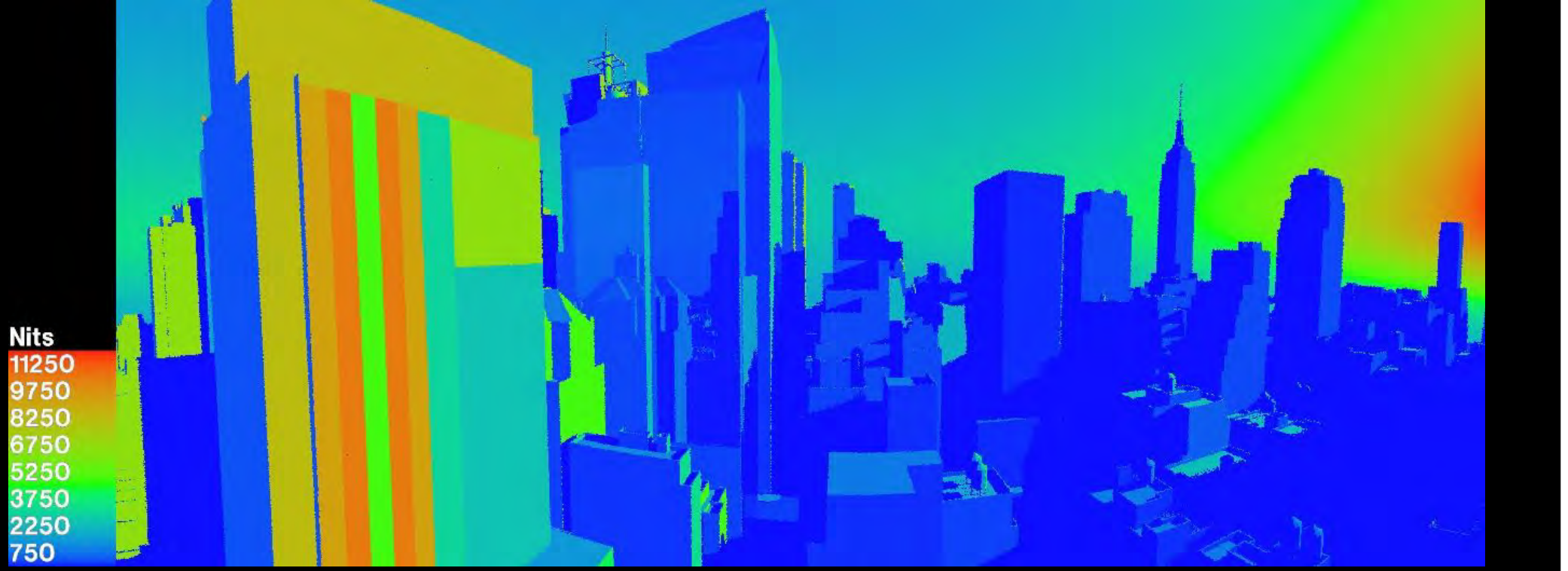
Shadow studies

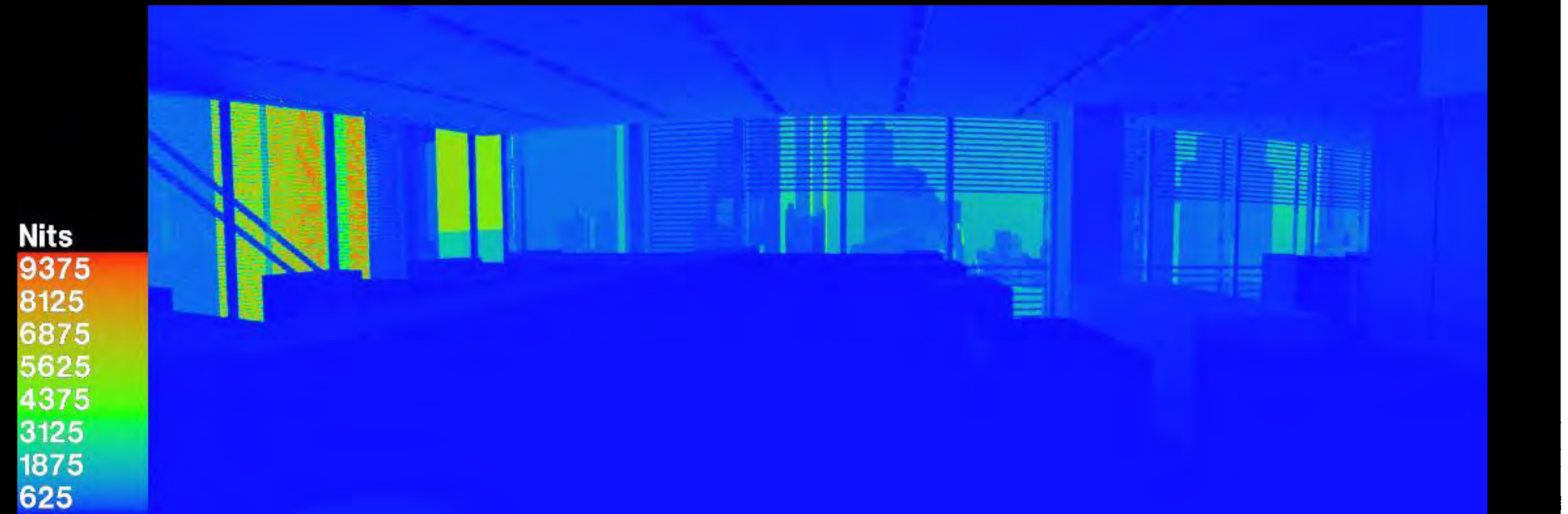




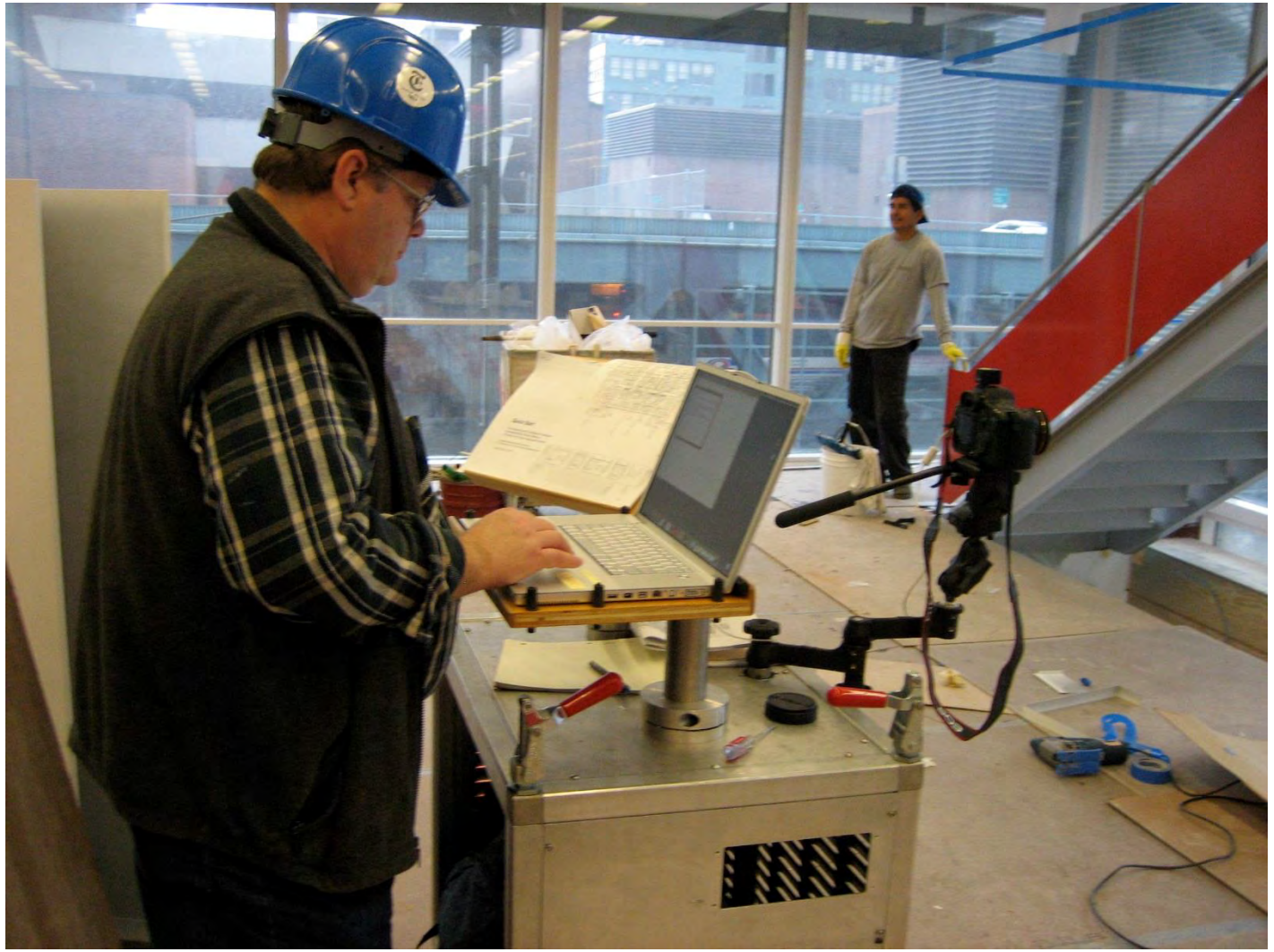
Reflected Glare

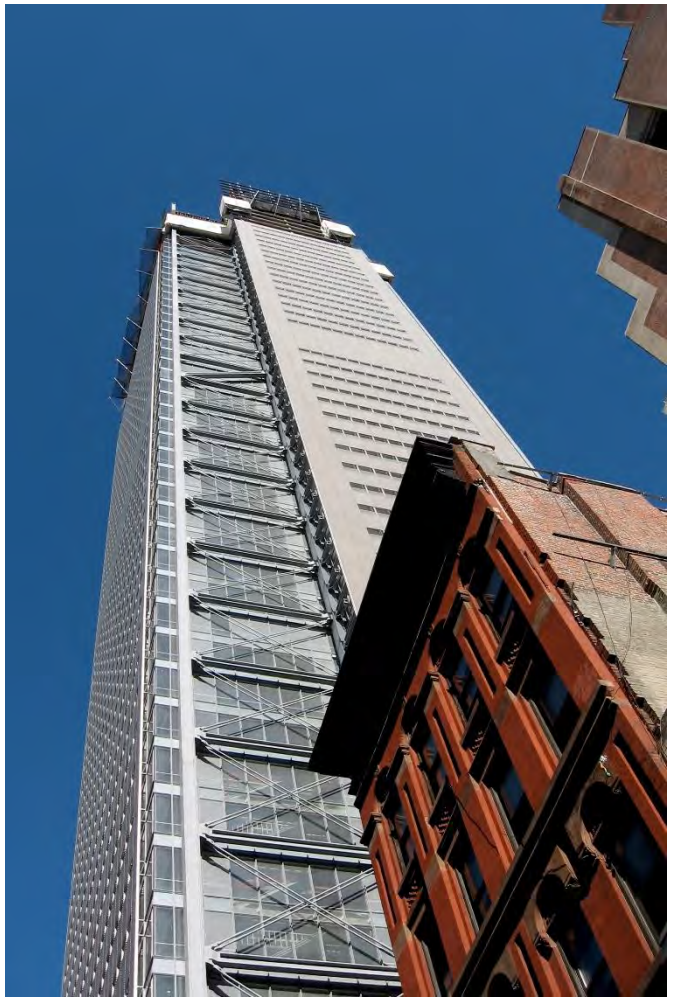
Opposing building is a source of potential reflected glare


Nits
11250
9750
8250
6750
5250
3750
2250
750


Nits
9375
8125
6875
5625
4375
3125
1875
625

The New York Times Headquarters: “Shade Commissioning Cart” being Tested





New York Times HQ Outcomes

LBNL Engagement: 2003

Occupancy: 2007

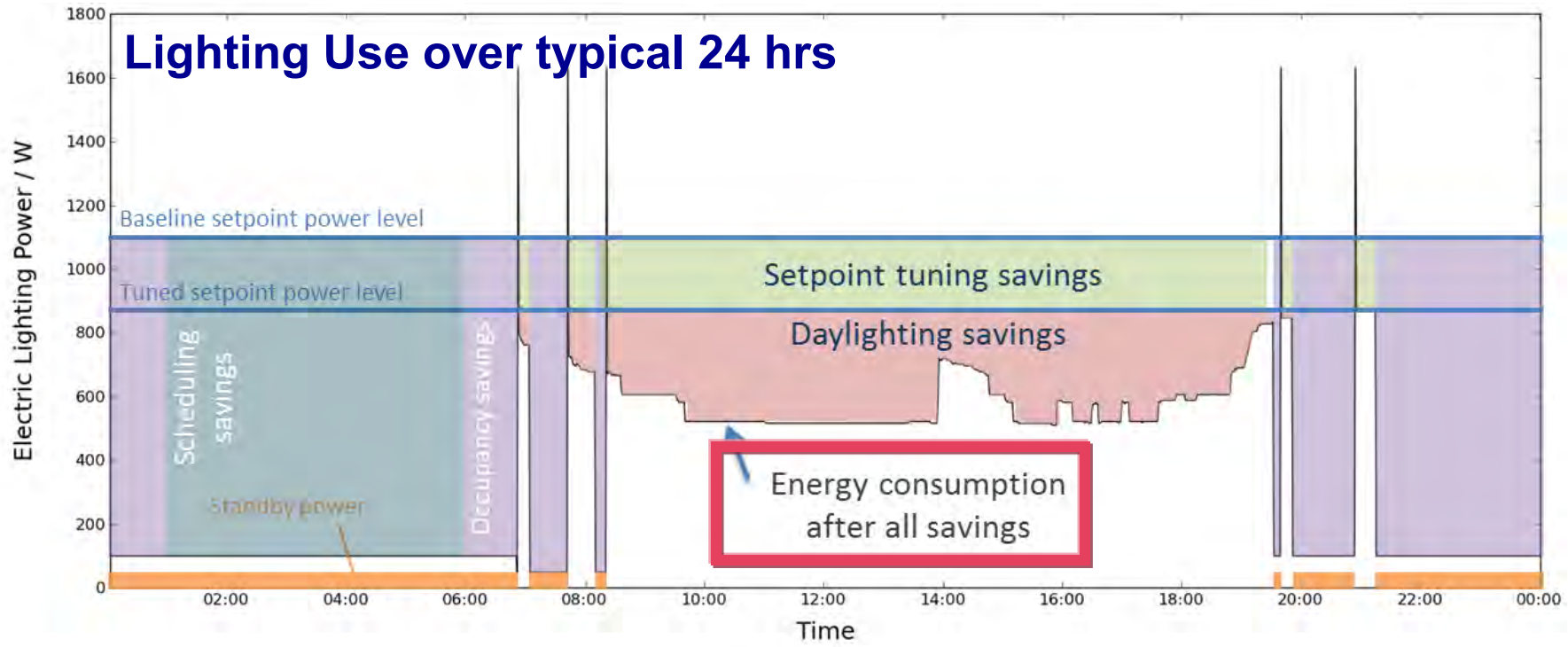
Monitoring and Post-Occupancy Study: 2012

New York Times Building
Energy Monitoring and Post Occupancy Evaluation
Highly Glazed Office Building vs Code Energy

Lighting Control Systems: 5 strategies, including daylight

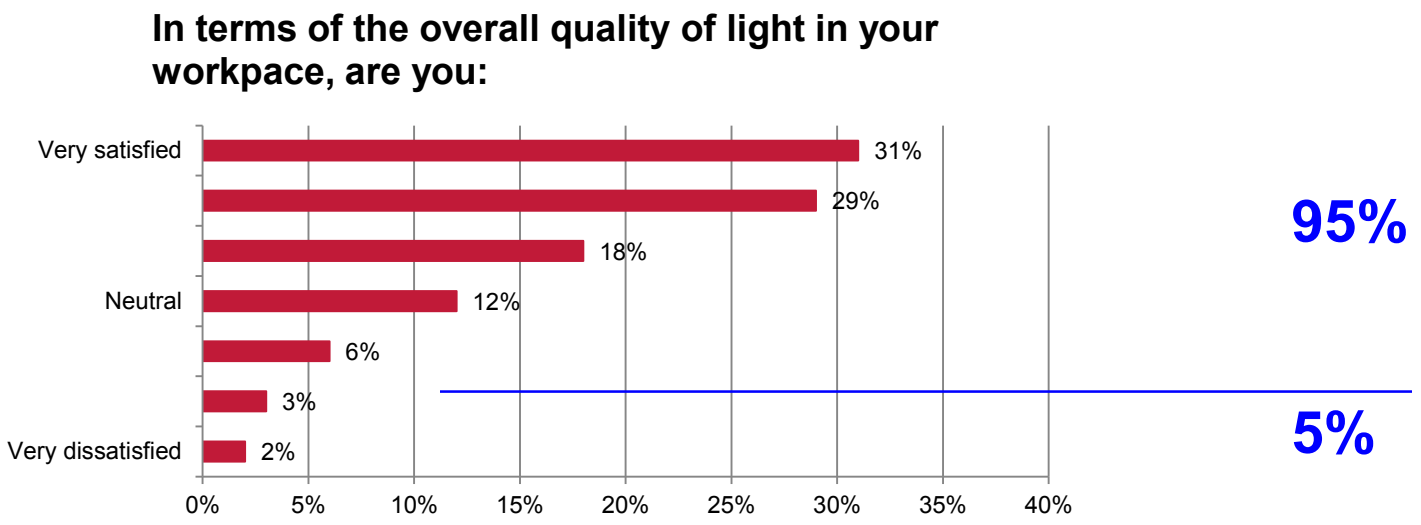
26% Energy Savings vs Code

56% Lighting Energy Savings vs Code

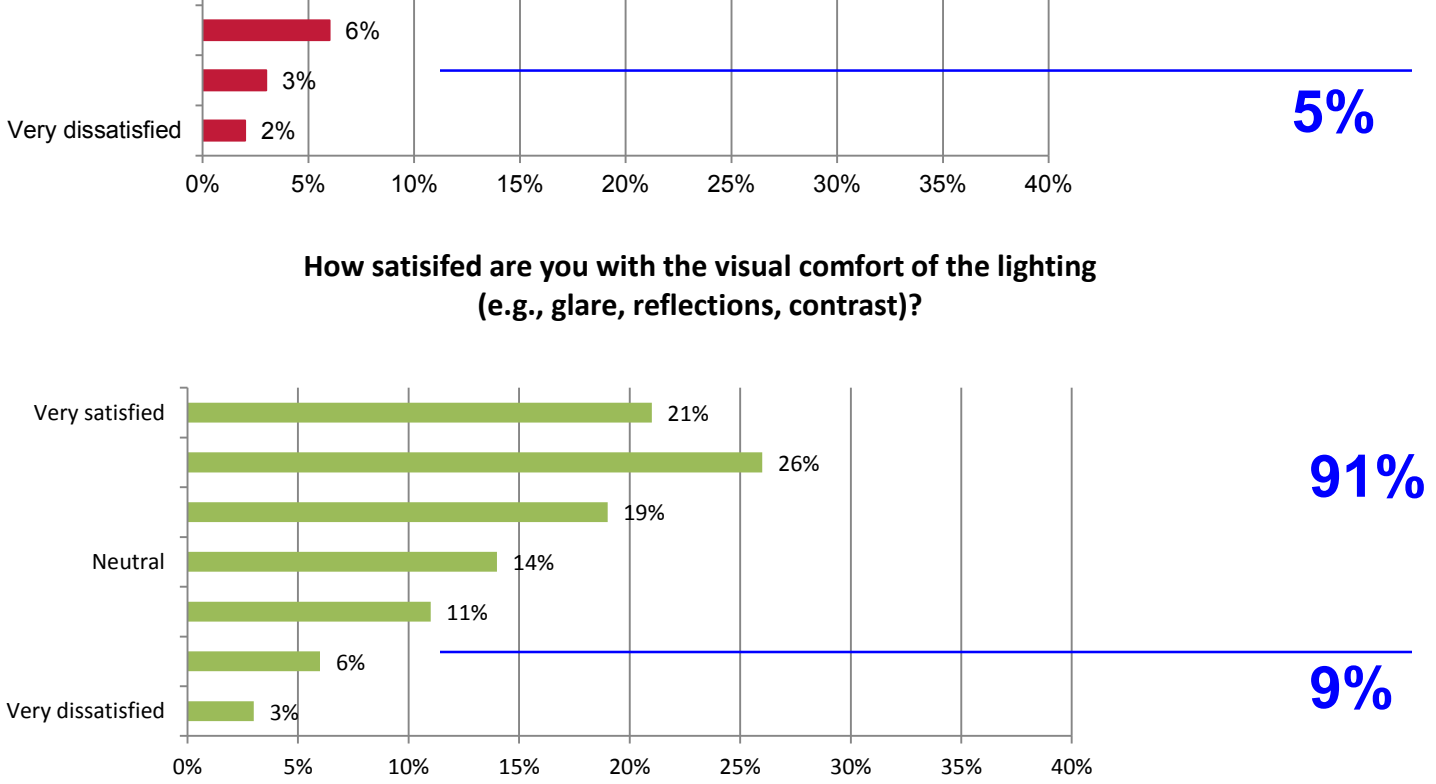


NY Times Building: Occupant Satisfaction is High

Quality of Light



Visual comfort



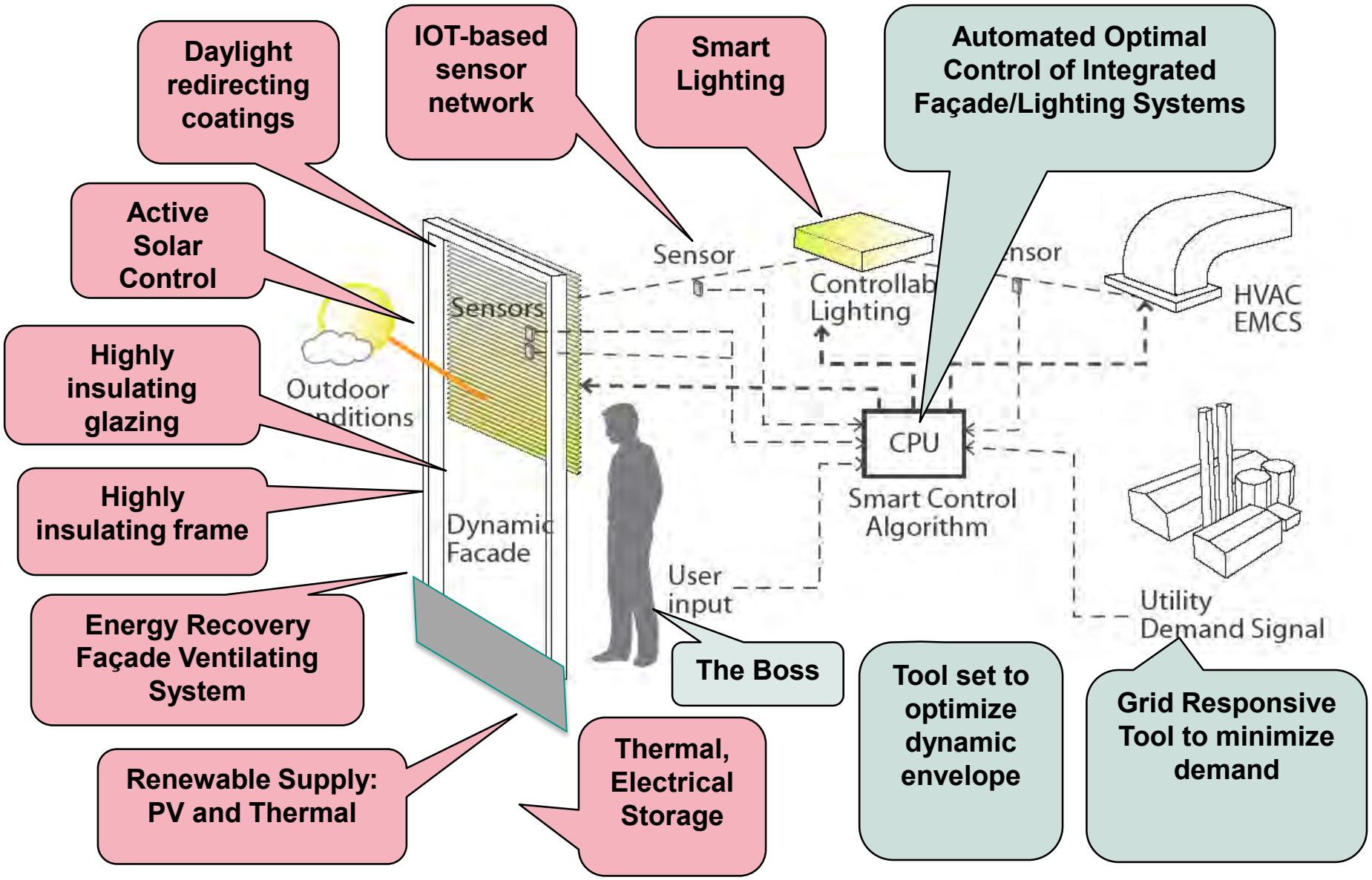
Success!
Dimmable Lighting, Automated Shading Work!
New Products Commercially Available
Satisfied Occupants

But – limited impact beyond this project

Challenges to Scaling Success

Resources for Design

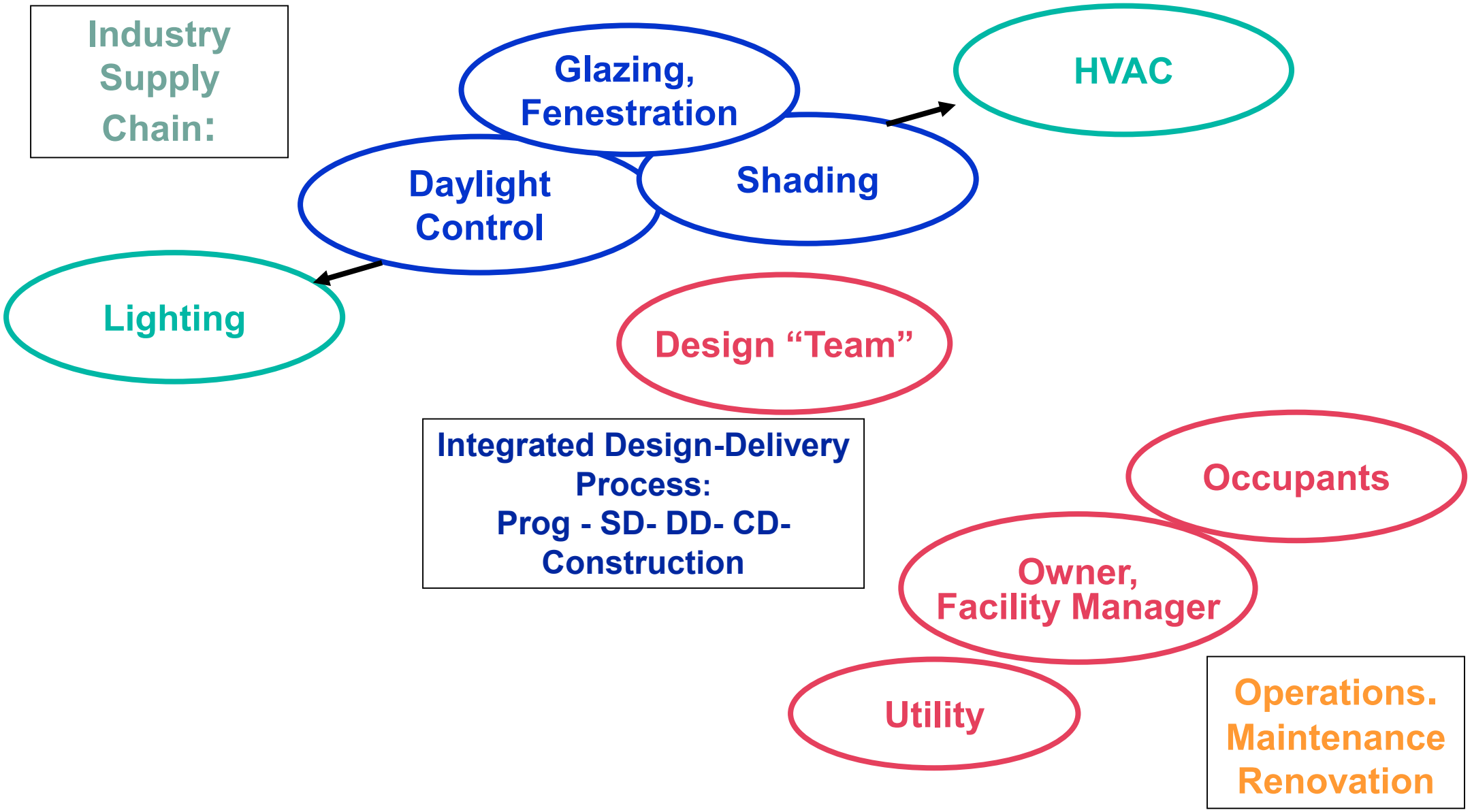
The Challenge: Delivering Complex Solutions that WORK!

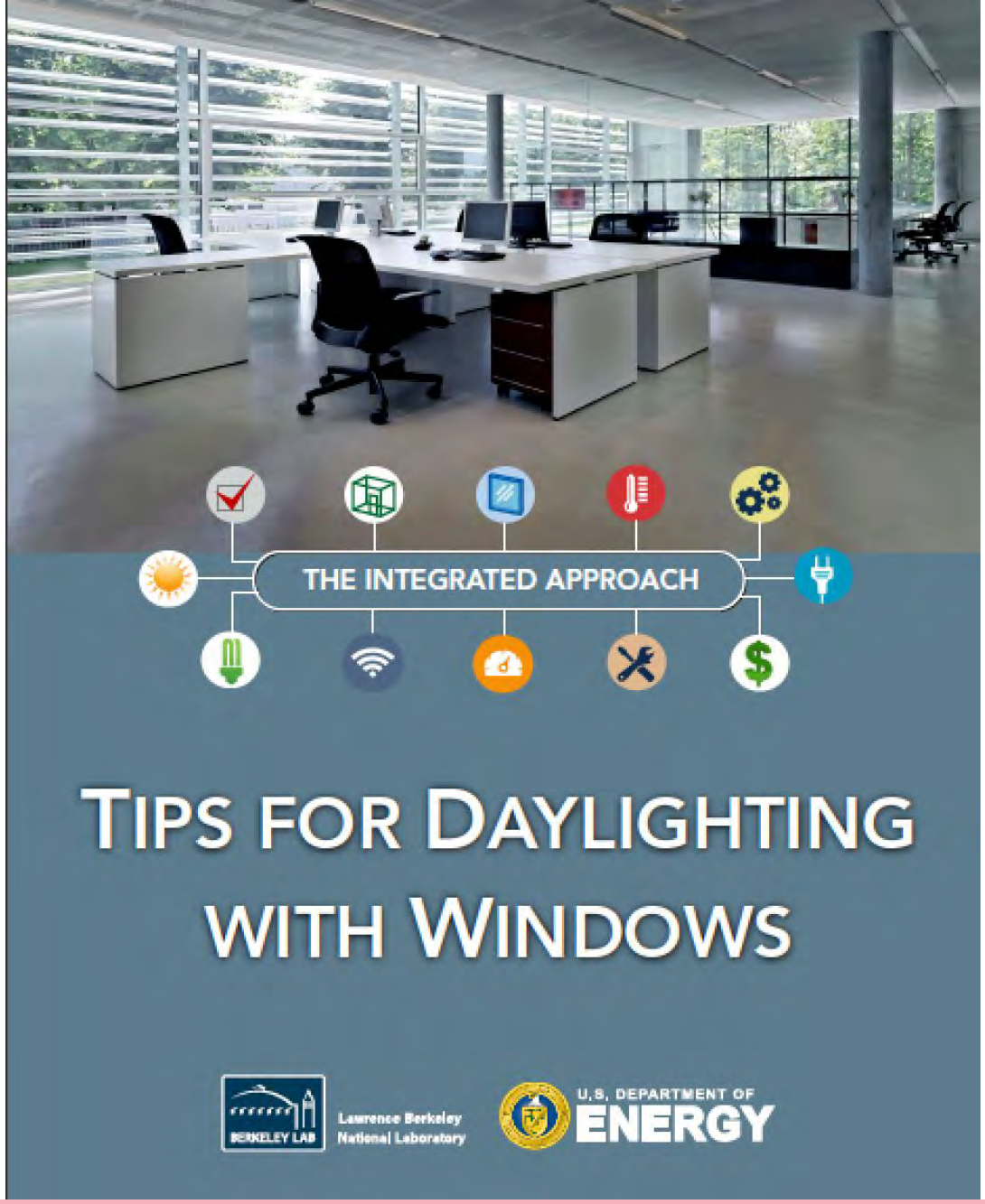


Need A Platform and Pathway to Create and Promote High Performance “Active, integrated Building Systems”

- Proof-of-concept: PLATFORM for **integrated, open, interoperable solutions**
- Adopt **INTERNET OF THINGS (IOT) technology**
- **Building Industry Coalition to define requirements, create market demand** for interoperable, integrated solutions

The Façade Design-Delivery Ecosystem





Topics	Phase
Integrated Approach	**Preparation**
Feasibility	Pre-Design
Envelope/ Room	Conceptual Design & Programming
Glazing	
Shading	
Mechanical Coordination	Schematic Design/ Design Development
Lighting	
Sensors & Controls	
Calibration/ Commissioning	Construction Documents
Maintenance	Pre-Occupancy
Cost-Benefit Analysis	Post-Occupancy

Download: https://buildings.lbl.gov/sites/default/files/tips-for-daylighting-2013.pdf

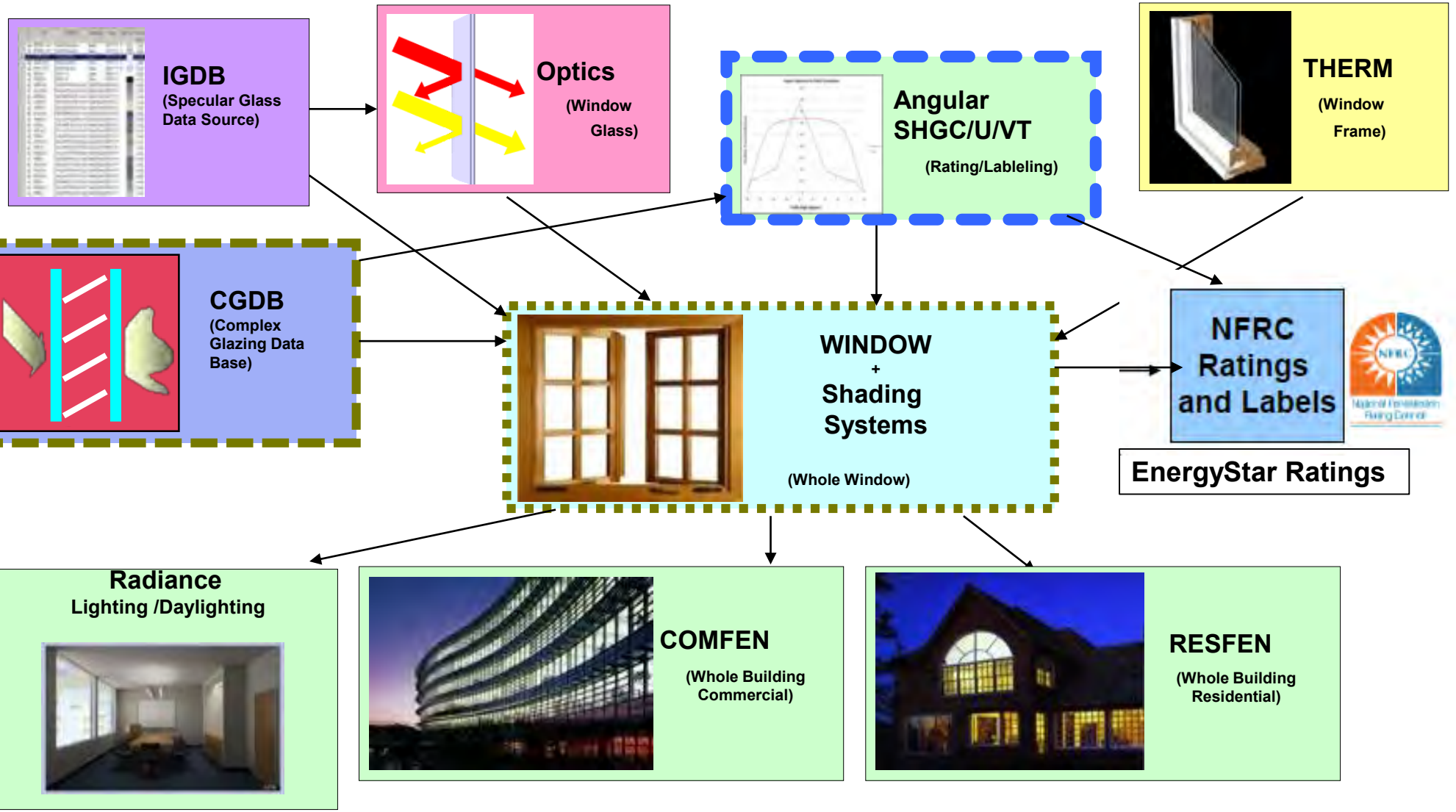
Web-Based Façade Design Tool

www.commercialwindows.org

Rapid Comparison of different scenarios for commercial windows

Glazing and Façade Decision-Support Tools

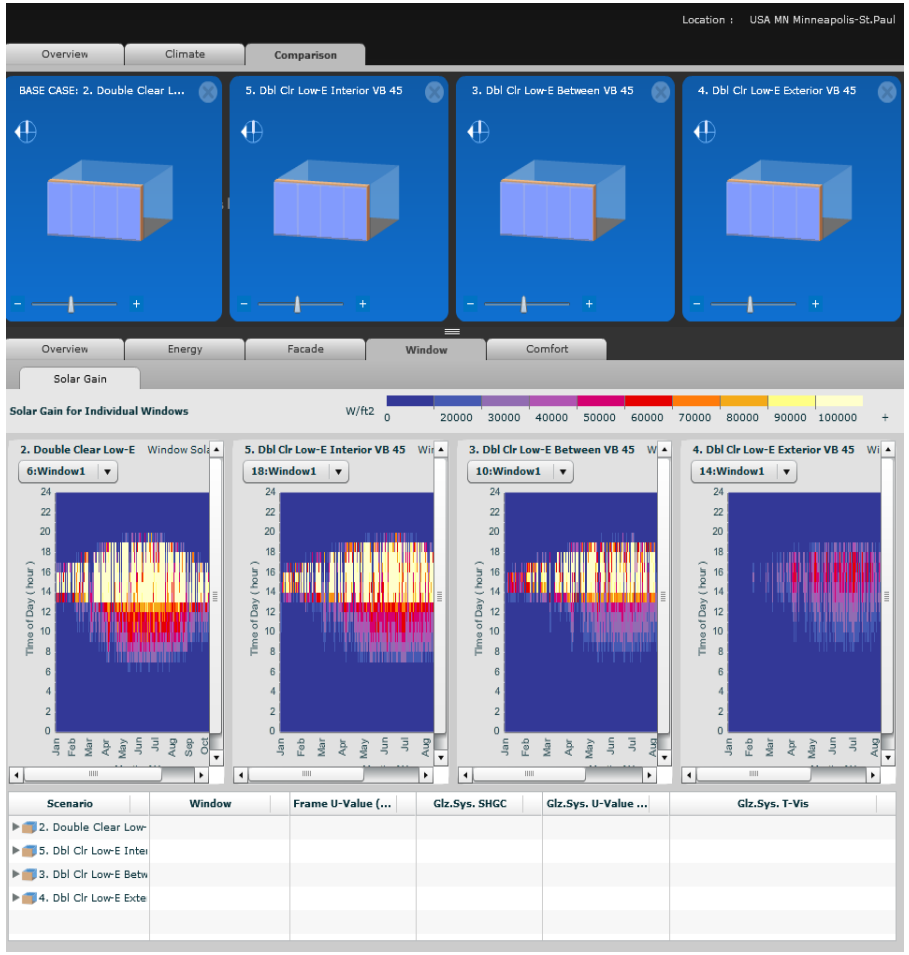
Download http://windows.lbl.gov/software/ 2016 ~ 40,000 Downloads



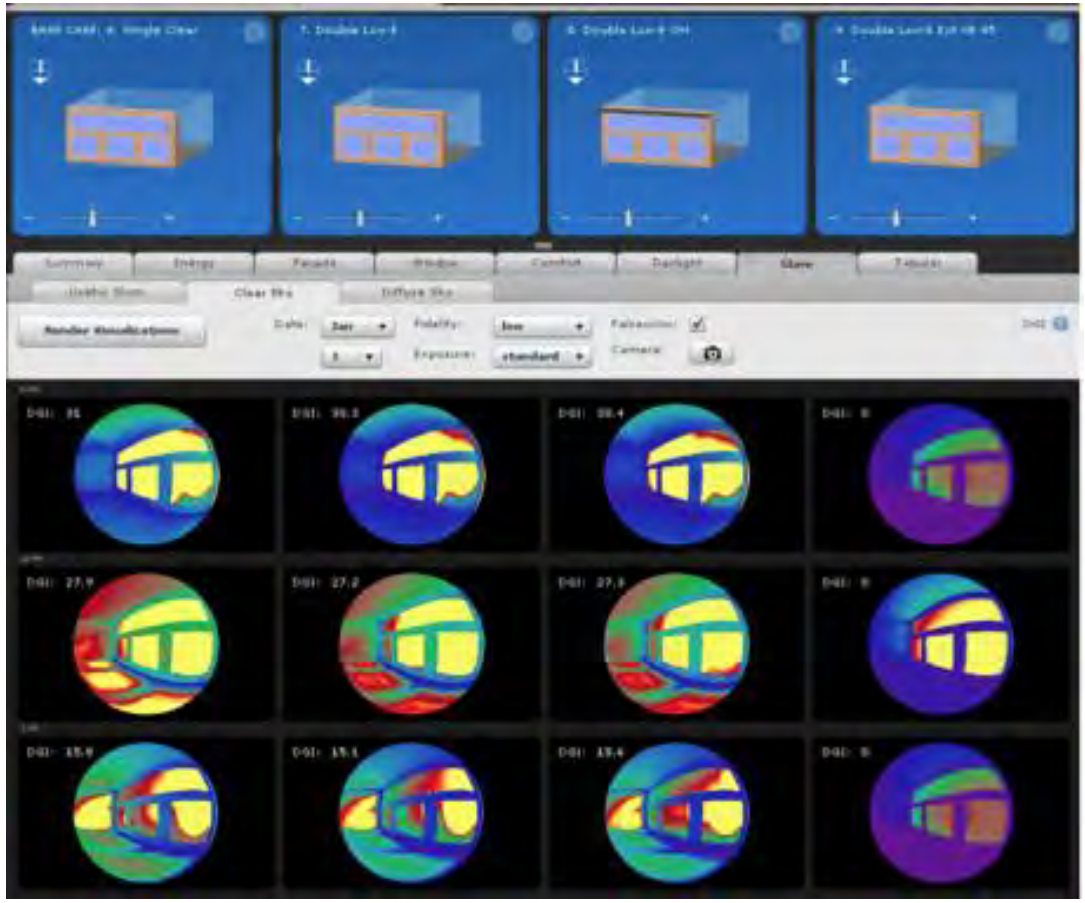
Commercial Windows Website **Efficient Windows Website** **Design /Simulation Tools**

COMFEN: Exploring Performance Details
Solar Gain/Daylight/Glare Results

Window solar gain



Daylight/Glare Assessment w/ Radiance



BERKELEY LAB
LAWRENCE BERKELEY NATIONAL LABORATORY

U.S. DEPARTMENT OF ENERGY

LBNL Windows and Daylighting Team 1976-2017 +

Research sponsored by USDOE, CEC, GSA, NYSERDA, NEEA, utilities and many others,
In collaboration with national and global industry and R&D partners

~300 Downloadable Reports, Tools

facades.lbl.gov
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flexlab.lbl.gov
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seselkowitz@lbl.gov

Nikolas Dando-Haenisch, AIA LEED
Principal
Grimshaw

3 new schools

192,340 hours (93 years)

Doubling of residential population

12 new hotels

5 MTA Board Chairman

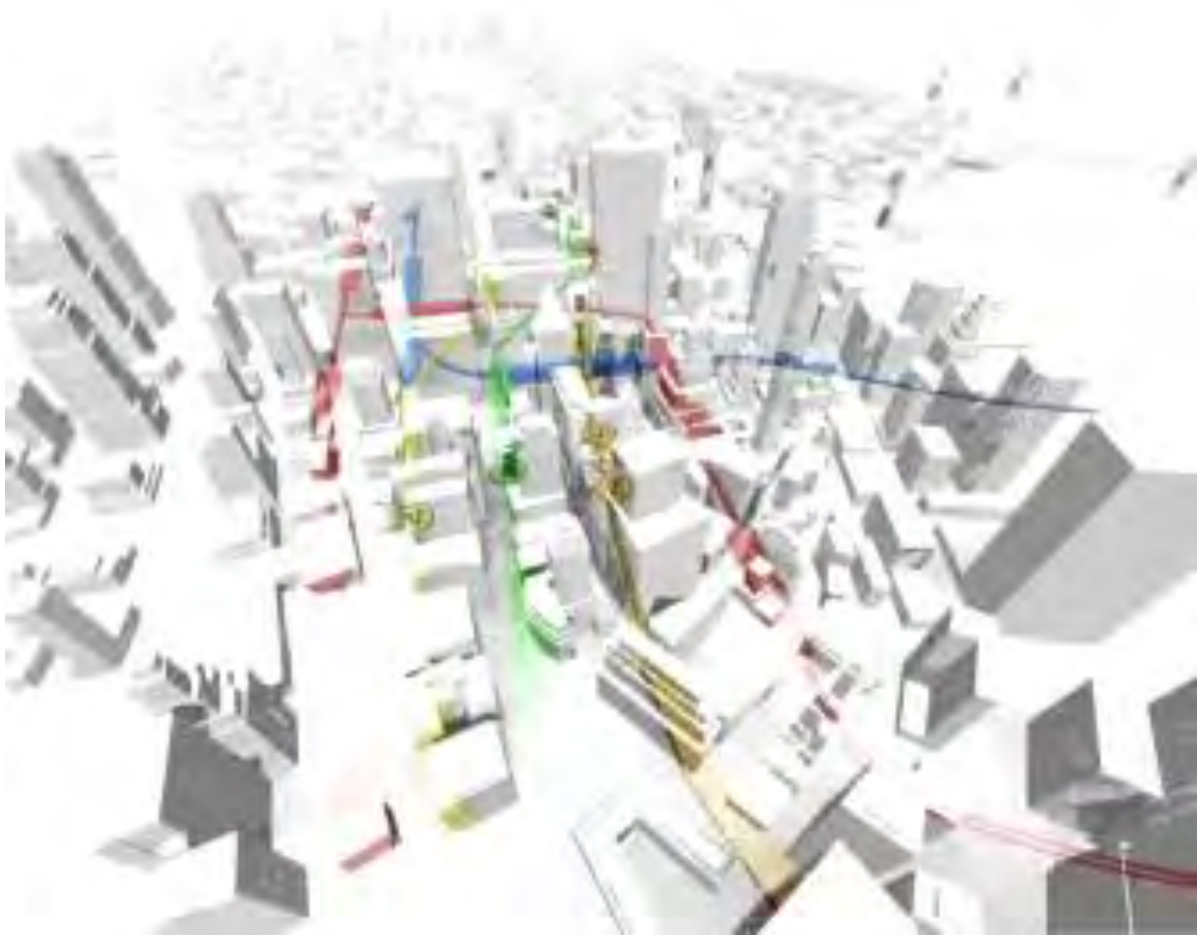
Philadelphia + San Francisco

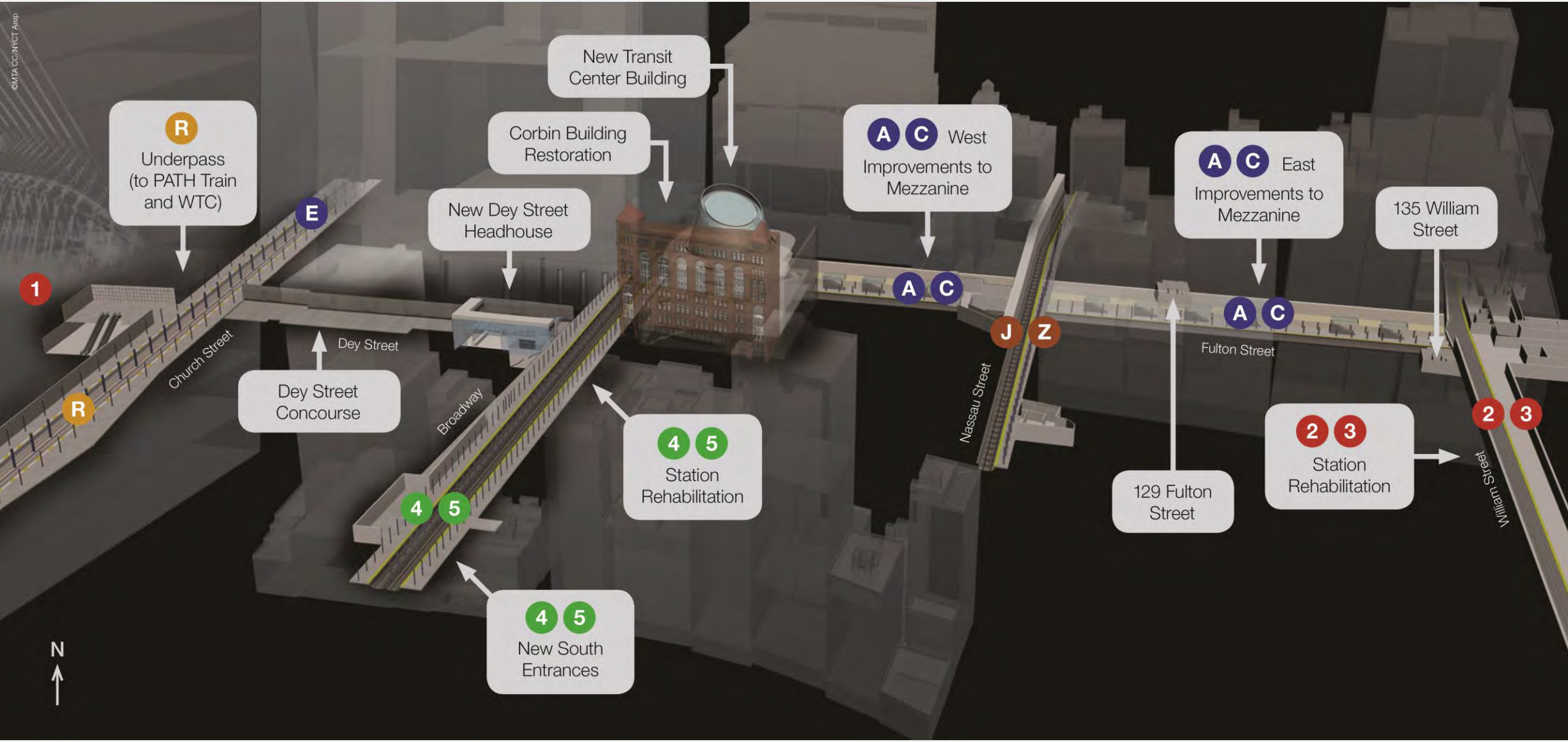
Class A **70M** sf

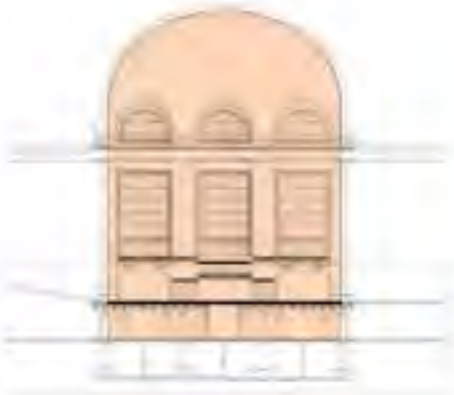
2/3 daily commuters

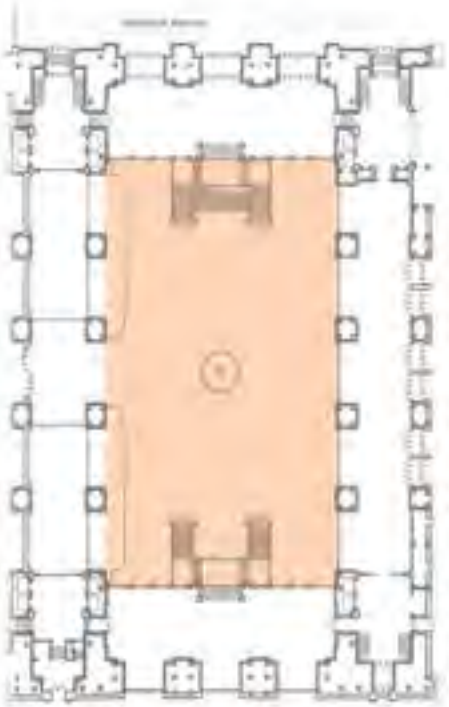
270,000+ daily transfers

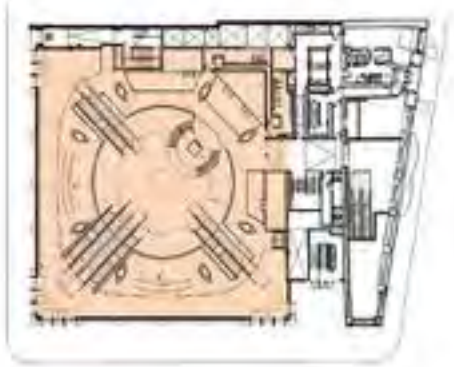
24% increase new tech start ups

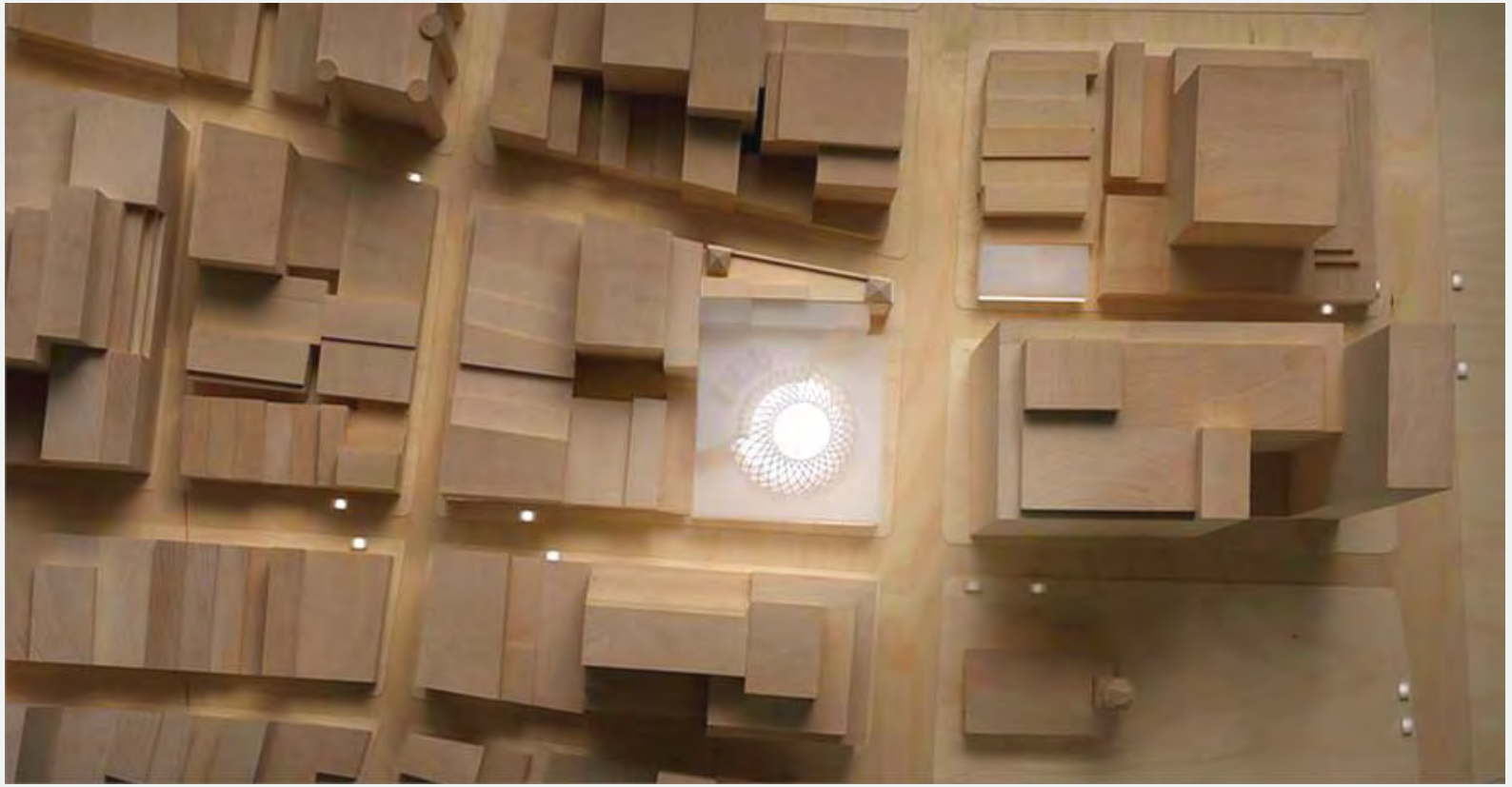


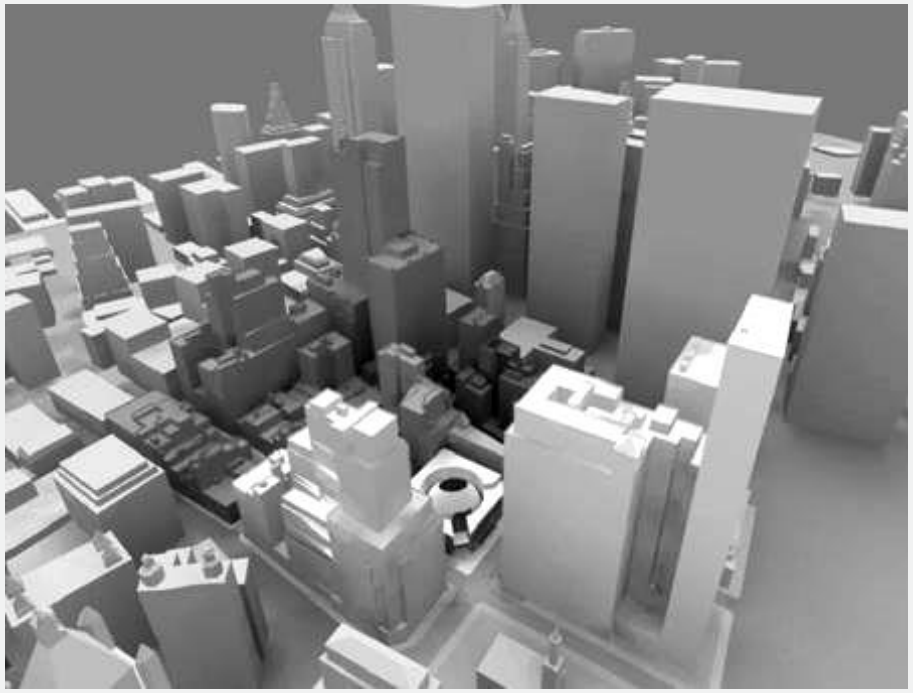

©MTA CC/NYCT Arup
New Transit Center Building
Corbin Building Restoration
New Dey Street Headhouse
R
Underpass (to PATH Train and WTC)
E
1
R
Church Street
Dey Street
Dey Street Concourse
Broadway
4 5
Station Rehabilitation
4 5
New South Entrances
A C West
Improvements to Mezzanine
A C
J Z
Nassau Street
A C East
Improvements to Mezzanine
A C
Fulton Street
129 Fulton Street
135 William Street
2 3
Station Rehabilitation
2 3
William Street
N





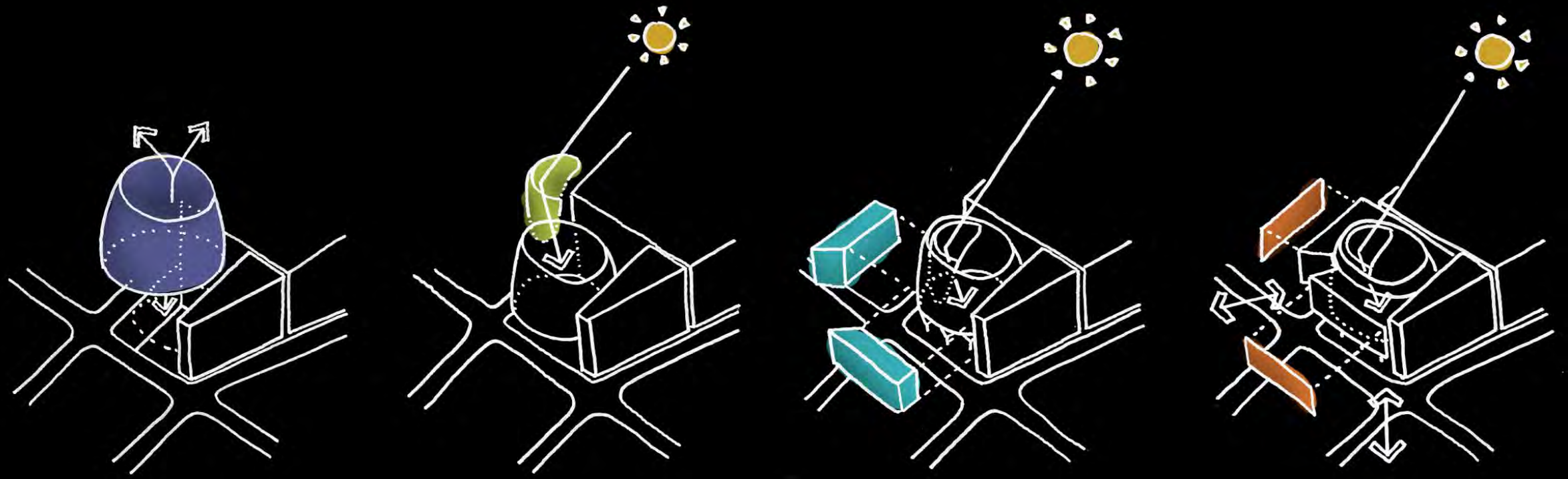




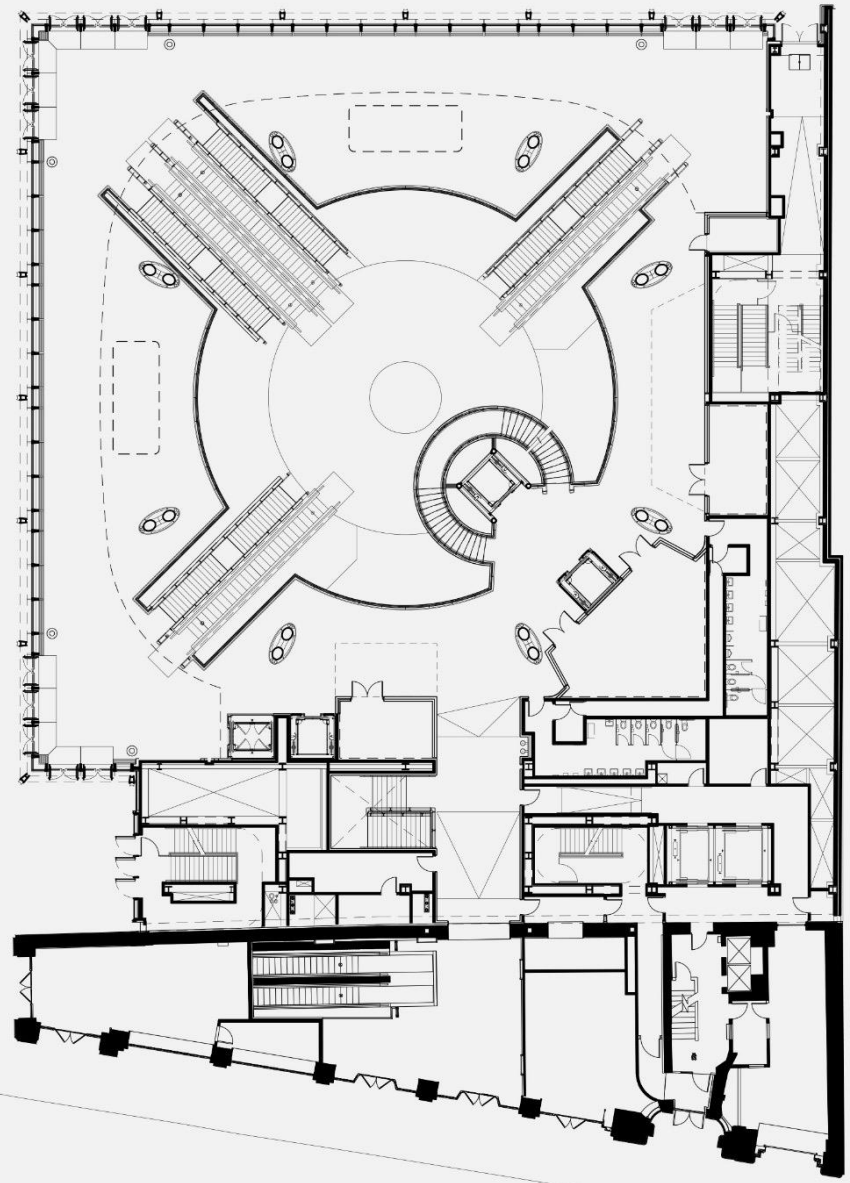


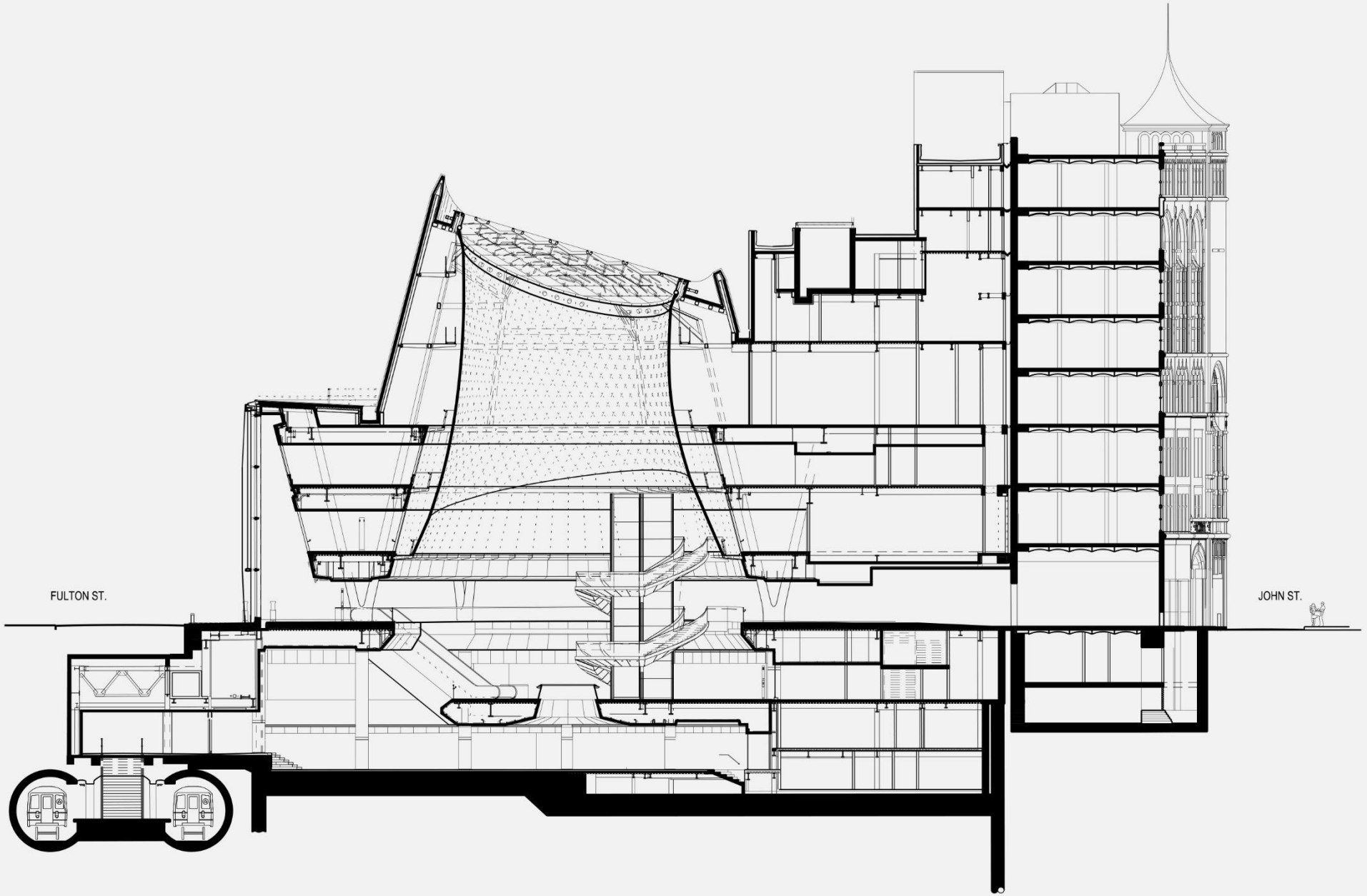
Aerial View Looking South

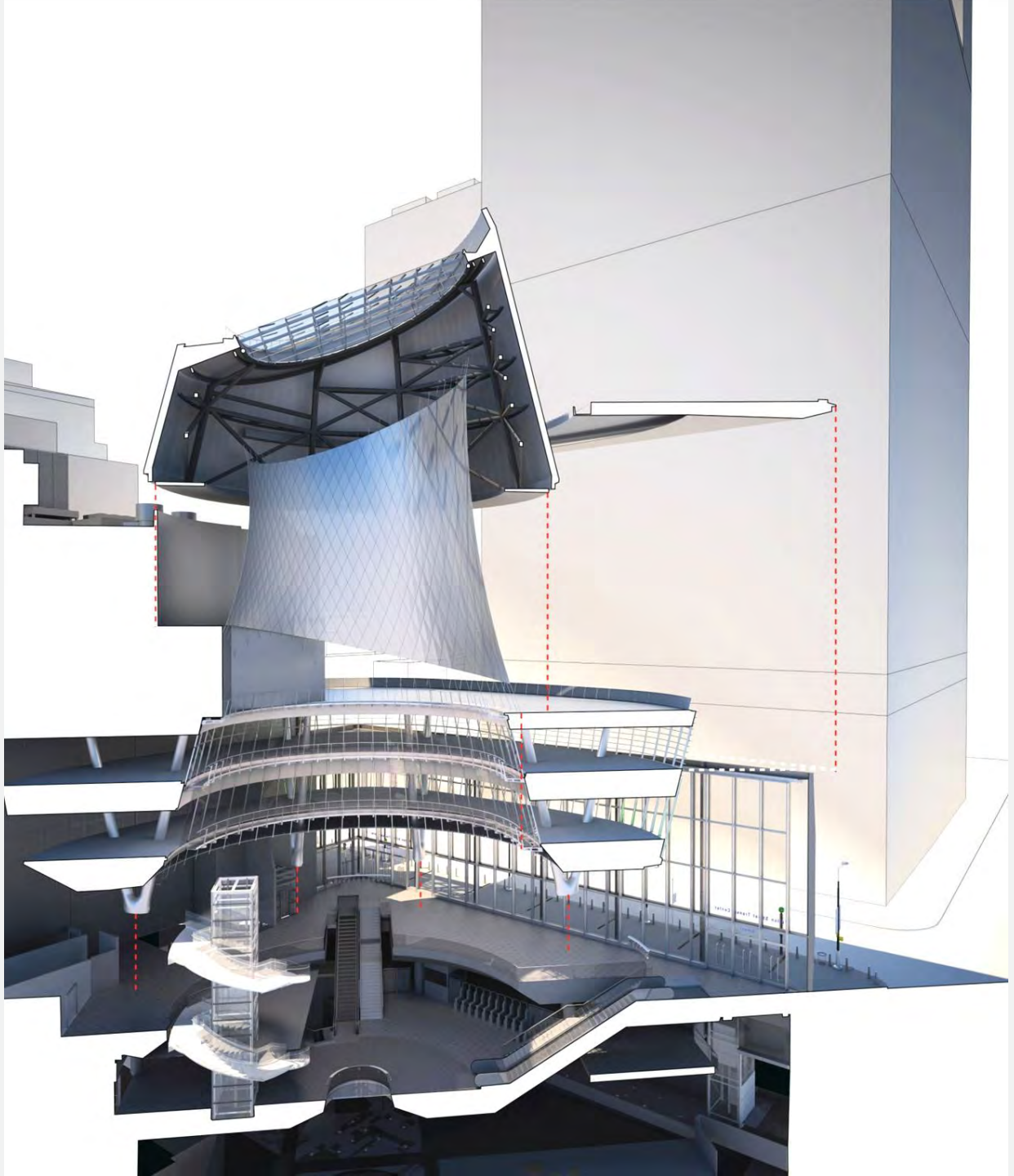
Solar Analysis

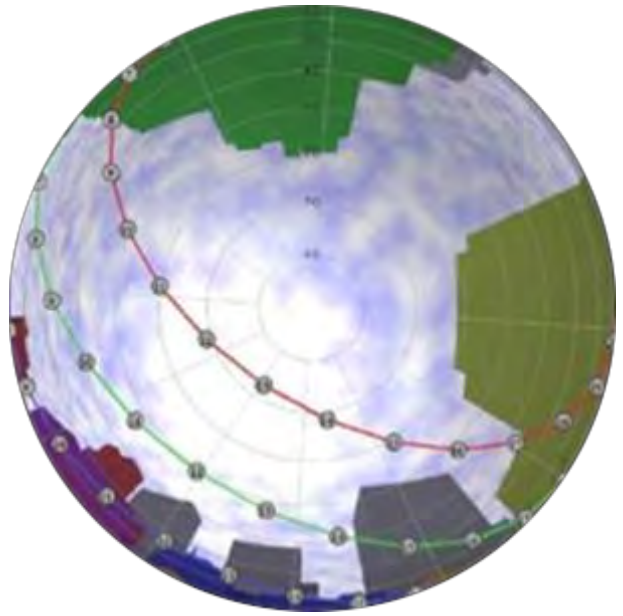


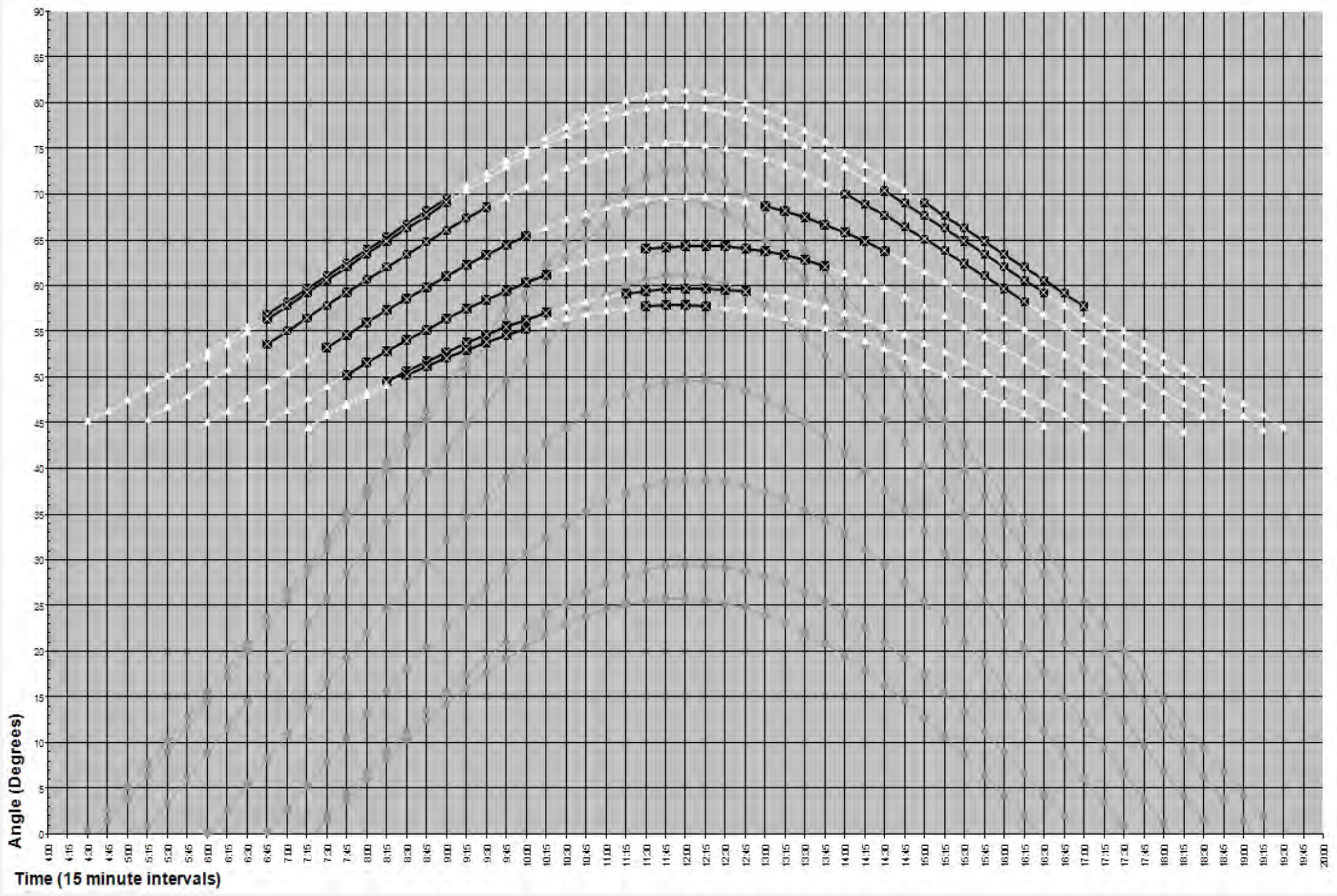

ONE WAY
Fulton Center
ONE WAY

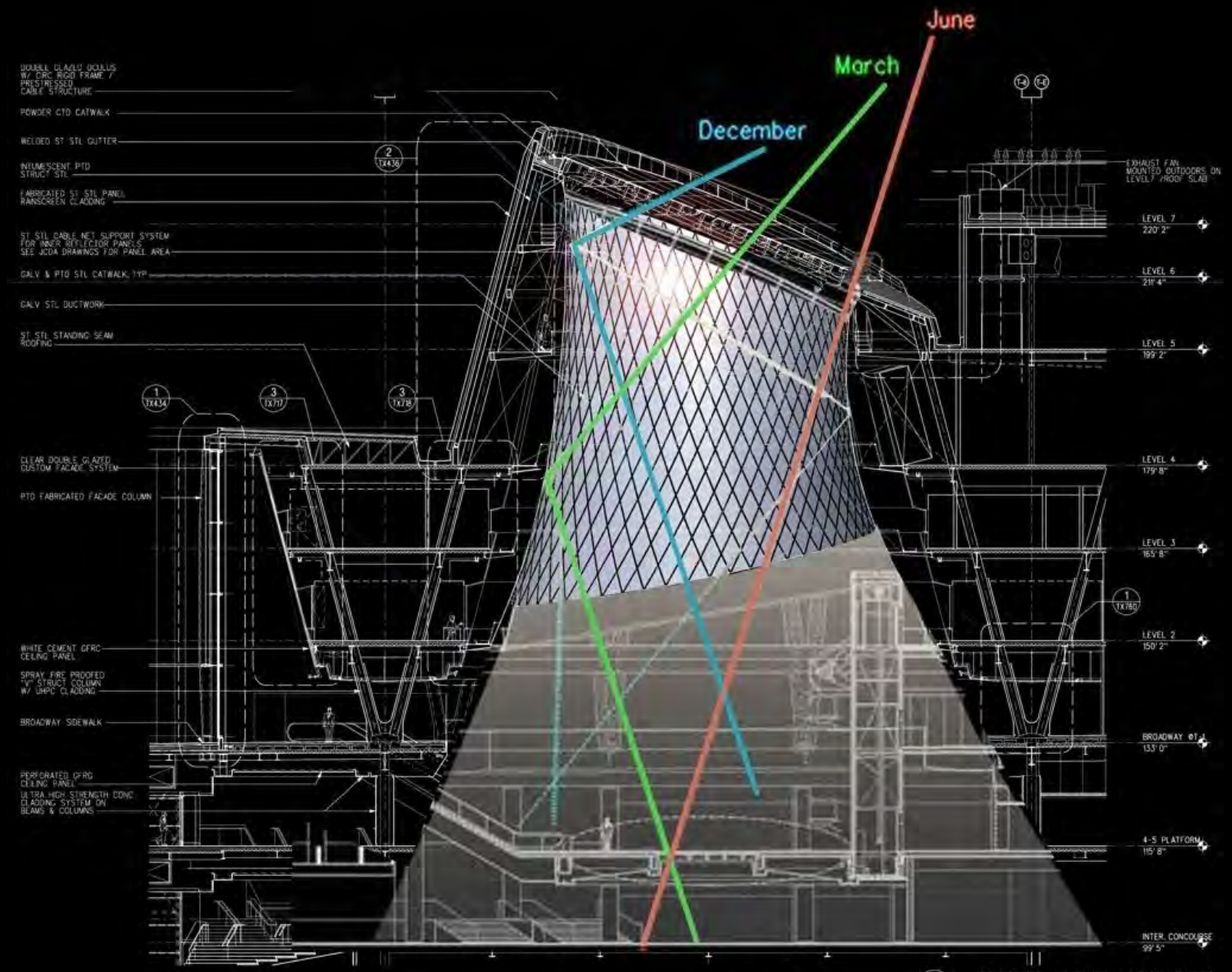



FULTON ST.
JOHN ST.



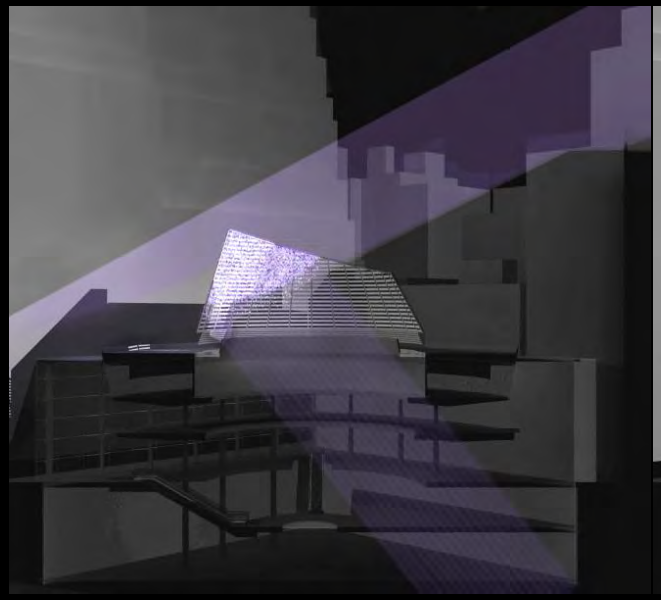



Angle (Degrees)
Time (15 minute intervals)

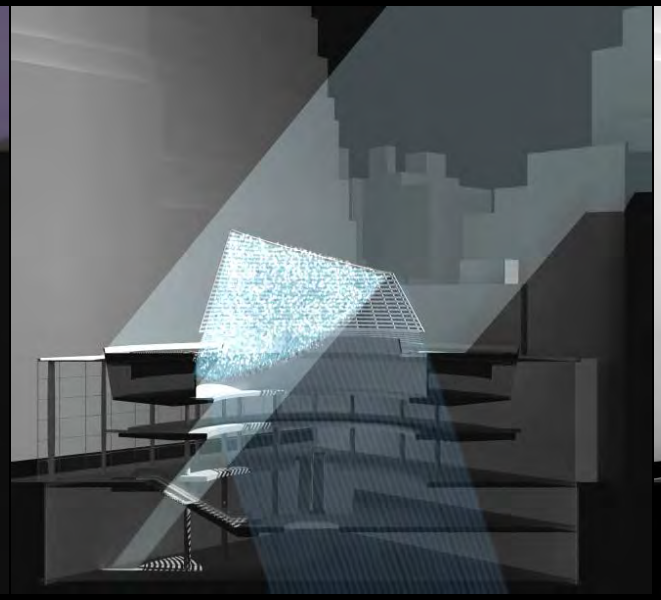


1 SECTION ALONG 'V' COLUMNS

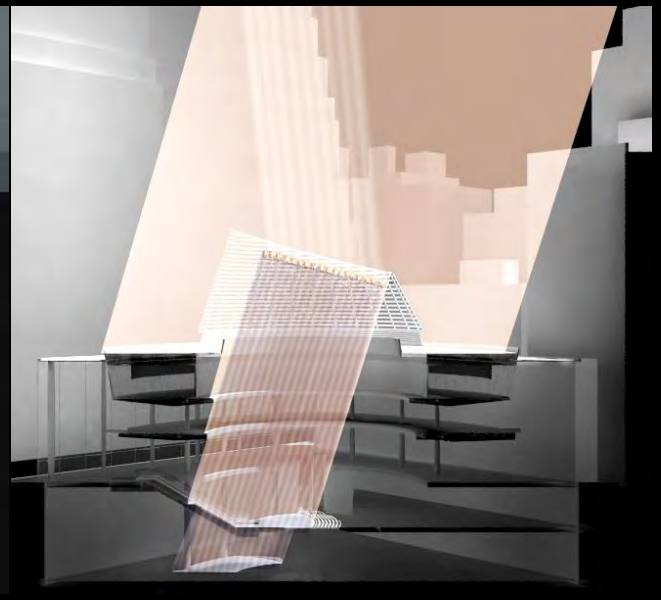
SCALE 1/8" -1'-0"



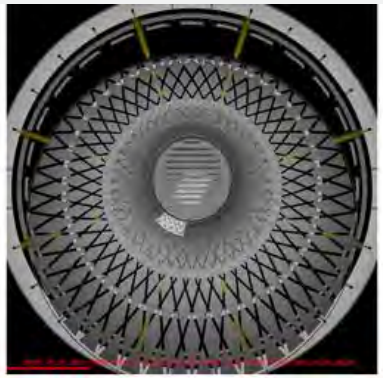
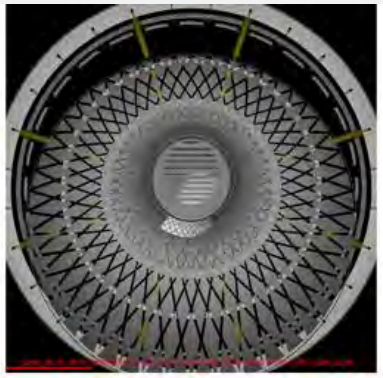
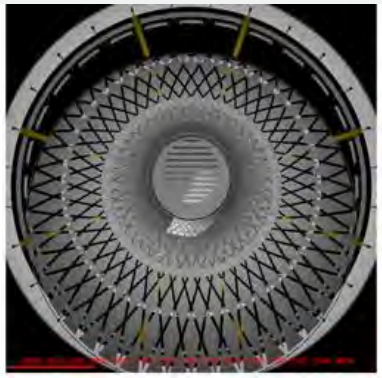
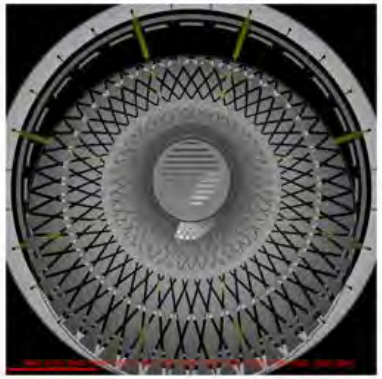
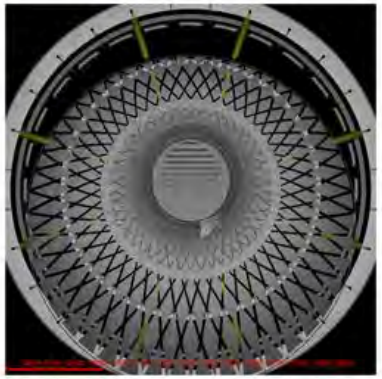
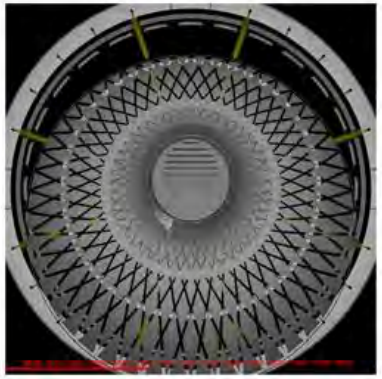
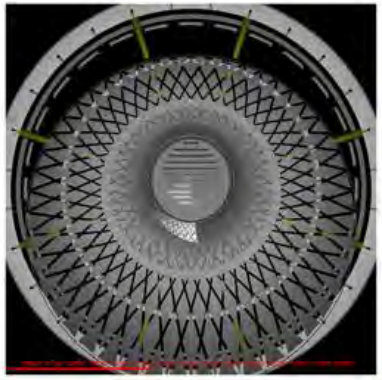
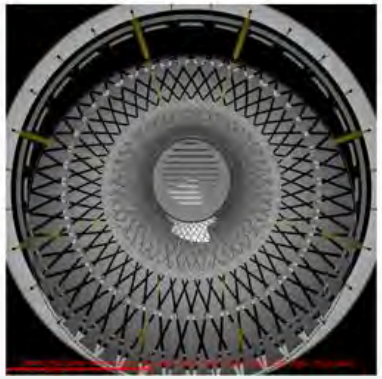
December 21 (noon)
Winter Solstice

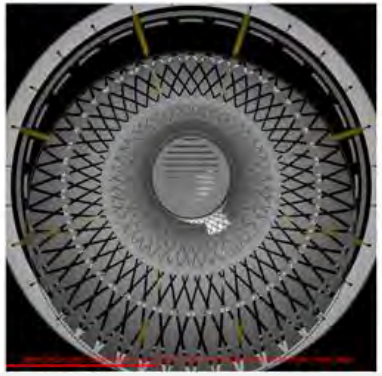
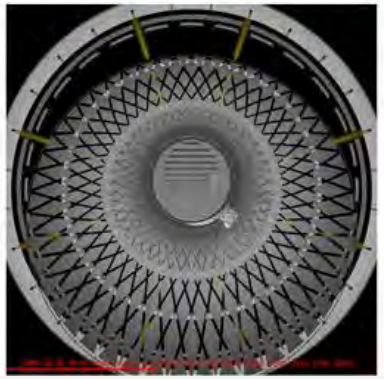


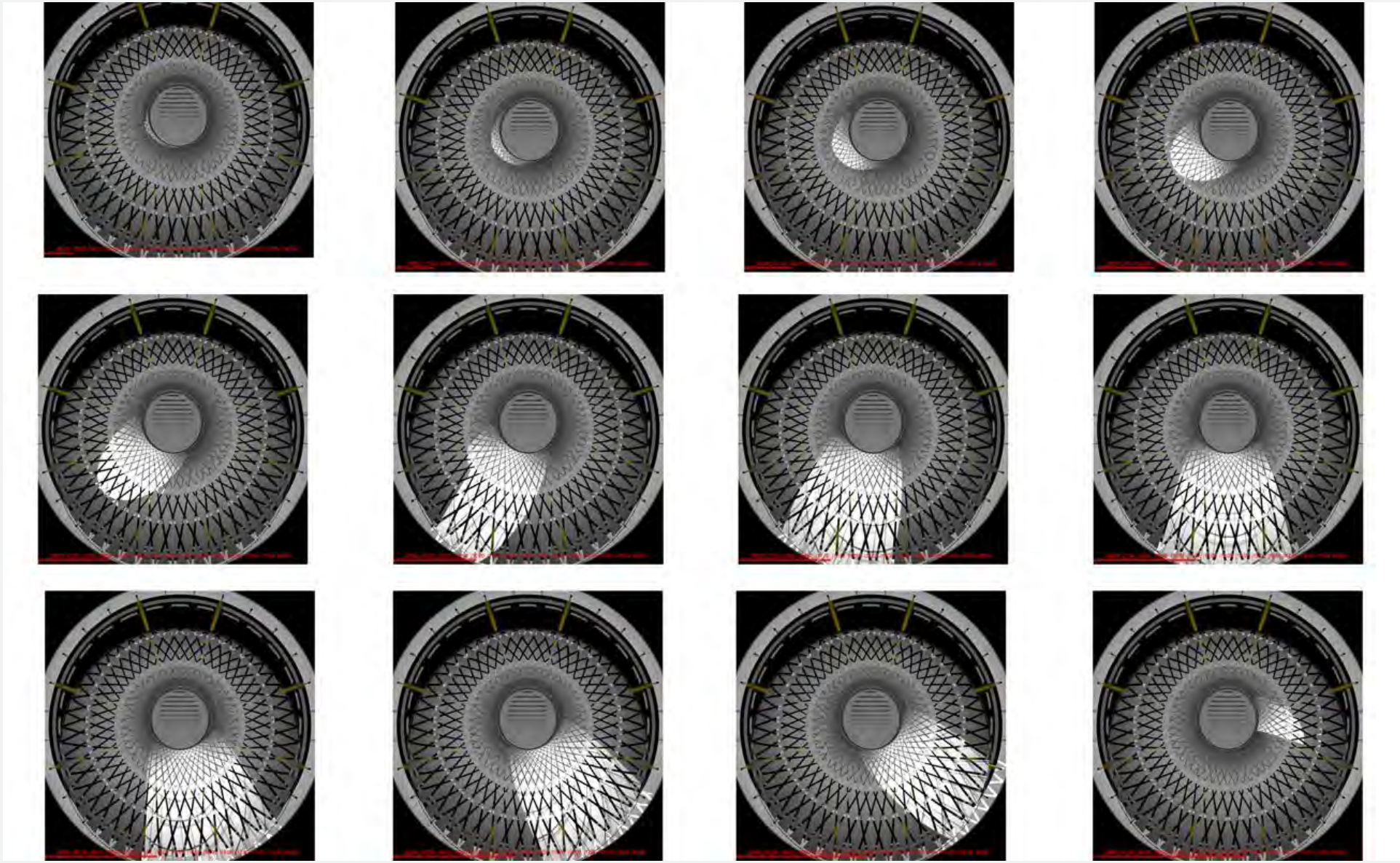
March/September 21 (noon)
Equinox

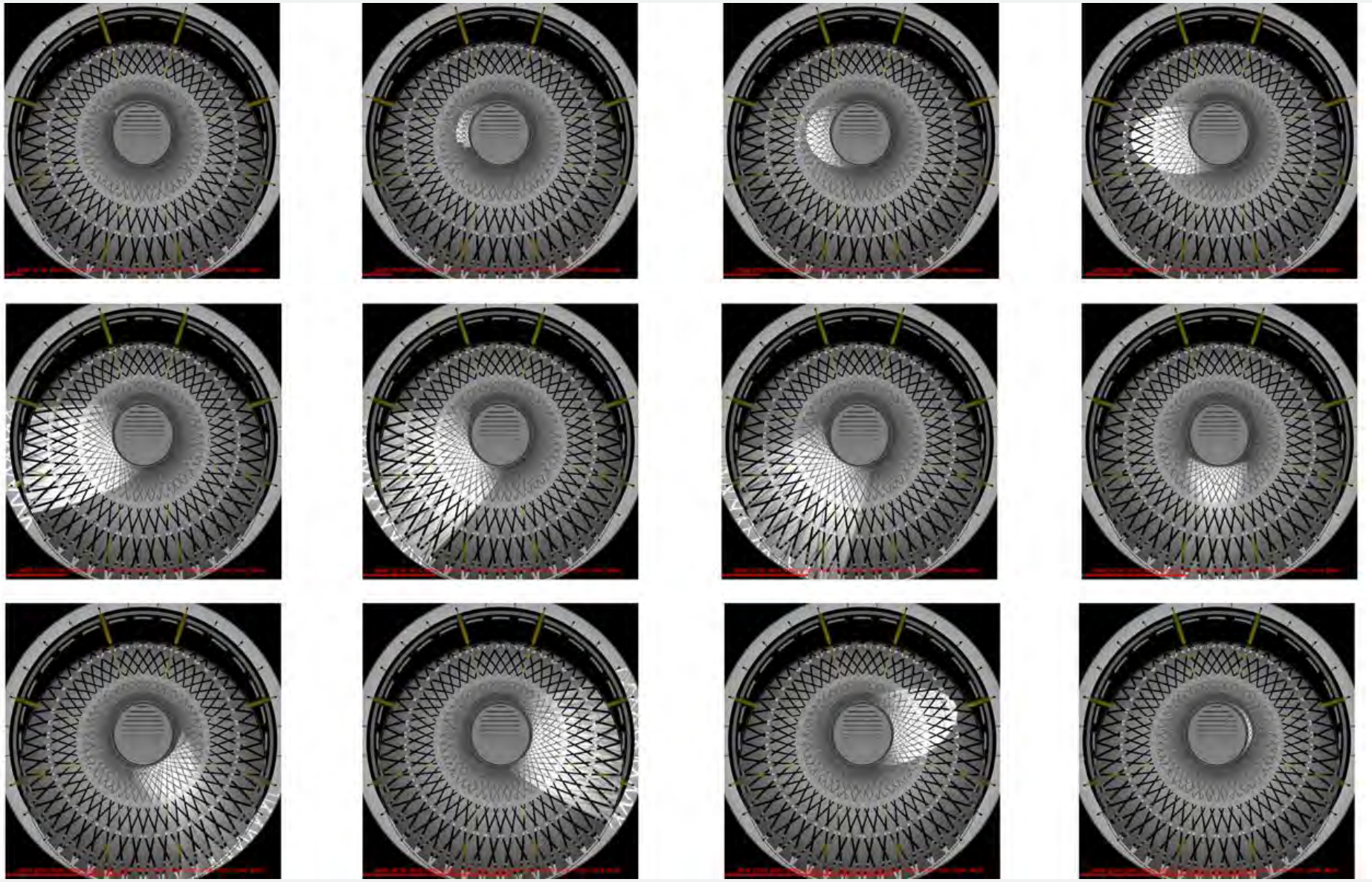


June 21 (noon)
Summer Solstice






BURBERRY
Exit
Broadway &
John St
Entry A C
BURBERRY
Exit
Exit


Fulton Center
Transportation
Exit

Architectural Record Daylighting Webinar

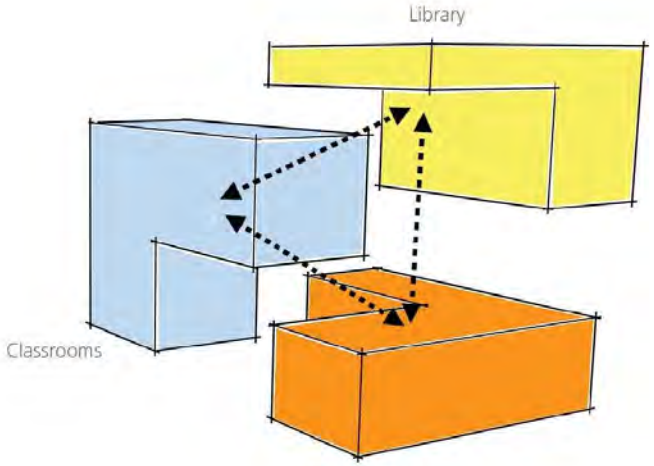
The University of Baltimore Law School

Matt Noblett, AIA, NCARB
Partner
Behnisch Architekten - Boston

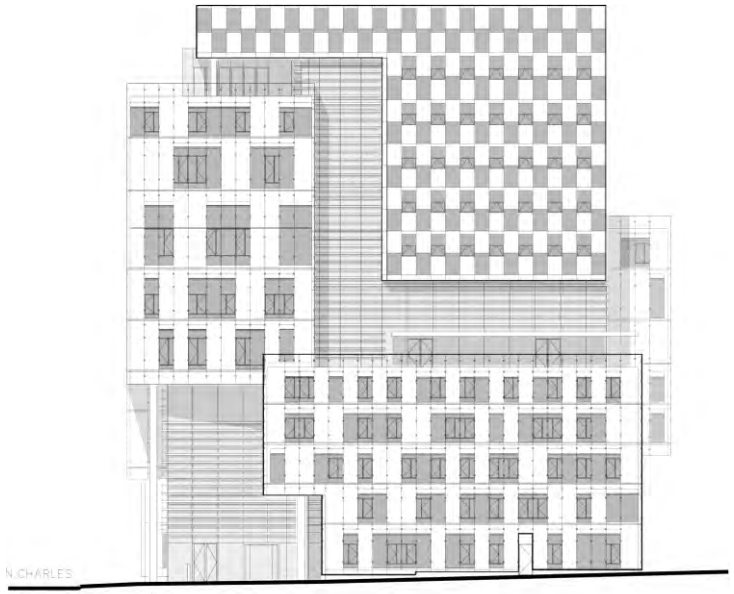
BEHNISCH ARCHITEKTEN

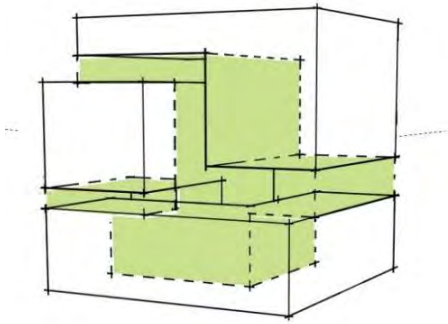
UB Campus Connectivity Study, Competition Diagram

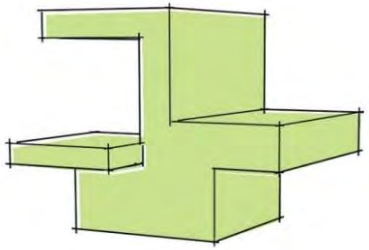
Site Plan



Competition Program Diagram

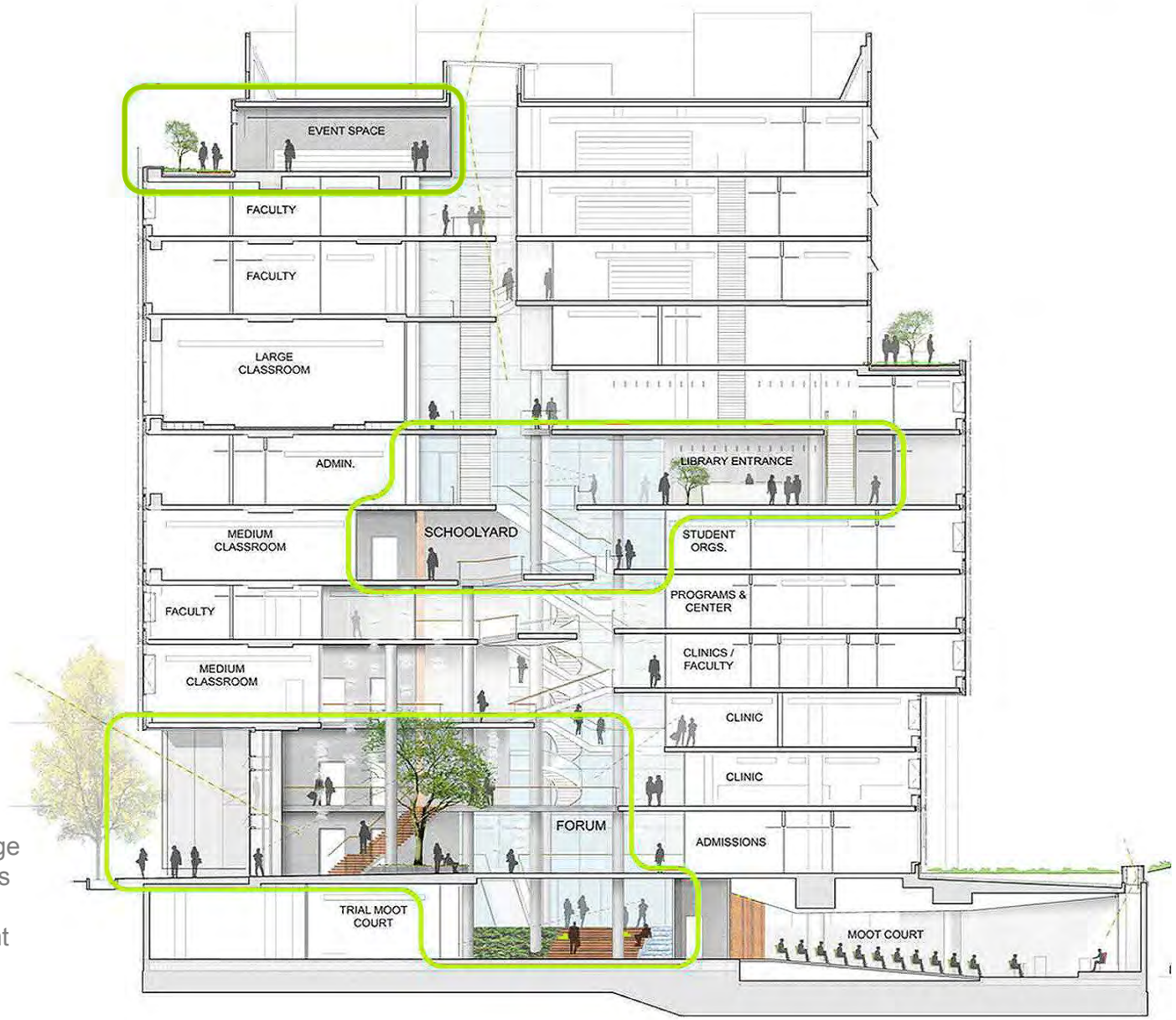






DESIGN CONCEPT
Atrium Neighborhoods

- Ramps, walkways, and stairs connect work areas
- Meeting points along these routes for employees encourage exchanges between colleagues
- Varied sequences of spaces enrich the working environment
- Communication
- Informal spaces

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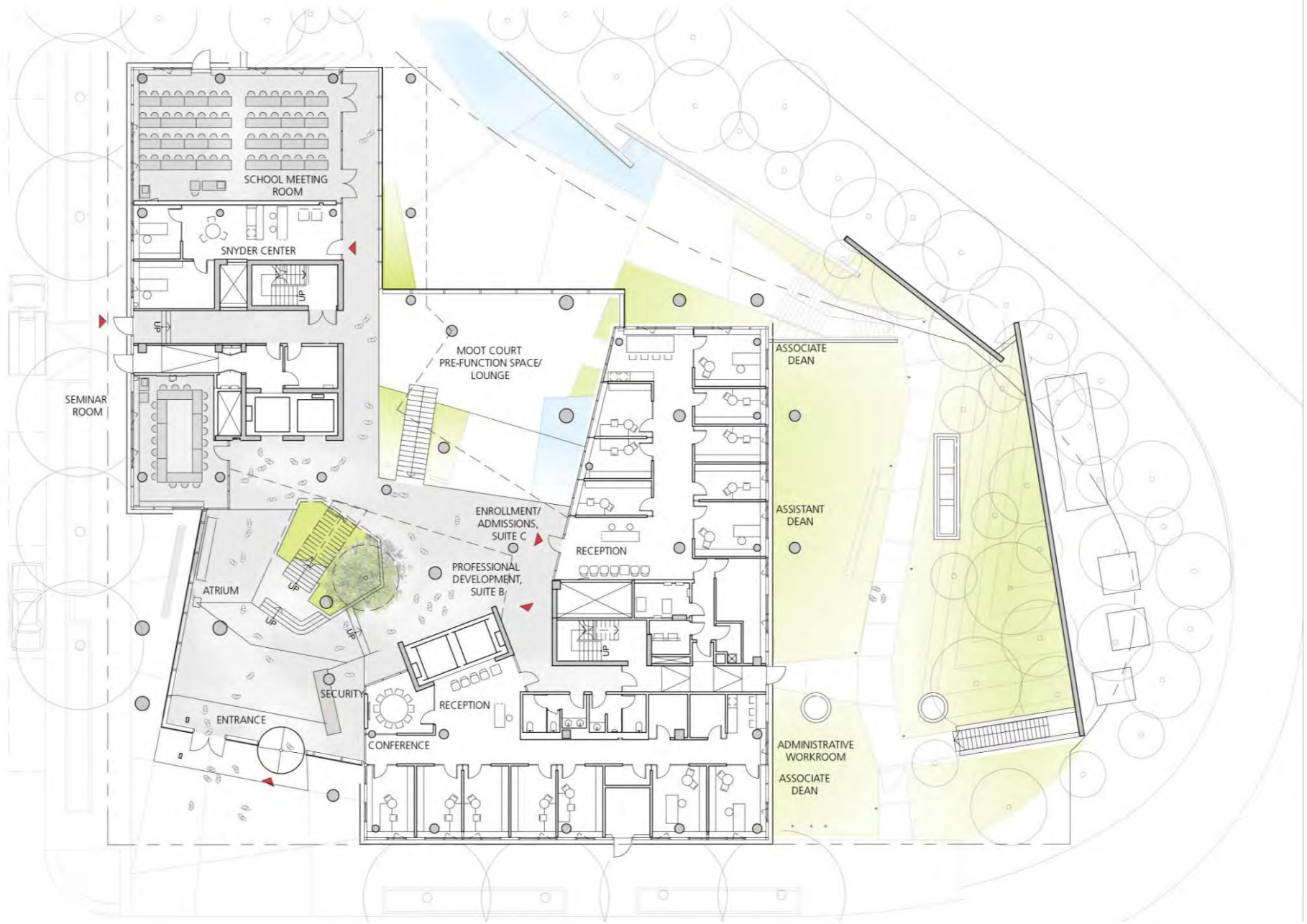
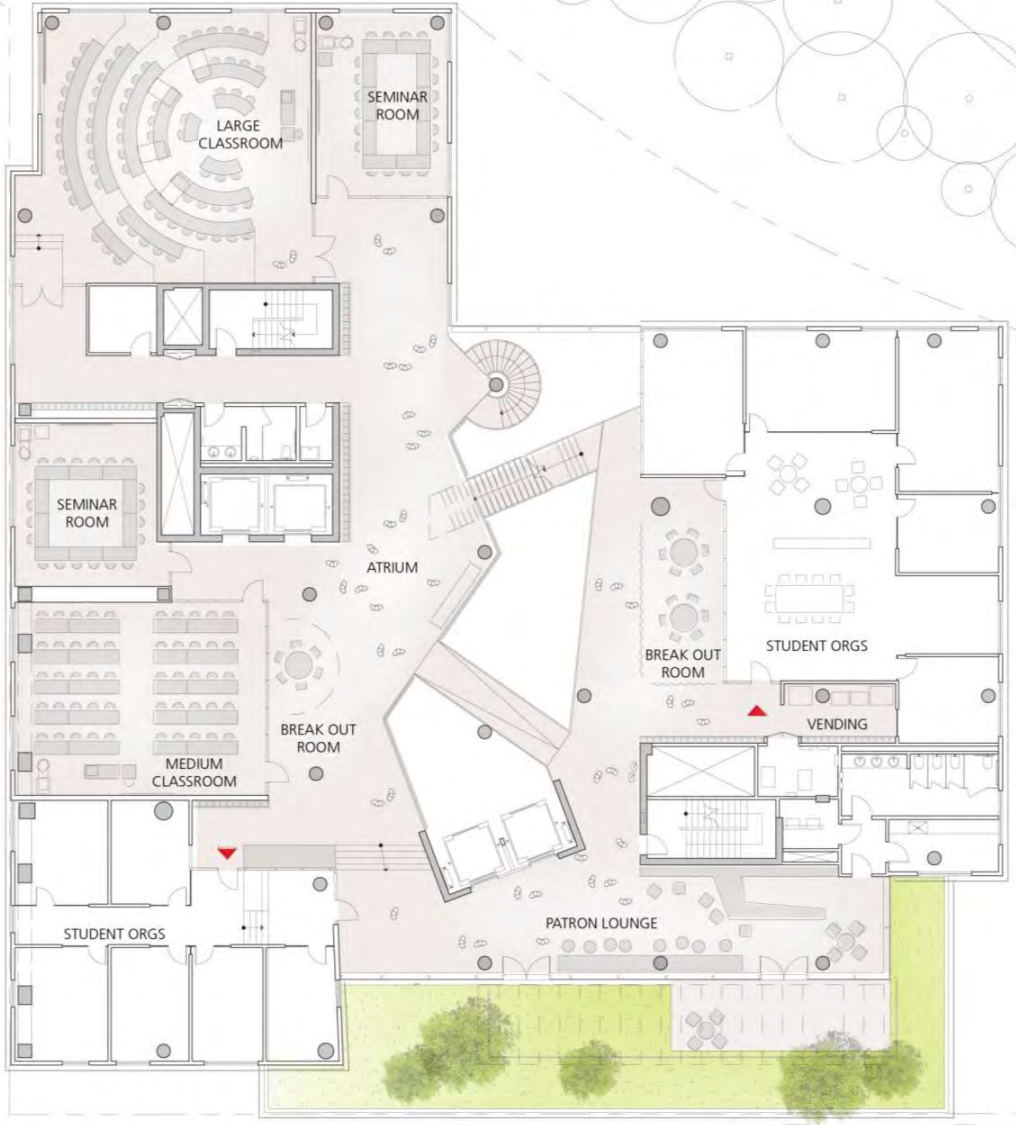
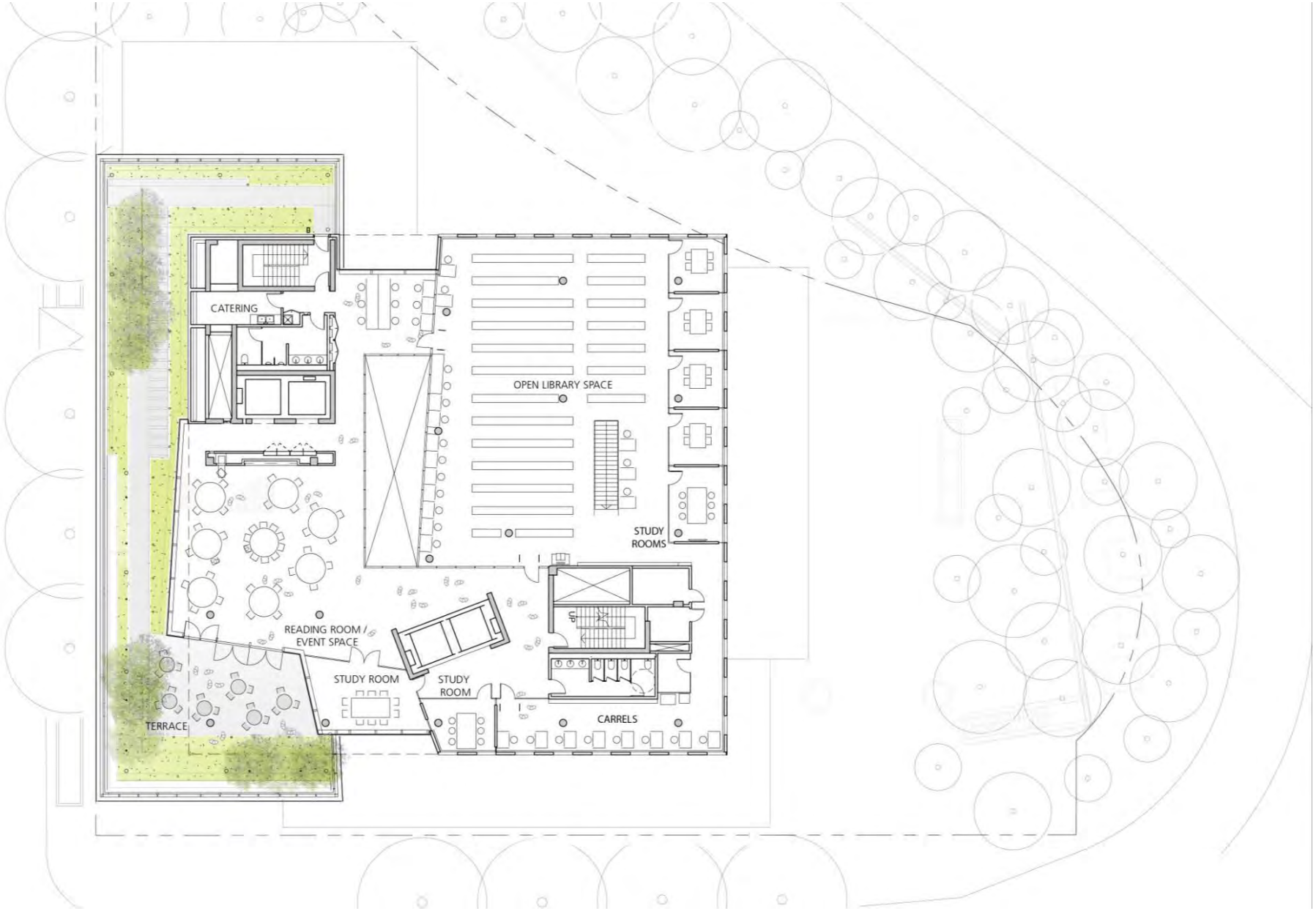
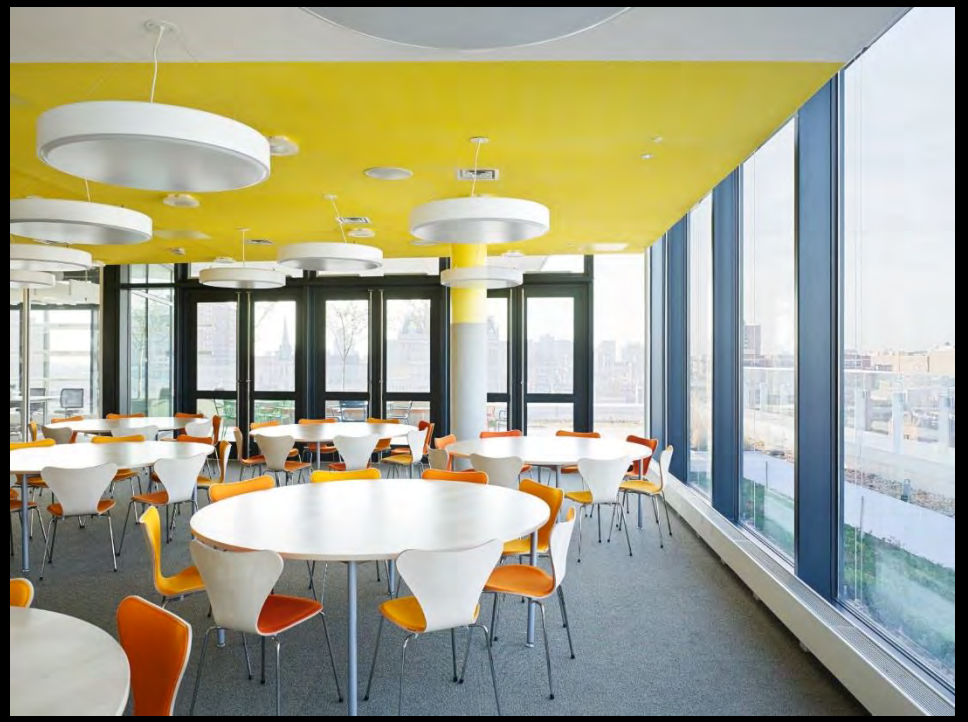

SCHOOL MEETING ROOM
SNYDER CENTER
UP
SEMINAR ROOM
MOOT COURT PRE-FUNCTION SPACE/ LOUNGE
ASSOCIATE DEAN
ENROLLMENT/ ADMISSIONS, SUITE C
RECEPTION
ASSISTANT DEAN
PROFESSIONAL DEVELOPMENT, SUITE B
ATRIUM
SECURITY
RECEPTION
ENTRANCE
CONFERENCE
ADMINISTRATIVE WORKROOM
ASSOCIATE DEAN



Coffee Area Level 6, Design Study

Level 6


CATERING
OPEN LIBRARY SPACE
STUDY ROOMS
READING ROOM / EVENT SPACE
STUDY ROOM
STUDY ROOM
CARRELS
TERRACE



BEHNISCH ARCHITEKTEN

OFFICE/CLASSROOM
FACADE

ALL WORKSPACES HAVE OPERABLE WINDOWS AND INDIVIDUALLY CONTROLLABLE, EXTERNALLY MOUNTED SUN PROTECTION.

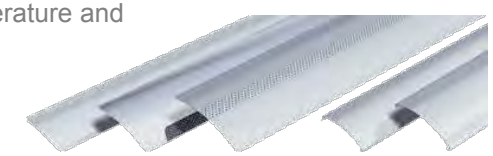
A GLASS RAINSCREEN PROTECTS THE PROGRAMMATIC INTERIOR WORKSPACES AND THE SUN SHADING DEVICES FROM STRONG WINDS.

ASSEMBLY
Double-Skin Facade

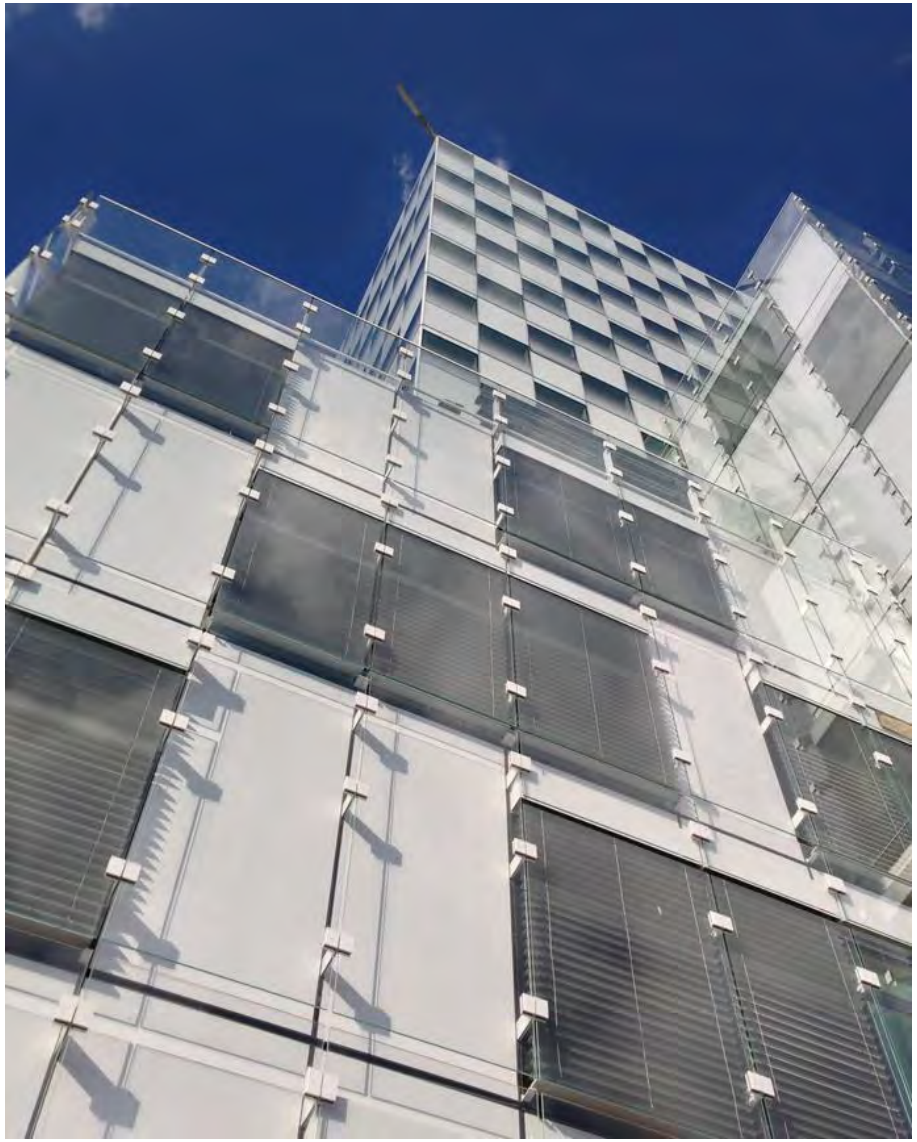
- Insulating low-e coated low-iron glazing
- Half-inch tempered laminated low-iron glazing
- Opaque metal composite panels
- Operable windows
- External shading

SOLAR CONTROL
External Venetian Blinds

- Distribution of Daylight
- Solar radiation: Allow daylight and block short- and long-wave spectrum
- Retract at 23 MPH
- Controlled by BMS
- Provide user comfort—air temperature and humidity
- Reduce use of artificial light



Landesgirokasse
Stuttgart, Germany



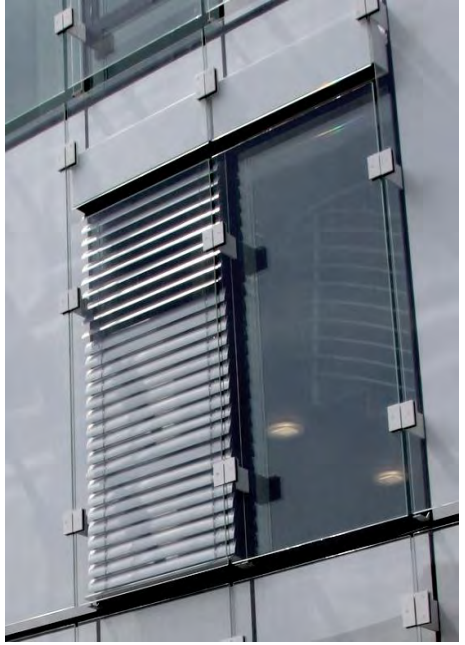
University of Baltimore Law School
Baltimore

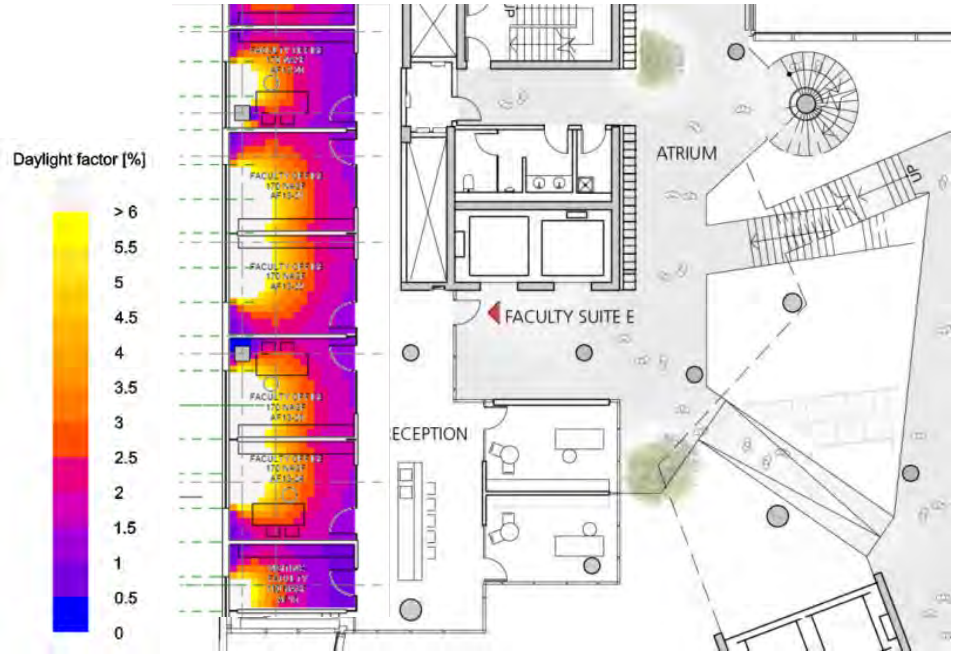

EXIT


EXIT

DAYLIGHTING
Spatial Organization & Local Control

- Daylight factor level +3%
- Outside retractable louvers reduce glare
- Exterior blinds tilt angles vary to allow daylighting to be redirected in upper one-third
- Up and down when facade radiation passes certain limits
- Local override for daylight

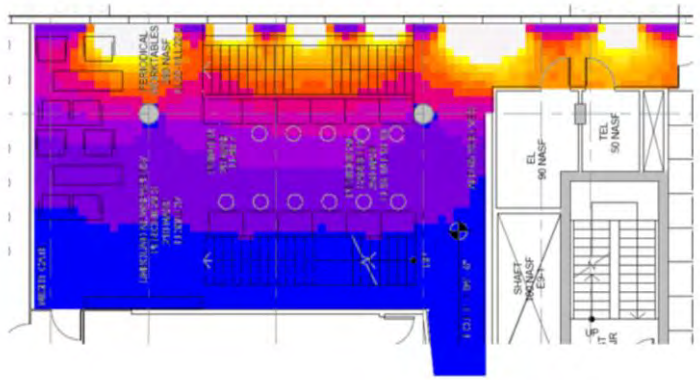


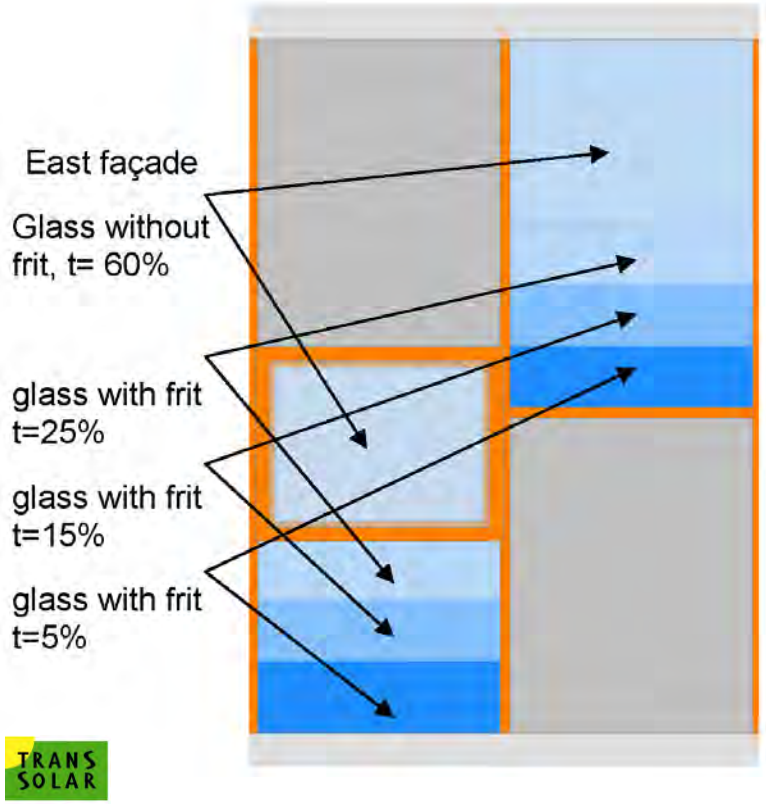



LIBRARY FACADE

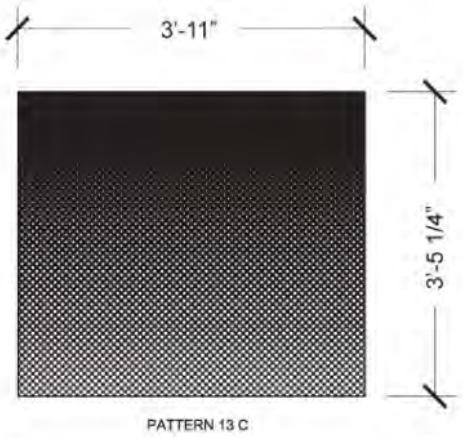
DAYLIGHT AND THERMAL CONTROL
Silkscreen Pattern

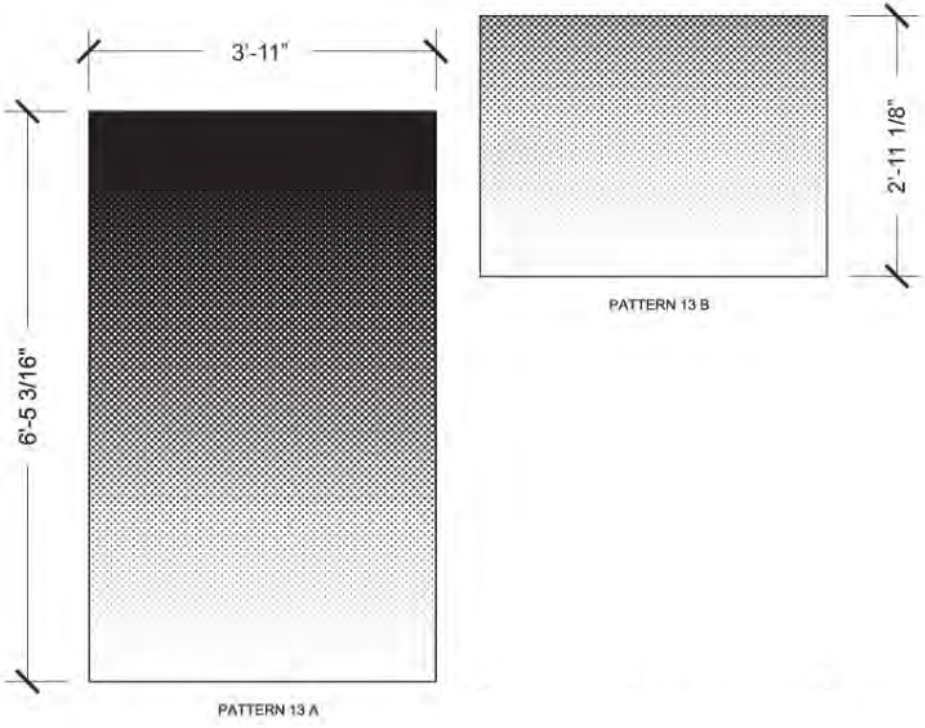
- No external shading
- Pattern minimizes coverage near ceiling
- Deep spaces force strategic programmatic layouts—stacks and circulation toward interior while reading rooms and group studies near facade
- Interior programs benefit from daylight from atrium
- Glare protection achieved with interior screens



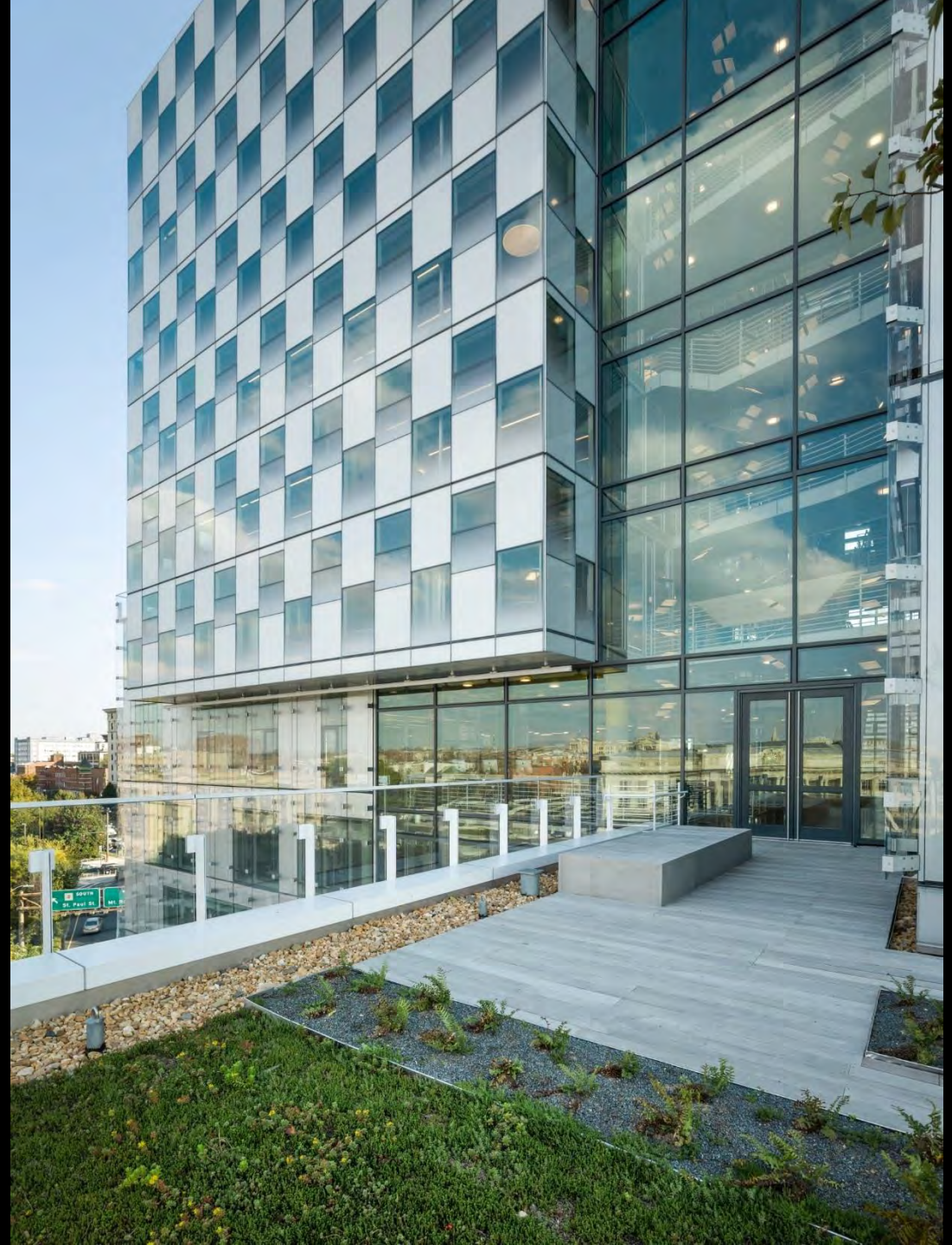


TRANS SOLAR





ATRIUM FACADE

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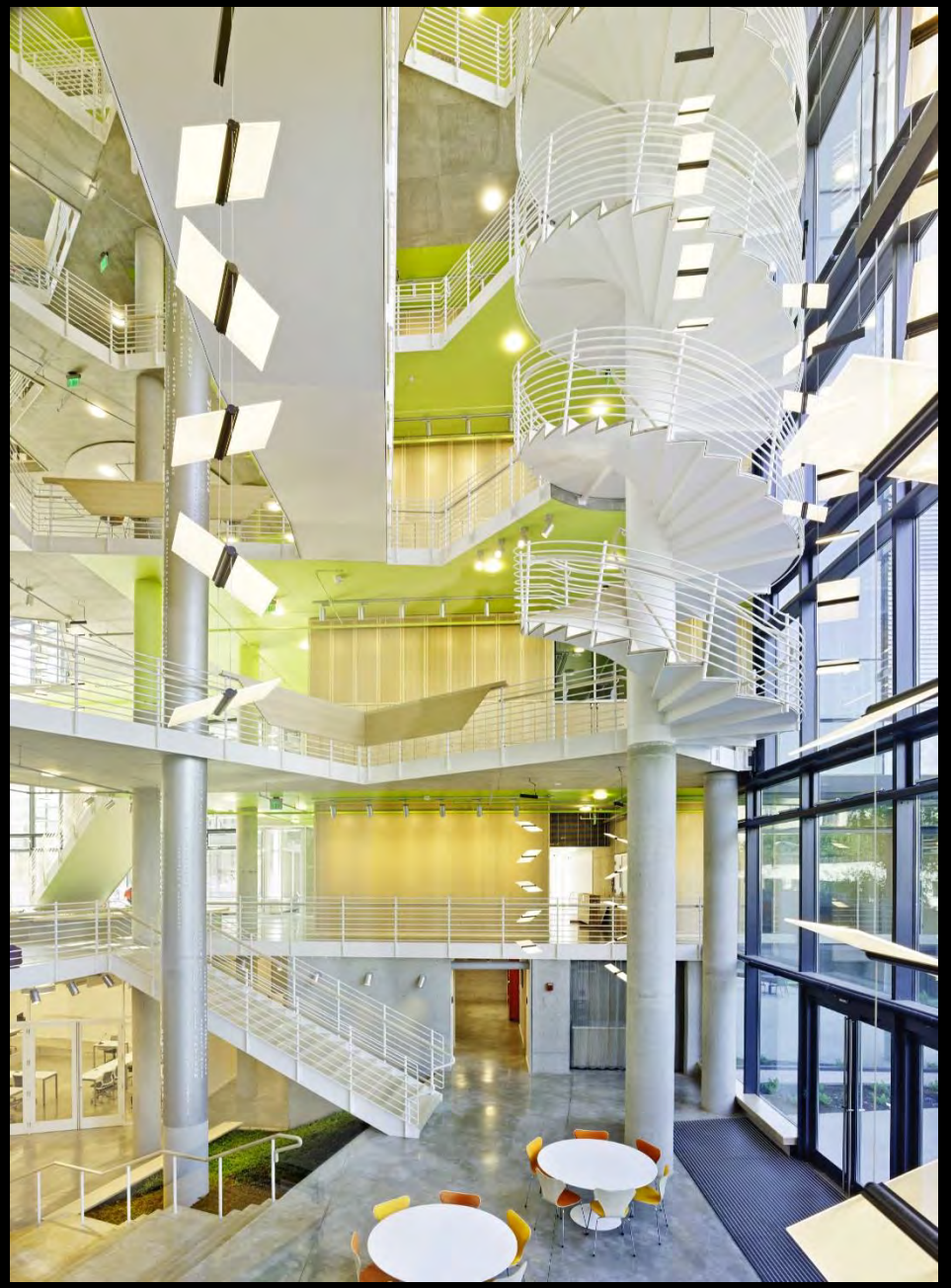
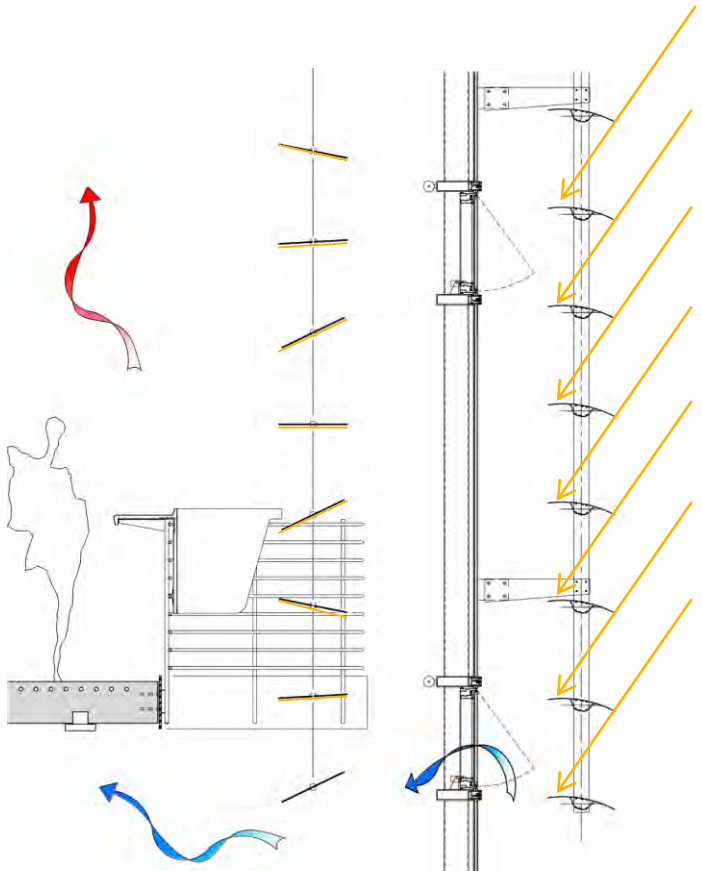
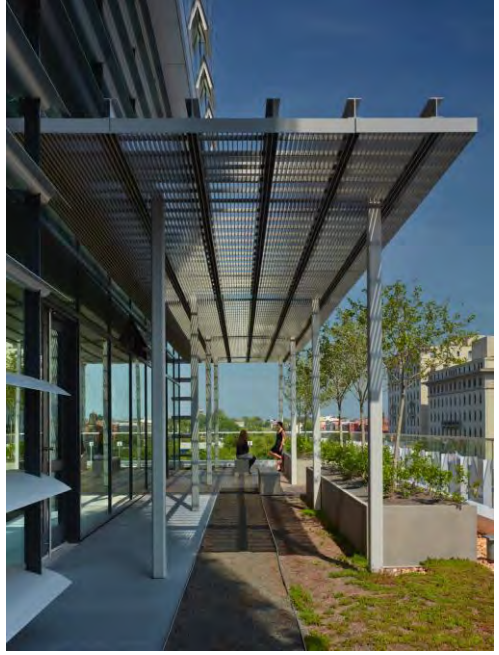
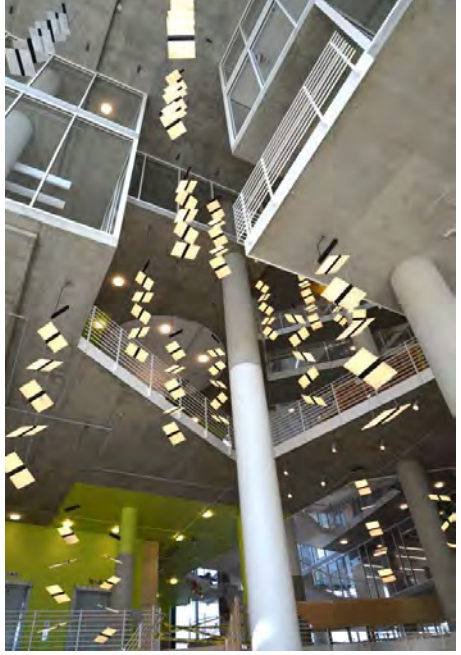


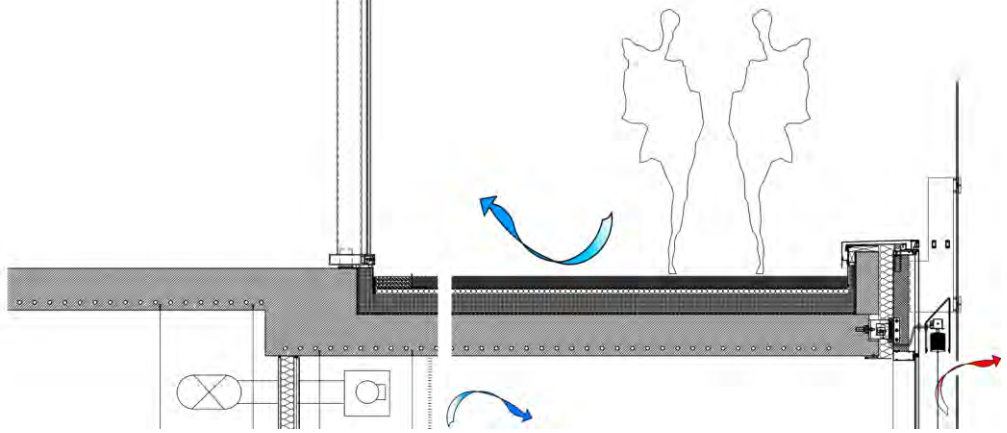


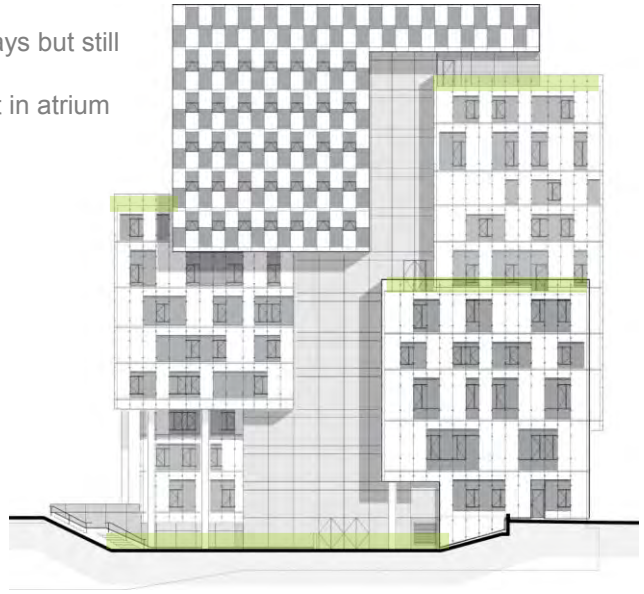




DAYLIGHTING
Fixed-Blade Louvers

- Spacing to block intense solar rays but still allow plenty of views out
- Minimal reliance on artificial light in atrium allows for more creative design





Thank you for your time.

This concludes The American Institute of Architects Continuing Education Systems course.

Please visit the CE Center to complete the quiz and receive your certificate.

Questions?

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