

Daylight, Glare and View: Impacts on Lighting Design

Pacific Energy Center
IES: A Light Affair

June 18, 2015

Lisa Heschong, FIES

Sacramento, Ca
lisa@lheschong.com

Why so much attention on daylighting now?

- **Americans spend 95% of our lives inside of buildings!**
- We need buildings that help keep us healthy
 - Exposure to natural patterns of light and darkness has been established as a key factor in circadian health
 - Access to daylight has been shown to be associated with better performance in schools and office buildings
 - Many green building standards encourage greater utilization of daylight in workplaces



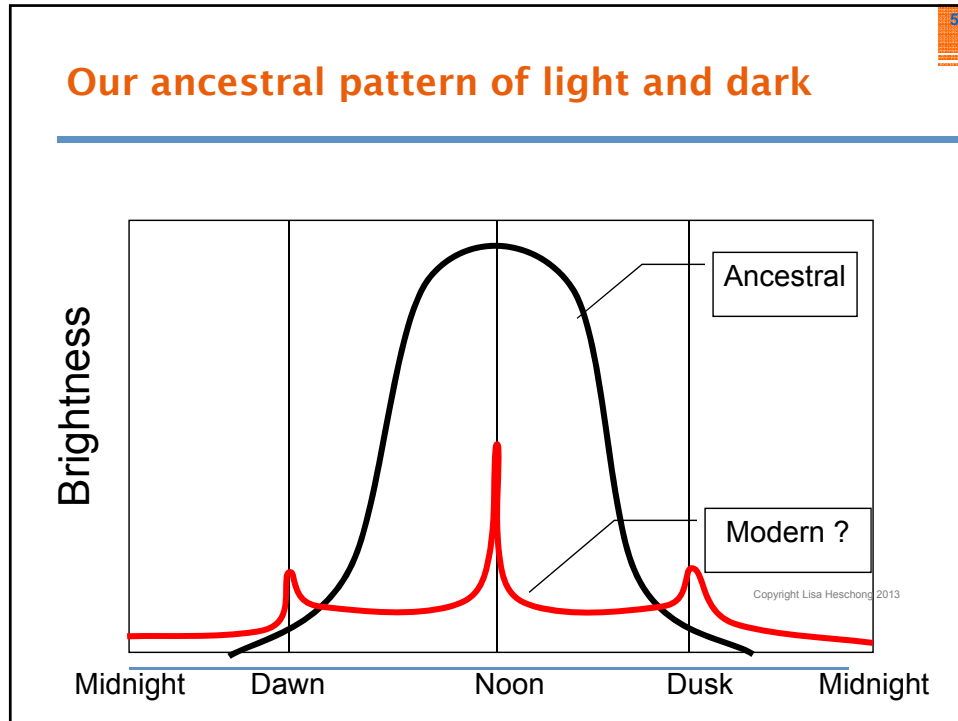
The age of fluorescent lighting... ...resulted in windowless workplaces

- Buildings are cheaper without windows
 - Deeper "plates"
 - Fewer walls
 - Less heat loss and heat gain
- Windows create "distractions" for children & workers
 - And maintenance problems
 - And HVAC challenges
- Electric lighting and mechanical ventilation
 - engineered to maintain the "ideal" (static) environment....24/7



Media attention to circadian health, 2015





Port Hueneme Naval Facilities Offices

- Simple office daylighting ... perfected as High Art
- In a simple, WWII navy bungalow
- sustainable
 - 60 yrs +
- reused
 - remodeled
- people care
 - high morale
- low energy
 - (+ easy climate)

The photograph shows the exterior of the Public Works Department building, a simple, single-story structure with large windows and a sign in front that reads 'PUBLIC WORKS DEPARTMENT'. A copyright notice 'Copyright Lisa Heschong 2013' is visible at the bottom left of the image.

A well daylit space: Balanced, subtle, dynamic



- “Daylight from two sides” = low glare illumination
- The electric lights are off 90% of the time (!)
 - we know, we monitored it...often at only 50 to 100 lux ambient



Where are the electric lights?

What is the role of the lighting designer
in a daylit building?

Bilbao Airport
Calatrava, architect

Day- Night Transformations



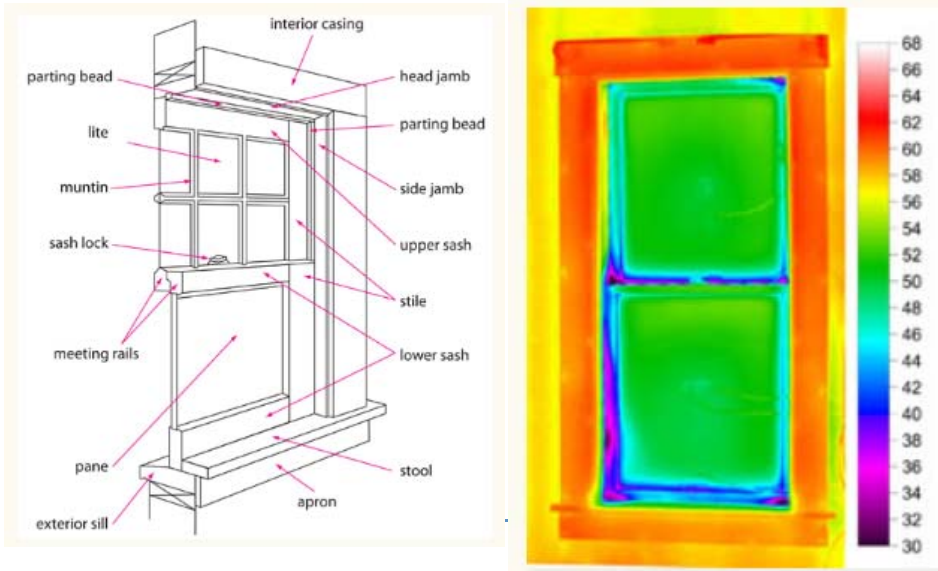
- Paris is the “City of Lights” – at night
- Electric lights are for nighttime
 - and the dark seasons and the dark places...

Daylight Visual Quality

- Daylight Illumination
 - How much?
 - Where, and when?
- Glare & Privacy
- View
- Electric Lighting
 - How much?
 - Where, and when?



There's much more to windows than just thermal performance....



Window Services:

1. Light
2. View
3. Air (ventilation)
4. Acoustic Control
5. Visual Privacy
6. Glare Control
7. Thermal Regulation
8. Display

Daylight Illumination

- People rarely complain about “excessive daylight”

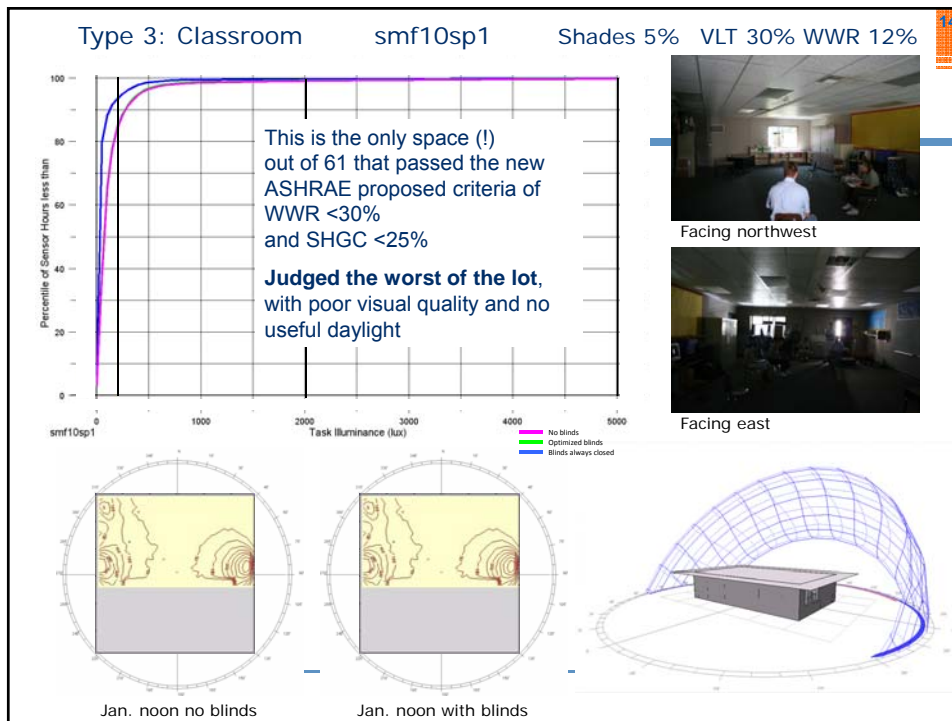
- Most importantly, the eye needs TIME to transition between very bright and very dim spaces

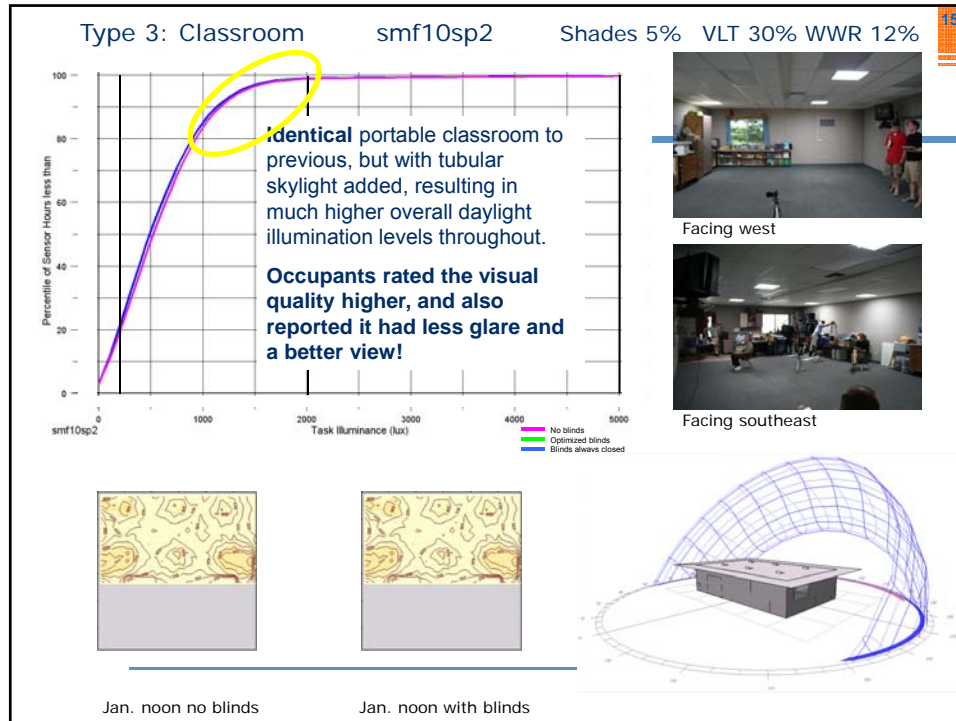
- People complain about “glare”

- which means “I can’t quite see what I am interested in seeing”
- Or “my eyes are getting tired”

- People complain about “dim” spaces

- Which usually means “dull”
- with lack of sparkle and lack of visual interest
 - Especially lack of view...





New IES LM-83-12: spatial Daylight Autonomy (sDA) and Annual Sunlight Exposure (ASE)

- Annual simulation-based calculations of daylight availability
 - Accounts for weather dynamics, sunlight, blinds operation

Blinds all open

Blinds all closed

Blinds operated

'Daylight' versus 'Sunlight'

- **Daylight**
 - Provides diffuse, even illumination
 - Enables electric lights to be turned off
- **Uncontrolled Sunlight**
 - Too bright
 - Too hot
 - Creates uncomfortable contrast
 - Can make a space appear darker by comparison



People do enjoy sunlight

- **When it is filtered and diffused**
 - Avoiding excessive brightness or heat
- **The designers' challenge is:**
 - how to get the right balance inside our buildings?



If there is too much sun...

- You can pretend you are outdoors!



Windows need visual modulation



- The sun moves, and so do reflections off of cars and other buildings
- So, occupants need the ability to adjust view window treatments as conditions change



- What about unoccupied cubicles?
- When blinds are left closed, all office occupants receive less daylight

Should designers assume windows will have blinds? YES!

- Blinds, shade, and curtains are ubiquitous
 - One field study showed that 93% of workplaces had some form of interior window controls
- Occupants want to control:
 - Privacy
 - Protection from a variety of (moving) glare sources
 - Sun, cars, puddles, other buildings
 - Brightness and intensity of views



Subtle changes in daylight patterns can have a big effect on occupant acceptance....

- Sunlight in field of view
 - But not on work surface
- Judged 'preferred'
- ¼ turn of blinds
 - Stripes on work surface
- Judged 'just disturbing'



Photos, © Mehlika Inanici & Kevin Van Den Wymelenberg

Dappled sunlight

Copyright Lisa Heschang 2013

- Magical moments

Capturing the movement of sunlight

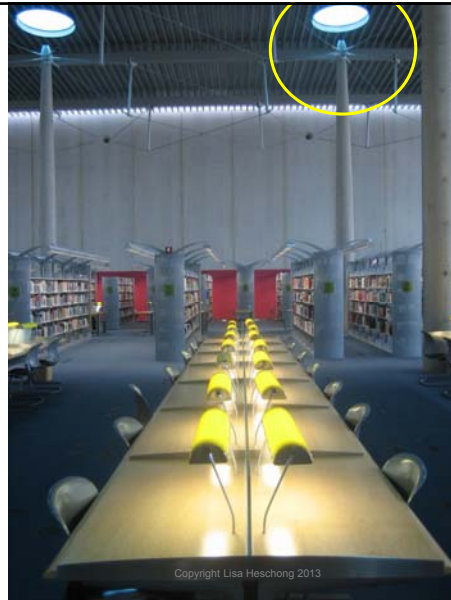
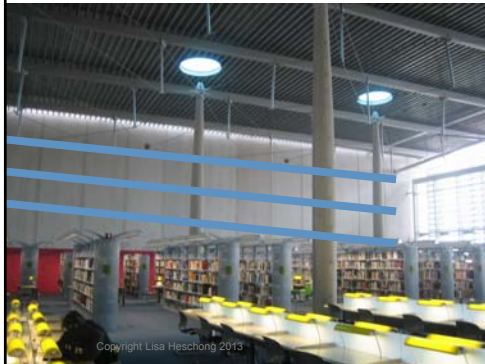
Copyright Lisa Heschang 2013

- Enlivens a space

San Francisco International Airport

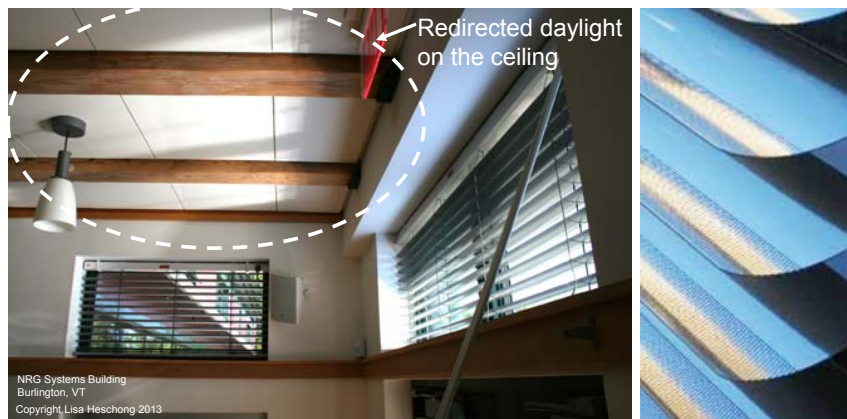
Solar Moments

- Phoenix Central Library
 - Daily noon passage
 - Lighting the candles at Summer solstice
 - a library town party?



Will Bruder, Architect

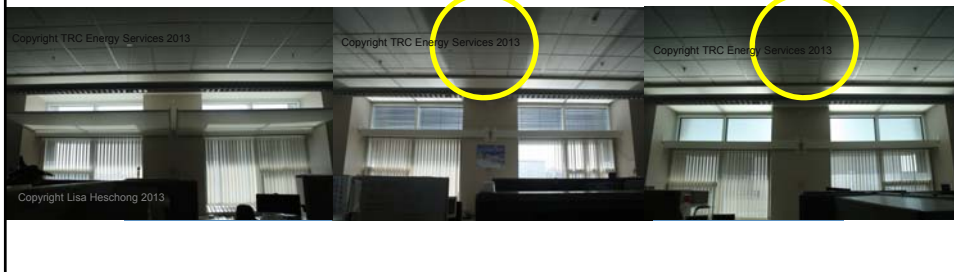
Redirect the sunlight, where it is useful...



- Inverted blinds, with concave surfaces facing 'up'
 - act as miniature light selves
 - angle can be adjusted to optimize sun light redirected to the ceiling
 - should be highly reflective, but not specular

3 sunlight redirecting options

- Use upper window to redirect sunlight deeper into space
 - Keep treatments well above 'eye level', i.e. 7'6" minimum
- **Lightshelf**
 - The architectural solution
- **Louvers**
 - 3" specular louvers
- **Optical Film**
 - Nanostructures refract the light



Daylight Redirecting Film

- Micro replicated structure reflects light incident on the window surface towards the ceiling
- Redirects more than 2/3rds of all incident light upwards towards the ceiling
- Extends 'daylight zone' about 8' into room for each 1' of treated upper window
- Can be combined with other solar control films or blinds options



Daylight Glare

- Everyone “knows it when they see it...”
 - But, as of yet, there are no good predictive tools/equations
 - There are about 12 equations, but none with field validity...
- Sunlight IS predictable –one, but not the only, cause of glare
 - A view of the solar orb is always too bright
 - Even through the darkest sunglasses!
 - Sun reflections and “patches” are often too bright
 - But sometimes welcome
- “Glare” is often a case of adaptation stress
 - The eye cannot adjust quickly enough: i.e. its a timing problem
 - Young and healthy eyes adapt faster than older or tired eyes
 - Glare = visual overload
 - The eye is the most energy intensive part of the body
 - Reduce effort, increase reward

Diffusing Glazing, when in Sunlight = GLARE



- All light...no information
- Like paving a wall with lensed luminaires!
 - (only even brighter)

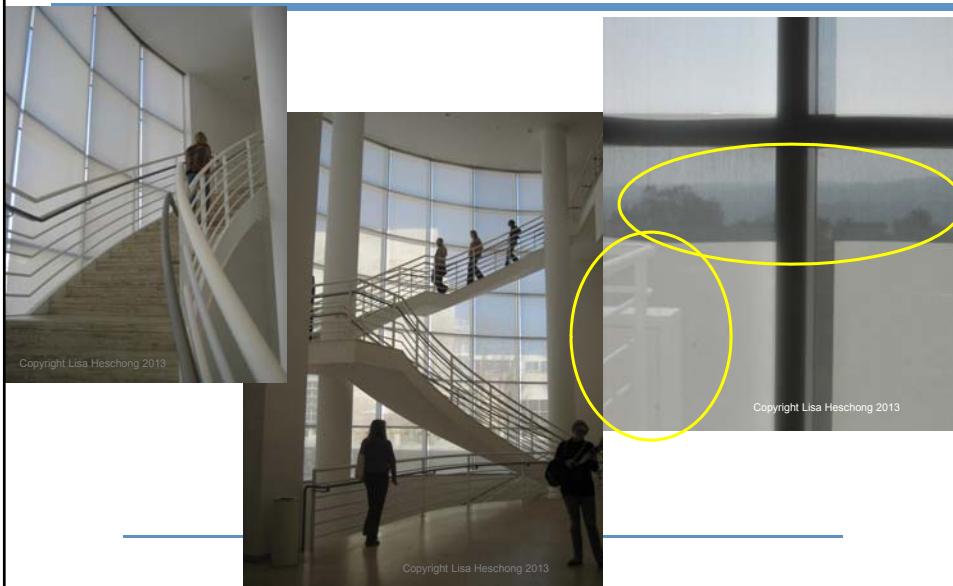


The downside of translucent shades



- In sunlight, shades become a brightly glowing surface – and essentially opaque
- Increasing contrast, and putting other objects into silhouette

White shades – are transparent only in the shadow



Modulation: Transparent v Translucent

- Depends on the direction of light
 - Opaque when looking from light to dark
 - Transparent only when looking from darker to lighter

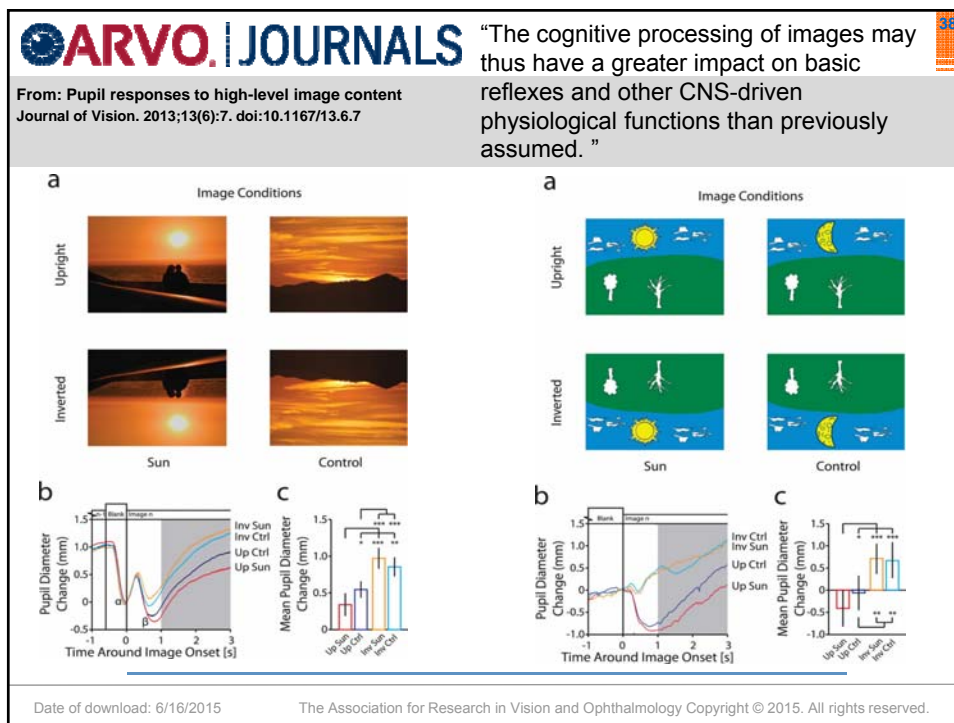
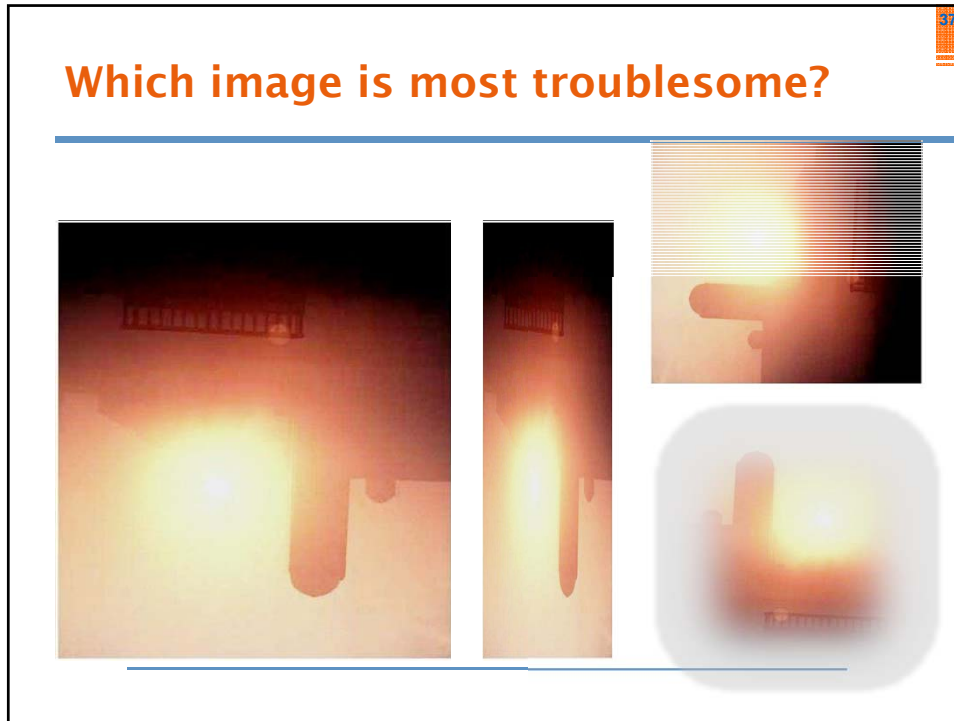


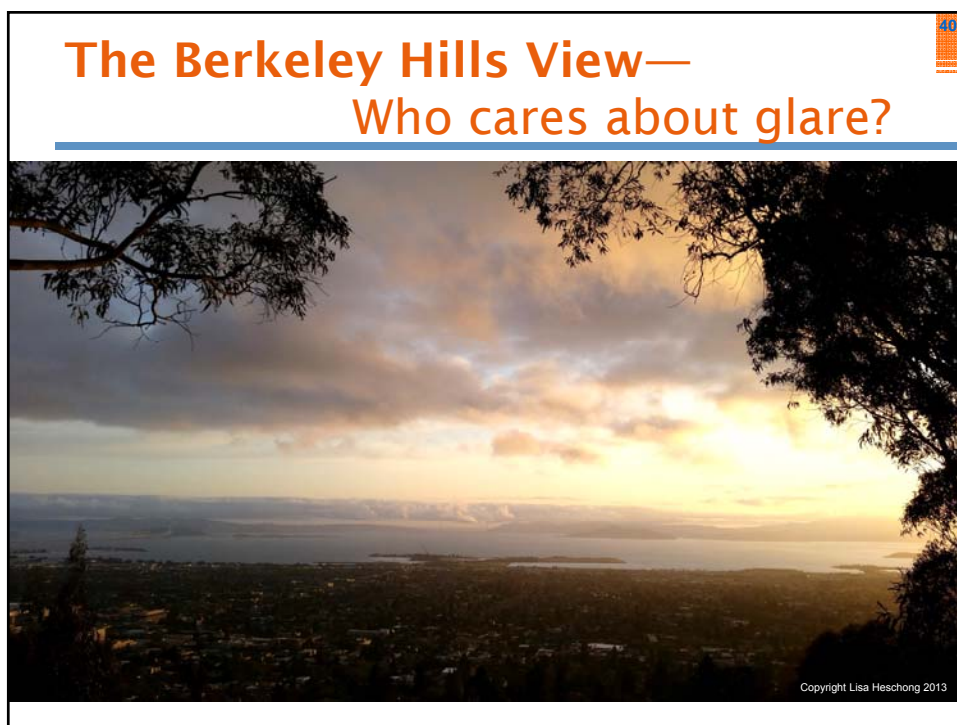
Fabric shades don't block the sun !

- They just break it into little pieces
- 5% "openness" still allows plenty of "pin-pricks" of beam sunlight through
- Will still wash out projected images
- Will still cause discomfort glare for anyone in line of sight of the solar disk
- or a reflection of solar disk









The New Whitney Art Museum in New York City

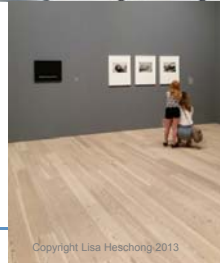


- Anchoring the southern end of the new **Highline** elevated linear park


Whitney Museum, NYC



- The **VIEW** is the main attraction




Does View Matter?



Copyright Lisa Heschong 2013

**In our 2nd round daylighting productivity studies:
View was the big winner !**

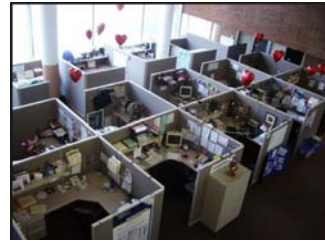
- **Call Center**
 - +7% to +12%
 - Worker speed
- **Desktop study**
 - +10% to +25%
 - 3 mental acuity tests
 - Less fatigue
- **Schools study**
 - +7% to +30%
 - Faster math and reading learning



Copyright Lisa Heschong 2013

In the SMUD Desktop Study

- Those workers with the best views
 - Had fewest complaints
 - About temperature
 - About acoustics
 - About smells and air quality
 - About ergonomics
 - And fewest stress-based health issues, such as:
 - Headaches, neck and back aches
 - Eye fatigue, general fatigue



Is this productive?



Qualities of 'good' views

- **Coherent, Informative Images**
 - Something interesting to look at – people, nature, fractal images
 - No annoyance: with obscured images, grids, moiré patterns
- **Natural Solar Spectrum**
 - Circadian stimulus appropriate to hour, place and season
- **Distance**
 - Eye health and development requires constant refocusing
- **Natural Rhythmic Movement**
 - Random patterns retain interest – water, traffic, shadows, clouds
- **The 'Biophilia Hypothesis'**
 - Sum: Animals, birds, fish, growing plants, clouds, landscapes



Standard Abrasives, 1995

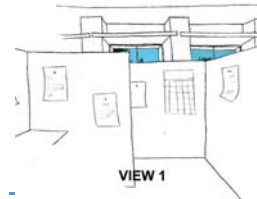
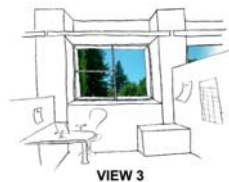
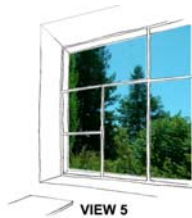
New plant, built to recover from 1989 Earthquake in San Fernando Valley

- Real work
- Real views
- Real daylight



What is an adequate view? LEED View Assessment

- Angular size of view



Simulated Views: SkyFactory, a Kansas corp



- Helpful?
- Creepy?



Window coverings circa 2015

WINDOW COVERINGS & ATTACHMENTS

Intelligent and unbiased guidance on the best window covering for your climate, your needs, your windows.

[Help Me Choose](#) [Compare Coverings](#) [Understanding Window Coverings](#) [Purchasing](#) [Glossary](#)

Compare (choose up to 5) [Start Over](#)

Interior	<input type="checkbox"/> Interior panel	<input checked="" type="checkbox"/> Applied film	Exterior	<input type="checkbox"/> Exterior storm	<input type="checkbox"/> Exterior solar screen
	<input type="checkbox"/> Interior solar screen	<input type="checkbox"/> Interior roller shade		<input type="checkbox"/> Exterior roller shade	<input type="checkbox"/> Fixed awning
	<input checked="" type="checkbox"/> Cellular shade	<input type="checkbox"/> Window quilt		<input type="checkbox"/> Retractable awning	<input type="checkbox"/> Roller shutter
	<input type="checkbox"/> Louvered blind	<input type="checkbox"/> Interior louvered shutter		<input type="checkbox"/> Exterior louvered shutter	
	<input type="checkbox"/> Drape/Curtain	<input type="checkbox"/> Sheer shade			
	<input type="checkbox"/> Pleated shade	<input type="checkbox"/> Roman shade			

[print this comparison](#) Show what's best for my windows using: [These 2 Coverings](#)

19 Product Categories + Automation + counting...

Interior Window Coverings

Applied Film - Interior
We only list window film manufacturers that make (FROD) provide a 10-year or longer warranty. Manufacturers can certify professional installers. You can... [\[more\]](#)

Cellular Shade
Cellular shades are either custom sized fabrications or the most common window dimensions. There are currently no standard performance standards for cellular shades. This... [\[more\]](#)

Drape/Curtain
Drapes and curtains are either custom sized fabrications or the most common window dimensions. There are currently no performance standards for drapes and... [\[more\]](#)

Interior louvered shutter
Interior louvered shutters are either custom sized fabrications or the most common window dimensions. There are currently no performance standards for interior... [\[more\]](#)

Interior Panel
Quality, low-storm interior panels can be made by local installers from national manufacturers specializing in high-end windows. Low-storm interior panels are... [\[more\]](#)

Interior roller shade
Interior roller shades are either custom sized fabrications or the most common window dimensions. There are currently no performance standards for interior roller... [\[more\]](#)

Interior Solar Screen
Interior solar screens are most commonly roller shades or purchased as custom sized fabrications or by dimensional internet. Performance of various solar screen... [\[more\]](#)

Louvered blind
Louvered blinds are either custom sized fabrications or internet sized common window dimensions. There are currently no consistent performance standards for louvered blinds. This... [\[more\]](#)

Plated shade
Plated shades are either custom sized fabrications or internet sized common window dimensions. There are currently no consistent performance standards for plated shades. This... [\[more\]](#)

Roman shades
Roman shades are either custom sized fabrications or internet sized common window dimensions. There are currently no consistent performance standards for Roman shades. This... [\[more\]](#)

Sheer shade
Sheer shades are either custom sized fabrications or internet sized common window dimensions. There are currently no consistent performance standards for sheer shades. This... [\[more\]](#)

Window quilt
Window quilts are either custom sized fabrications or, much less common internet sized of the most common window dimensions. There are currently no consistent thermal performance standards for... [\[more\]](#)

Exterior Window Coverings

Exterior roller shade
Exterior roller shades, exterior roller shade are either custom fabrications or internet sized of the most common window dimensions. There are currently consistent thermal performance standards... [\[more\]](#)

Exterior solar screen
Fixed solar screens are commonly manufactured by local fabrication shops. Fixed solar screens are commonly manufactured by local fabrication shops. Fixed solar screens are commonly manufactured by local fabrication shops. Fixed solar screens are commonly manufactured by local fabrication shops. Performance of various solar screen fabric is a... [\[more\]](#)

Exterior Storm
Quality, low-storm windows can be made by local storm window fabricators ordered from national manufacturers specializing in high performance exterior windows. Storm frames can be based on... [\[more\]](#)

Fixed awning
Fixed awnings are either custom fabrications or, much less commonly, internet sized of the most common window dimensions. There are currently no consistent thermal performance standards for fixed... [\[more\]](#)

Retractable awning
Retractable awning: Retractable awnings are custom fabrications; use the manufacturer to locate a qualified local installer. There are currently no consistent thermal performance standards for... [\[more\]](#)

Roller shutter
Roller shutters are custom fabrications; use the manufacturer to locate a qualified local installer. There are currently no consistent thermal performance standards for exterior roller shades... [\[more\]](#)

Automation

Attachment Automation
Automation of window coverings and attachments includes motors, controllers, and sensors, and even remote-operation apps. If a window cover is adjustable, then it can be automated for easier... [\[more\]](#)

Show what's best for my windows using: These 5 Coverings

Applied film

[View Details](#)

[Purchasing Guide](#)

Cellular shade

[View Details](#)

[Purchasing Guide](#)

Interior louvered shutter

[View Details](#)

[Purchasing Guide](#)

Fixed awning

[View Details](#)

[Purchasing Guide](#)

Roller shutter

[View Details](#)

[Purchasing Guide](#)

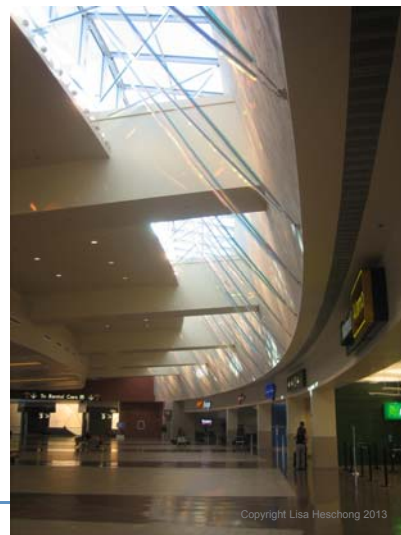
Features	Applied film		Cellular shade		Interior louvered shutter		Fixed awning		Roller shutter	
	lo	hi	lo	hi	lo	hi	lo	hi	lo	hi
Thermal										
Insulation	[Progress bar]		[Progress bar]		[Progress bar]		[Progress bar]		[Progress bar]	
Airtightness	[Progress bar]		[Progress bar]		[Progress bar]		[Progress bar]		[Progress bar]	
Solar Heat Control	[Progress bar]		[Progress bar]		[Progress bar]		[Progress bar]		[Progress bar]	
Winter Comfort	[Progress bar]		[Progress bar]		[Progress bar]		[Progress bar]		[Progress bar]	
Condensation Resistance	[Progress bar]		[Progress bar]		[Progress bar]		[Progress bar]		[Progress bar]	
Ventilation	[Progress bar]		[Progress bar]		[Progress bar]		[Progress bar]		[Progress bar]	
Visual										
View	[Progress bar]		[Progress bar]		[Progress bar]		[Progress bar]		[Progress bar]	
Visible Transmittance (VT)	[Progress bar]		[Progress bar]		[Progress bar]		[Progress bar]		[Progress bar]	
Daylighting Control	[Progress bar]		[Progress bar]		[Progress bar]		[Progress bar]		[Progress bar]	
Glare Control	[Progress bar]		[Progress bar]		[Progress bar]		[Progress bar]		[Progress bar]	
Privacy	[Progress bar]		[Progress bar]		[Progress bar]		[Progress bar]		[Progress bar]	
Functional										
Prime Window Protection	[Progress bar]		[Progress bar]		[Progress bar]		[Progress bar]		[Progress bar]	
Egress	[Progress bar]		[Progress bar]		[Progress bar]		[Progress bar]		[Progress bar]	
Security	[Progress bar]		[Progress bar]		[Progress bar]		[Progress bar]		[Progress bar]	
Noise Control	[Progress bar]		[Progress bar]		[Progress bar]		[Progress bar]		[Progress bar]	
Sound Absorption	[Progress bar]		[Progress bar]		[Progress bar]		[Progress bar]		[Progress bar]	
Installation & Durability										
Durability and Service Life	[Progress bar]		[Progress bar]		[Progress bar]		[Progress bar]		[Progress bar]	

Window Coverings circa 2020:

- AERC
 - Attachments Energy Rating Council
 - Residential product label in 2017
 - Commercial database in 2018
 - Heating performance ✓
 - Cooling performance ✓
 - Daylight, view, glare performance ??

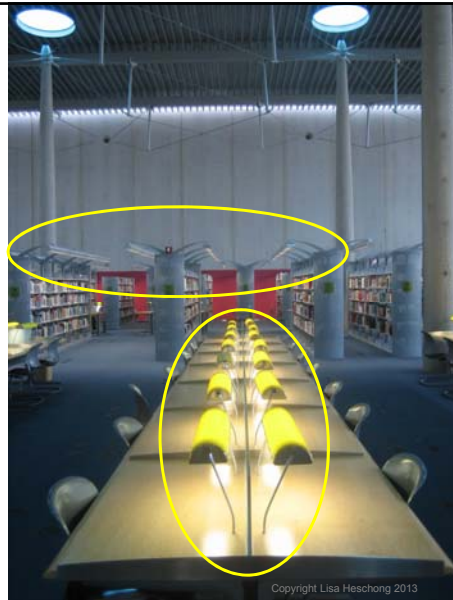
Have faith in daylight

- Use photocontrols!
- Save energy...
 - help the planet



Solar Moments

- Phoenix Central Library
 - Electric lighting is supplementary
 - Where, and when, needed...



Will Bruder, Architect

New York Times Building: State of the Art in Daylight Integration ? circa 2005



- Highly automated system
 - Blinds and overhead lights
- Blinds re-commissioned to only close 2/3 way
 - Better daylight savings
 - Less claustrophobia
 - More occupant satisfaction



- According to Glen Hughes, manager of the NY Times automated blinds project:
 - The better the view, the more frequently occupants manually opened blinds
 - Allowing 2' of sunlight at base of window helped relieve the claustrophobia of closed shades
 - and greatly improved the daylight energy savings!

**Micro inverted blinds,
embedded inside double glazing --
Alder Creek Middle School, Truckee, CA**



- south facing classrooms have little shading
- all windows have micro-blinds integrated into double pane glass
 - allowing for easy cleaning, ventilation, dust-free optics, protected from little hands

**Inverted blinds in south facing windows
Redirect sunlight**

- Upper blinds redirect sunlight to ceiling (note bright ceiling)
- Middle and lower blinds adjusted for local control for view, glare, privacy

Note luminaire parallel to windows, turned off



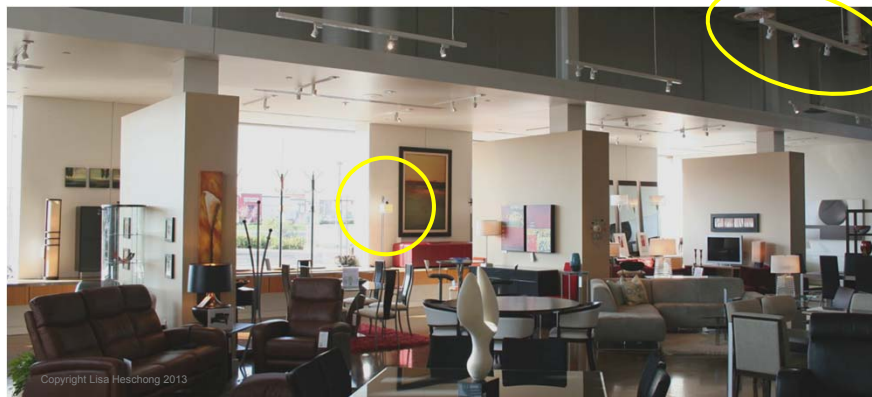
Scandinavian Design

- A little bit of sunlight sets the stage



Scandinavian Design

- Reflect the light on perpendicular surfaces



Display windows that work

63



- Roseville, California



Why Daylighting? Because:

64



- *It's good for people*
- *It's good for the planet*

Thank you for your interest!

lisa@lheschong.com

<https://youtu.be/USYwmkFjHMA?>

Intro: 38 sec to 2:28 seconds
Seasonal comparison: 3:30 to 2:28 seconds

This film is based on simultaneous timelapse photography and studies the differences in the geographical orientation and the light of the sun, in a room in Denmark at 55° 6' N, 12° 5' W latitude

...and its impact on us as human beings

Circadian Light
School of Architecture,
of Circadian Light

Carlo Volf, PhD
Copenhagen, Denmark

All differences are rendered in fast motion. A 24 hour cycle is represented in 2 minutes.