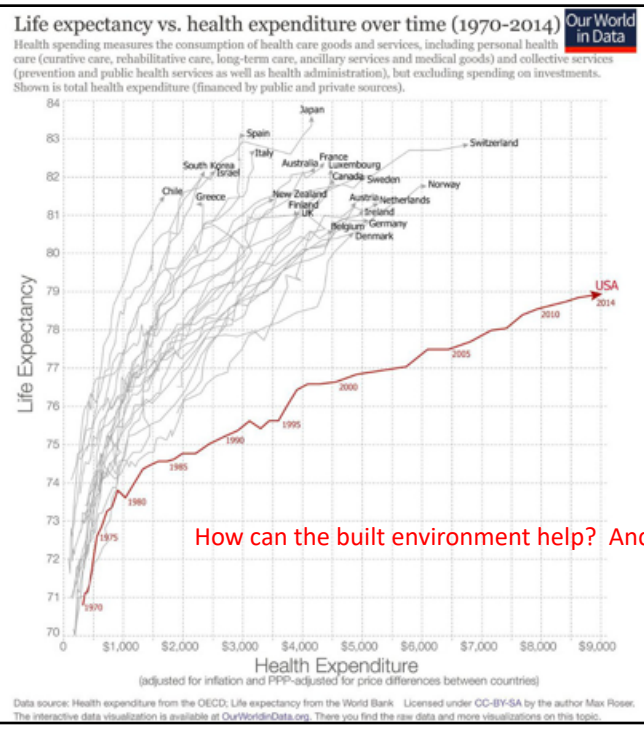

Kings Road House - Schindler


Kings Road House - Schindler

design the unseen

scales beyond

INSTITUTE FOR HEALTH
IN THE BUILT ENVIRONMENT



How can the built environment help? And daylight?

University of Oregon – Energy Studies in Buildings Laboratory

University of Oregon – Biology and the Built Environment Center

University of Oregon – Baker Lighting Laboratory

Harvard University

Northwestern University

OHSU

Institute for Health in the Built Environment

Oregon State University

Santa Fe Institute

Portland State University

Arizona State University

Oregon Research Institute

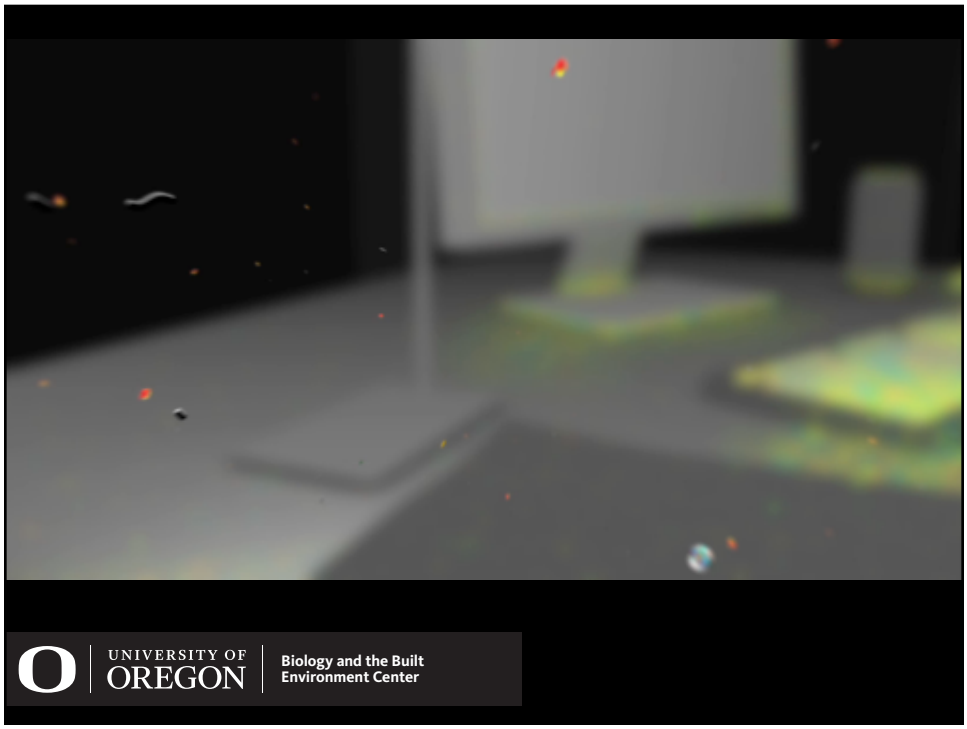

ALFRED P. SLOAN FOUNDATION
1934
neea
UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
STATE OF OREGON
1859
USDA
SIEMENS
method
ecover
view
PERKINS+WILL
SRG
PAE
EYP
SEA
SCOTT|EDWARDS ARCHITECTURE
POINTENERGY
INNOVATIONS
SERA
LACEY GLASS
The Smart Choice in Daylighting Systems
SKANSKA
VENTACITY SYSTEMS
ALWAYS HEALTHY • ALWAYS EFFICIENT
BetterAir
the world's first probiotic air and surface purifier
KALWALL
high performance translucent building systems
LUTRON
dyson
AIA
Portland
CO ARCHITECTS
ROWELL
BROKAW
SG


Daylighting Design in the Pacific Northwest, Van Den Wymelenberg & Meek, UW Press

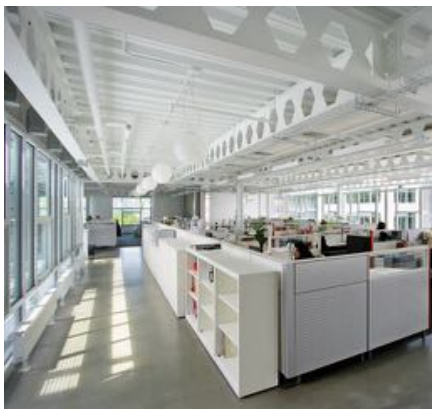

Portland Community College - SRG Architects

Florence Nightingale Ward

Radiant Heating, Thin Floor plates, Courtyard gardens, Cross Ventilation



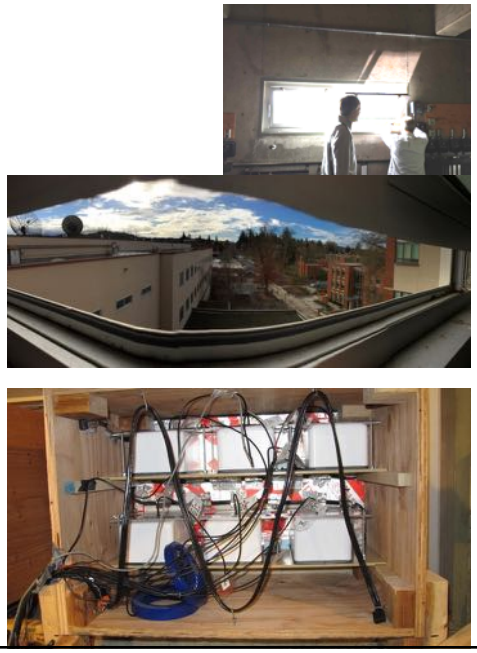
Dust Microbial Communities have Dosage-Dependent Responses to Daylight

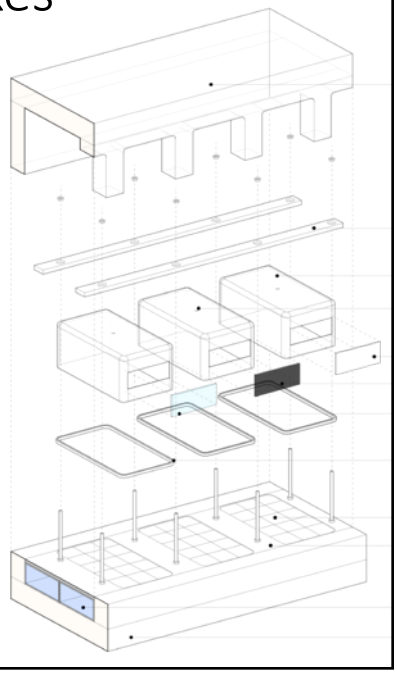


Terry Thomas – Photo Meek VDW

How can we use this as a design tool?

Daylight Dust Bunny Boxes





Daylight Dust Bunny Boxes

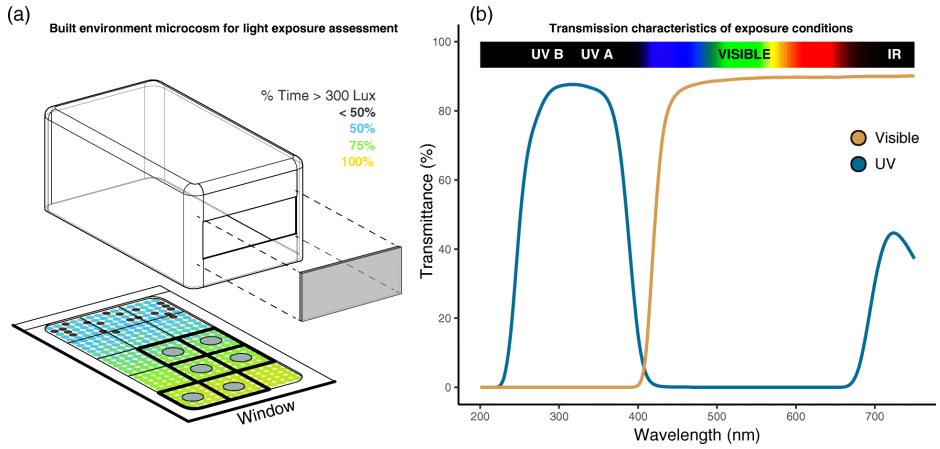
UV Light

Apogee SU 100 – UV-A/B Sensor
250-400 nm
w/m^2

Visible Light

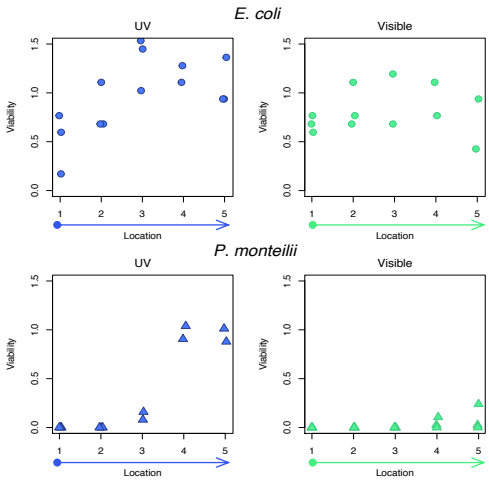
Li-Cor 210 SA – visible light
400-700 nm
lux or footcandles

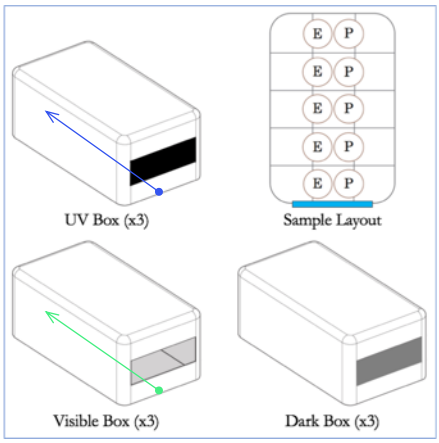
Daylight Autonomy in Dust Bunny Boxes



Fahimipour et al, 2018 // https://microbiomejournal.biomedcentral.com/articles/10.1186/s40168-018-0559-4

Bacterial Culture Study

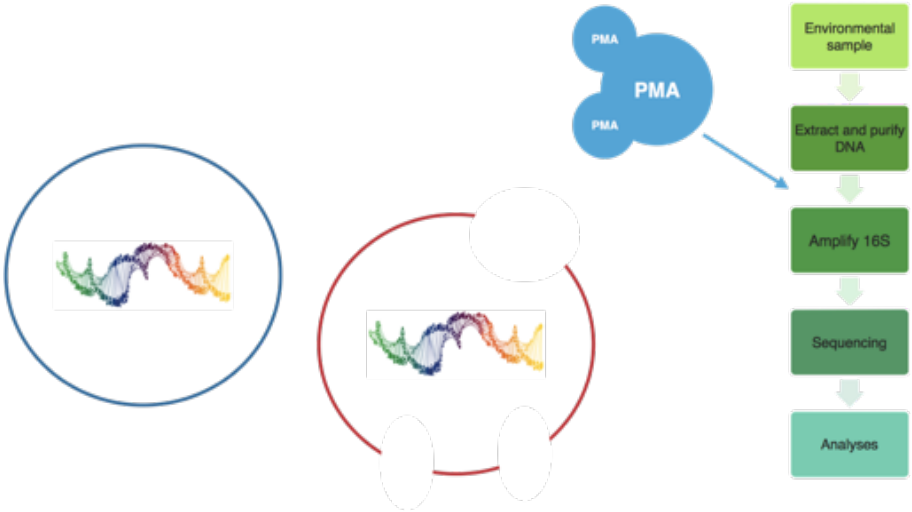




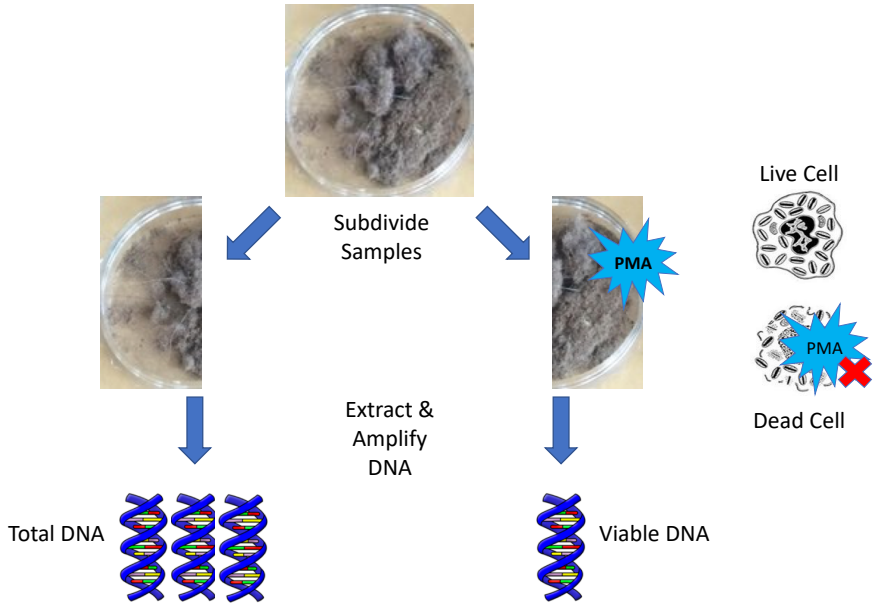
The effect of UV and visible light on the viability of *P. monteilii* and *E. coli* relative to the average colony count of dark boxes.

High-throughput DNA Sequencing

PMA to understand viability & qPCR to understand absolute abundance



PMA Treatment



High-throughput DNA Sequencing

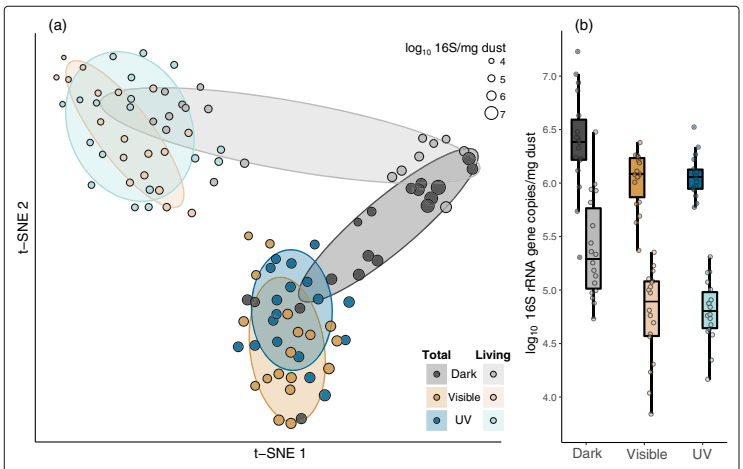
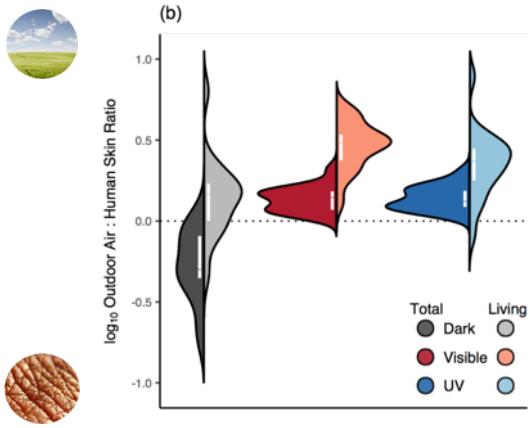


Fig. 2 Effects of light on dust community β-diversity and microbial abundance. **a** t-distributed stochastic neighbor embedding (t-SNE; [52]) visualization of pairwise Canberra distances, calculated using $\log_{10} 1 + x$-transformed RSV absolute abundances. Ellipses delineate treatment groups and represent one standard deviation from the group centroid. Points represent bacterial communities that are colored by their corresponding lighting regime: dark are gray, visible are gold, and ultraviolet are blue. The size of each point is scaled proportionately to the qPCR-based estimates of absolute bacterial abundances. Dark and light shades of each color indicate whether the sample represents the total or viable community respectively. **b** Boxplots of qPCR-based estimates of $\log_{10}$-transformed absolute abundance per milligram dust. The left and righthand boxes for each factor level correspond to the total and living bacterial abundances respectively. Colors are the same as in panel **a**

Fahimipour et al, 2018 // https://microbiomejournal.biomedcentral.com/articles/10.1186/s40168-018-0559-4

High-throughput DNA Sequencing

Light exposure reduces abundance of skin-associated bacteria in dust

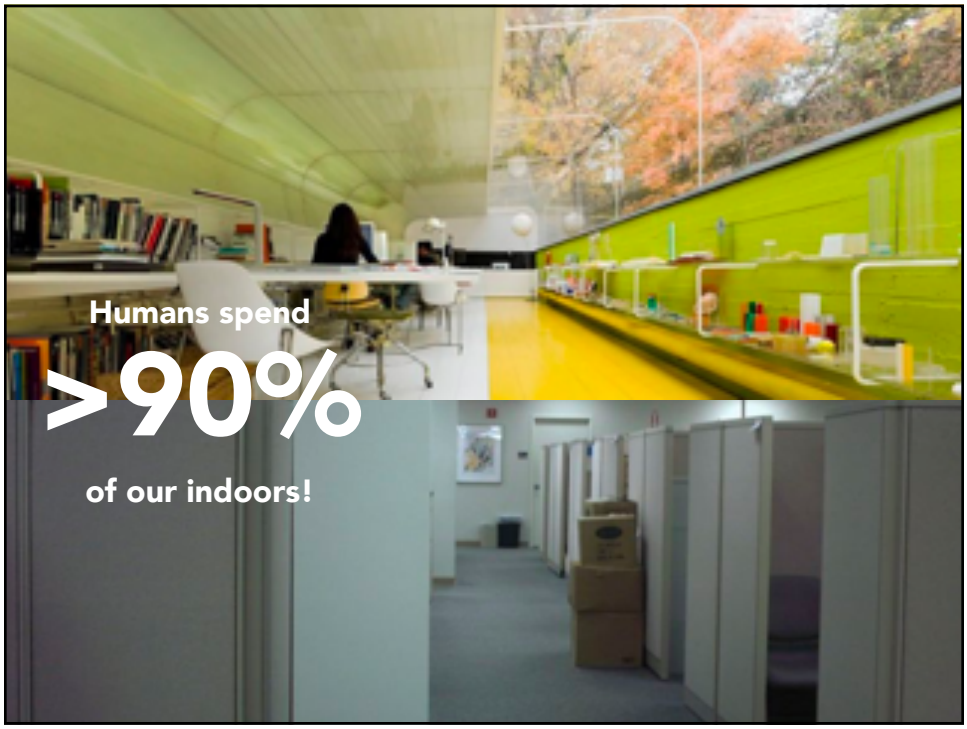


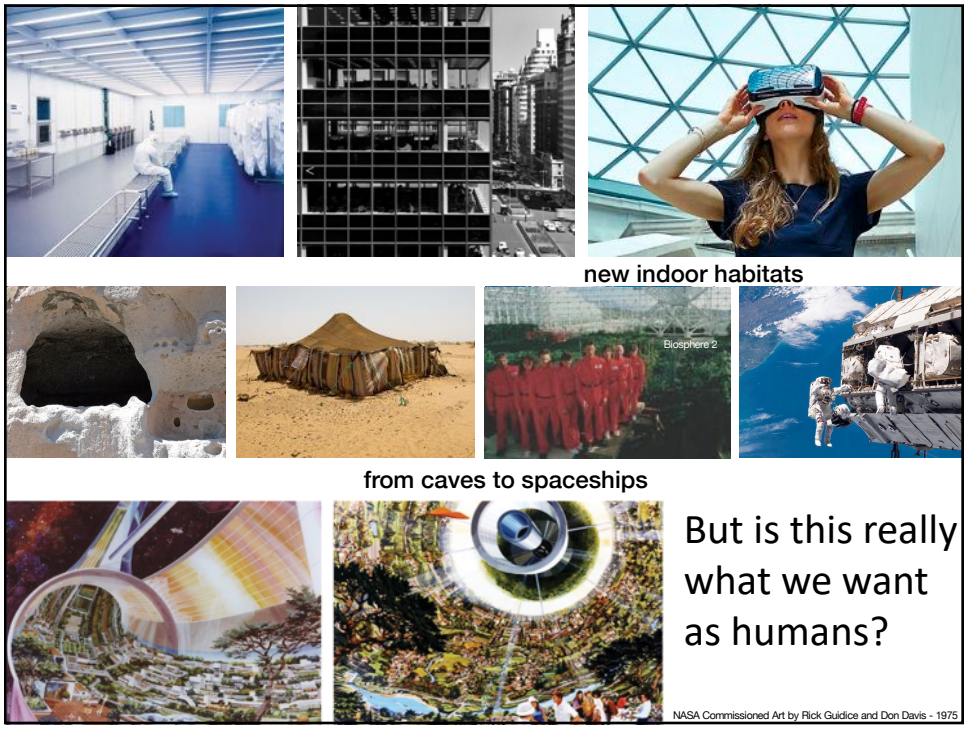
Used source-tracker - a machine learning classifier - to assign bacteria found in the dust to environmental or human sources

Dust experiencing light has a significantly **lower proportion** of living human-derived bacteria, instead containing more environmental bugs

Fahimipour et al. *In Review*

Fahimipour et al, 2018 // https://microbiomejournal.biomedcentral.com/articles/10.1186/s40168-018-0559-4





Courtesy: UW - Meek

Workers value daylight and views over anything else!

Terry Thomas – Photo Meek VDW

Environmental Services Building – Photo Meek VDW

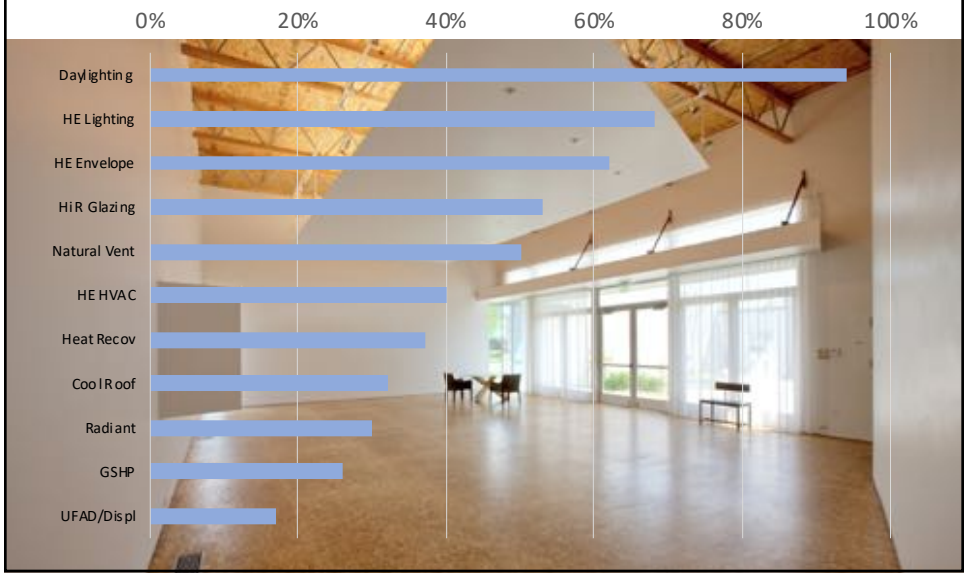
VIEWS, esp. vegetation & water, increase property value ~ 60%

Daylight is #1 Sustainable Strategy

J.Crist Gallery, Carver Photo Meek VDW

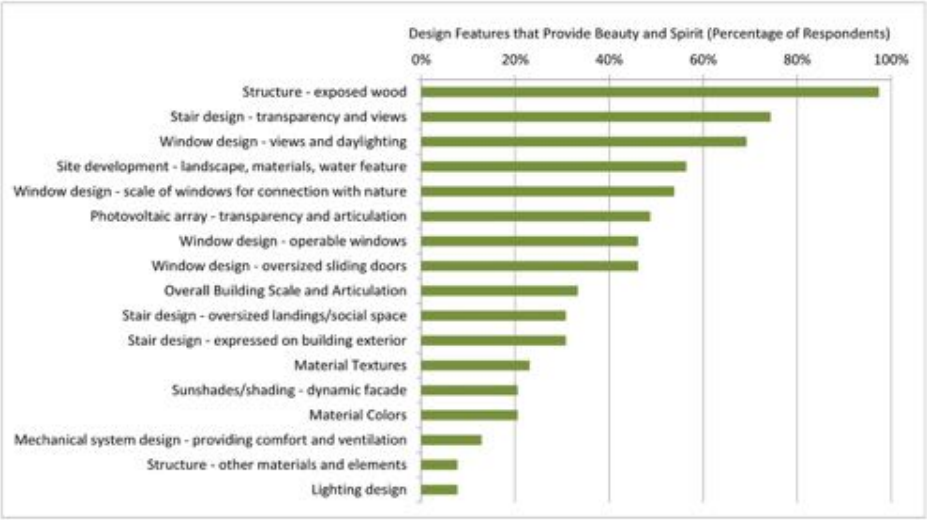
Daylight is #1 Sustainable Strategy

2014 NBI - Technologies Used in ZNE Buildings



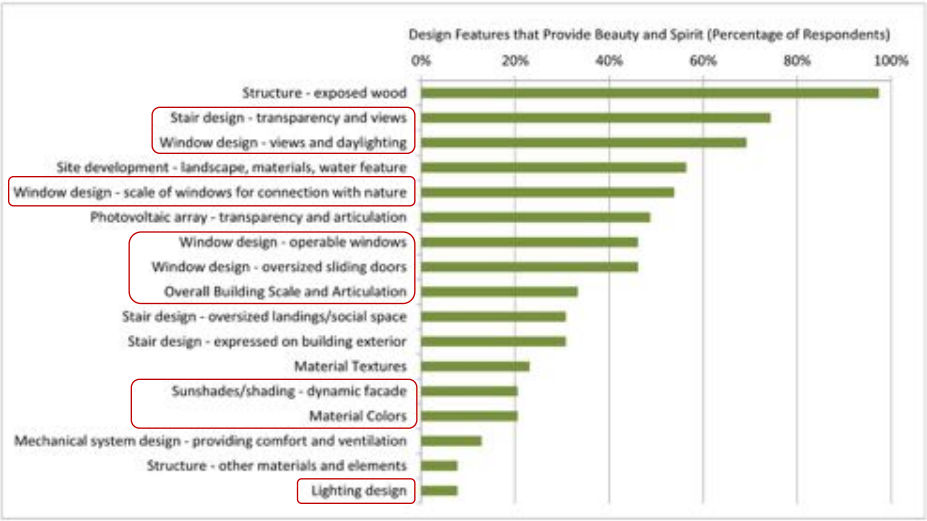
Courtesy: Bullitt Foundation

LBC Beauty and Spirit Occupant Survey



Courtesy: Bullitt Foundation / UW-Meek

LBC Beauty and Spirit Occupant Survey



Courtesy: Bullitt Foundation / UW-Meek

Ford Motor Company Automobile Storage and Finishing 1908 Image: AKA

Daylit for health…

"Light is as necessary to the perfect growth and nutrition of the human frame as are air and food; and, whenever it is deficient, health fails, and disease appears… Artificial is but a very bad substitute for natural light. Plants reared in a strong artificial light will become green, and grow, but the green is of a pale yellowish hue, and they are sickly looking and diseased. This fact partly explains the pallid and pasty complexion of those who turn day into night, and whose existence is spent in a great measure by candle-light. **For health, we cannot have too much light, and, consequently, too many or too large window."**

The Duty on Glass. (February 22nd, 1845). The Lancet, 1, 214-215.

Poor Daylight and Health

Glass Tax and Masonry Construction

Association pour le Patrimoine de Leysin

An Architecture of Salubrity

Glass and Daylight

"energy will be too cheap to meter"

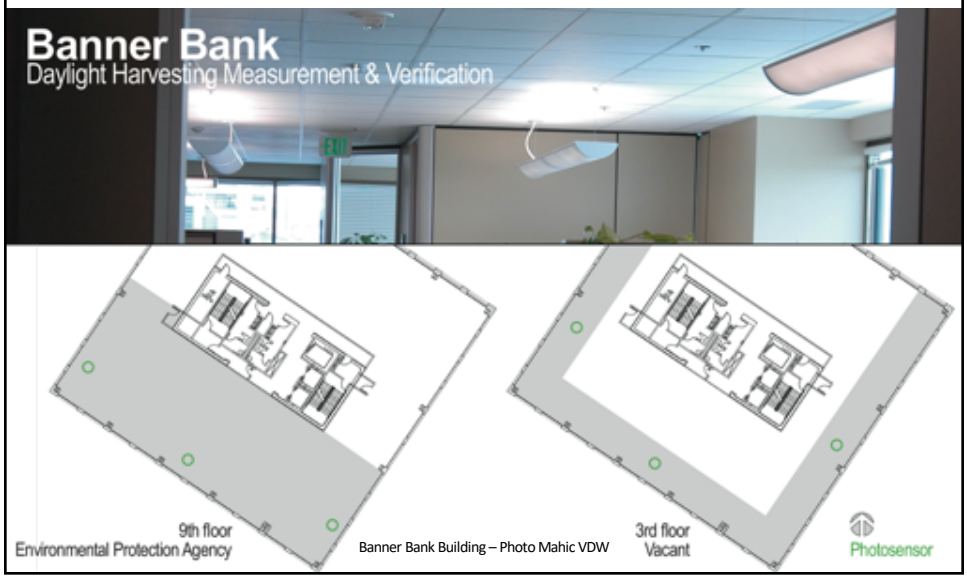
Lewis Strauss – Chairman of the U.S. Atomic Energy Commission, 1954

thin blue line between us and beyond

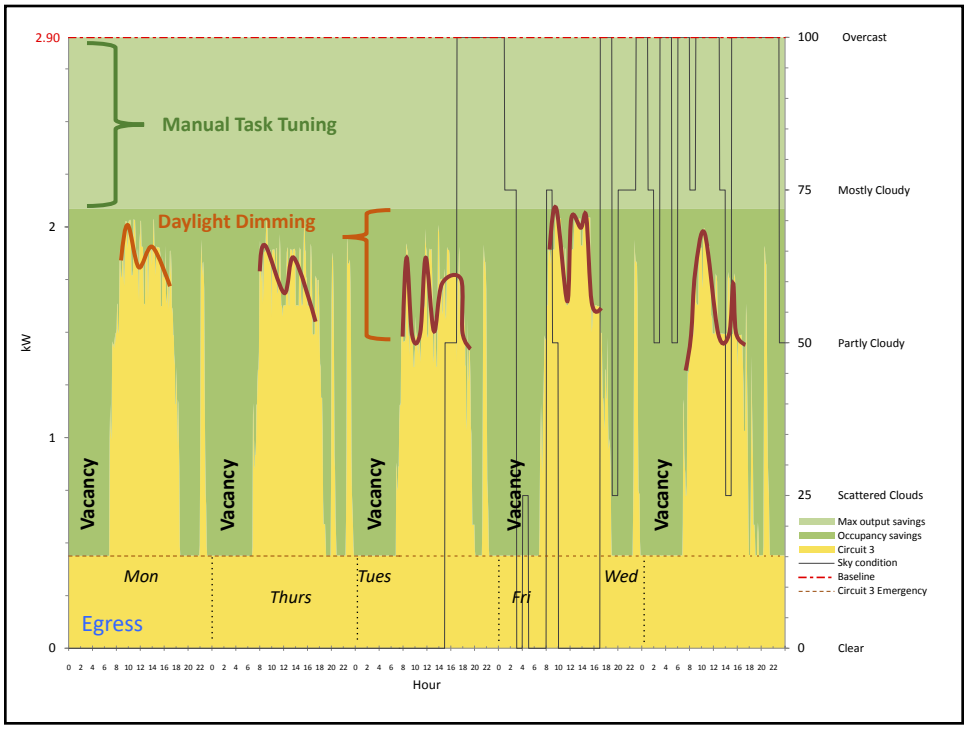
50%

of BTUs are consumed by buildings!

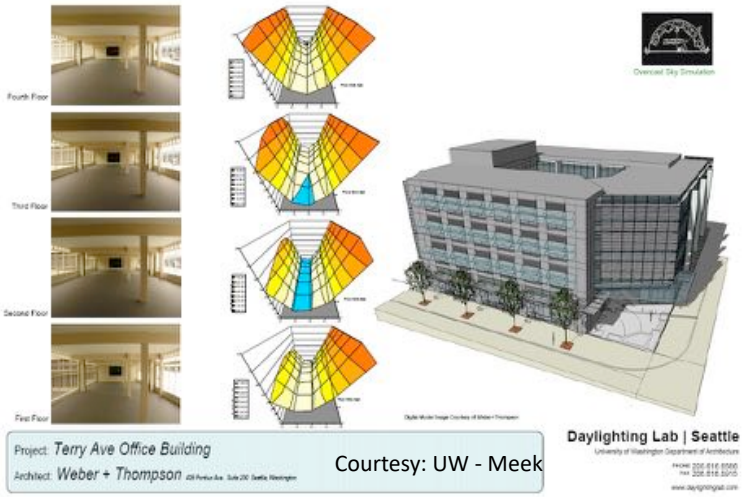
Daylit…to save energy…and recruit tenants



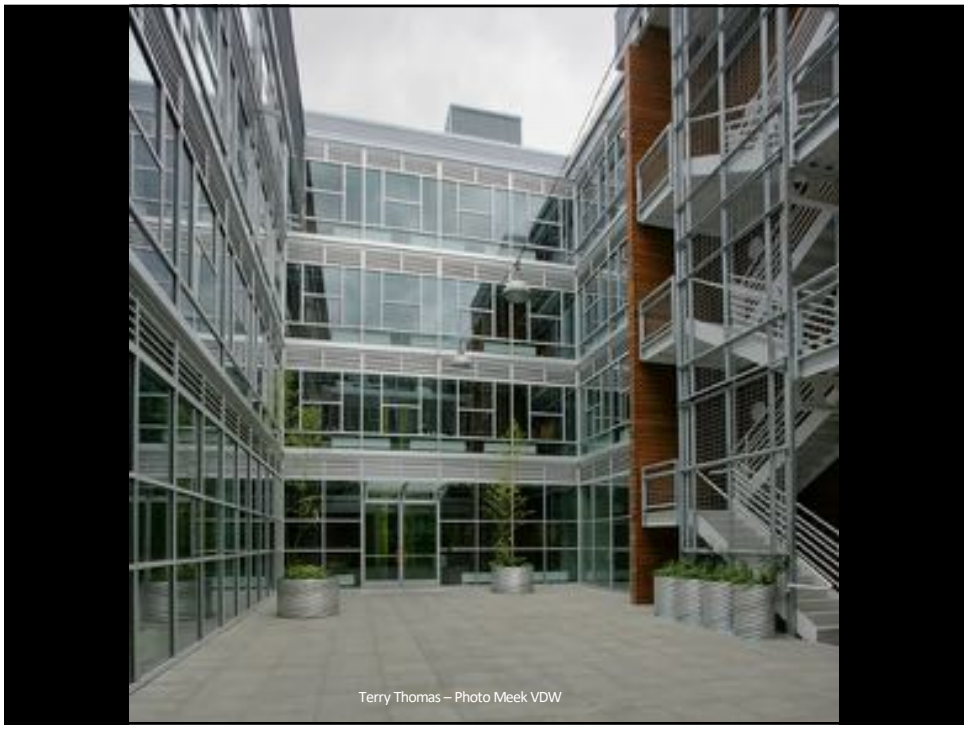

Banner Bank Building – Photo Mahic VDW


2.90
2
1
0
kW
Manual Task Tuning
Daylight Dimming
Vacancy
Vacancy
Vacancy
Vacancy
Vacancy
Mon
Thurs
Tues
Fri
Wed
Egress
Hour
100 Overcast
75 Mostly Cloudy
50 Partly Cloudy
25 Scattered Clouds
0 Clear
Max output savings
Occupancy savings
Circuit 3
Sky condition
Baseline
Circuit 3 Emergency

Daylit…to save energy…and recruit tenants



Courtesy: UW - Meek



Terry Thomas – Photo Meek VDW

Design EUI :48 kbtu/sf-yr
Measured: 41 kbtu/sf-yr

Installed LPD: 0.6 w/sf
Measured LPD: 0.26 w/sf

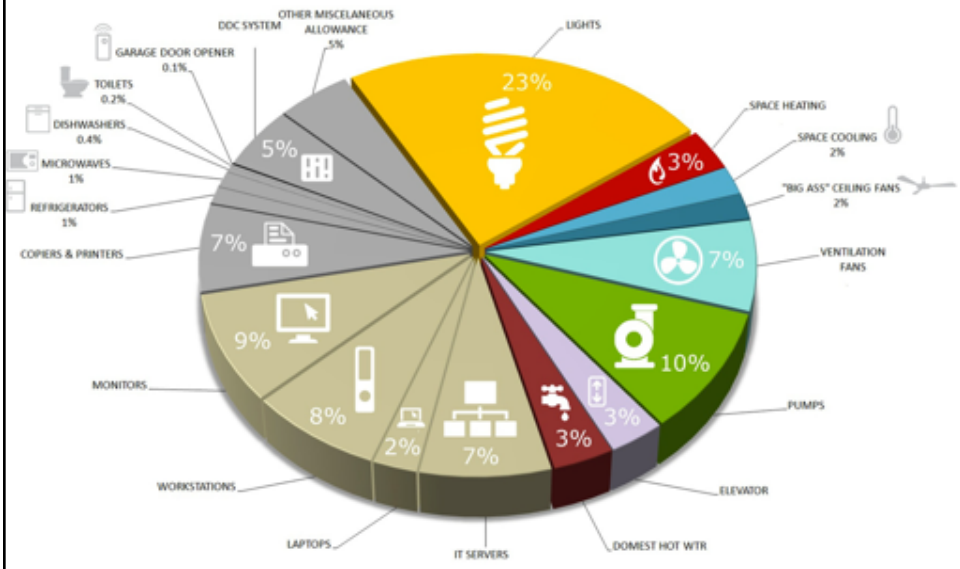
High Occupant Satisfaction

Terry Thomas – Photo Meek VDW


Courtesy: Bullitt Foundation

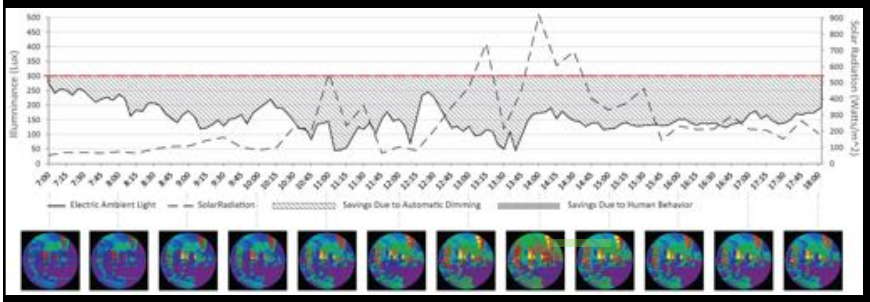
Daylit for ZNE

.4 w/sf connected LDP

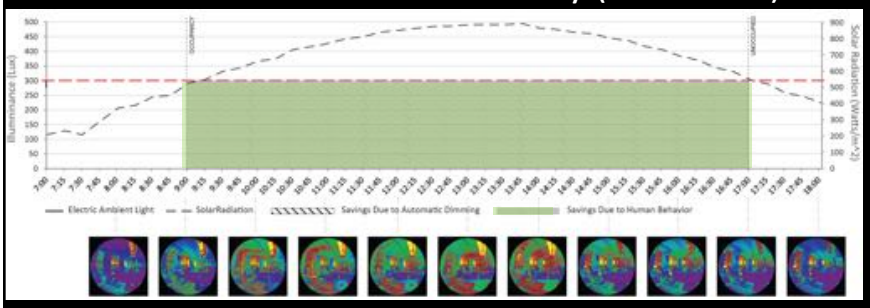


Courtesy PAE

Overcast Summer Day (27 June 2016)



Clear Summer Day (1 Jul 2016)



Should we let the market decide?

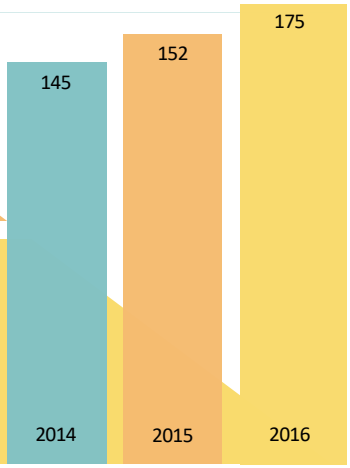
Are we there yet?

Ambitious, achievable goals…BUT

6 firms
reported an average pEUI savings of 70% or greater across their portfolio

16 firms
reported portfolio average pEUI savings between 60% and 70%

331 projects
met the target of at least 70% pEUI savings–and over a third of those projects were 100,000 sq.ft. or greater



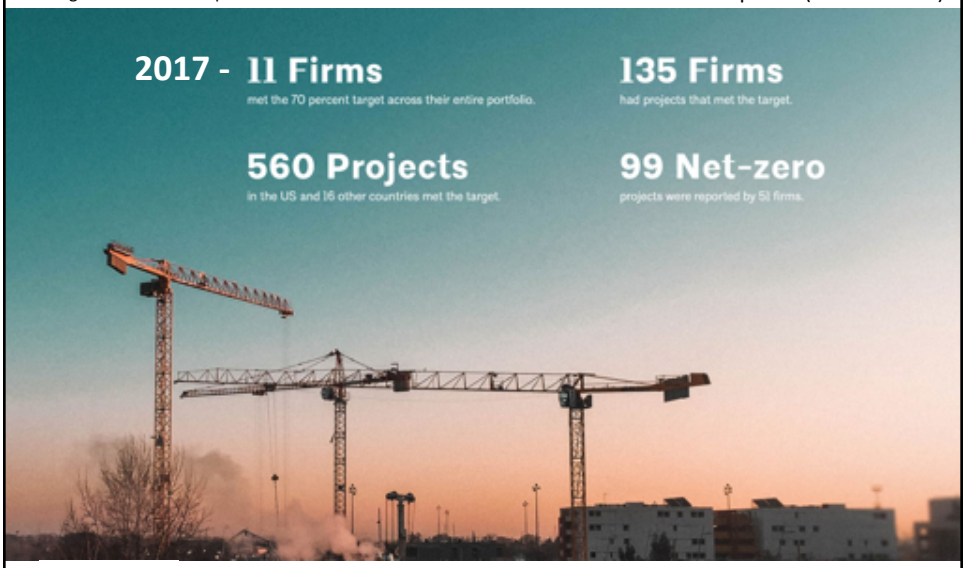
source: AIA 2030 By the Numbers: The 2016 Summary of the AIA 2030 Commitment

AIA

2016 - 6 firms

reported an average pEUI savings of 70% or greater across their portfolio

2017 Report – (most current)



AIA

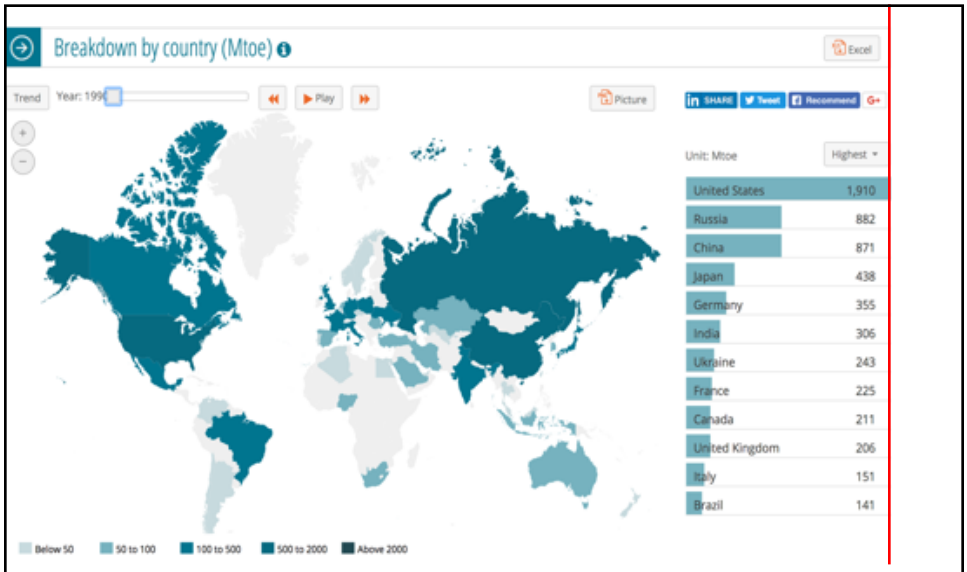
6 -> 11 achieving // 175 -> 212 reporting

AIA, "PICK UP the PACE!"

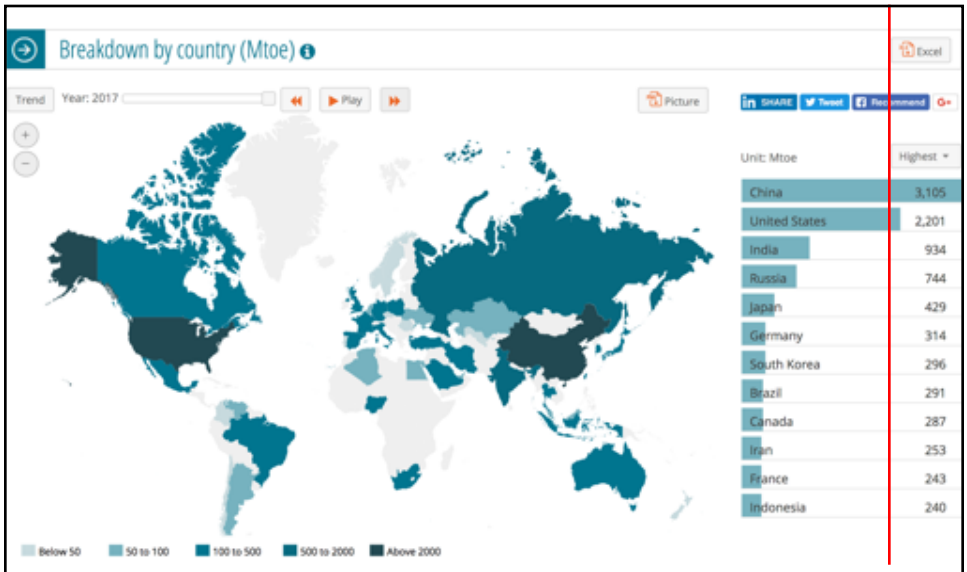
AIA

2.3% energy consumption in 2017

oops!



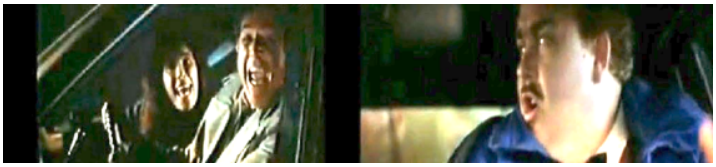
1910 Mtoe
1990 in US



1910 Mtoe
1990 in US
…
2201 Mtoe
2017 in US

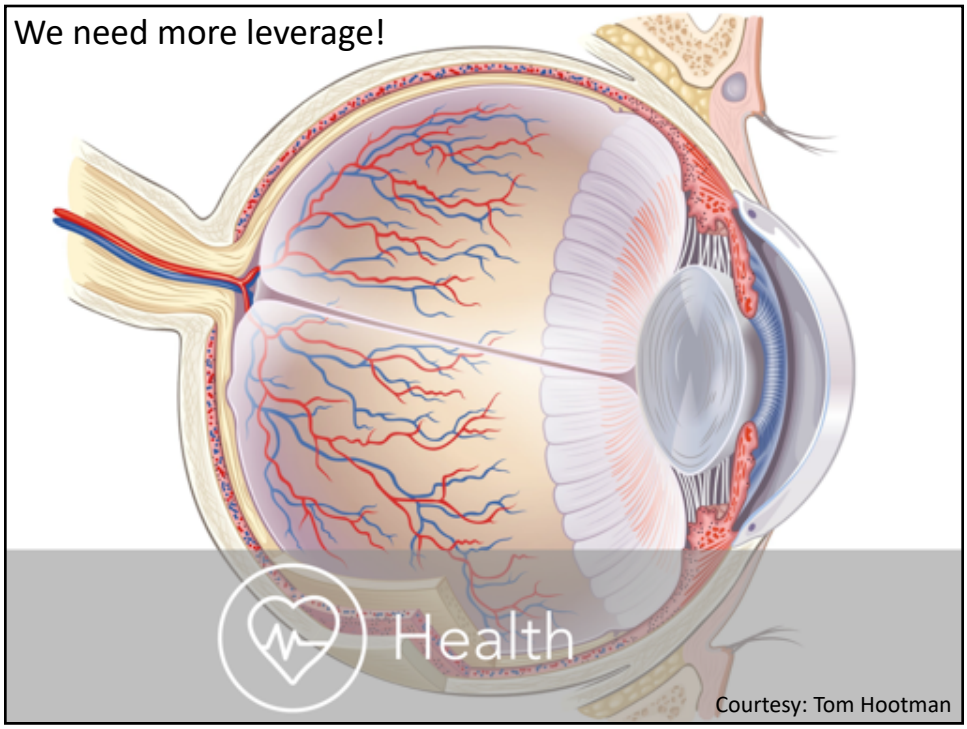
Should we let the market decide?

Are we there yet?



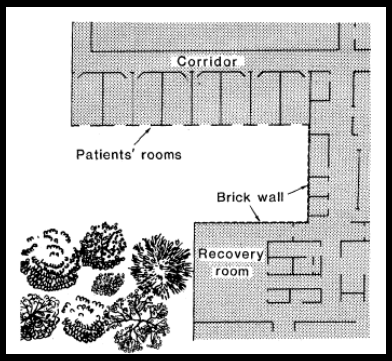
You're going the wrong way!

We need more leverage!



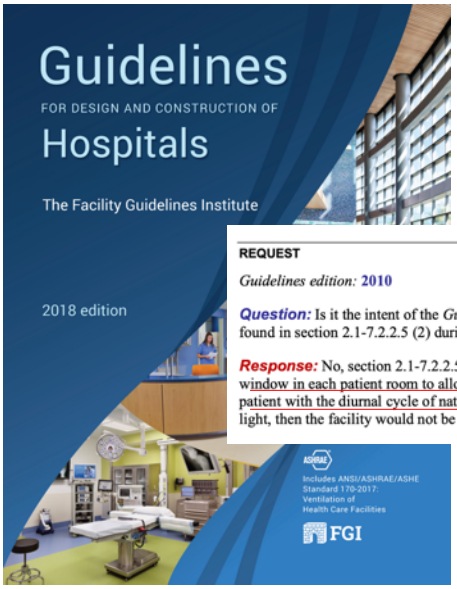
Courtesy: Tom Hootman

1984 – 35 Years ago…we learned daylight and view increases healing



Ulrich (1984) identified an:
- 8.5% reduction in post-operative hospital stay (7.96 days versus 8.7 days)
- Patients received fewer negative evaluations from nurses
- Patients took fewer strong analgesics.

TODAY – we require windows in patient rooms



REQUEST

Guidelines edition: **2010** *Paragraph reference:* **2.1-7.2.2.5 (2)**

Question: Is it the intent of the *Guidelines* to require facilities to meet the window area requirements found in section 2.1-7.2.2.5 (2) during renovations?

Response: No, section 2.1-7.2.2.5 (2) applies only to new construction. The *Guidelines* requires a window in each patient room to allow light into the room, permit views from the room, and connect the patient with the diurnal cycle of natural light. If an existing patient room has a window providing natural light, then the facility would not be required to increase the window area in existing buildings.

Patient rooms intended for more than 24 hours of occupancy must have window of area … as defined in section…

1995 – 24 years ago we learned daylight improves retail sales

Wal-Mart, Lawrence Kansas,
Reported "significantly higher" sales in the skylit part of the store
*The Wall Street Journal, Monday, Nov. 20, **1995***

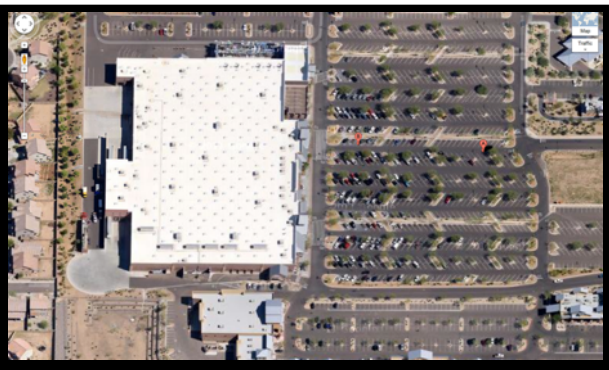
HMG –Retail Sales
2002 - Retail Sales driven by:
1) store hours
2)years since remodel
3)presence of skylights

TODAY – retail stores use skylights

Sacramento Walmart

Portland, ME
Walmart

Portland, OR
Walmart



Phoenix
Walmart

Moncton
Costco

Boise
Walmart

Detroit
Walmart

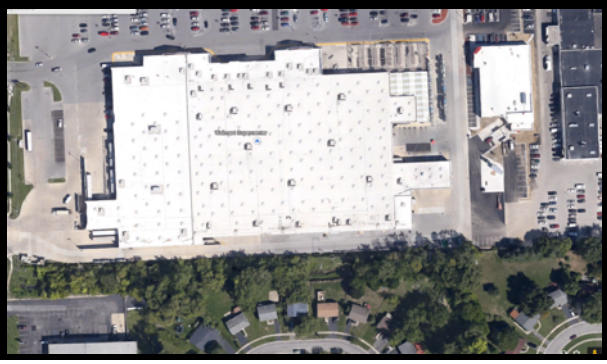
Omaha
Walmart

Des Moines
Walmart

Minneapolis Walmart

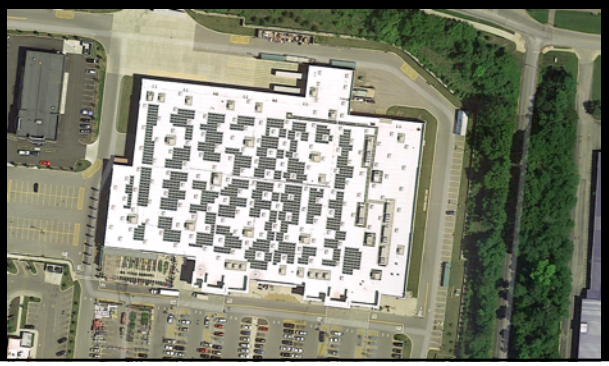
Indianapolis Walmart

Cleveland Walmart



Toledo Walmart

Pittsburgh Walmart



Cincinnati Walmart

!

TODAY – Title 24 & IECC require skylights in box stores

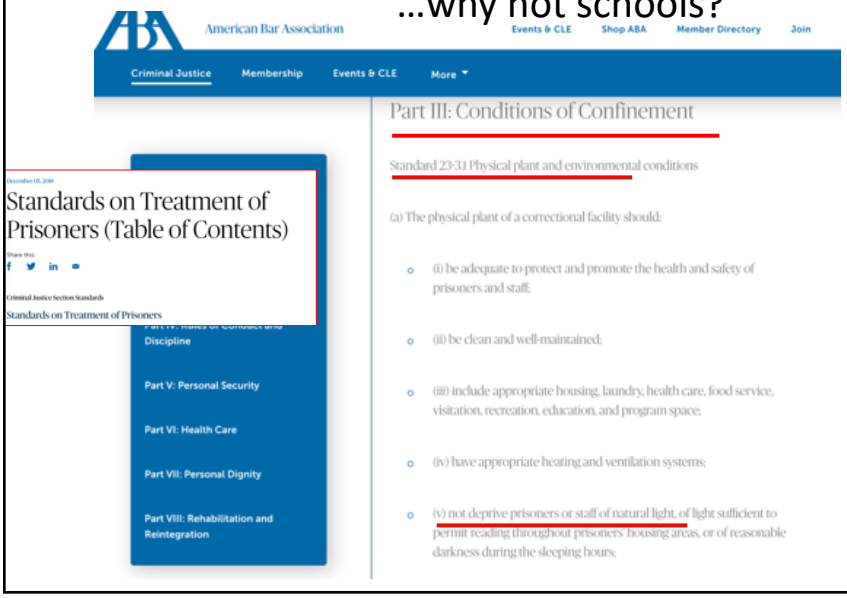
1999 – 20 years ago we learned daylight improves learning outcomes

Studies show links between improved learning and daylit classrooms with a view.
-Heschong Mahone Group 1999, 2003

- Capistrano: In the year analyzed (1998), students with the most daylight improved **20% more on math** and **26% more on reading** tests (99% certainty).

Seattle & Ft. Collins: Students with the most daylight performed 7-18% better than students with the least daylight.

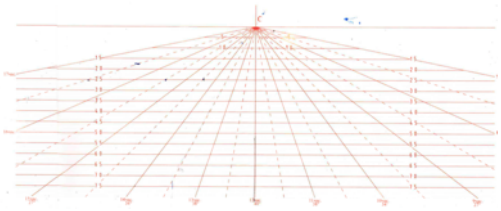
TODAY – We require prisons have natural light …why not schools?



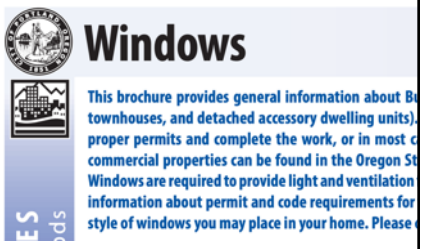
TODAY – We rarely require windows in codes

England BS 8206-2:2008…
To guarantee a satisfactory daylight uniformity, the area which does not receive direct skylight should not exceed 20% of the floor area, as quantified in the BS 8206 Part2 2008.

» The EU Workplace (Health, Safety and Welfare) Regulations (1992) requires that "Every workplace shall have suitable and sufficient lighting" and that this lighting "shall, as far as is reasonably practicable, be by natural light «



Windows into living spaces in Kiev must have 2 hours of sunlight per day

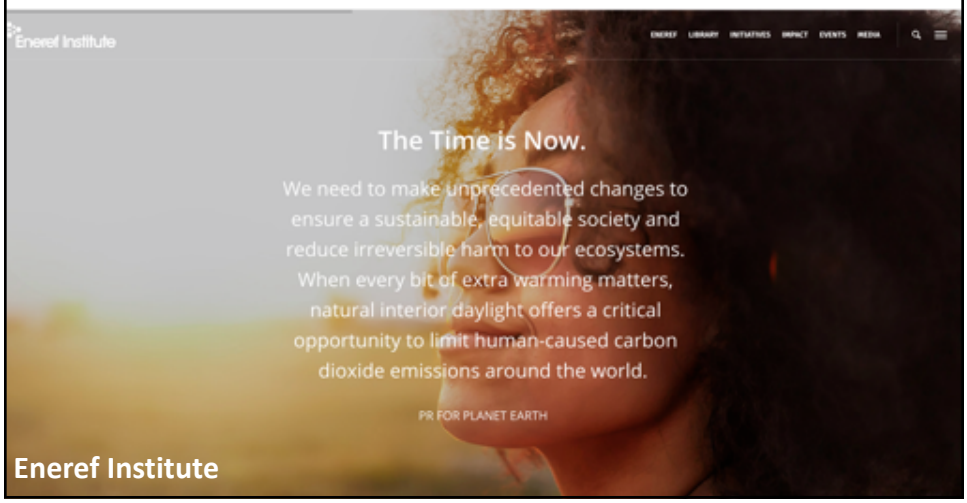


https://www.portlandoregon.gov/bds/article/93025

Spatial Equity - Daylight for All

When…? …will we require windows in schools…

…. daycares, senior living, offices, housing ?



Eneref Institute

Who?

I propose…

Illuminating ENGINEERING SOCIETY

NEMA National Electrical Manufacturers Association

Attachments Energy Rating Council AERC

ICC INTERNATIONAL CODE COUNCIL®

ASHRAE

NIH National Institutes of Health

AMA

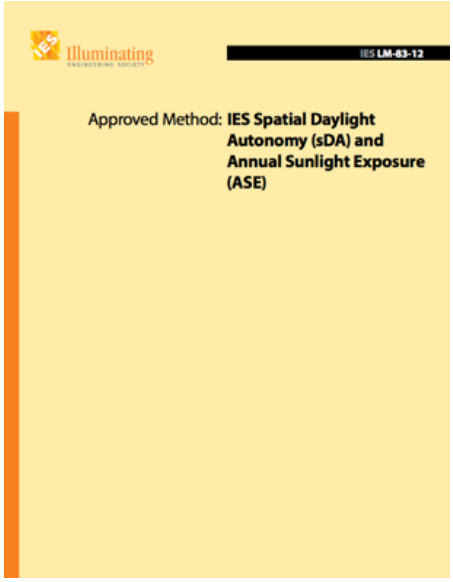
CDC U.S. Department of Health and Human Services Centers for Disease Control and Prevention

?

U.S. FOOD & DRUG ADMINISTRATION

IES Leadership

IES LM-83-12
Approved Method:
IES Spatial Daylight Autonomy (sDA) and Annual Sunlight Exposure (ASE)

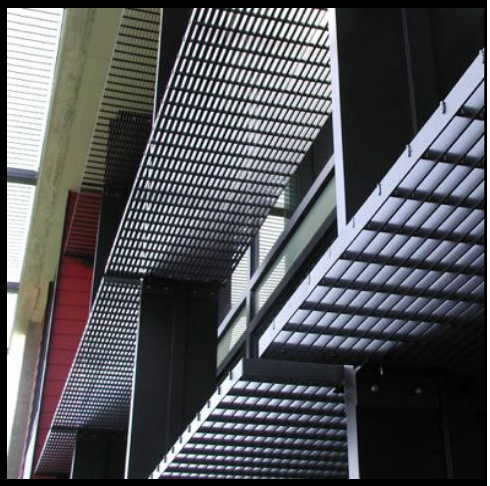


84

Courtesy: IES

Courtesy: Meek VDW

Courtesy: Meek VDW



Courtesy: Meek VDW

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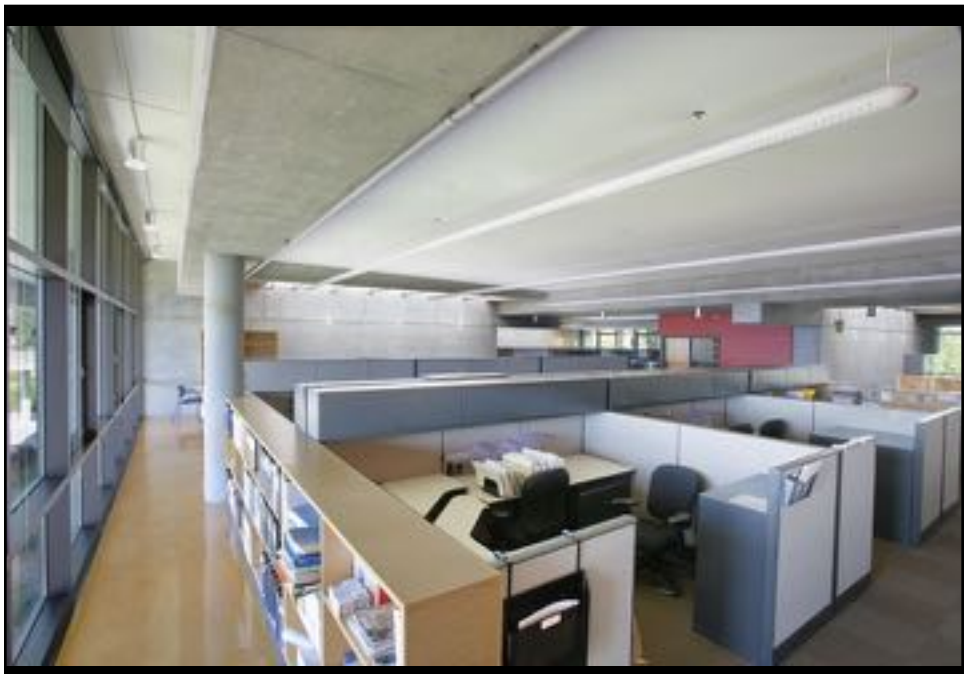
Courtesy: Meek VDW

Courtesy: Meek VDW

Courtesy: Meek VDW



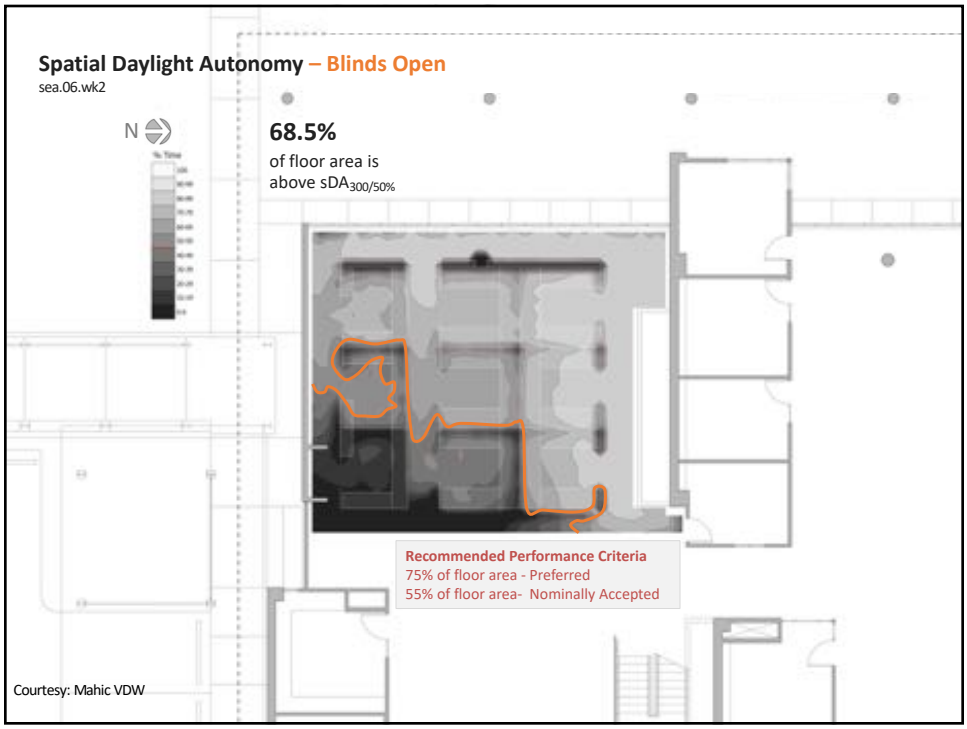
Courtesy: Meek VDW

Courtesy: Meek VDW

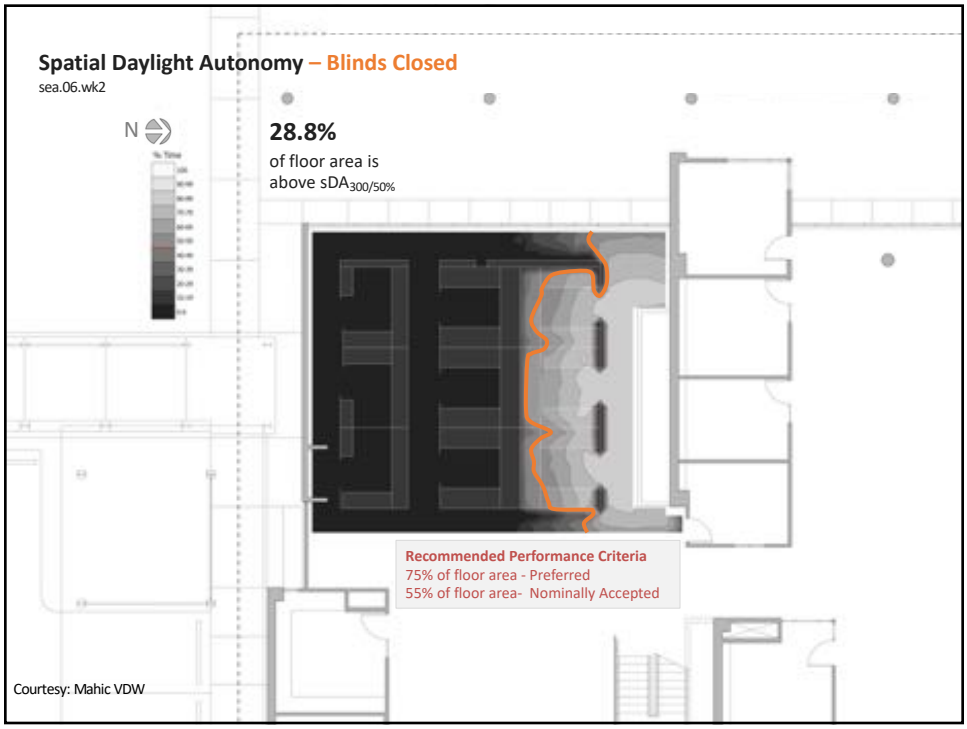
Courtesy: Meek VDW

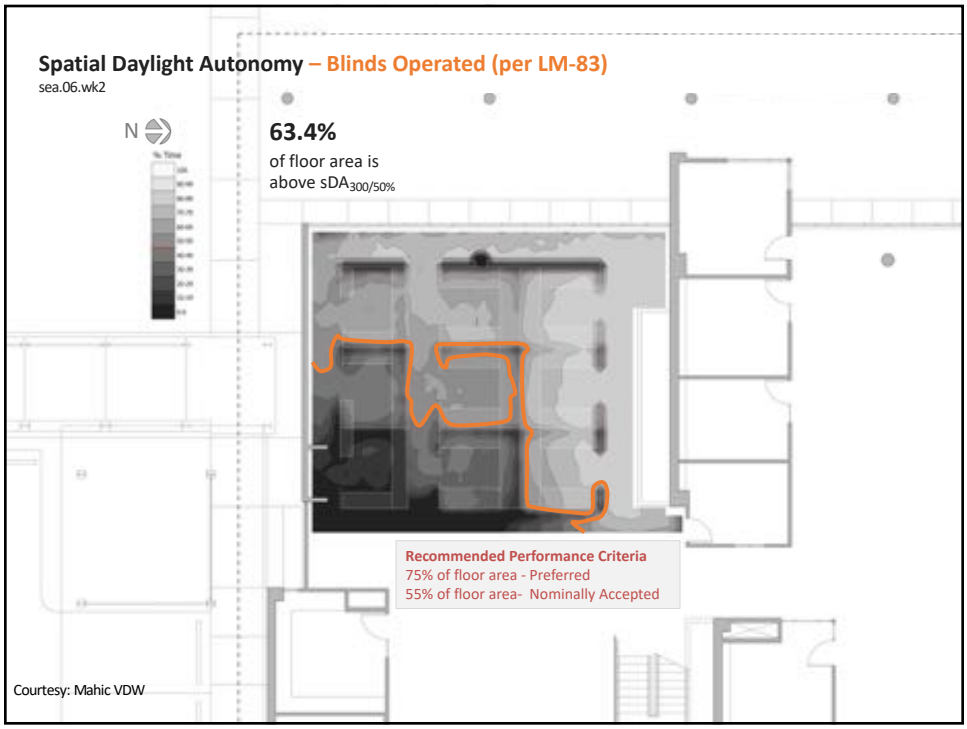
Courtesy: Meek VDW

Courtesy: Mahic VDW



Courtesy: Mahic VDW


Spatial Daylight Autonomy – Blinds Closed
sea.06.wk2
N
28.8%
of floor area is
above sDA300/50%
Recommended Performance Criteria
75% of floor area - Preferred
55% of floor area- Nominally Accepted
Courtesy: Mahic VDW

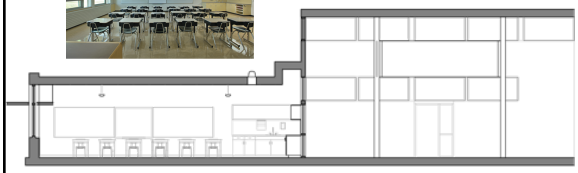

Spatial Daylight Autonomy – Blinds Operated (per LM-83)
sea.06.wk2
N
63.4%
of floor area is
above sDA300/50%
Recommended Performance Criteria
75% of floor area - Preferred
55% of floor area- Nominally Accepted
Courtesy: Mahic VDW

Ash Creek Elementary | Monmouth, OR | BOORA Architects
Photo: Nick Hubof, UI-IDL
Rendering: Nick Hubof, UI-IDL

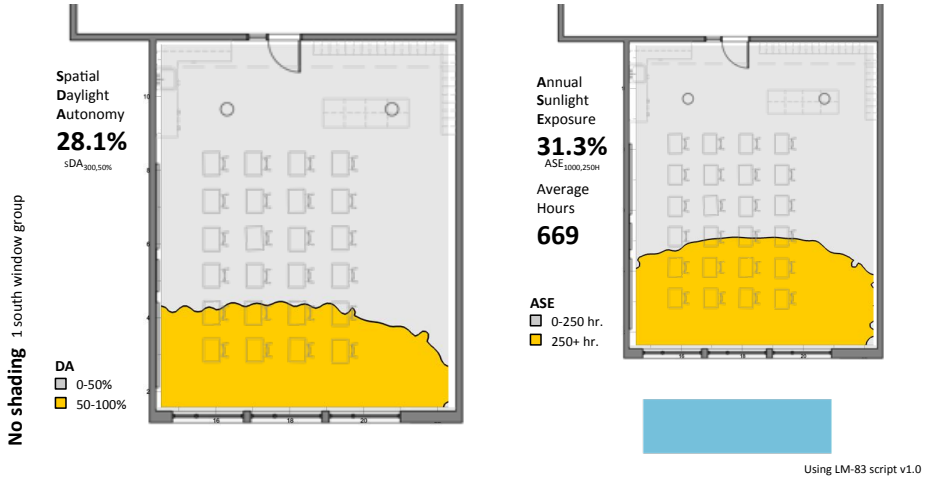
Annual metrics for a classroom model

South face.
- Run with varied number of window groups.

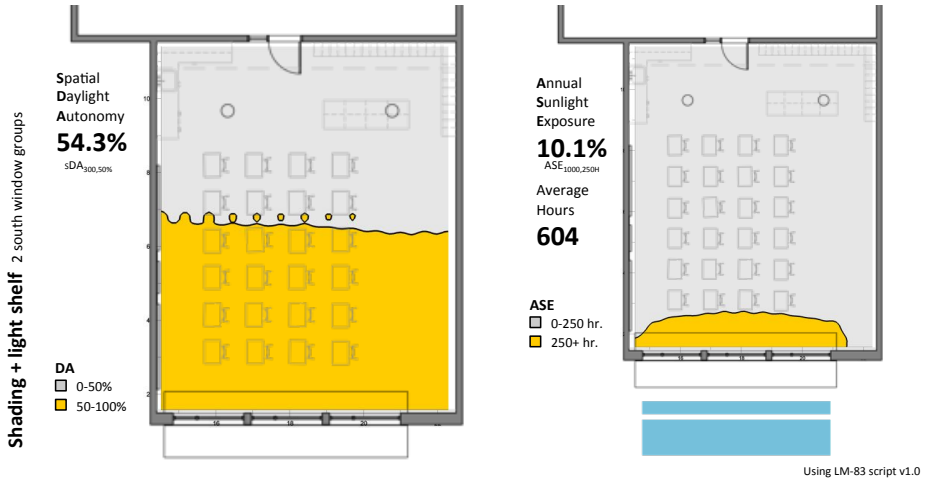
North re-light.
- Run as a single north-facing window group.



Courtesy: Mahic Hubof VDW



Courtesy: Mahic VDW

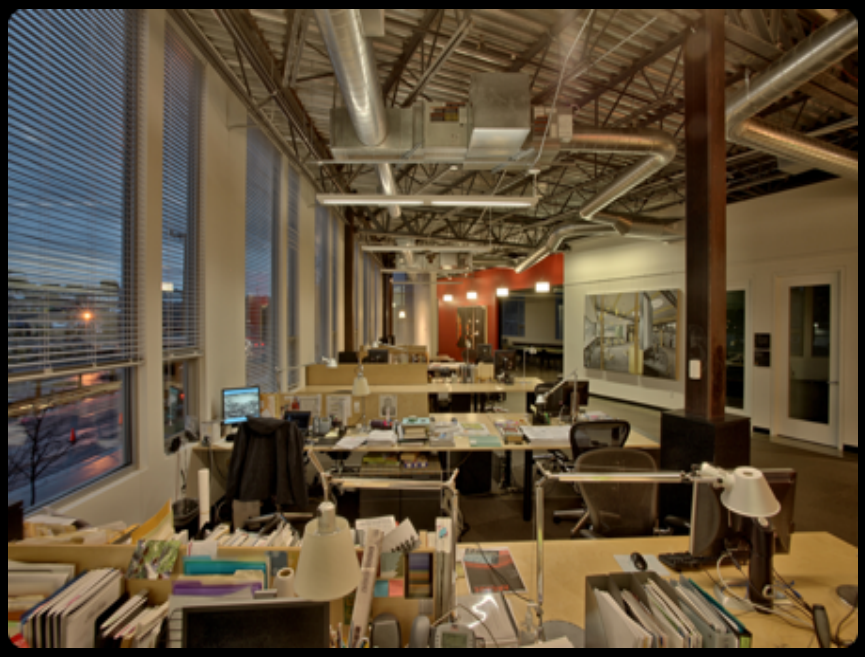


Courtesy: Mahic VDW


Courtesy Craig Johnson, UCSD
FOR LEASE
RESTAURANT / RETAIL


Courtesy: UW - Meek

Courtesy: UW - Meek



Courtesy: UW - Meek

Courtesy: UW - Meek

Courtesy: UW - Meek

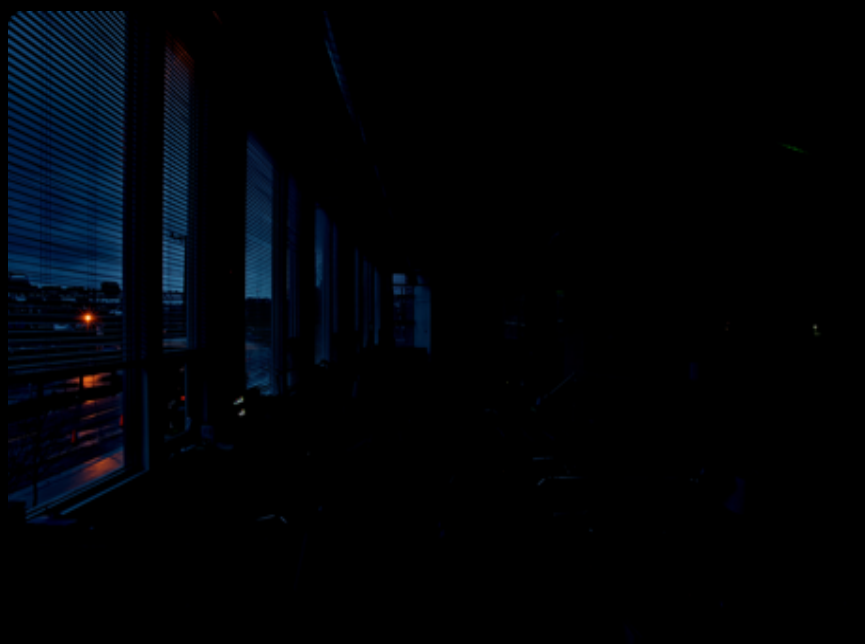
Courtesy: UW - Meek

Courtesy: UW - Meek

Courtesy: UW - Meek

Courtesy: UW - Meek

Courtesy: UW - Meek



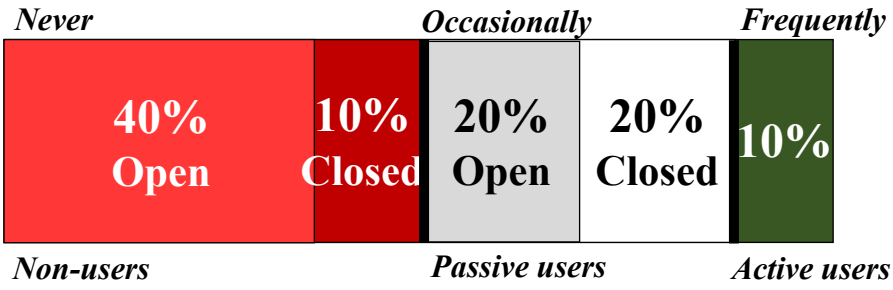
Courtesy: UW - Meek

Manual Blind Behavior Field Study

Courtesy: Nezamdoost VDW

Proposed Model Structure (from July-August 2018 DMC Meetings)

Proposed Manual Algorithm – Proportion of Window Blinds Operate:



- Applicable to **Buildings** with 10+ **window blinds** per **window group**
- Applicable to **Spaces** with 10+ **window blinds** per **window group**
- **Requires Modification** for buildings or spaces with fewer than 10 window blinds per window group

Courtesy: Nezamdoost VDW

Automation in Construction 92 (2018) 133–150

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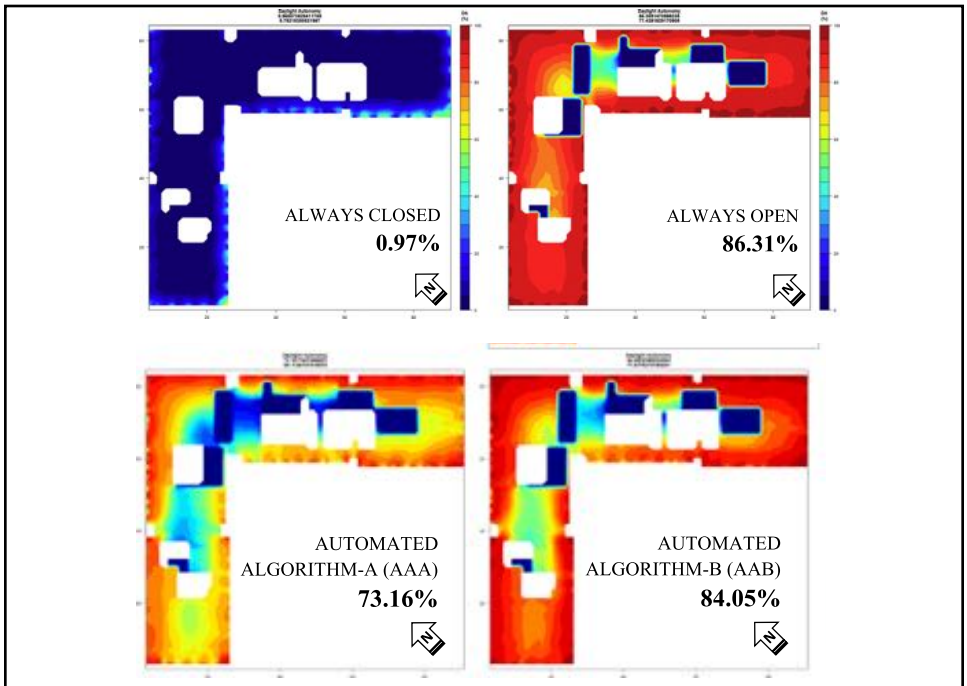
journal homepage: www.elsevier.com/locate/autcon

Assessing the energy and daylighting impacts of human behavior with window shades, a life-cycle comparison of manual and automated blinds

Amir Nezamdoost*, Kevin Van Den Wymelenberg, Alen Mahic

University of Oregon, Energy Studies in Buildings Laboratory, Eugene & Portland, OR, USA



Nezamdoost et al, 2018

Fig. 16. Spatial Daylight Autonomy plot for each blind control algorithm.

Fig. 18. Annual end-use energy consumption comparison of six manual or automated blind algorithms (interior/exterior).

Nezamdoost et al, 2018

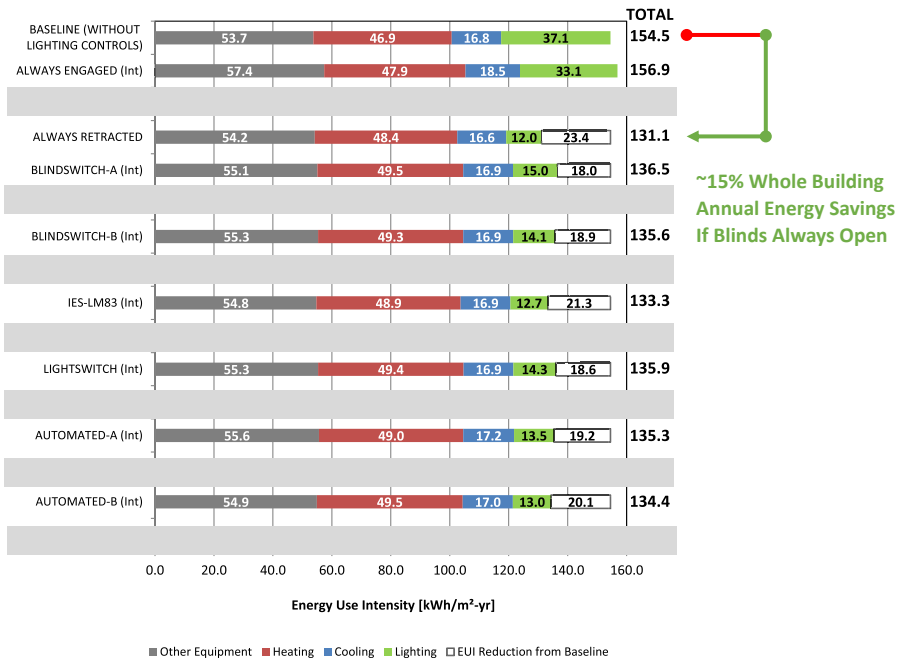
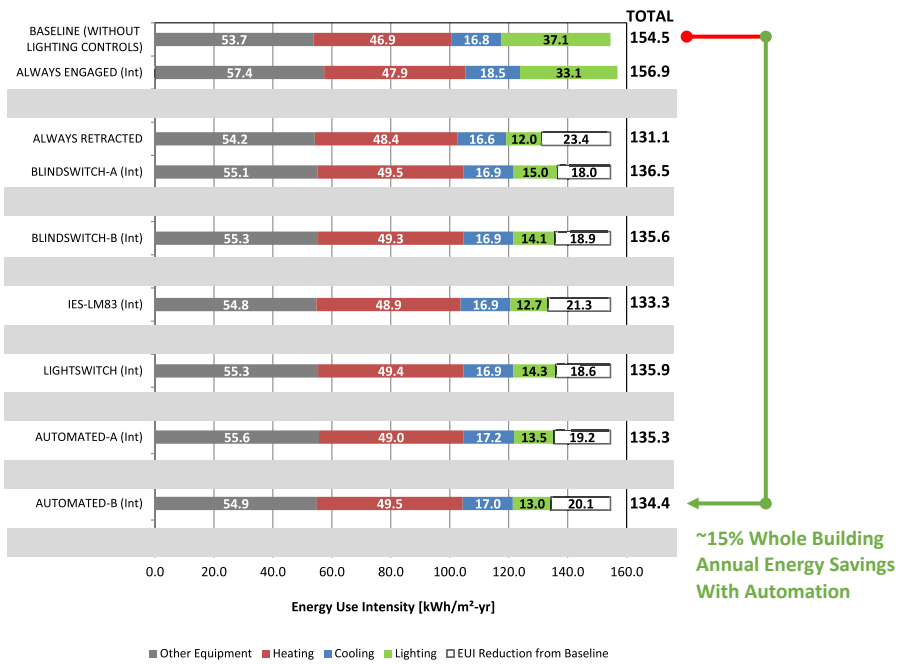


Fig. 18. Annual end-use energy consumption comparison of six manual or automated blind algorithms (interior/exterior).

Nezamdoost et al, 2018



~15% Whole Building Annual Energy Savings With Automation

Fig. 18. Annual end-use energy consumption comparison of six manual or automated blind algorithms (interior/exterior).

Nezamdoost et al, 2018

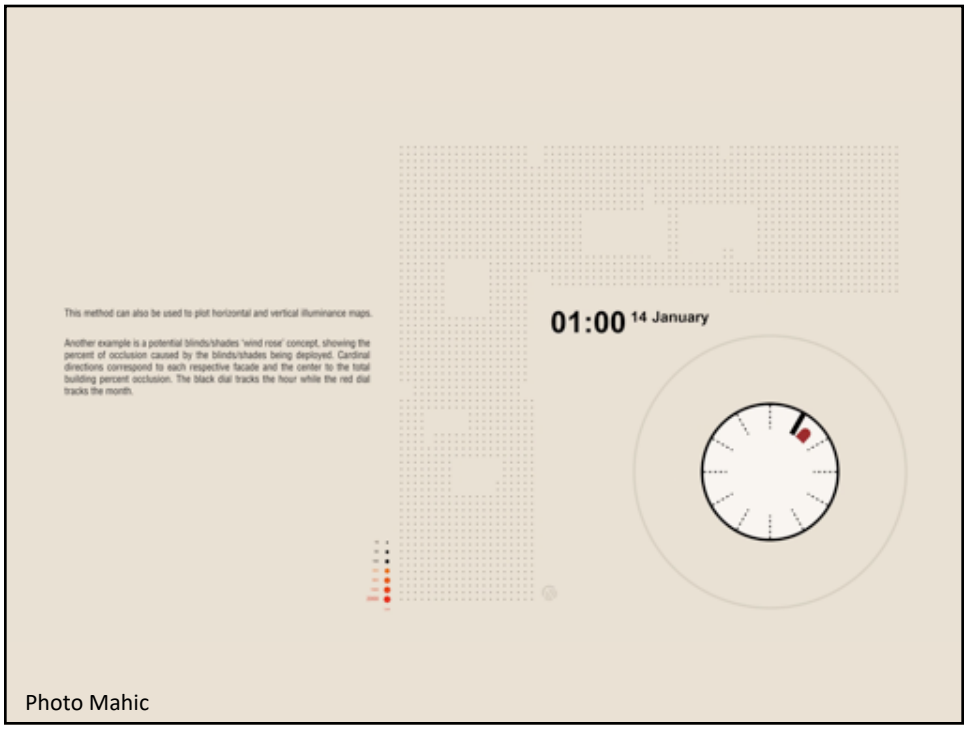


Photo Mahic

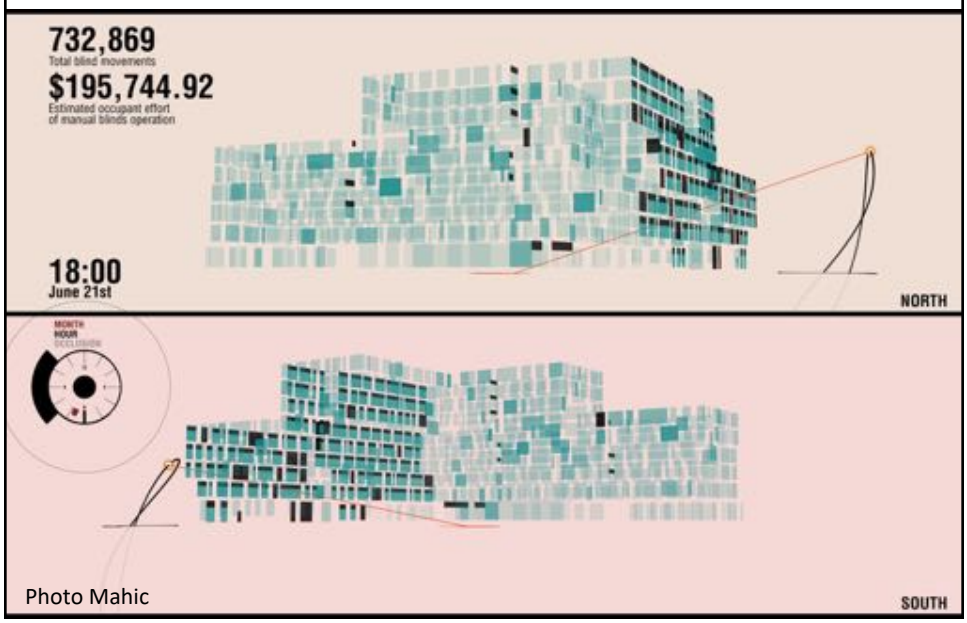
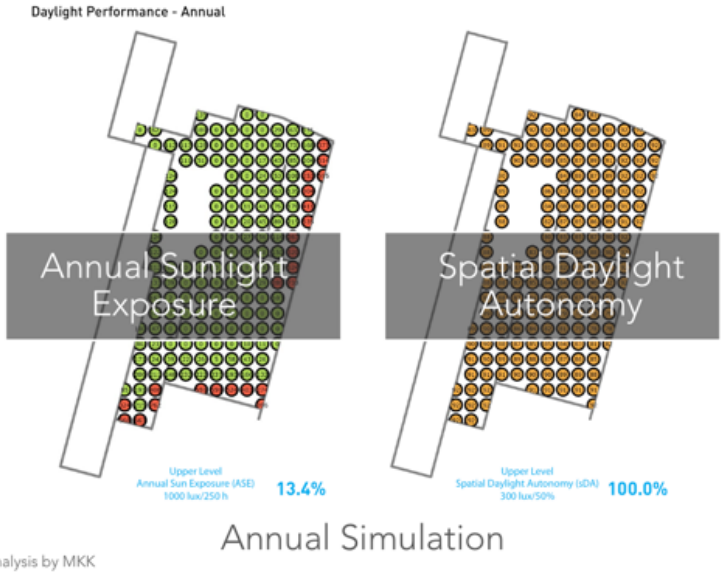


Photo Mahic

You want accurate LM-83 blind use? - Lightstanza!



Courtesy: Dan Glaser

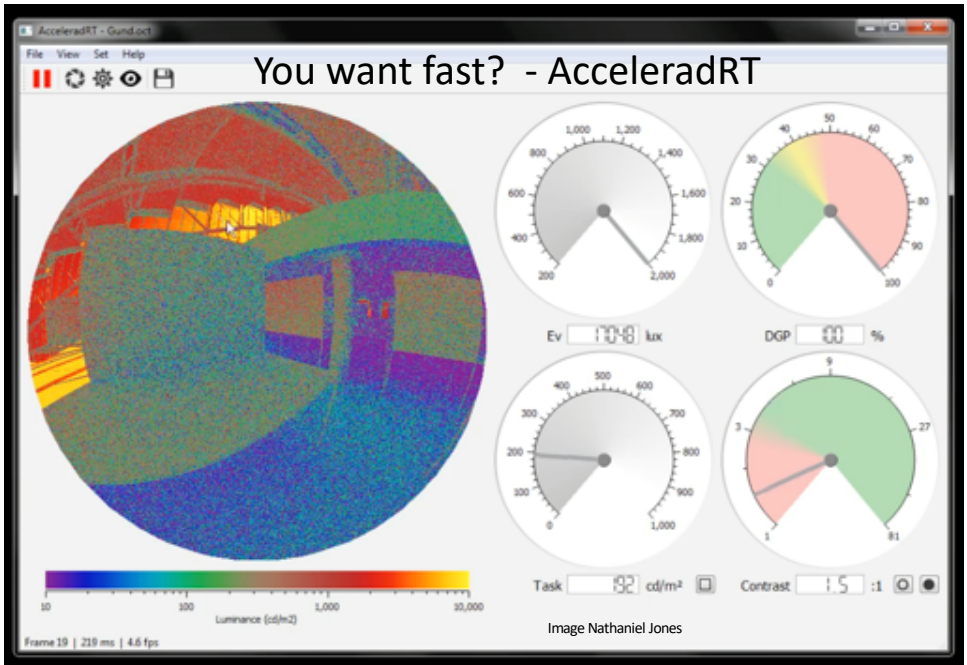
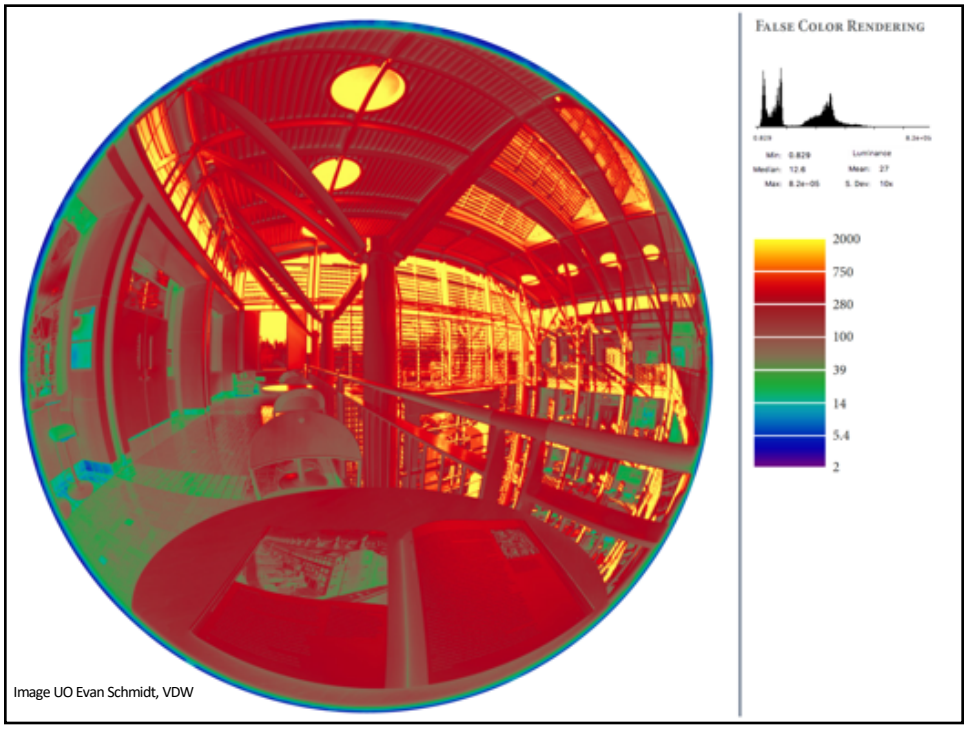
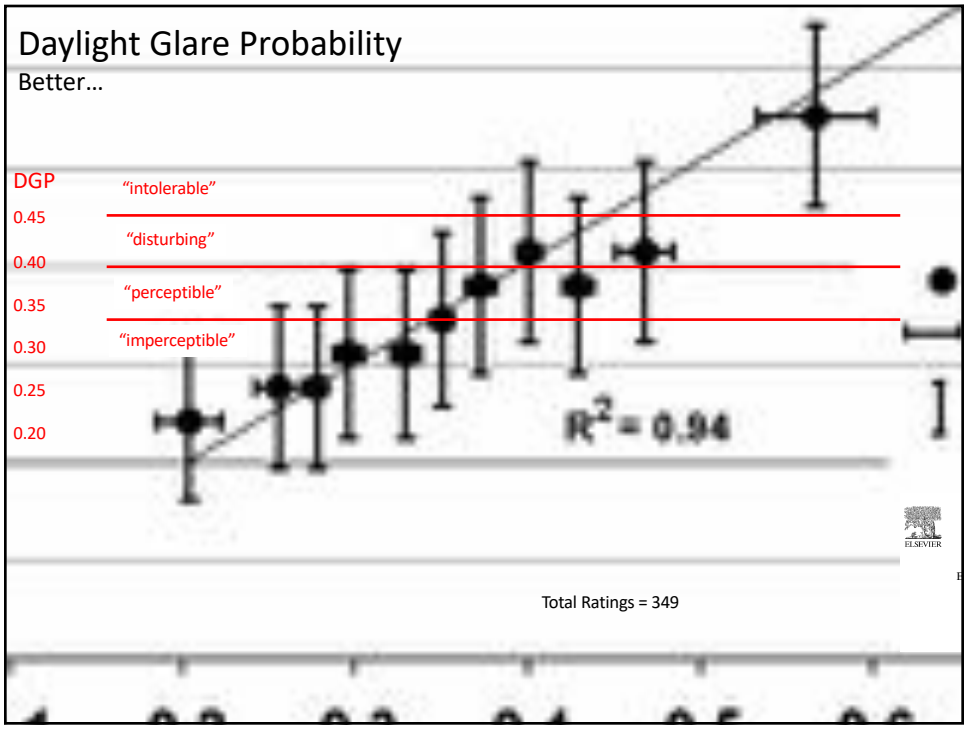


Image Nathaniel Jones

https://nljones.github.io/Accelerad/ https://nljones.github.io/Accelerad/rt.html

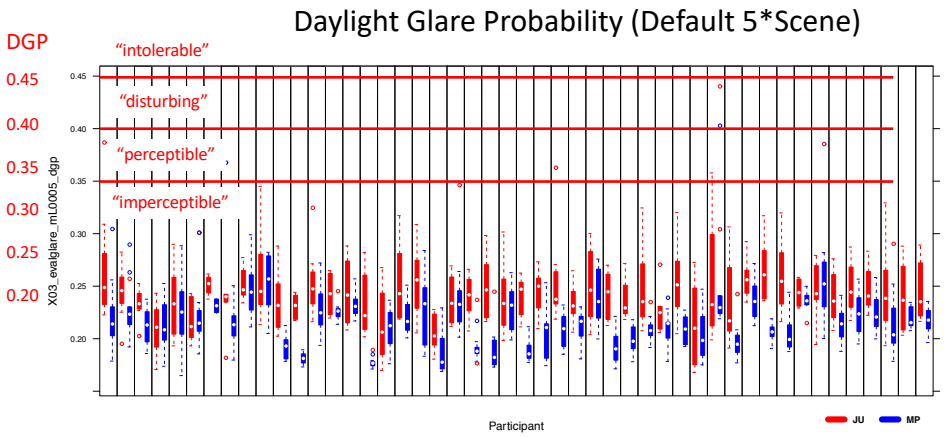

False Color Rendering
2000
750
280
100
39
14
5.4
2
Image UO Evan Schmidt, VDW


Daylight Glare Probability
Better…
DGP
0.45
0.40
0.35
0.30
0.25
0.20
"intolerable"
"disturbing"
"perceptible"
"imperceptible"
$R^2 = 0.94$
Total Ratings = 349

Daylight Glare Probability

Validation?

Better…but not enough…



JU = "Just Uncomfortable"

MP = "Most Preferred"

Total Ratings = 93 participants * 16 conditions = 1488

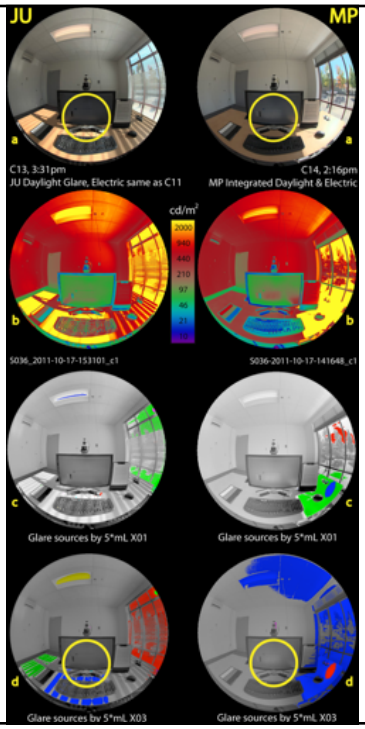
Daylight Glare Probability

Better…but not enough…

"Just Uncomfortable"

DGP Scene
32%

DGP Task
32%



"Most Preferred"

DGP Scene
45%

DGP Task
44%

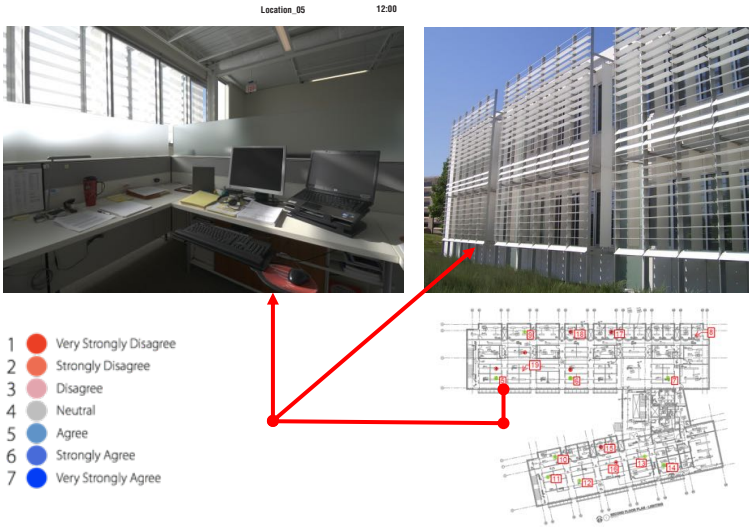


Image VDW

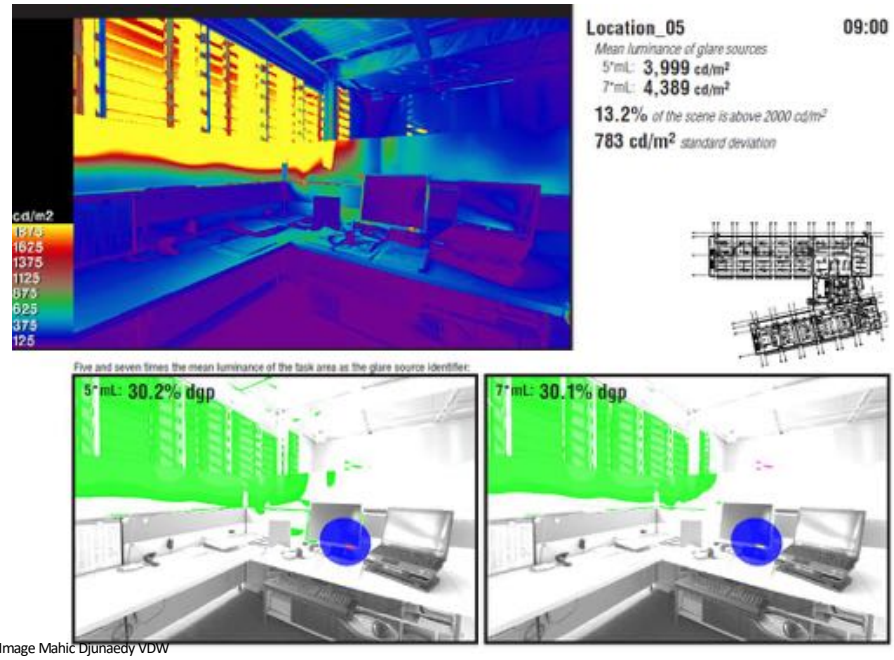


Image Mahic Djunaedy VDW

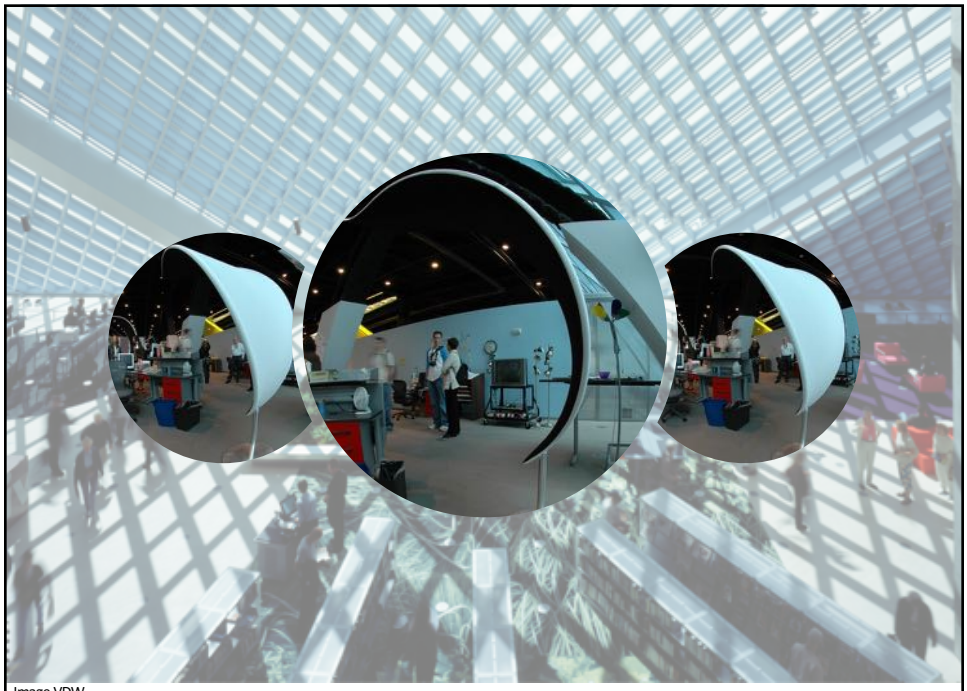


Image VDW

TaskShade™

Improving Integrated Daylighting Design

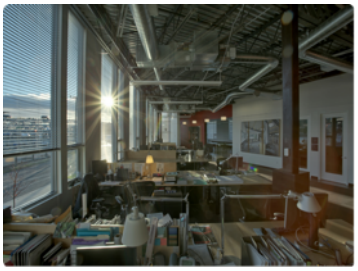


Image Meek

Image VCW

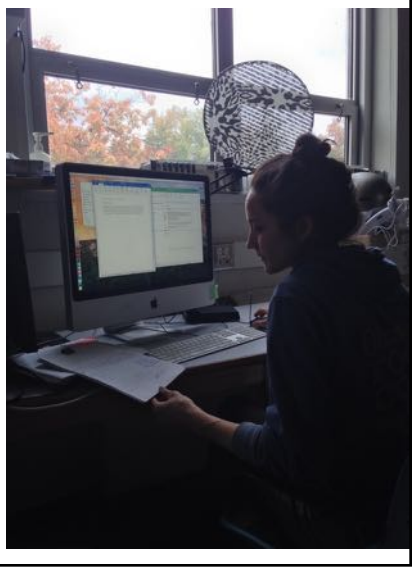


Image VCW

> 80% of participants wanted sunlight if available…

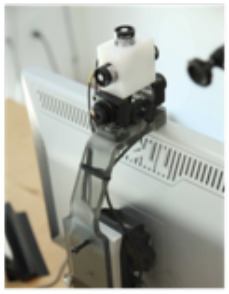
Van Den Wymelenberg, PhD Dissertation, 2012

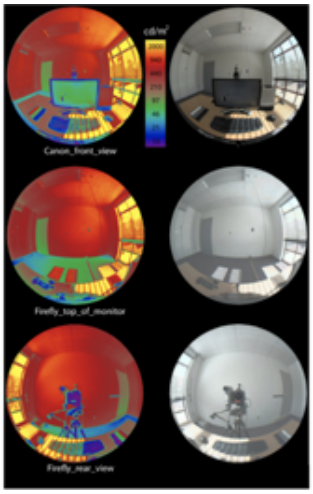
Courtesy: UW - Meek

Feasibility of HDR-derived Control?

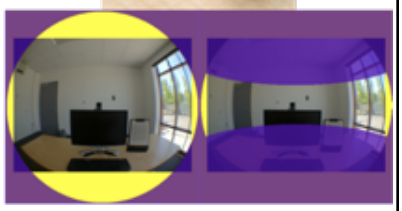
Privacy…
Pixel based control

location





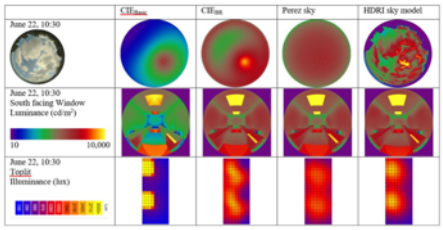
low-cost sensor

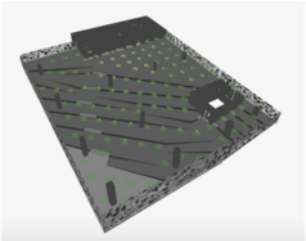


Van Den Wymelenberg, PhD Dissertation, 2012

Simulation in the Control Loop

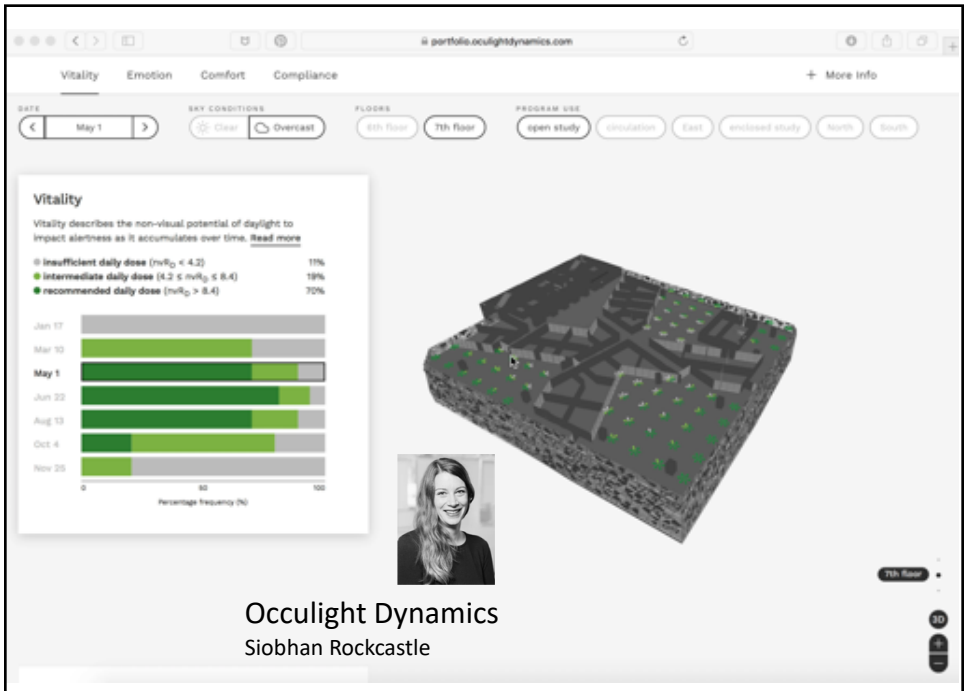
Using High Dynamic Range Imaging as the Light Source to Daylight Simulations *Real world HDRs to generate spatial renderings in near real time anywhere you want a sensor*





Inanici and Liu, Robust Sky Modelling Practices in Daylight Simulation, PLEA 2016, LA, CA July 11-13, 2016

Oculight Dynamics
Siobhan Rockcastle



Occulight Dynamics
Siobhan Rockcastle

Who?

I propose…

Illuminating ENGINEERING SOCIETY

NEMA National Electrical Manufacturers Association

AERC Attachments Energy Rating Council

ICC INTERNATIONAL CODE COUNCIL

ASHRAE

NIH National Institutes of Health

AMA

CDC U.S. Department of Health and Human Services Centers for Disease Control and Prevention

Thank you! // Kevin Van Den Wymelenberg // kevinvdw@uoregon.edu

Sunsetting:

- Current paradigm of DSM, prescriptive in favor of performance
- Energy efficiency in favor of carbon
- Single Point in time daylight simulation in favor of CBDM
- Lighting design primarily about supporting basic human function

On the Horizon:

- Automated facades will flex through alternate optimizations
- Expansion of non-energy benefits / NEBs 4 ZEBs
- Daylight as spatial equity movement – rights to light
- Expanded understanding of daylight and health
  - Synthesis of Vitamin D – indoor unconditioned sun spaces
  - Daylight as indoor air quality indicator
    - Bacterial, fungal, viral ecologies indoors
    - Photolysis and chemical exposures
  - Mind wandering and micro-restorative moments - view
  - Circadian dosage - designed circadian spaces
- Formalization of architectural daylight as a health indicator
- Bridges between health care spend and construction/energy spend

Next research needs to get there:

- Manual blind use behaviour…and in incorporation simulation
- Visual discomfort knowledge…and in incorporation simulation
- Circadian dosage knowledge…and in incorporation simulation
- Visual delight knowledge … and in incorporation simulation

Thank you! // Kevin Van Den Wymelenberg // kevinvdw@uoregon.edu