Rethinking Lighting Application Efficiency

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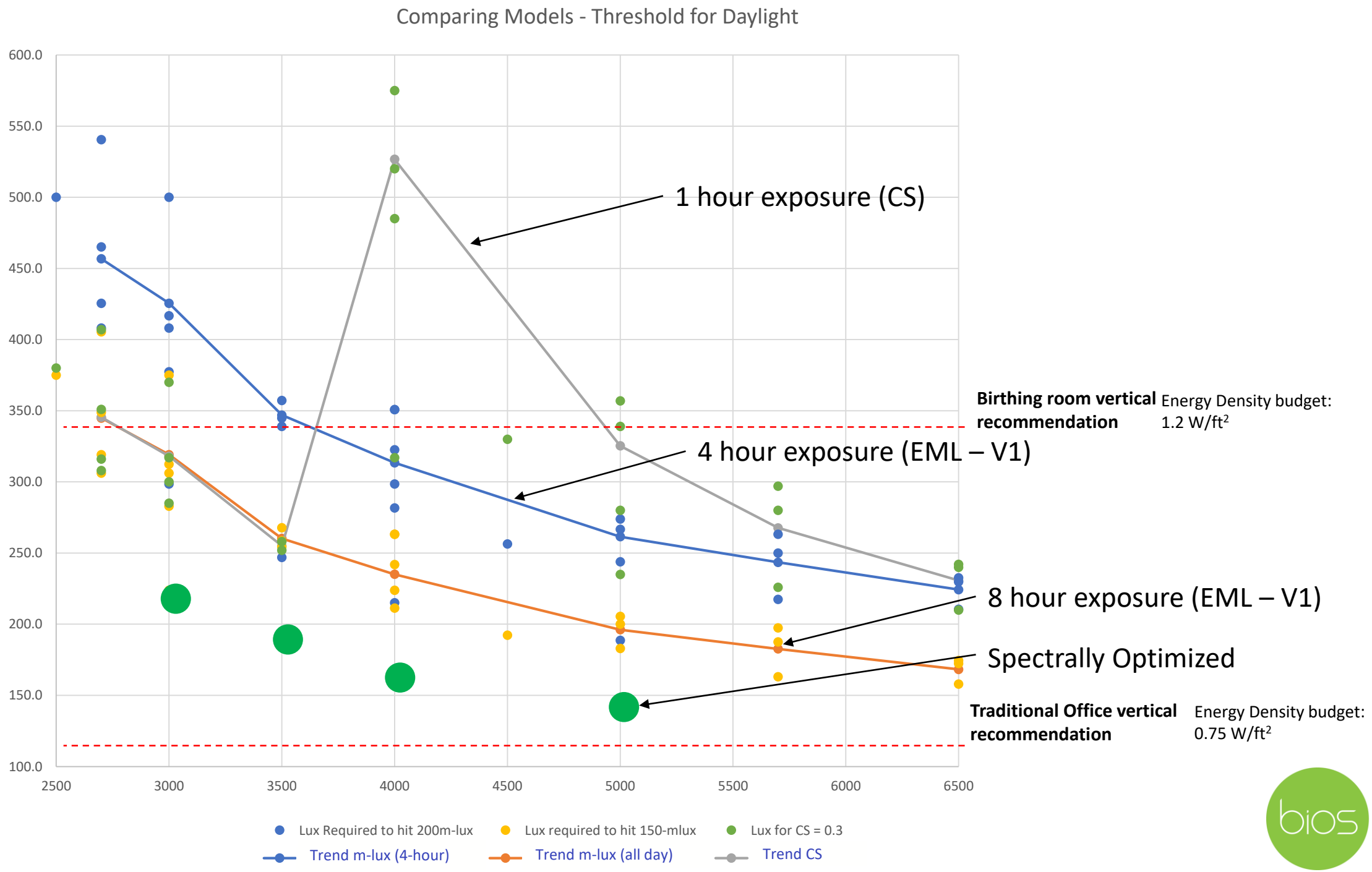
BIOS Lighting

About BIOS

- Focused on Circadian Lighting and Horticultural Lighting
- We make fixtures in the Horticultural space
- We make light engines in the Circadian Lighting space
  - Partner with architectural lighting companies to incorporate our technology in their fixtures
  - Designed to provide the benefits without off-putting colors or complicated controls
  - https://www.bioshumanlight.com/


The Threshold for Daylight


Comparing Models - Threshold for Daylight
600.0
550.0
500.0
450.0
400.0
350.0
300.0
250.0
200.0
150.0
100.0
2500
3000
3500
4000
4500
5000
5500
6000
6500
1 hour exposure (CS)
4 hour exposure (EML – V1)
8 hour exposure (EML – V1)
Spectrally Optimized
Birthing room vertical recommendation
Energy Density budget: 1.2 W/ft²
Traditional Office vertical recommendation
Energy Density budget: 0.75 W/ft²
Lux Required to hit 200m-lux
Lux required to hit 150-mlux
Lux for CS = 0.3
Trend m-lux (4-hour)
Trend m-lux (all day)
Trend CS


WELL versus CS Warm
1.00E+00
9.00E-01
8.00E-01
7.00E-01
6.00E-01
5.00E-01
4.00E-01
3.00E-01
2.00E-01
1.00E-01
0.00E+00
0.016
0.014
0.012
0.01
0.008
0.006
0.004
0.002
0
3.80E+02
4.30E+02
4.80E+02
5.30E+02
5.80E+02
6.30E+02
6.80E+02
7.30E+02
WELL
LRC Warm
Standard 3500K LED (1 lm)
Spectrally Optimized 3500K (1 lm)

What's your favorite CCT? Designing the space YOU work in

CCT	My Favorite	I would NEVER
6500K	X%	X%
5000K	X%	X%
4000K	X%	X%
3500K	X%	X%
3000K	X%	X%
2700K	X%	X%

Sample size: xx

I will compare your answers with answers I've received in Philly, Europe, and Japan

Data from IES Illuminate - Philadelphia

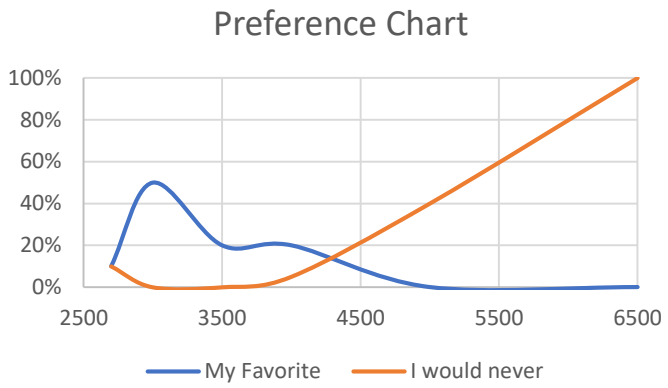
CCT	My Favorite	I would NEVER
6500K	0%	100%
5000K	0%	80%
4000K	20%	5%
3500K	70%	0%
3000K	10%	0%
2700K	5%	10%

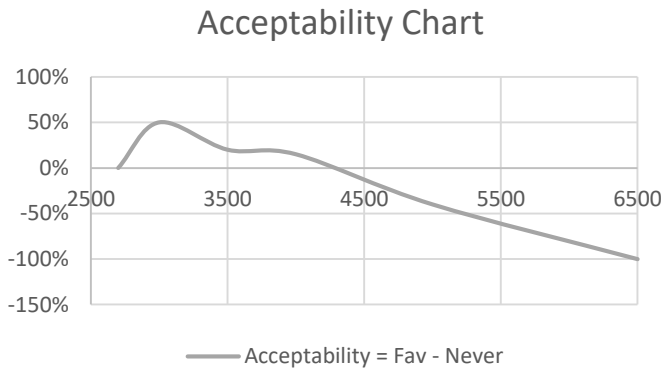
Sample size: 90

Data from IALD Europe in Barcelona

CCT	My Favorite	I would NEVER
6500K	0%	100%
5000K	0%	40%
4000K	20%	5%
3500K	20%	0%
3000K	50%	0%
2700K	10%	10%

Sample size: 50

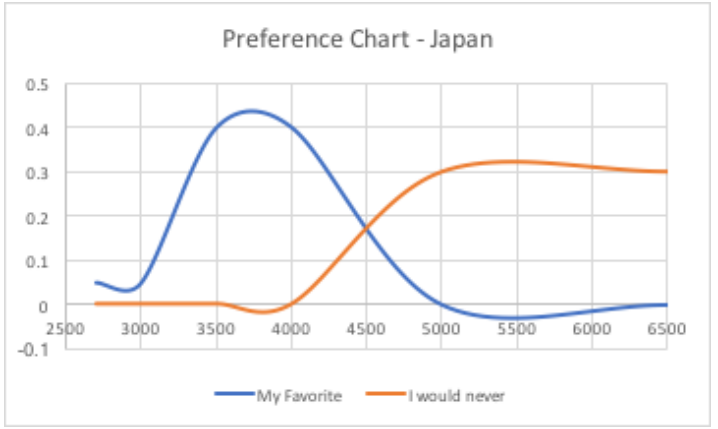


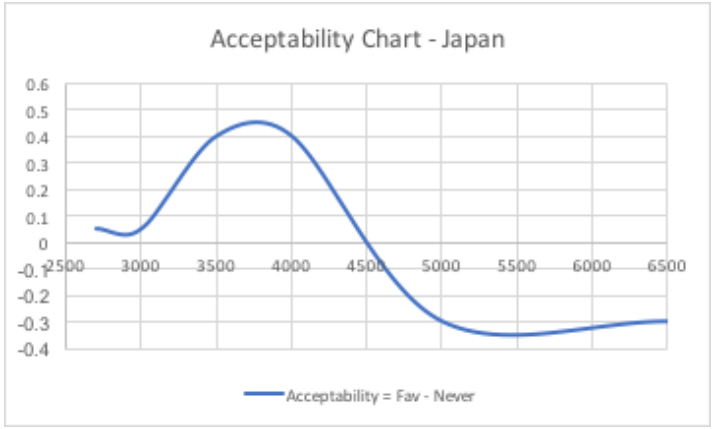


SHOCKING Data from International Workshop at UC Berkley with 90% Japanese participants

CCT	My Favorite	I would NEVER
6500K	0%	30%
5000K	0%	30%
4000K	40%	0%
3500K	40%	0%
3000K	5%	0%
2700K	5%	0%

Sample size: 20

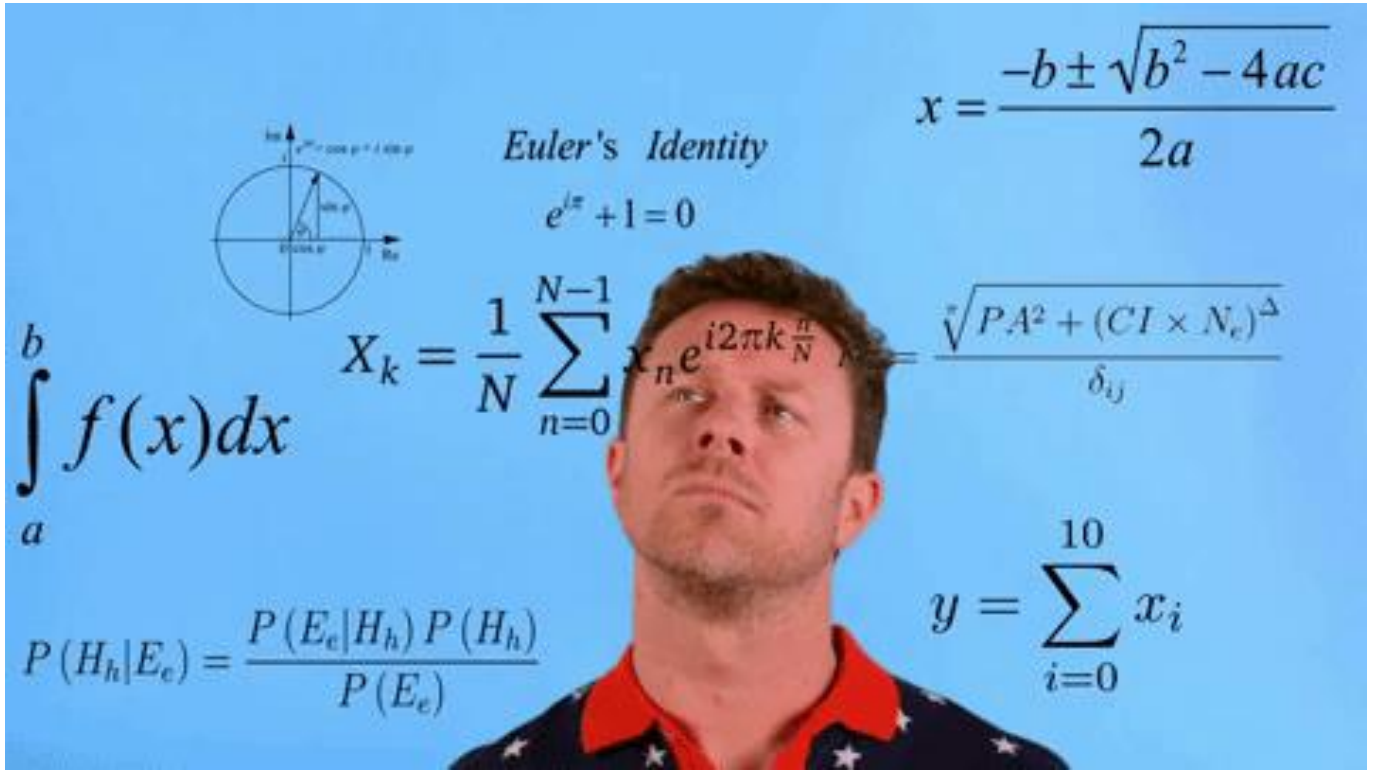




It just might be that EVERYONE hates cool/cold white light…

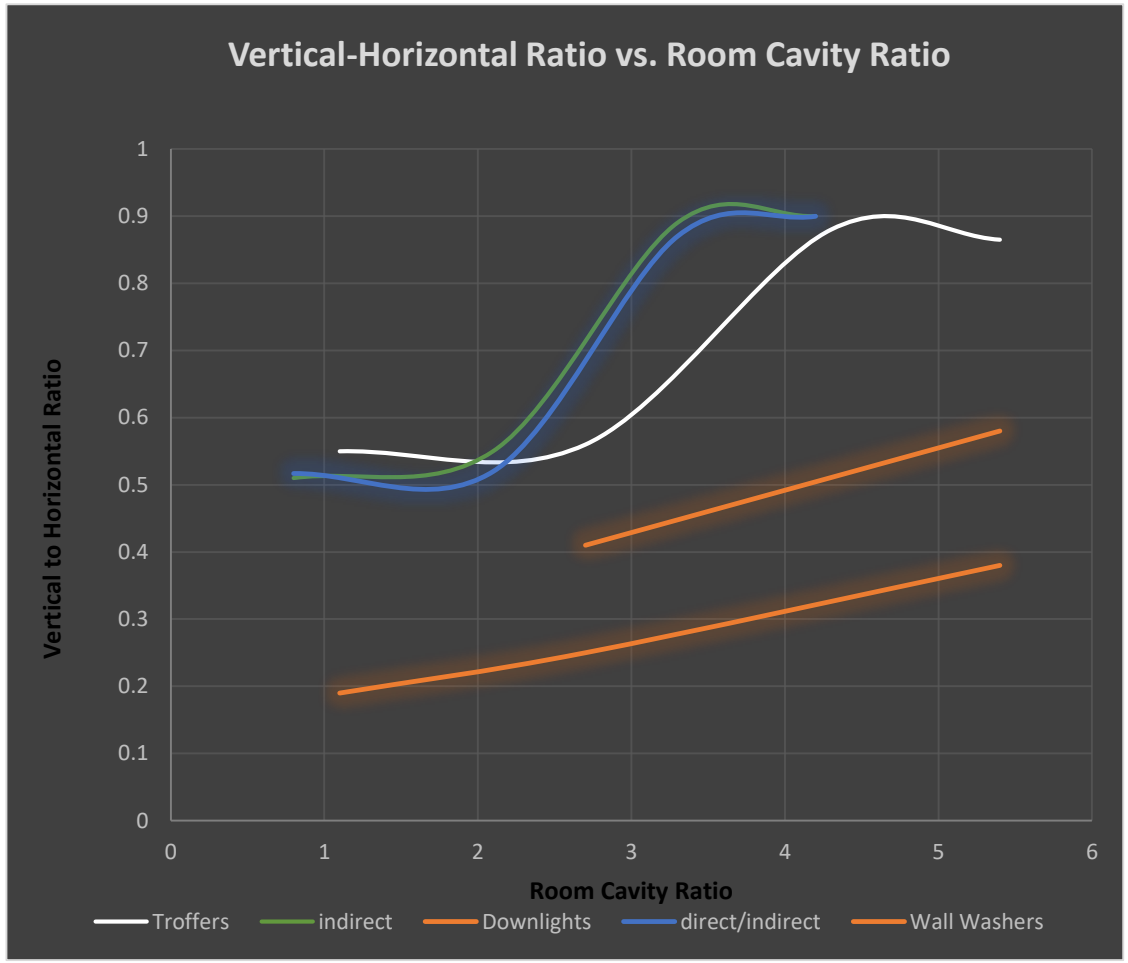
Vertical Calculations?

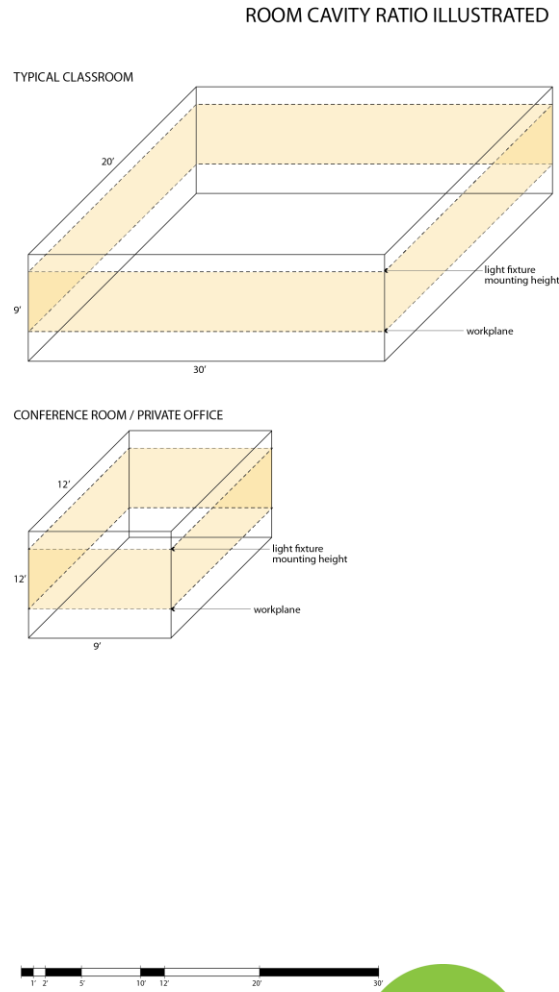
- Most people don’t know how to do vertical calculations
- It requires a whole new process in AGI32



Vertical to Horizontal Ratios by RCR

- RCR is essentially the wall to floor ratio
  - RCR is small for open plan office
  - RCR is large for private offices
- Fixture type can increase vertical illuminance
  - But only for certain room cavity ratios
- For open office, you need to make 2 horizontal lumens for each vertical lumen





Data gathered at BIOS via simple AGI32 simulations

So….I’m here at the DOE, talking about spending MORE energy?

I don’t think we’re done. We’re just beginning

We need to understand the parameters

Timing	Spatial	Intensity	Spectral

Light what you want to see

The best way to save energy is to focus light at what you want people to see

The Open Plan Office

- What does the occupant want to see?
- New Metrics
  - Mean Room Surface Exitance (MRSE)
  - Task/Ambient Illumination Ratio (TAIR)

Task/Ambient Illumination Ratio (TAIR)

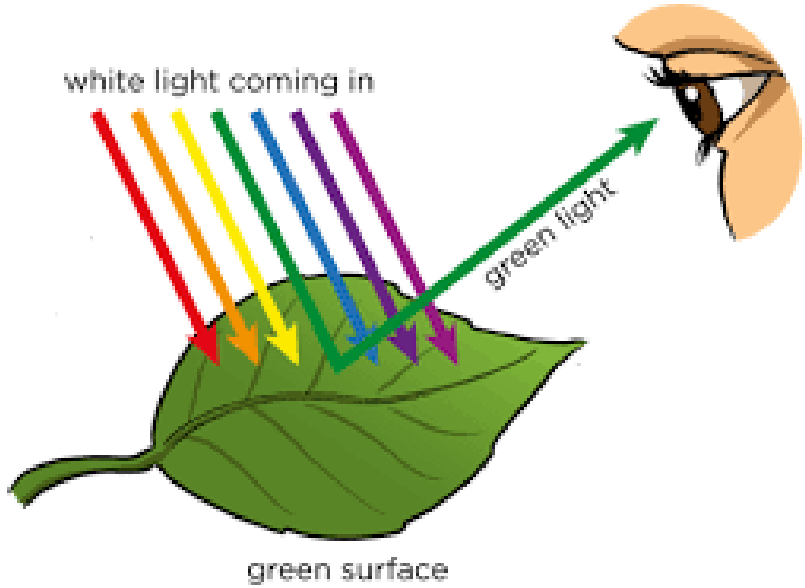
- Noticeable difference
  - 1.5:1
- Distinct difference
  - 3:1
- Strong difference
  - 10:1
- Emphatic difference
  - 40:1

The Open Plan Office

- Emphasize the regions you want to see
- De-emphasize the regions you don’t want to see

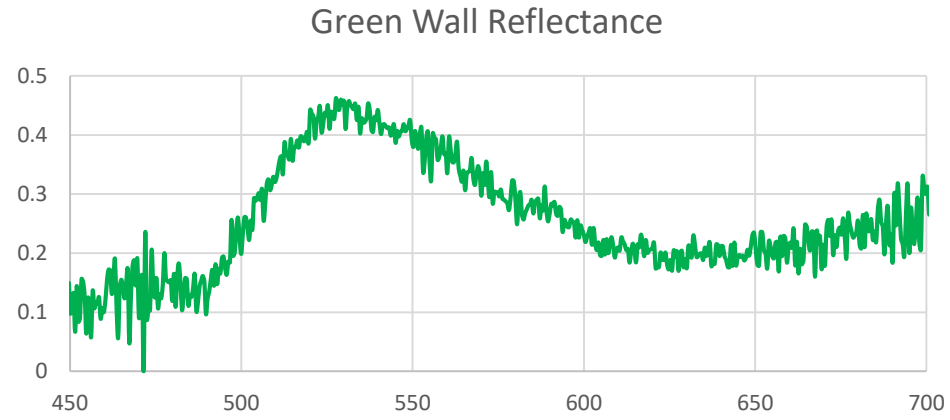
Mean Room Surface Exitance (MRSE)

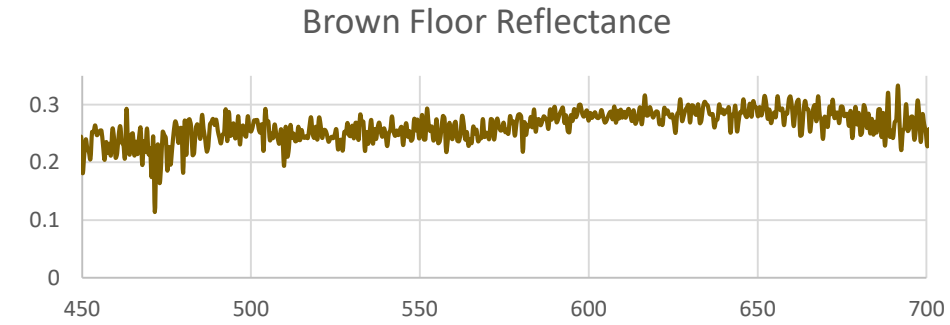
- Perceived brightness of the space is defined by the reflected light coming **off** walls.
  - This **isn't** lux falling onto the surface
- Optimization requires
  - Directing light at these surfaces
  - Spectral Optimization?
- Bright light is 150 lm/m2 (Kitt Cuttle, IESNA Fires report)



BIOS Lobby

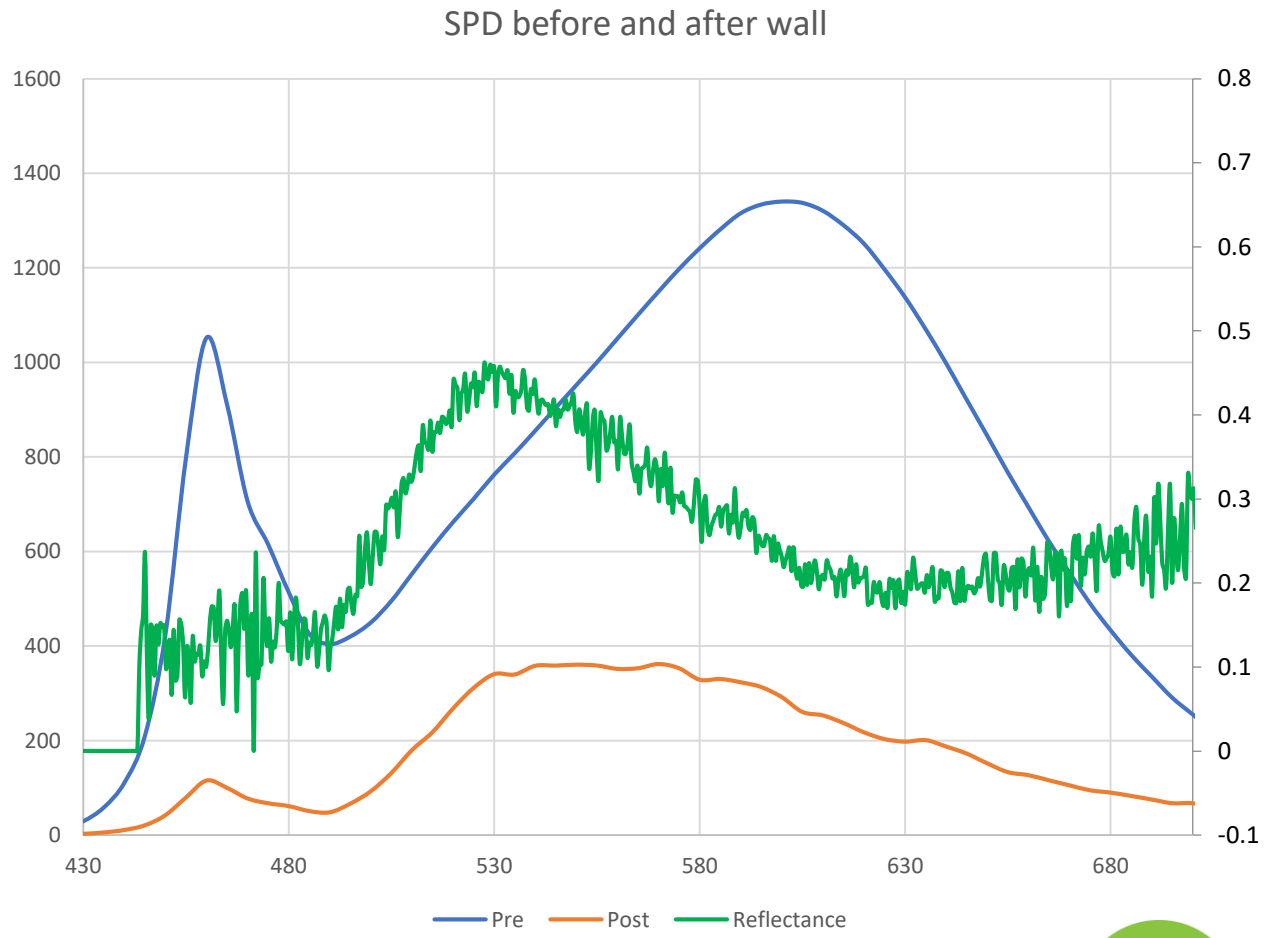
- BIOS Office has green walls, white walls and brown floor





Spectral Reflectance

- Take that LED Light Source
  - Say you get 125 lm/W out of the fixture
  - Say you magically get it all onto the wall
    - You only get 29% of the lumens reflected back
      - 36.25 lm/W
      - In order to achieve 150 lm/m2 MRSE, you'll need 500 lux to hit that wall.
  - You just created a bunch of light, only to get absorbed



Closing thoughts

Classic lighting was well suited for lighting the horizontal task

- The task is now becoming self illuminated and/or vertical

Vertical illuminances are more important for circadian effects of light

Perceived brightness can come from illumination of what you want to see

- Perhaps these two converge

Lighting the floors first means you'll lose 80% at the first bounce

- Perhaps the "spill over" is enough for things like the floor

Is a paradigm shift required to truly gather energy savings?