LEDucation

Designers Light Forum

Using LED lighting for Video in conference and other spaces with cameras

C. Brooke Silber
Jim Yorgey

Tuesday March 13th, 2018

CONTINUING EDUCATION AIA

leducation.org

Credit(s) earned on completion of this course will be reported to AIA CES for AIA members. Certificates of Completion for both AIA members and non-AIA members are available upon request.

This course is registered with AIA CES for continuing professional education. As such, it does not include content that may be deemed or construed to be an approval or endorsement by the AIA of any material of construction or any method or manner of handling, using, distributing, or dealing in any material or product.

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, participants will be able to:

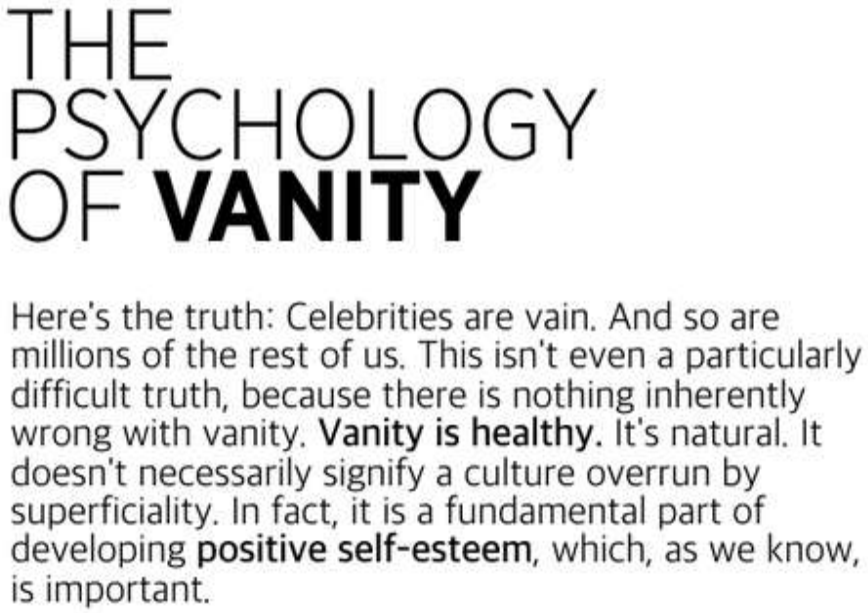
1. Be able to evaluate when and where to employ particular LED luminaires for videoconferencing needs.
2. Become familiar with the interaction of the camera capabilities and LED sources, driver and controls.
3. Develop an appreciation of the use of Luminance Criteria instead of Illuminance Criteria to qualify adequate lighting.
4. Become familiar with the new ANSI Standard IES/AVIXA (formerly Infocomm) RP-38 standard for videoconferencing lighting.

Introduction:
Criteria used to evaluate LED Solutions

- Room/Task Criteria
- Camera/Codec Function
- Displays
- Interaction of LEDs
- Controls
- ANSI/IES/AVIXA Standard (RP-38)

Room and Task Criteria

- Render People
  - 60% of communications are via “body language”
  - Desire naturalistic modeling
  - Professional looking environment, not “stagey”
- Provide visual comfort for participants



THE PSYCHOLOGY OF **VANITY**

Here's the truth: Celebrities are vain. And so are millions of the rest of us. This isn't even a particularly difficult truth, because there is nothing inherently wrong with vanity. **Vanity is healthy.** It's natural. It doesn't necessarily signify a culture overrun by superficiality. In fact, it is a fundamental part of developing **positive self-esteem**, which, as we know, is important.

By **Peggy Drexler Ph.d.,**
www.psychologytoday.com
31 MAY, 2016

Bad Facial Lighting

- Shadowing/Dark eyes
  - Poor eye contact and difficulty identifying who is speaking

Bad Facial Lighting

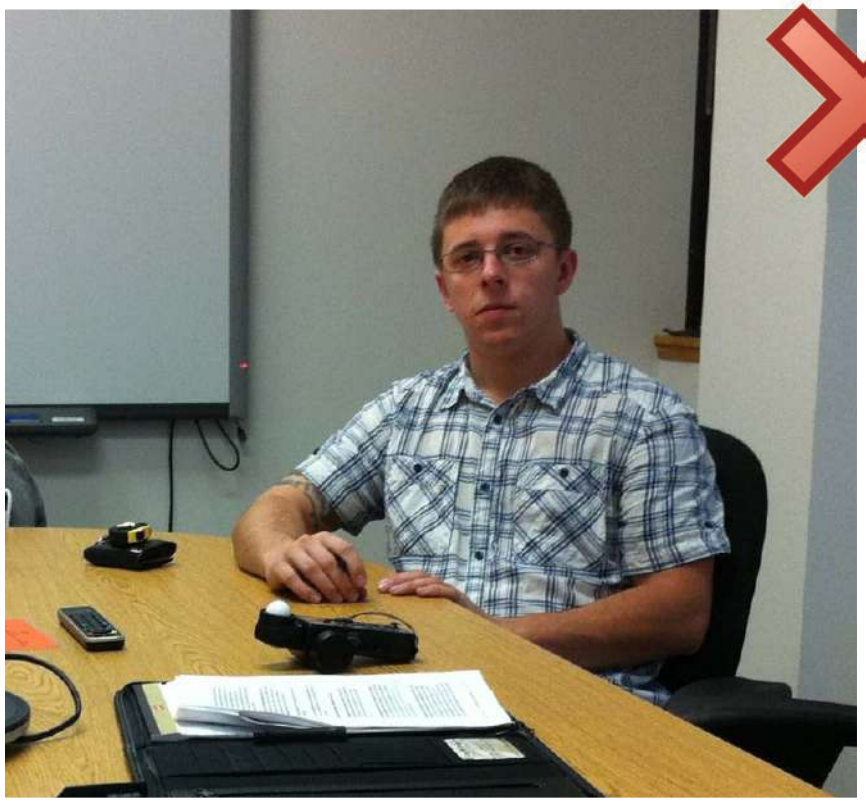
- Backlighting
  - Large windows in the back ground causing silhouetting

Bad Facial Lighting

- Top lighting only
  - Creates bright lighting on the top of the head and shoulders
- Lack of depth
  - Creates flat lighting as well

Bad Facial Lighting

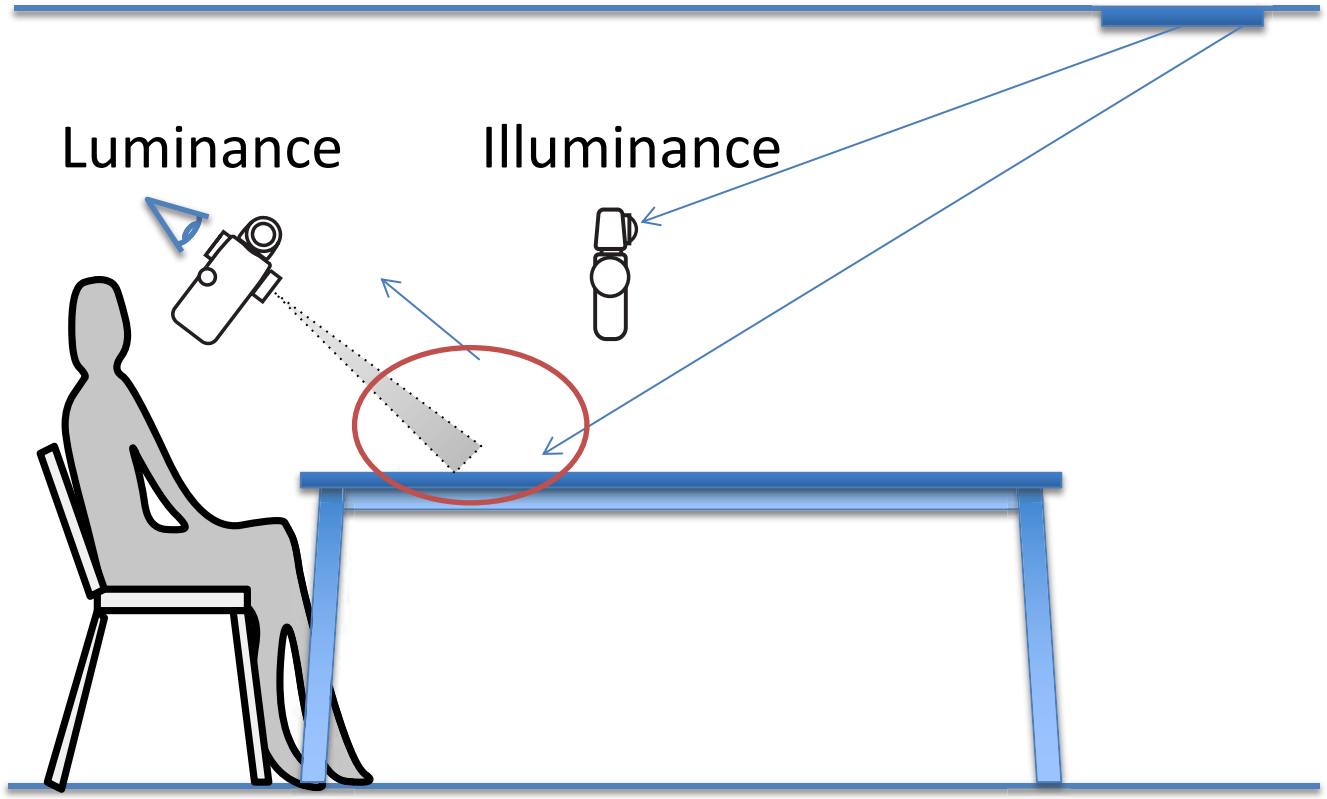
- Table lighting only
  - Lighting table only means faces are illuminated on one side



Good Facial Lighting

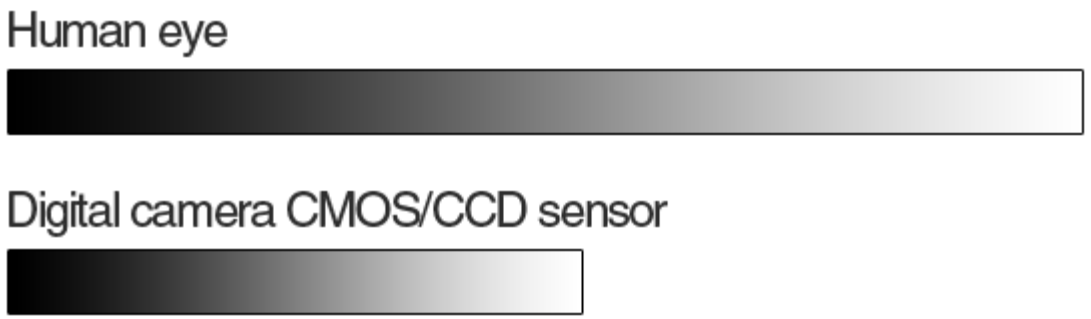
Room and Task Criteria

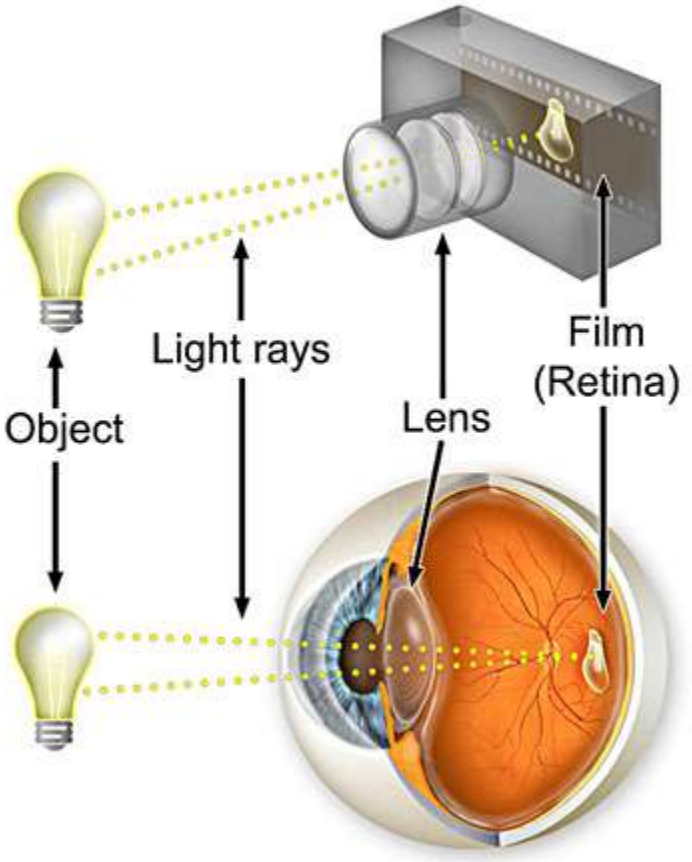
- Illuminance vs. Luminance
- Metrics/Measure
- Calculating Luminance

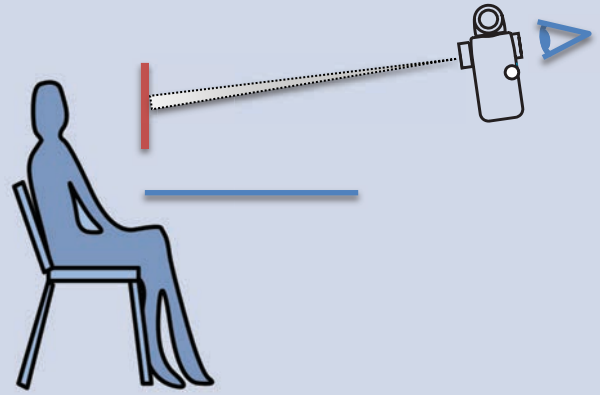
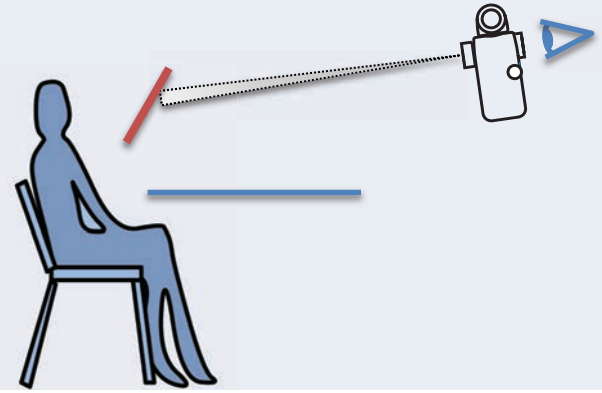
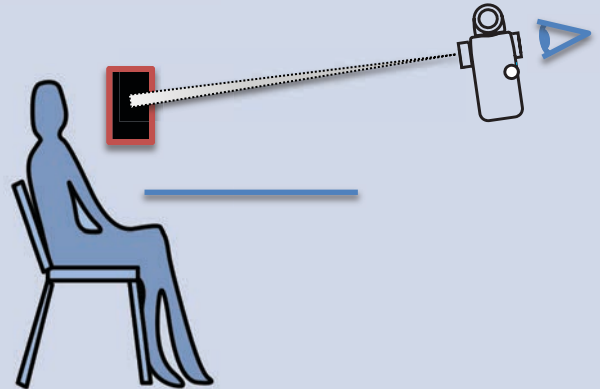


Eye versus Camera

- Both perceive luminance
  (not illuminance)
- However the dynamic range is far greater for the human eye

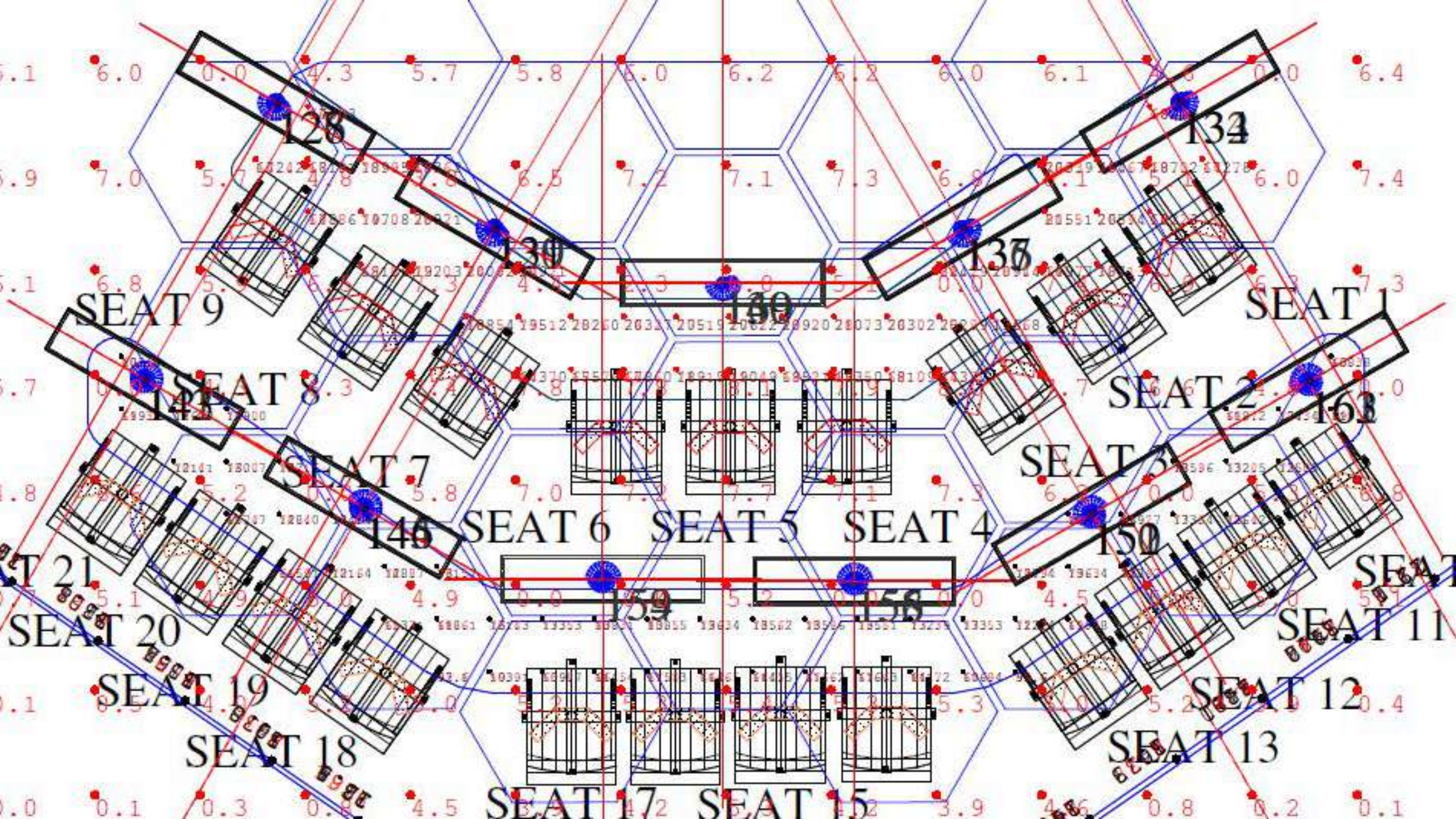




Participants | Measurements & Calculations		Performance Criteria
Luminance On 18% gray card - vertical		**11 to 21** cd/sq.m, at each seating position. Target: **15-20** cd/sq.m
Key:Fill Luminance Ratio On 18% gray card - vertically angled		**1.2:1 to 2.5:1**
Left:Right Luminance Ratio On 18% gray card - horizontally angled		**0.33:1 to 3:1**

Walls | Measurements & Calculations	Performance Criteria
Average Vertical Luminance of the Wall Surface • 1m x 1m grid, entire Rear Wall, rear half of Side Walls. • Exclude minimum measured value, then average remaining.	Minimum **30** cd/sq.m
Wall-to-Participant Luminance Ratio Average vertical wall luminance (as above), divided by the average of all participant gray card Key Light luminance measurements.	From **0.7:1 to 1.8:1** or From **2.2:1 to 6:1**
Uniformity, Mean:Minimum Luminance Ratio Average Rear and Side wall luminance (as above), divided by the second smallest wall luminance measurement value.	Maximum **2.1:1**

Table | Measurements & Calculations	Performance Criteria
Average of **horizontal luminance measurements** • At 12” from edge of the work surface at each required participant seating position.	Minimum **30** cd/sq.m
Table-to-Participant Luminance Ratio • Average horizontal table luminance (as above), divided by the average of all participant gray card Key Light luminance measurements	**0.7:1 to 1.8:1** or **2.2:1 to 6:1**


128
130
134
136
140
SEAT 9
SEAT 1
SEAT 8
SEAT 2
SEAT 7
SEAT 3
146
150
SEAT 6
SEAT 5
SEAT 4
159
158
SEAT 20
SEAT 11
SEAT 19
SEAT 12
SEAT 18
SEAT 13
SEAT 17
SEAT 15

LEDucation

Calculating Luminance

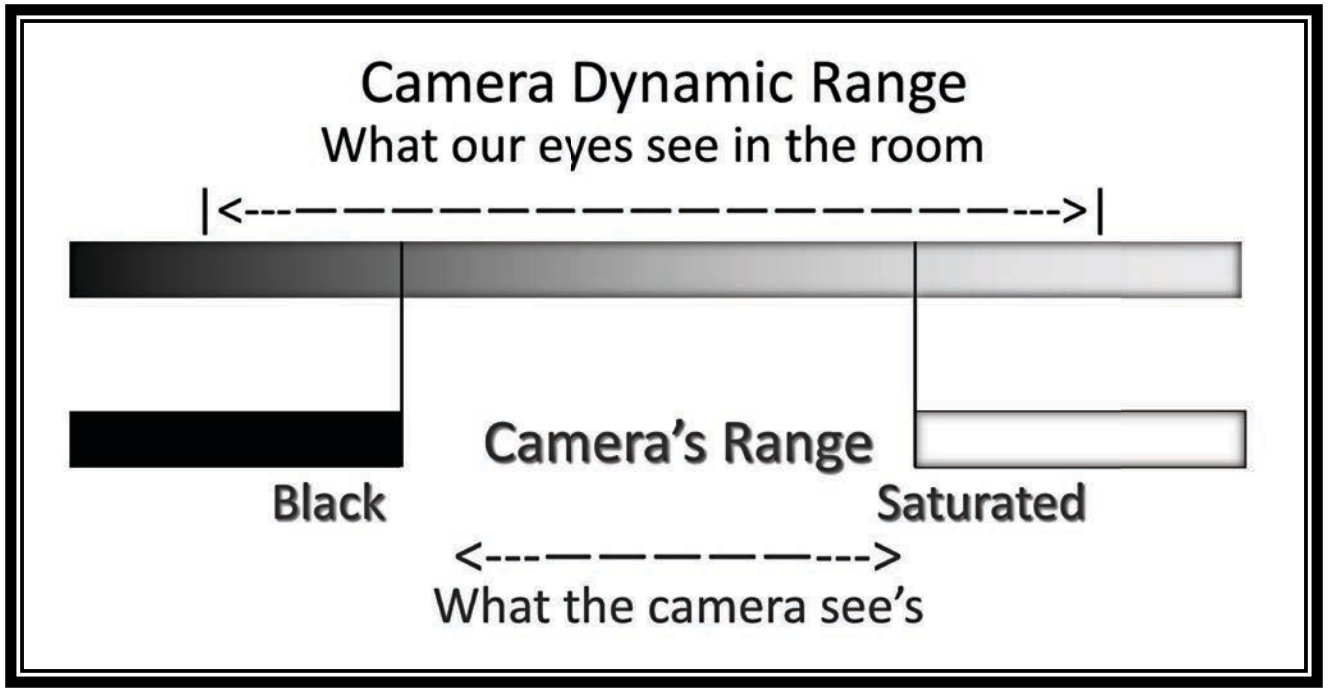
Label	Units	Avg.
Face 1 Top Center	Cd/Sq.m.	37.95
Face 1 Bottom Center	Cd/Sq.m.	19.01
Face 1 Top Left	Cd/Sq.m.	21.52
Face 1 Bottom Left	Cd/Sq.m.	14.55
Face 1 Top Right	Cd/Sq.m.	38.01
Face 1 Bottom Right	Cd/Sq.m.	13.83
Face 2 Top Center	Cd/Sq.m.	43.72
Face 2 Bottom Center	Cd/Sq.m.	21.18
Face 2 Top Left	Cd/Sq.m.	30.98
Face 2 Bottom Left	Cd/Sq.m.	17.84
Face 2 Top Right	Cd/Sq.m.	38.4
Face 2 Bottom Right	Cd/Sq.m.	17.88
Face 3 Top Center	Cd/Sq.m.	41.44
Face 3 Bottom Center	Cd/Sq.m.	25.68
Face 3 Top Left	Cd/Sq.m.	35.18
Face 3 Bottom Left	Cd/Sq.m.	18.79
Face 3 Bottom Right	Cd/Sq.m.	32.46
Face 3 Top Right	Cd/Sq.m.	15.14
Face 4 Top Center	Cd/Sq.m.	43.23
Face 4 Bottom Center	Cd/Sq.m.	18.68
Face 4 Top Left	Cd/Sq.m.	29.33
Face 4 Bottom Left	Cd/Sq.m.	16.73
Face 4 Bottom Right	Cd/Sq.m.	37.79
Face 4 Top Right	Cd/Sq.m.	14.73
Face 5 Top Center	Cd/Sq.m.	44.28
Face 5 Bottom Center	Cd/Sq.m.	17.4
Face 5 Top Left	Cd/Sq.m.	35.2
Face 5 Bottom Left	Cd/Sq.m.	15.39
Face 5 Bottom Right	Cd/Sq.m.	34.88
Face 5 Top Right	Cd/Sq.m.	13.88

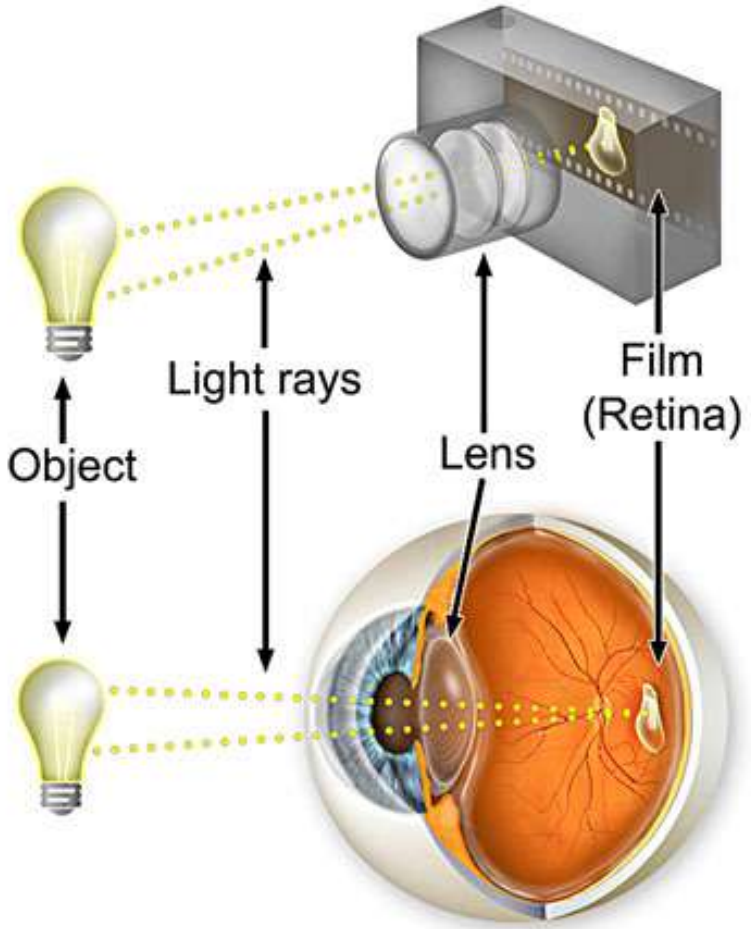
Camera and Codec Criteria

- Eye vs. Camera
- Video Image Considerations

Cameras

Eyes vs. Cameras





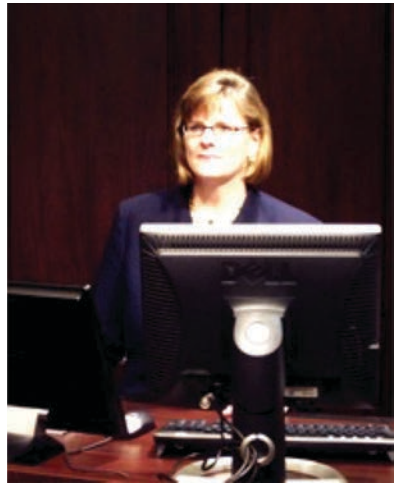
leducation.org

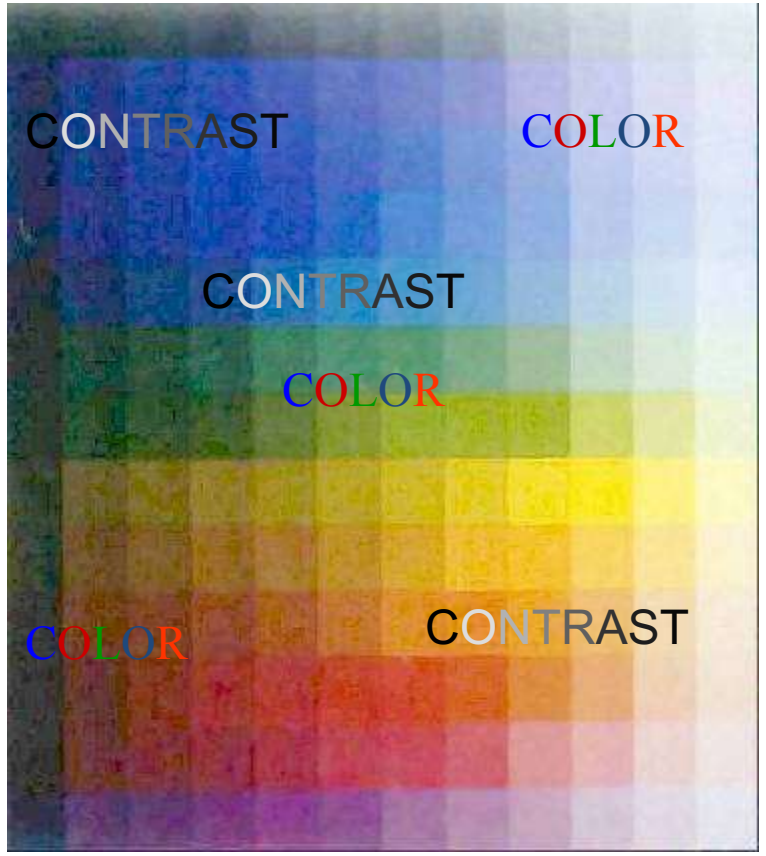
Cameras

- **Video Image Considerations**
  - Contrast
  - Sensitivity
  - Image Noise
  - Iris Operation
  - Burnout
  - White Balance
  - Focus / Depth Of Field

Cameras

- Video Image Considerations
- Contrast Affects
  - Image Details
  - Iris Operation
- Important Relationships
  - Subject and Background
  - Adjacent Areas of Background





Cameras

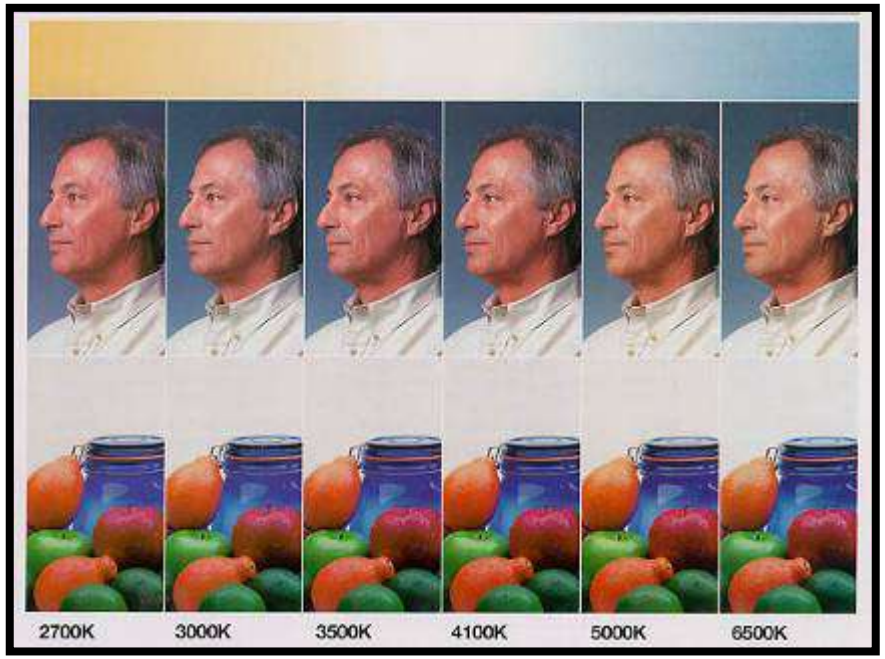
- **Video Image Considerations**
  - Sensitivity
    - Ability of CCD to “see” the image
    - Sufficient light is required
  - Image Noise
    - Results When Available Light Is Below The Baseline “Noise” Level
    - The End Visible Effect Is Image “Snow”
  - Luminance Based Metrics

Cameras

- **Video Image Considerations**
  - Iris Operation
    - Controls amount of light entering camera
    - Similar to human eye
  - Burnout
    - Overload of CCD

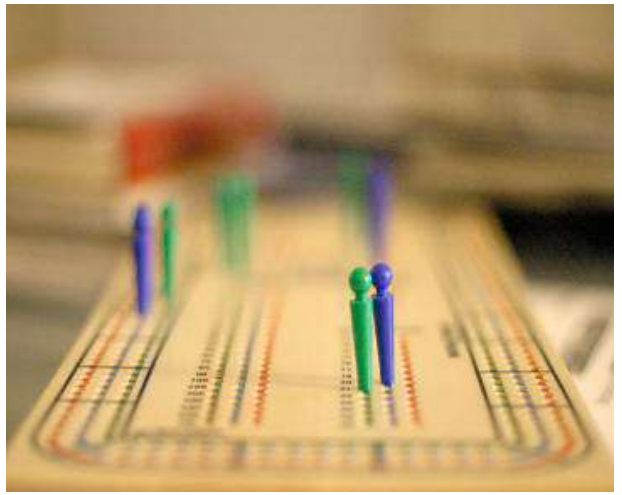
Cameras

- **Video Image Considerations**
  - White Balance
    - Adjustment Of Camera Sensitivity Curve
    - Corrects For Color Temp Of Lamp
    - Can be Adjusted For
      - 3000K To 3500K color temperature (CCT)



Cameras

- **Video Image Considerations**
  - Focus / Depth Of Field (DOF)
    - Small Aperture - Wide DOF
      - All Subjects In Focus
    - Large Aperture - Narrow DOF
      - Specific Subjects In Focus



Cameras

- Image Lighting Considerations
  - Light Source To Subject Angle
    - Symmetric – Safe
    - Variation – Adds Modeling
  - Camera To Subject Angle
    - Defines “Point Of View”
    - Defines “Field Of View”
  - Camera To Light Source(s) Angle
    - Direct Glare – “Flashing”
    - Reflected Glare – From Furniture & Other Surfaces
    - Image Depth & Modeling

Codecs

- The Codec *[Code - Decode]*
- Transfers Digitized video/audio between end points
  - Video Noise → Image Degradation
    - – Poor Contrast → Pixel Loss
      - » Movement & Detail → Frames Dropped

Displays

Front Projection

- Designed to reflect light
- Least tolerant of ambient light

Displays

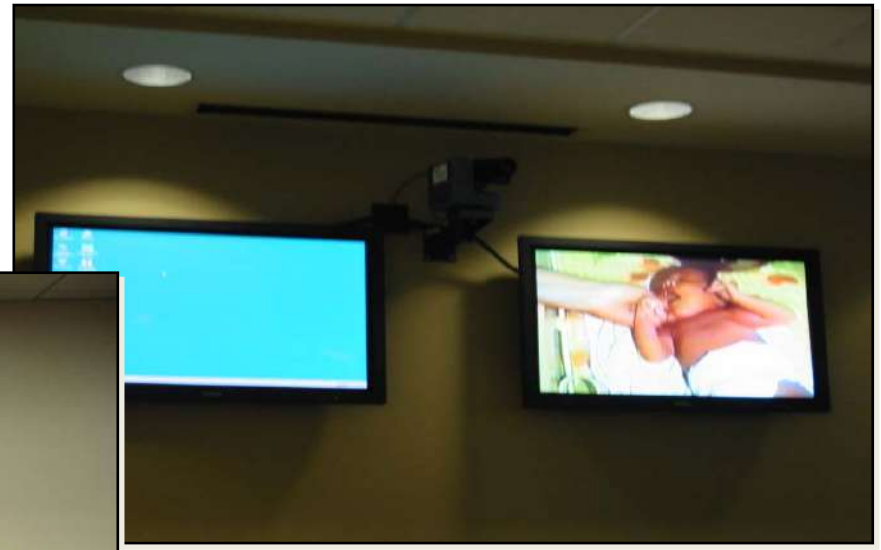
Rear Projection

- Image Projected from behind screen
- Screen Reflects less ambient light
- More tolerant than front projection

Displays

Direct View

- LCD, LED, OLED monitors
- Have the best tolerance to ambient light



Interactions of LEDs with Camera Technologies

- Sources
- Drivers
- Optics/Photometrics
- Whole Luminaire

Fluorescent versus LED Solutions

- Fluorescent fixtures have historically proven to provide even, controllable lighting in VTC spaces
- Designers may be hesitant to veer away from fluorescent solutions
- LEDs may offer equivalent lighting with additional advantages

However there are considerations and cautions when using LED solutions….

Fluorescent **versus LED Solutions**

- Fluorescent has typically been more forgivable with regards to system compatibility
- Larger source = greater visual comfort
- Softer distribution = less intensity
- Greater optical control and accessories developed/available

Fluorescent **versus LED Solutions**

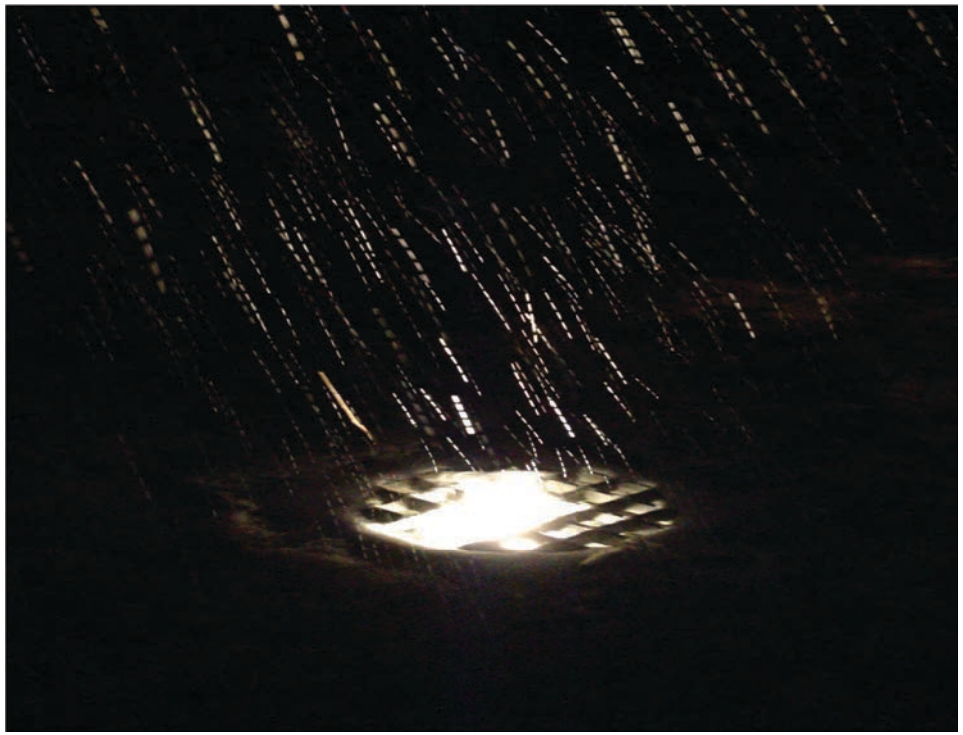
Fluorescent Source

Linear LED Source (cove)

Recessed LED troffer

Fluorescent versus LED Solutions

…..well in this example halogen vs LED



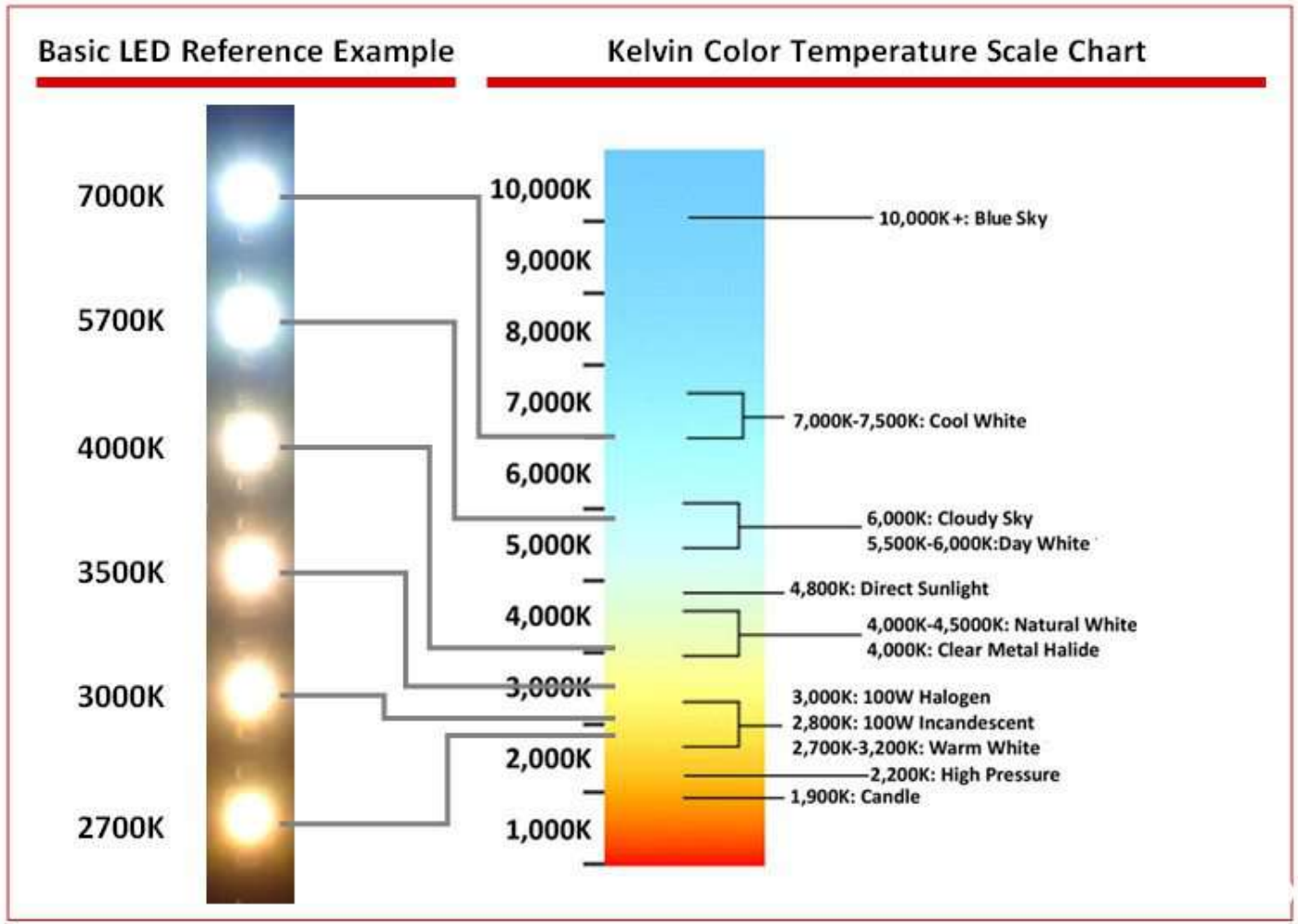
Fluorescent **versus LED Solutions**

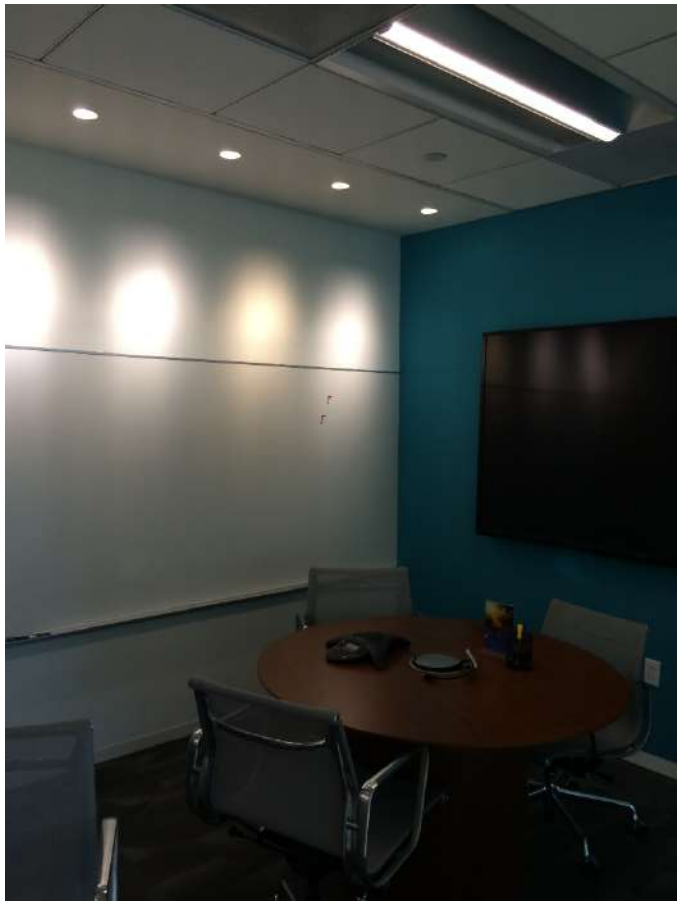
- LED fixtures (and controls) are becoming less expensive and more widely available
- They offer a viable alternative design solution
- Unlike fluorescent, the LED light source may be integral to the fixture, ensuring compatibility between LED module and driver
- Choose manufacturers who provides fixture and controls together to ensure compatibility

Fluorescent **versus LED Solutions**

- Component based LED solutions allow for flexibility but…. You better have confidence in your contractor
- Detail everything – this contractor really didn't understand – including how to clean
- Integrated LED system with channel and lens

Color – Correlated Color Temperature



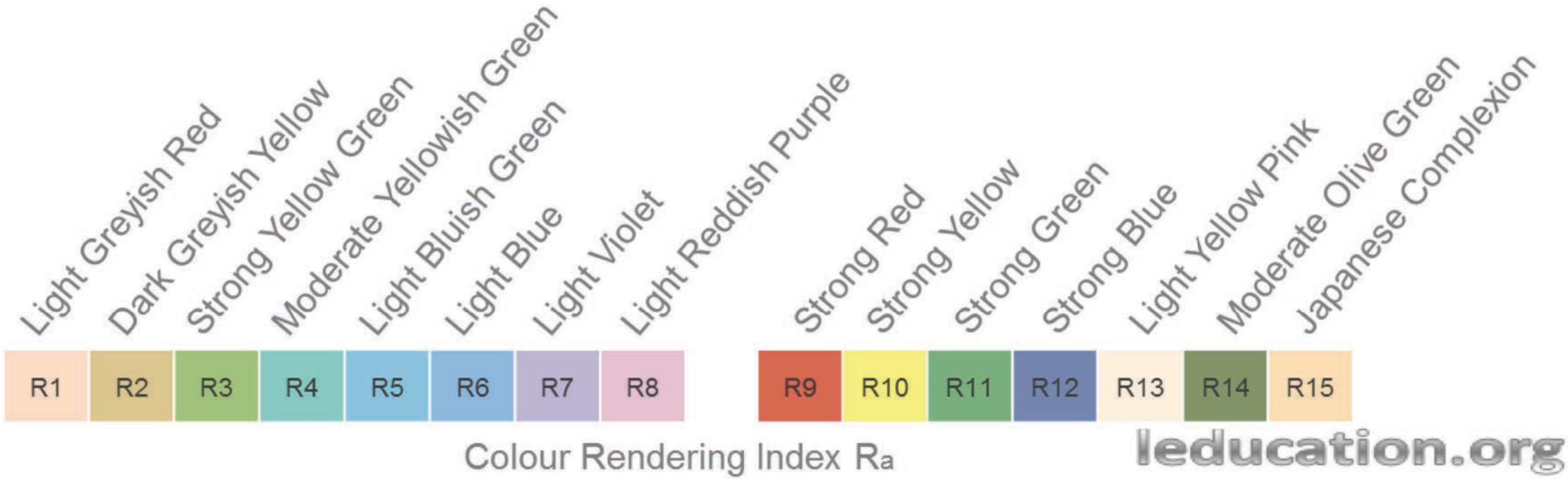


LEDucation

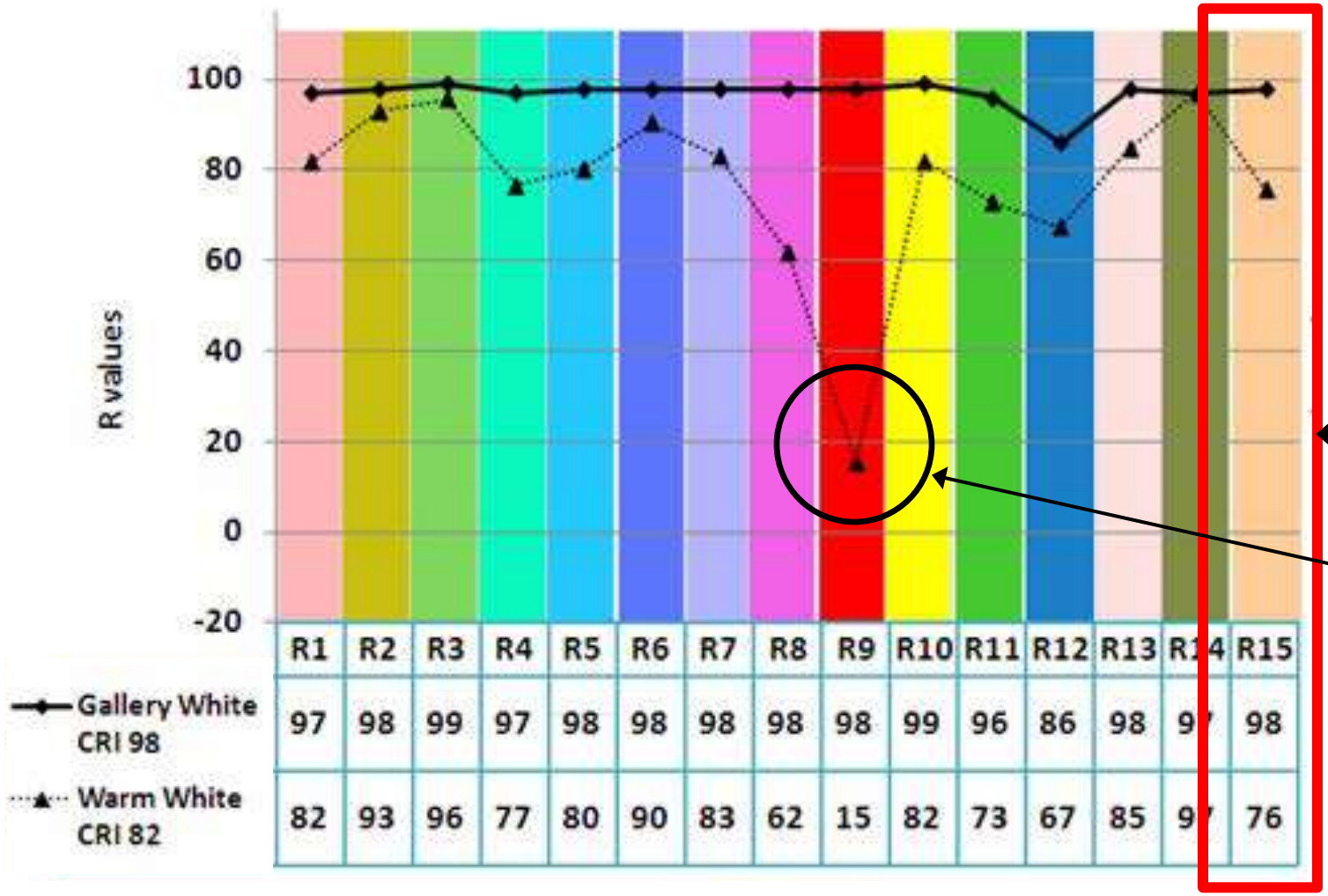
Color Consistency (or Inconsistency)

COLOR – Color Rendering Index

- The reference colors used to evaluate CRI are the R1-R8 colors. Mostly pastels.
- When LEDs started to become mainstream it was noted that the traditional CRI measure did not always reveal consistent results.
- R9-R15 were added to the test; critical colors are R9 (red) and R15 (skin tones).



COLOR – Color Rendering Index



	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12	R13	R14	R15
Gallery White CRI 98	97	98	99	97	98	98	98	98	98	99	96	86	98	97	98
Warm White CRI 82	82	93	96	77	80	90	83	62	15	82	73	67	85	97	76

However for environments with cameras we are often most interested in the person – which translates to skin tones.

Only one skin tone identified - R15

Often we focus on the deficiency in the R9 when evaluating CRI

COLOR – Facial modeling

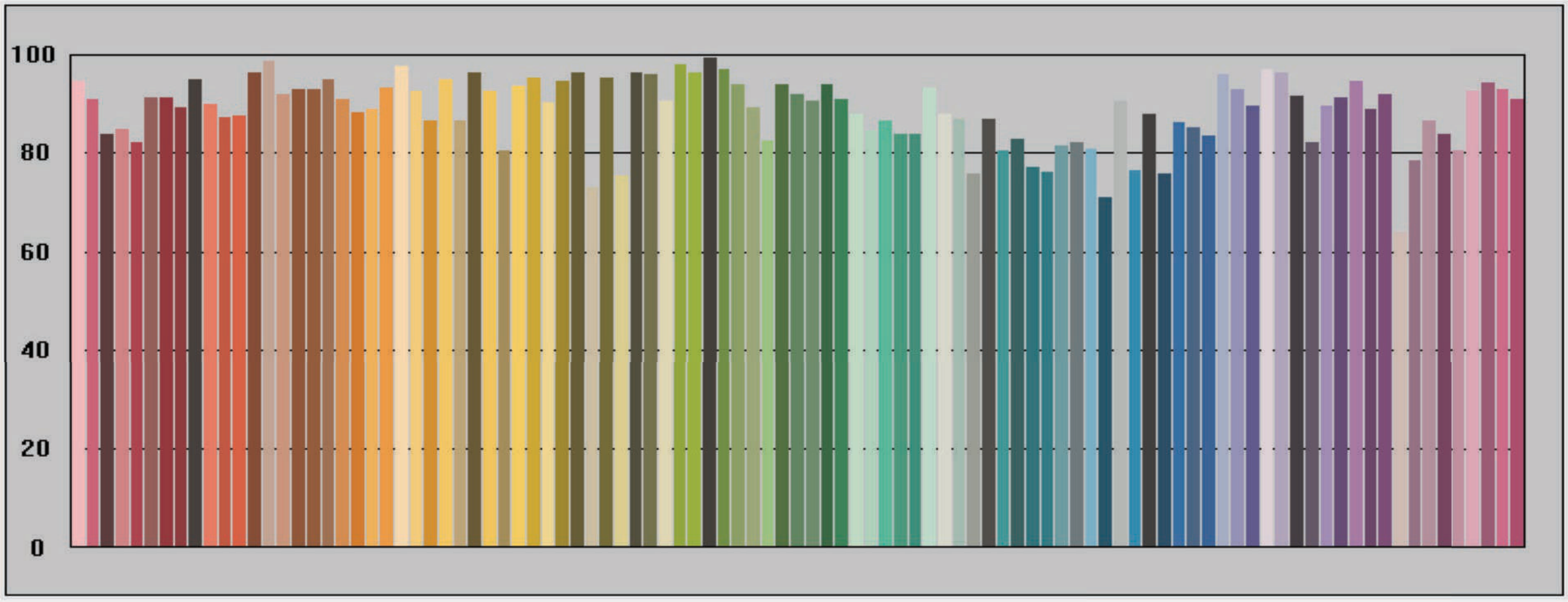
LEDucation

COLOR: TM-30 Color Fidelity

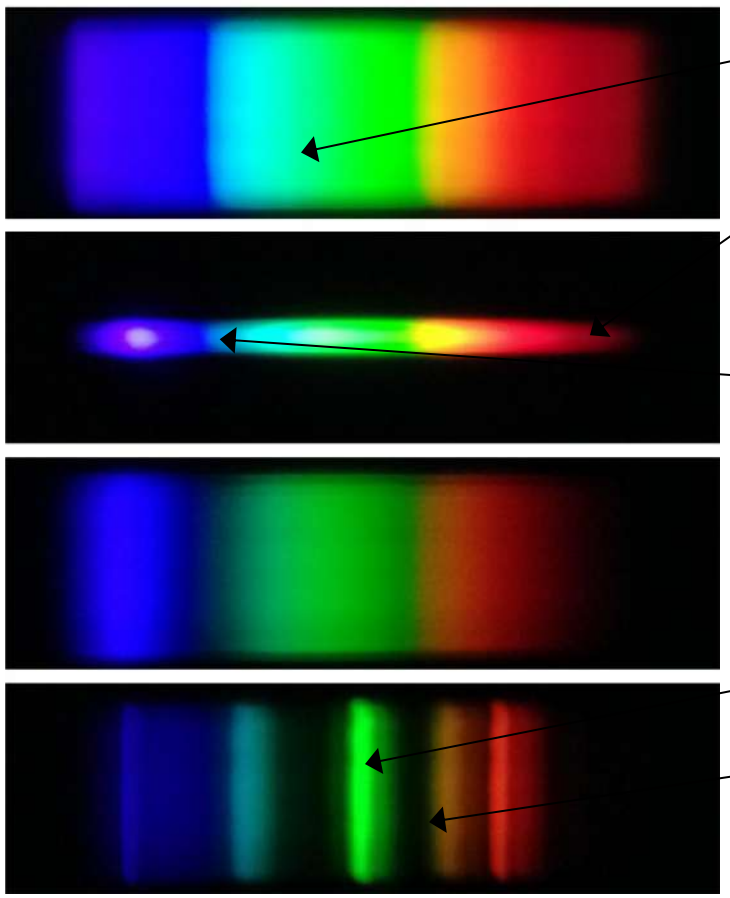
Rf = 88.5 (Fidelity Index)

Rg = 97.4 (Gamut Index)

Rf,skin = 93.3 (Gamut Index, Skin)



COLOR – Spectral Power Distribution



Even emission across the entire spectrum

Red spectrum is not complete

Cyan portion of the spectrum is not always robust

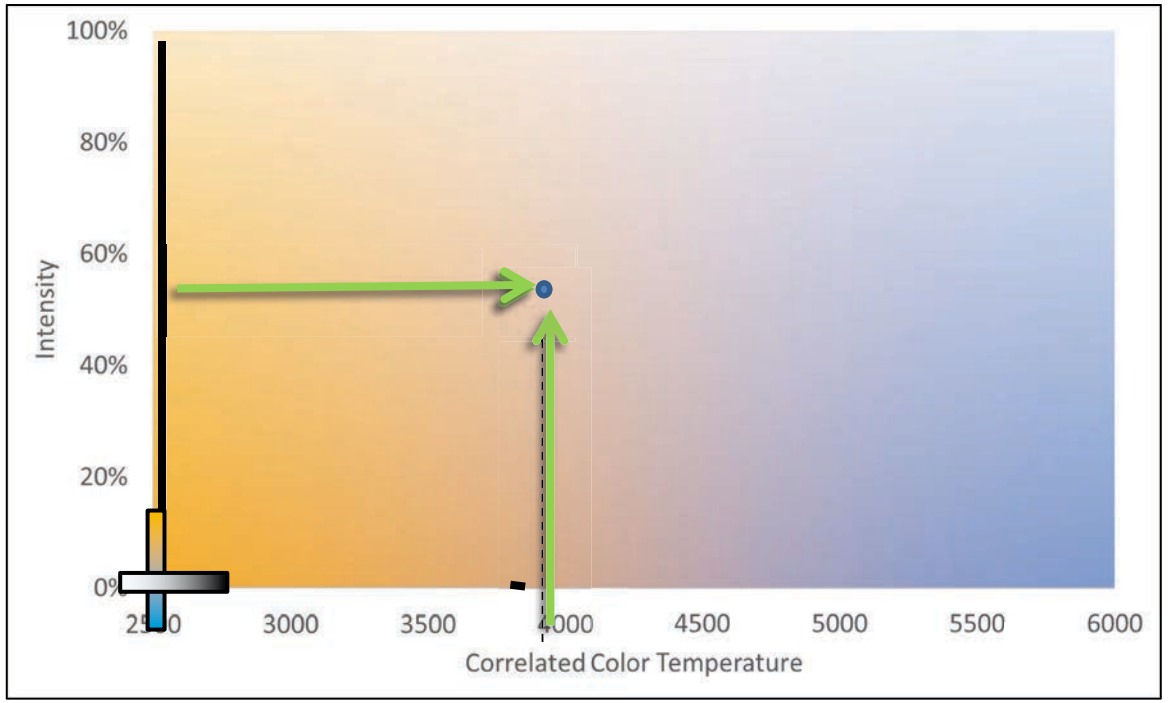
Some high CRI (98) LEDs are more complete throughout the entire spectrum

Shows peeks of wavelengths

Various colors are missing from the spectrum

Tunable White

- Ability to modify the Color Temperature (CCT) of LED fixtures is becoming popular
- For VTC spaces the key is maintaining the same CCT for all of the lighting
- This is important for the camera
- Fixtures that allow Intensity separate from CCT control allows for a positive user experience



Tunable White

- Just because we can have color tuning doesn't mean we should…. should we?
- Cameras do not like shifting colors
- Often AV consultants will just let the camera auto white balance
- Auto white balance compensates making the faces appear blue, orange, or even green (even when we are not sick)

LED Solutions

- Benefits that make LED fixtures desirable in VTC applications:
  - When designed properly, LED fixtures provide the same glare free lighting as their fluorescent counterparts
  - With proper specification, LEDs can deliver consistent color temperature, with little degradation or color shift over their lifetimes

LED Solutions

- Benefits that make LED fixtures desirable in VTC applications:
  - Longer lifetime – LEDs consistently deliver 50,000+ hour life, even longer when dimmed
  - Lower heat dissipation – LEDs dissipate less heat, increasing energy savings by reducing demand on HVAC cooling systems
  - Efficient – LEDs use less energy initially, and they reduce energy at a roughly 1:1 ratio as they are dimmed

Pay attention to energy codes because there may be allowances for environments with cameras…..

LED Drivers

- The selection of an appropriate driver is not limited to just making sure it matches the LED module being used.
- Drivers are the primary component that determine performance of the LED lamp or fixture
- It is important to understand what operating mechanism of the LED driver
  - Pulse-width modulation (PWM) or constant current reduction (CCR).
  - Drivers using CCR are critical for video conference applications in order to ensure good video performance

LED Drivers

Pulse Width Modulation (PWM)

- LED's have a rated current - amount of current required to get the maximum light output
- PWM driver - the current is switched at a high frequency
  - The ratio of on time to off time determines the LED brightn

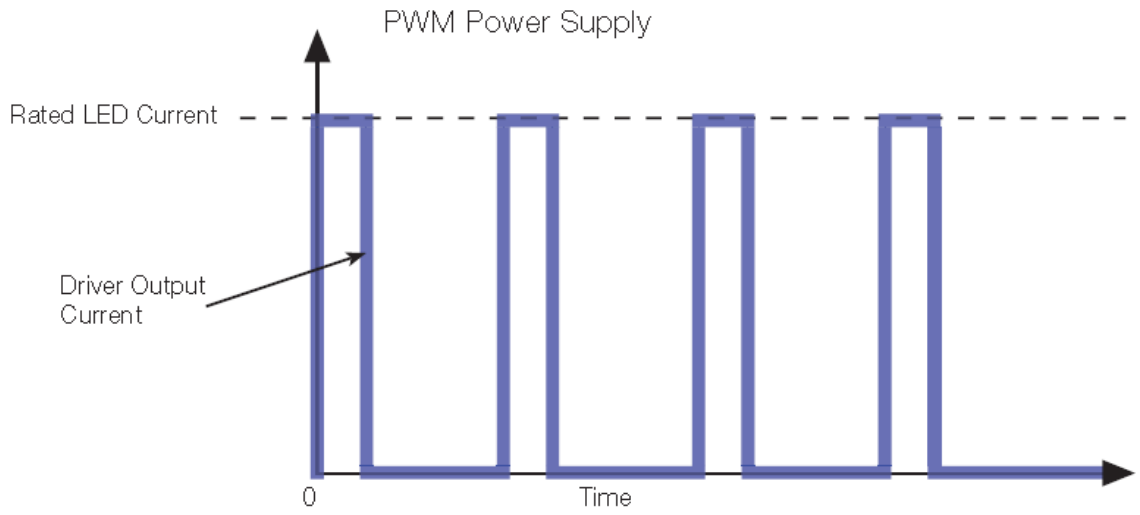


Diagram showing PWM of an LED that is dimmed to approximately 25%.

LED Drivers

Pulse Width Modulation (PWM)

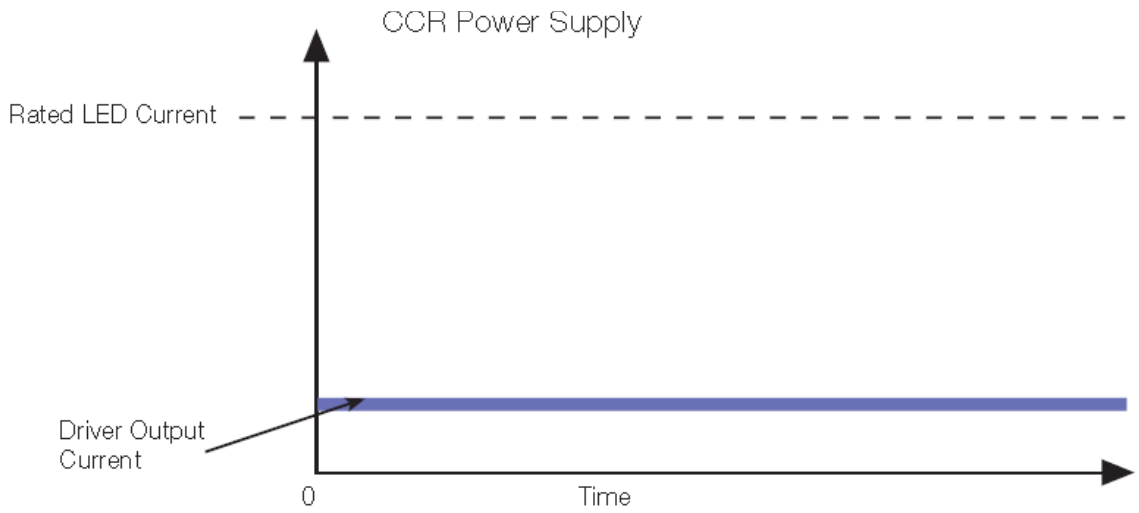
- If the PWM frequency is not high enough Interference with video signals will occur
- Use of CCR drivers eliminate interference issues
- For an in depth study of flicker refer to NEMA standard
  - LSD 75 Temporal Light Artifacts: Test Methods and Guidance for Acceptance Criteria

LED Drivers

Constant Current Reduction (CCR)

- CCR Driver - the current flows continuously at a set amount for a given light level
- The amount of light output is proportional to the current
  - The current is reduced to reduce the brightness of the LED.

diagram showing an LED that is reduced to approximately 25% using CCR.



LED Drivers

Input Control Protocols

- The signal and wiring type between the dimming control and LED lamp/fixture
  - LED Bulbs generally use line voltage control
  - Fixtures can one of several methods
  - The control protocol MUST match the protocol of the driver!

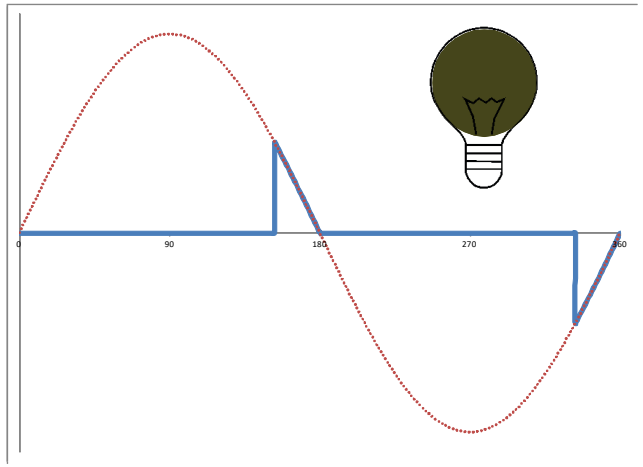
Control Protocols

- Line Voltage -Analog
  - Forward Phase
  - Reverse Phase
  - Not recommended for VTC spaces
- Low Voltage- Analog
  - 0-10V
- Low Voltage - Digital
  - DALI / EcoSystem
  - DMX 512

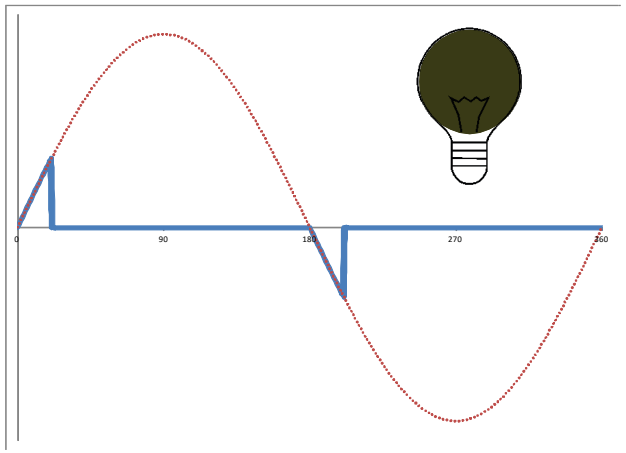
Control Protocols

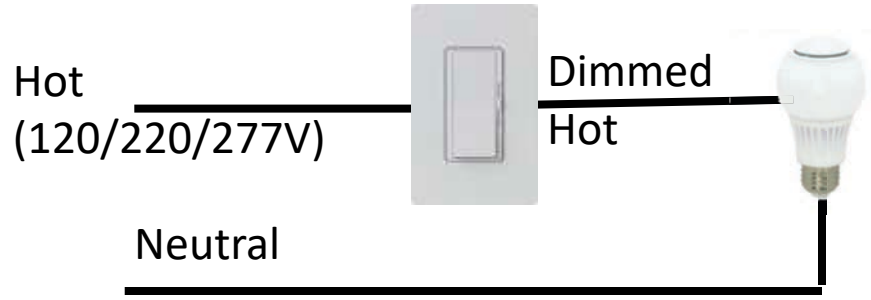
- Forward Phase Cut- Analog (Leading Edge/Triac)
  - Not originally designed for LEDs
- Reverse Phase Cut - Analog (Trailing Edge/ELV)
  - Provides better LED performance

Forward Phase



Reverse Phase

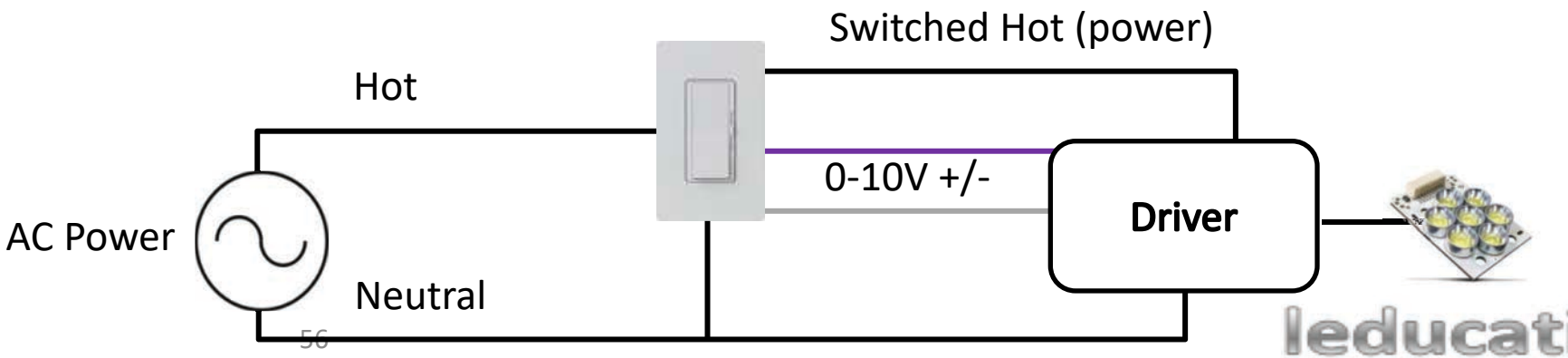




leducation.org

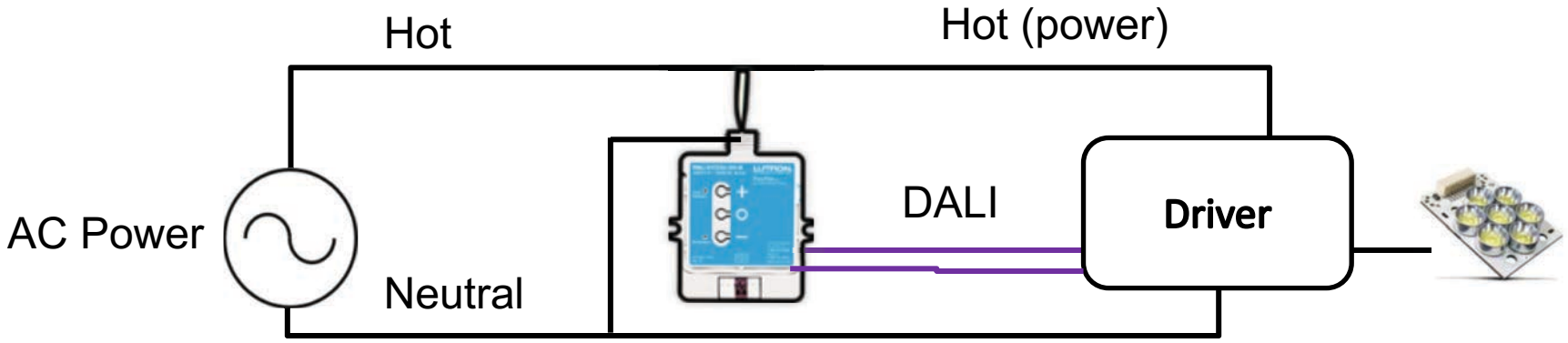
Control Protocols

- 0-10V - Analog
  - Common control standard for dimming
  - Separate control and line voltage wiring to each control zone
  - Two common control types
    - Sink - driver creates voltage (IEC standard 60929)
    - Source – Control creates voltage



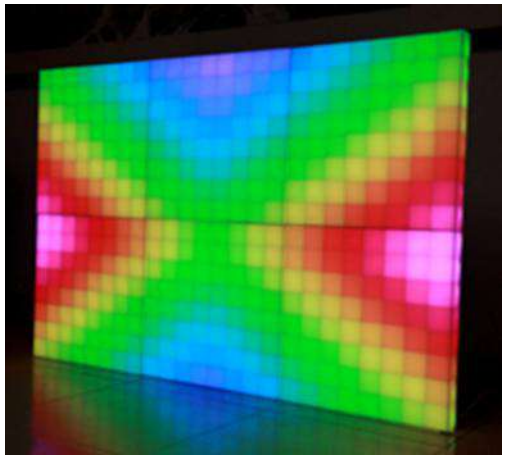
Control Protocols

- DALI – Digital Addressable Lighting Interface
  - Digital control standard, low voltage wiring and line voltage to all fixtures /multiple zones
  - Line voltage connected directly from Breaker Panel
  - Line voltage and DALI can be run together



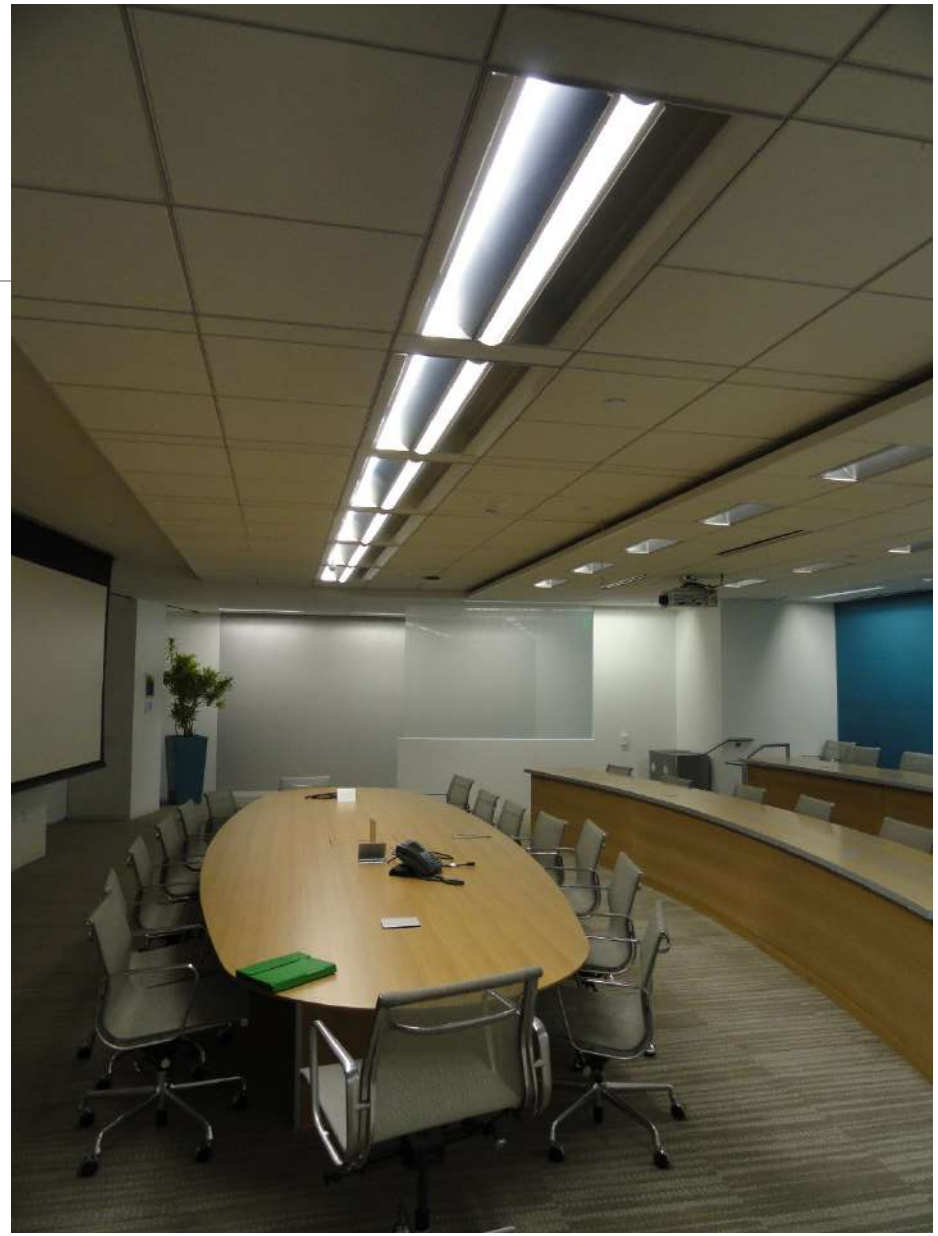
Control Protocols

- DMX-512 - Digital
  - Originally theatrical protocol
  - Popular for applications with RGB (Red Green Blue) and LED lighting
  - Can be used for single color and white tuning applications
  - Class 2 digital wiring, more complex installation

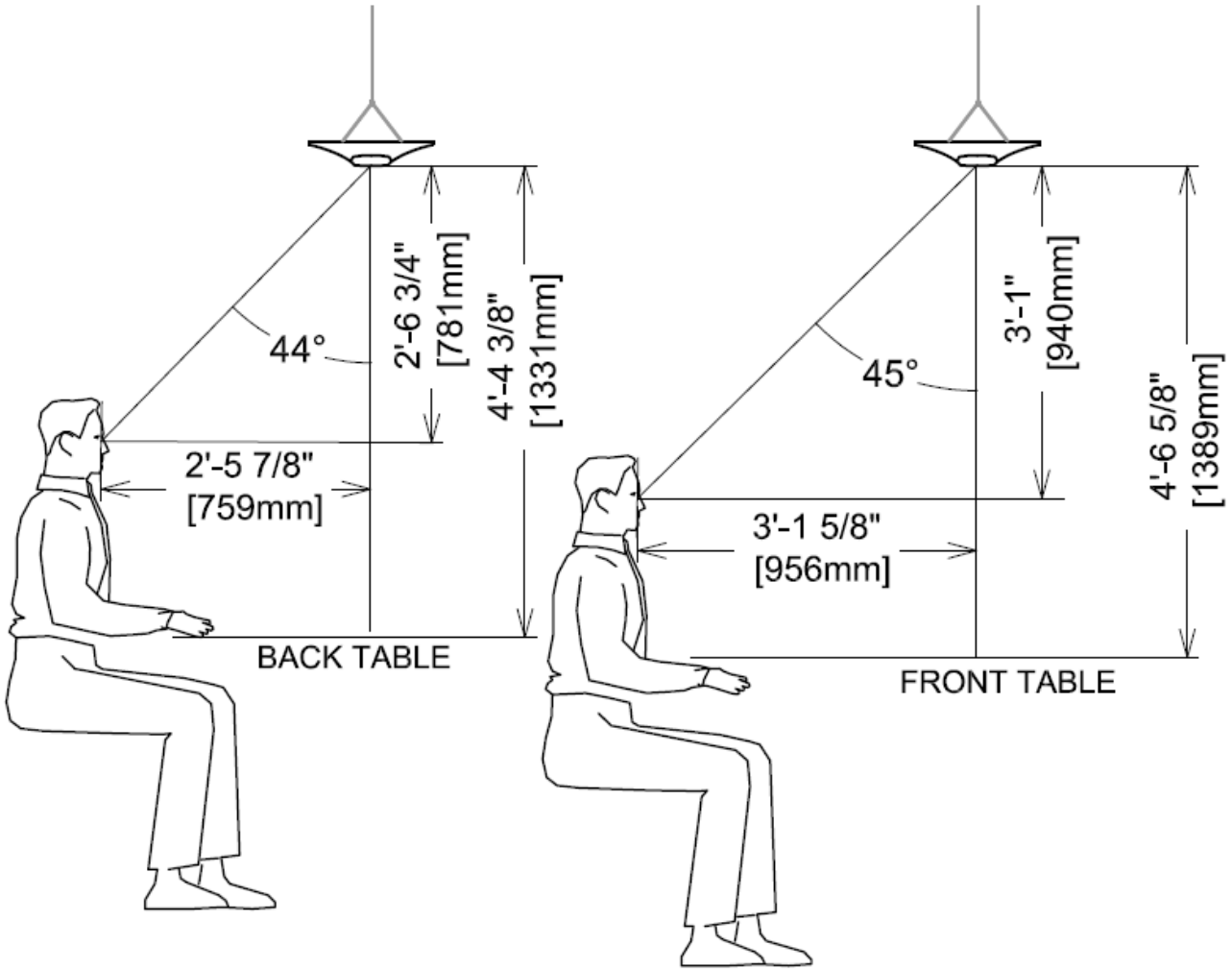


Luminaire and Optics

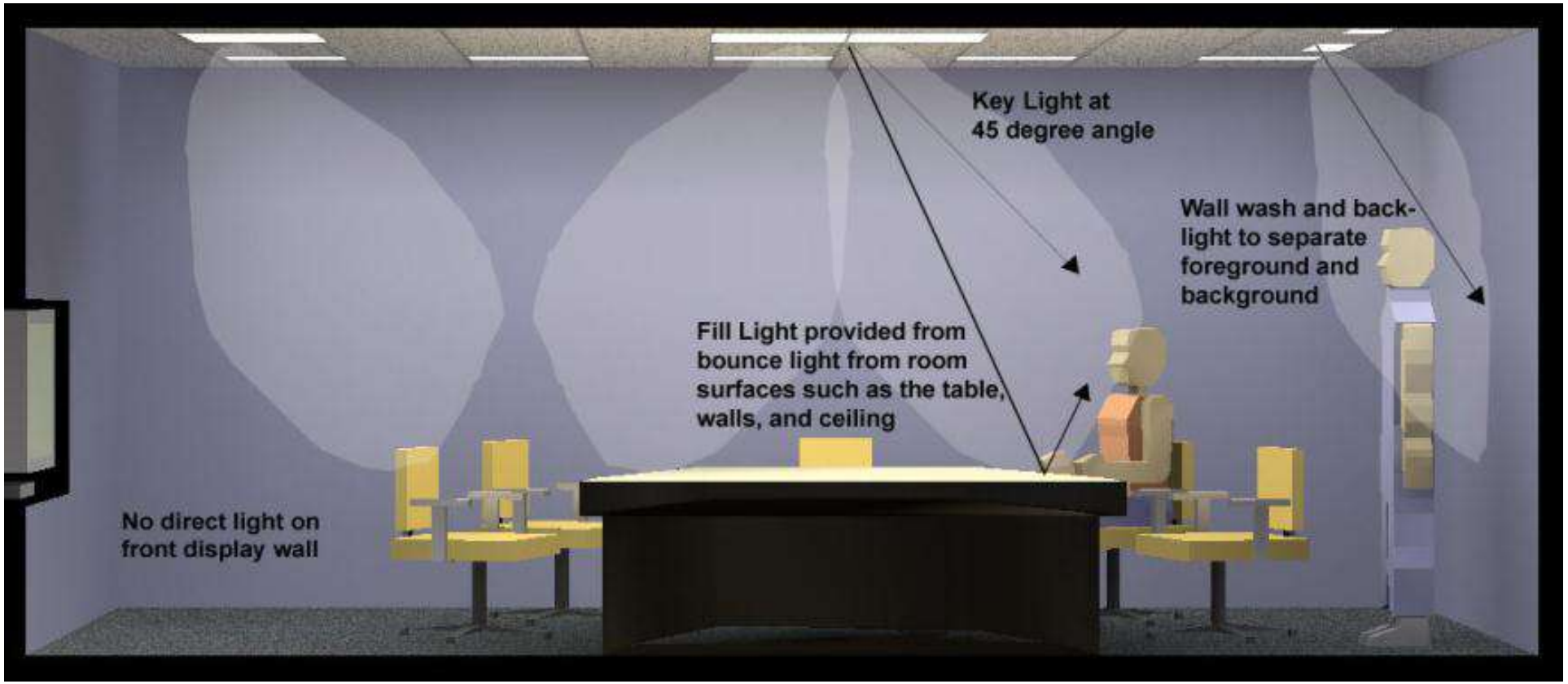
- Geometry/Location
- Photometrics
- Direct vs Indirect
- Layers
- Views/Glare



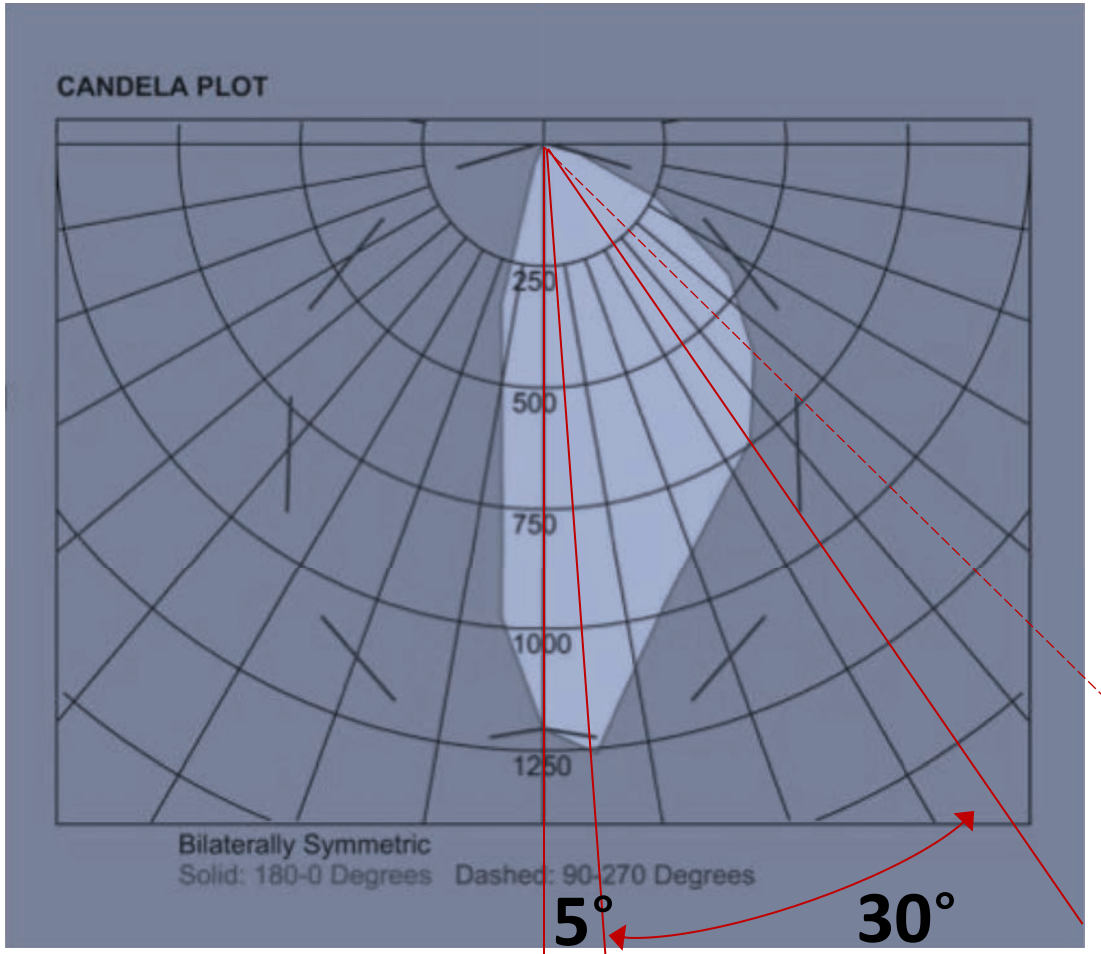
Luminaire and Optics – Location and Geometry



Luminaire and Optics – Location and Geometry



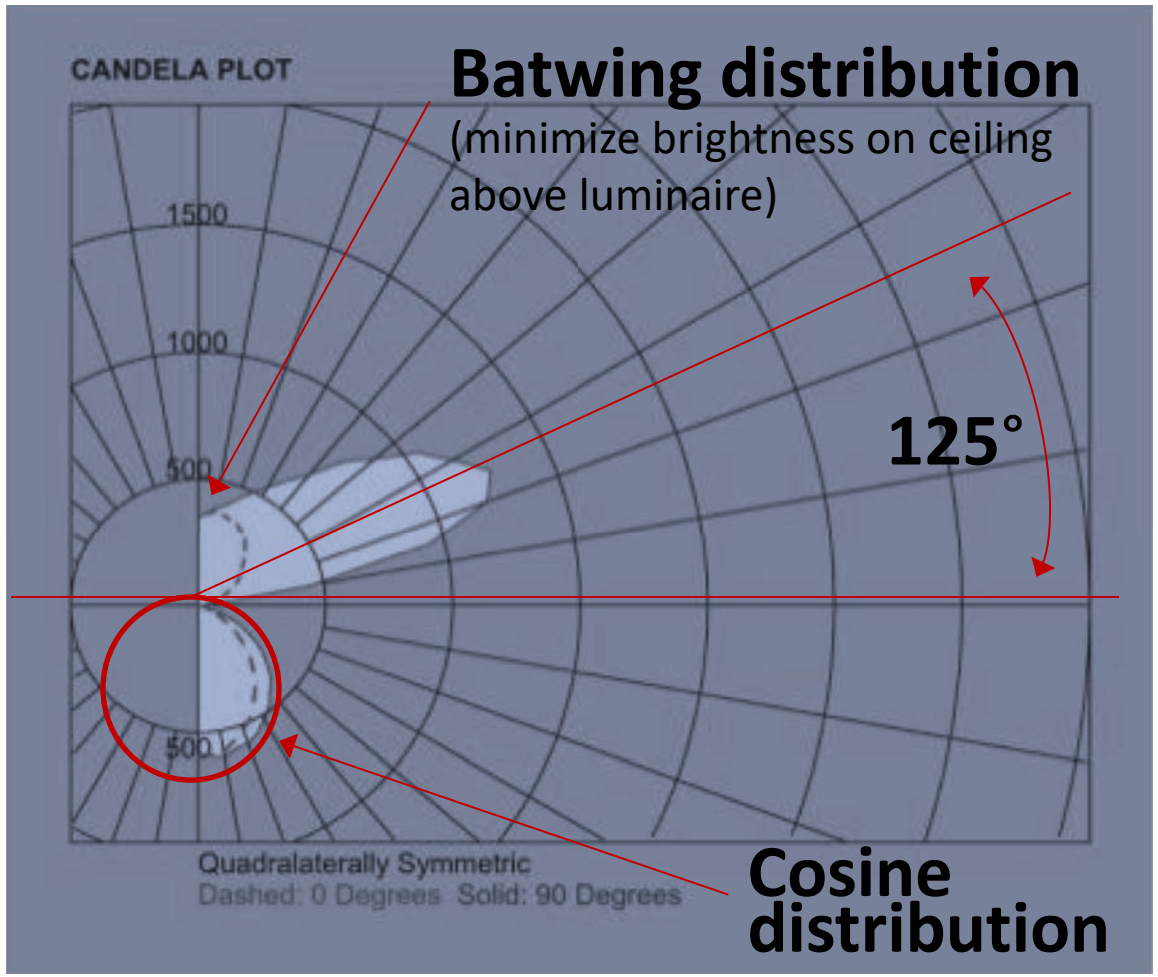
Luminaire and Optics – Photometrics



Key Light

- Concentrated, describes 3-D form, creates highlights and shadows
- Frontal at 45 degrees ideally both vertical and horizontal
- Target facial plane and cover torso area

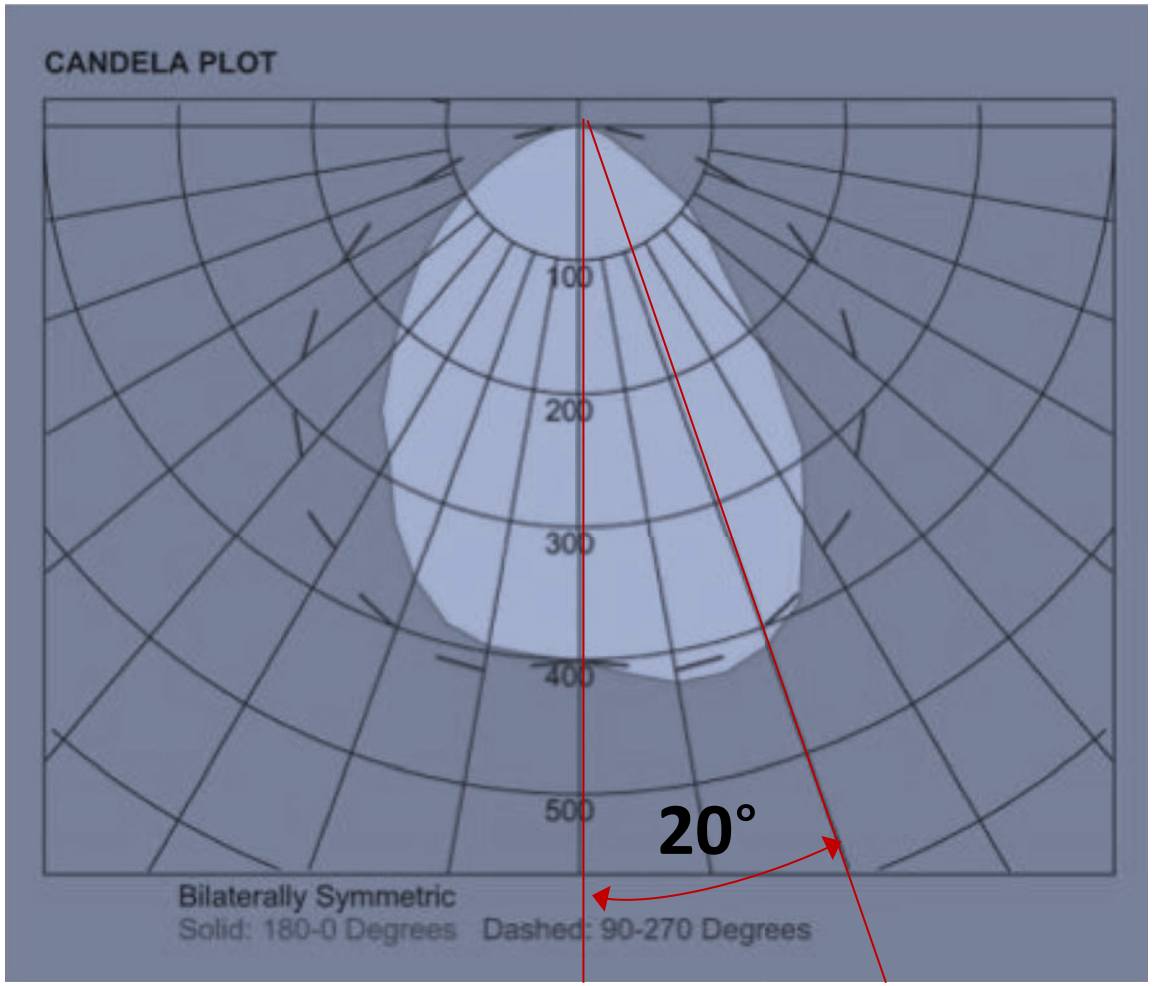
Luminaire and Optics – Photometrics



Fill Light

- Diffuse, softens shadows
- Ideally placed opposite key at 45 degrees vertical and horizontal
- Diffuse light can be provide both from the actually luminaire or/and the room/furnishing surface reflectances

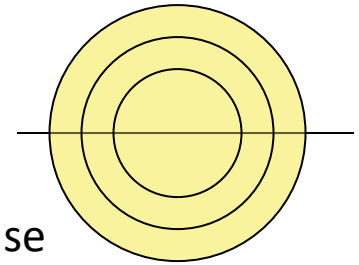
Luminaire and Optics – Photometry



Background Light

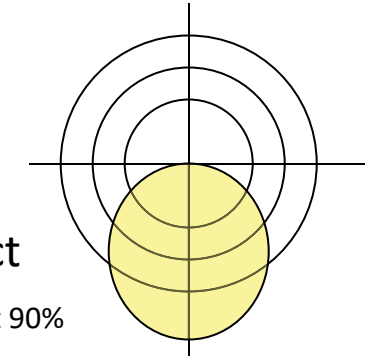
- Illumination of the vertical surface behind participants creates depth and separates foreground (faces) and background
- Should be relatively uniform across the camera view

Luminaire and Optics – Direct versus Indirect



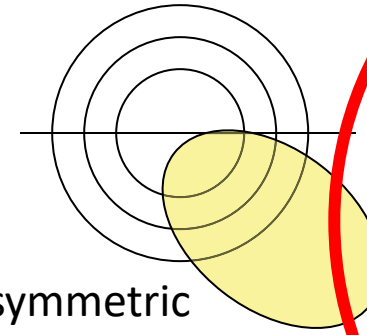
Diffuse

Nearly equal all directions



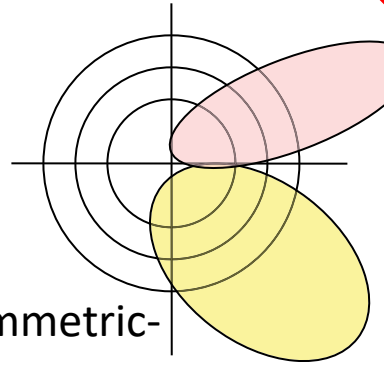
Direct

At least 90% of light down



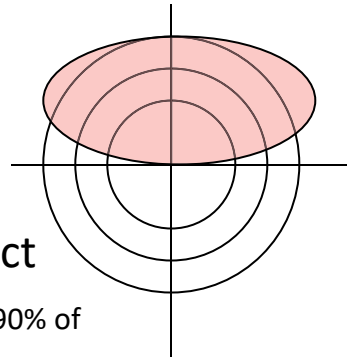
Asymmetric

In a specific distribution (none of the above)



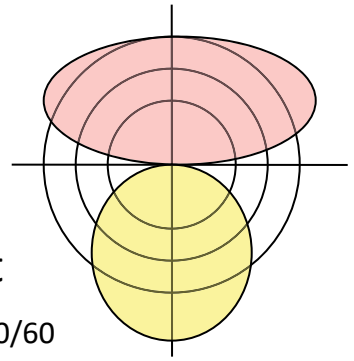
Asymmetric-indirect

60-90% of light up in a specific distribution toward faces



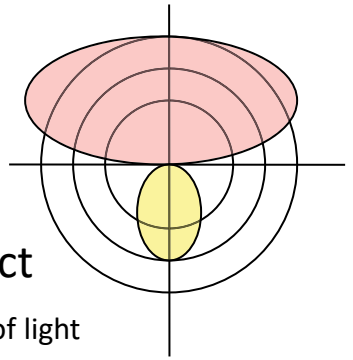
Indirect

At least 90% of light up



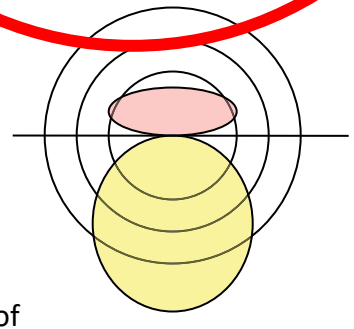
Direct-indirect

Between 40/60 and 60/40



Semi-indirect

60-90% of light up

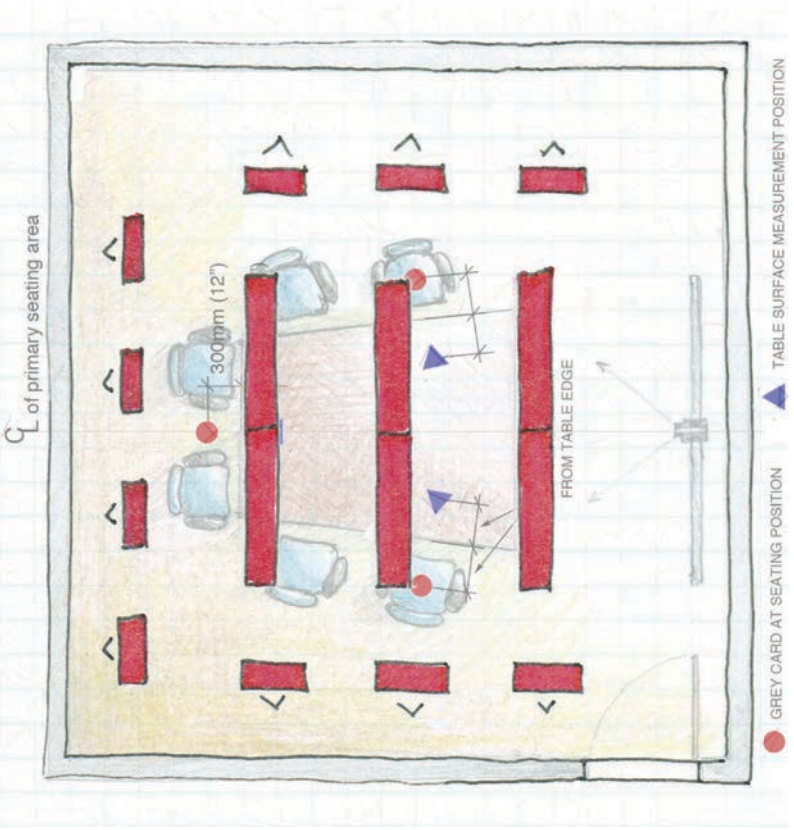


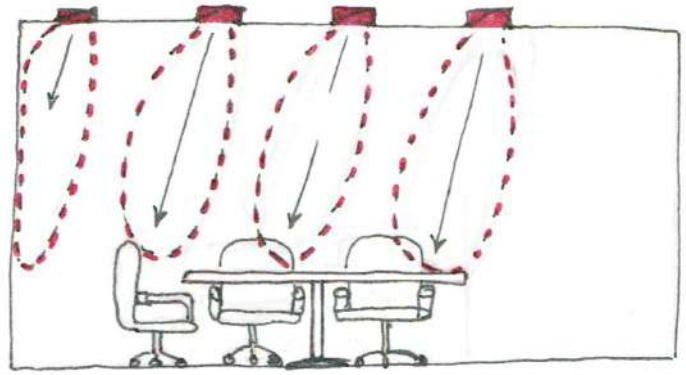
Semi-direct

60-90% of light down

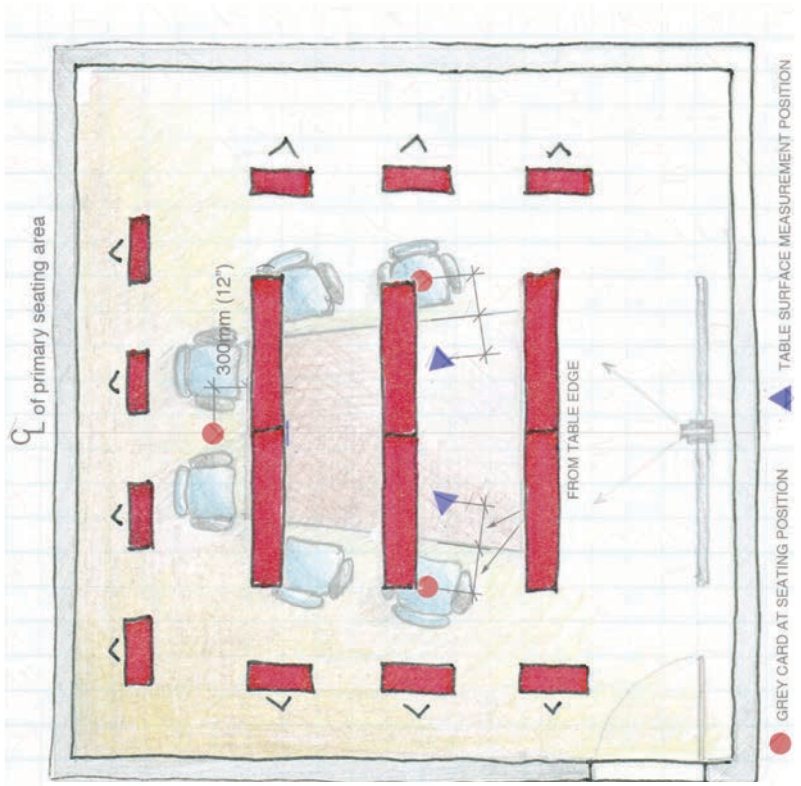
Luminaire and Optics – Direct Lighting

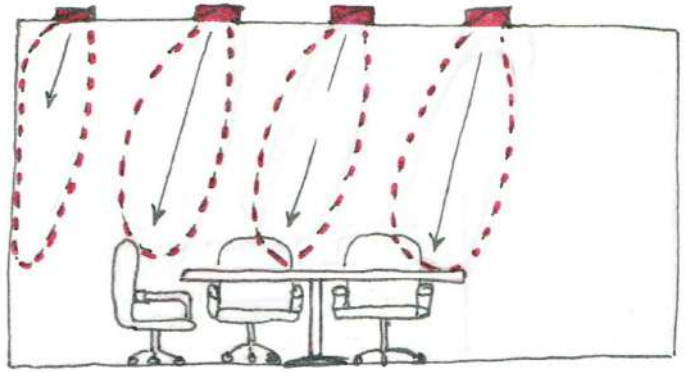
- Direct lighting provides the greatest portion of key light
- Fill and background light is accomplished via reflected light off the walls
- Fixtures should be located slightly in front of the participants to ensure proper distribution of light on the faces
- Exact location of fixtures depends significantly on the height and geometry of the room





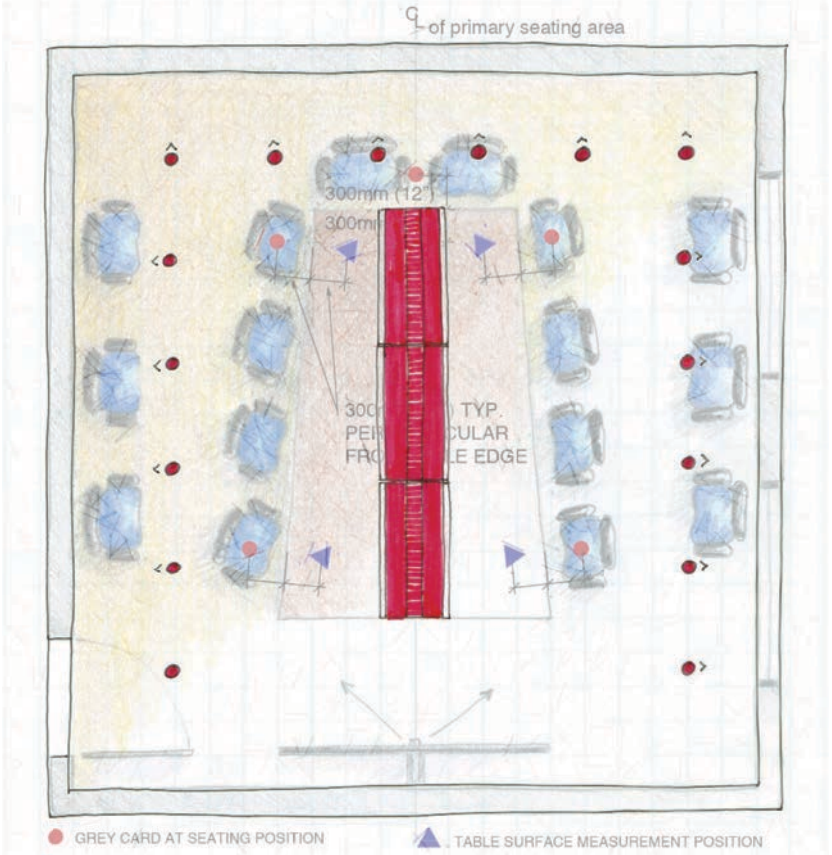
Luminaire and Optics – Direct Lighting

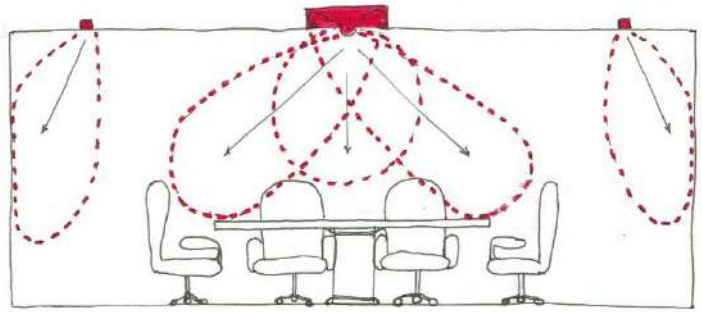




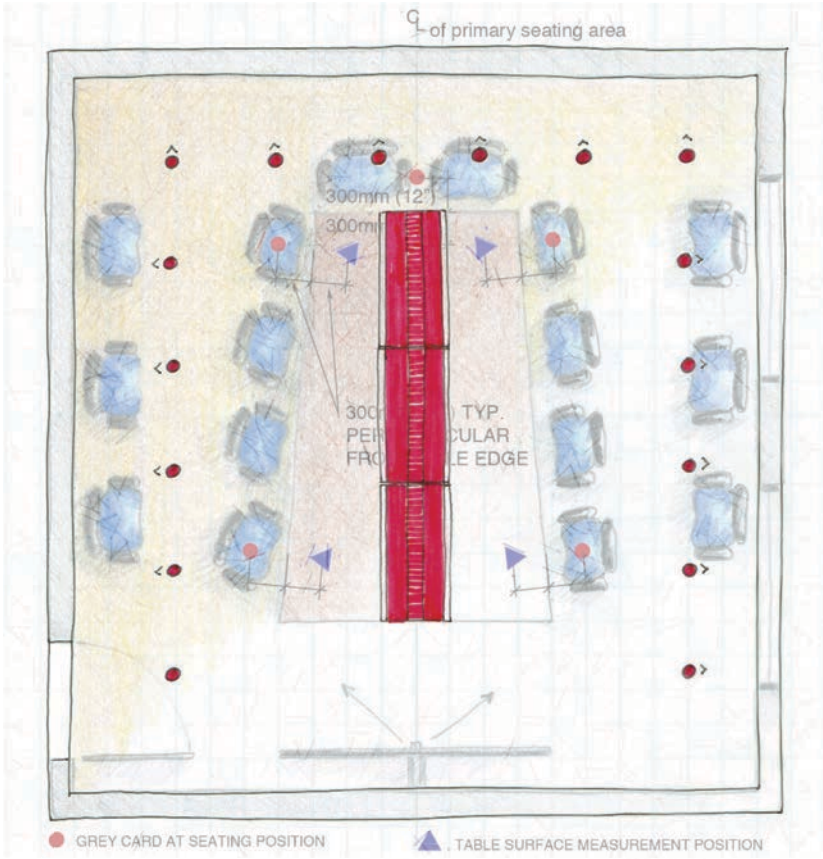
Luminaire and Optics – Asymmetric & Semi-direct Lighting

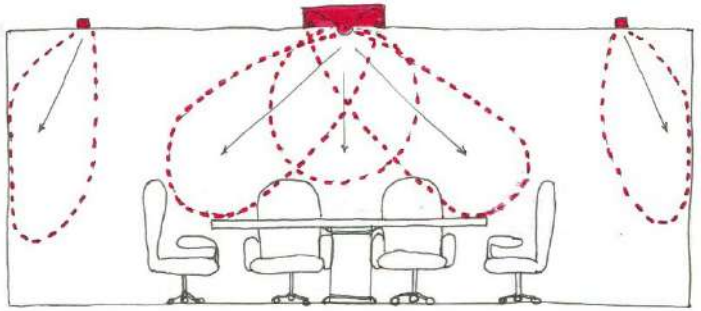
- Asymmetric lighting provides the key light at an optimal angle (approximately 45 degrees) for the occupants
- Fill and background light is primarily accomplished via reflected light off the walls (via wallwashers).
- A small portion of light is directed upwards softening the contrast at the ceiling
- Exact location of fixtures is still dependent on the height and geometry of the room





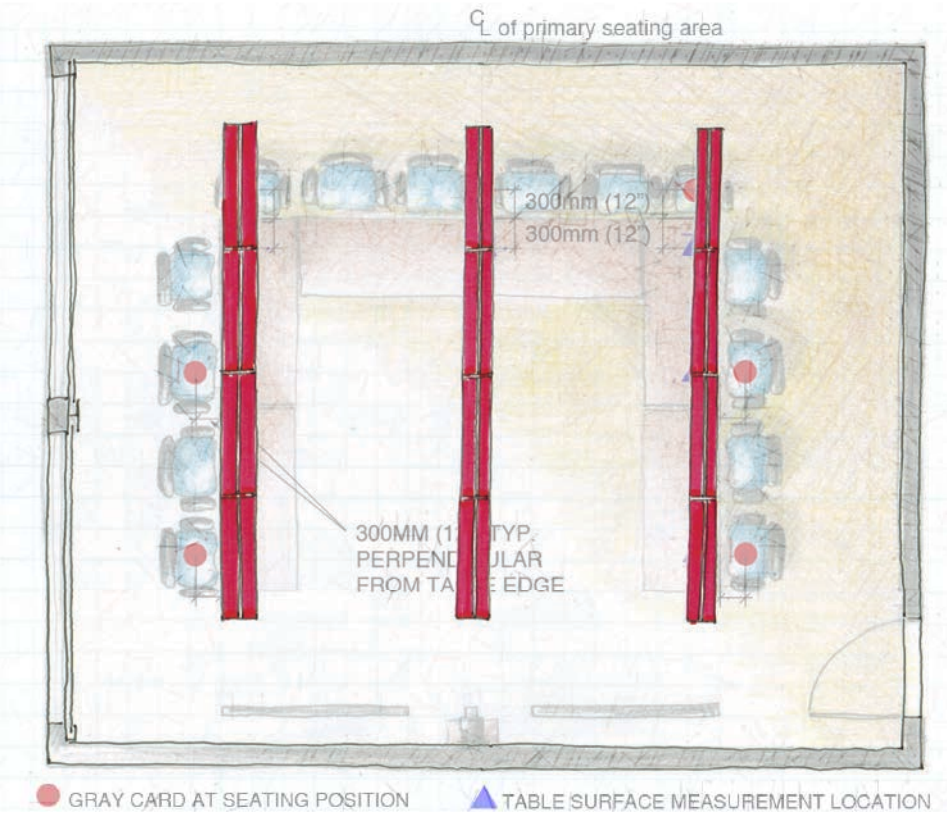
Luminaire and Optics – Asymmetric & Semi-direct Lighting

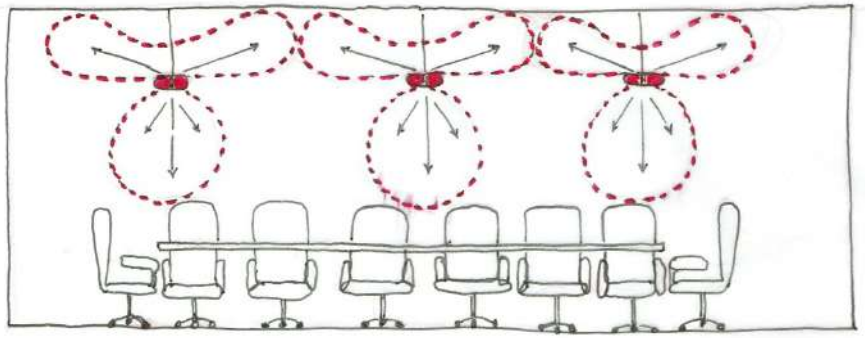




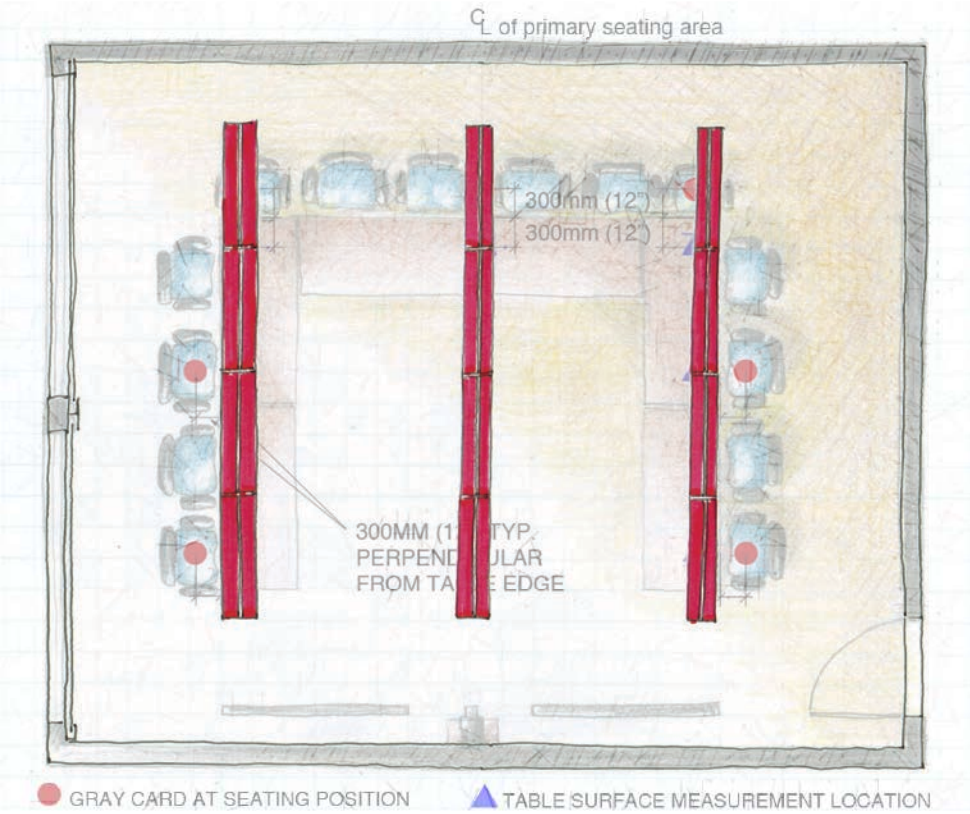
Luminaire and Optics – Indirect Lighting

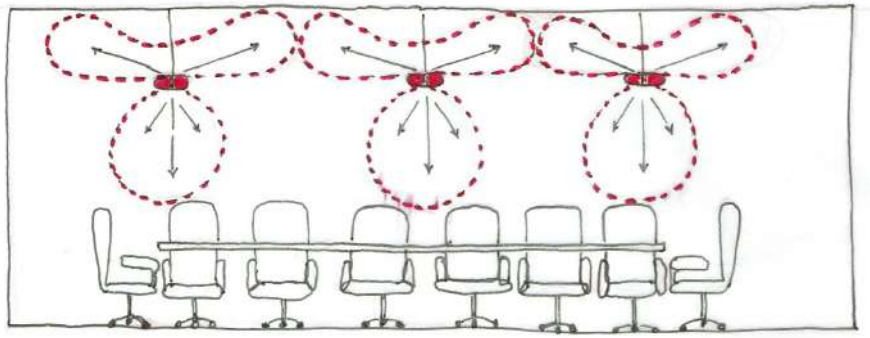
- Indirect lighting provides good soft diffuse fill light as well as key light.
- Varying levels of key light can be achieved depending on the location/type of pendant.
- Mounting heights are critical to minimize the luminance contrast of the ceiling. (Higher ceiling heights are helpful).
- Indirect lighting can be more forgiving and flexible for locating fixtures.





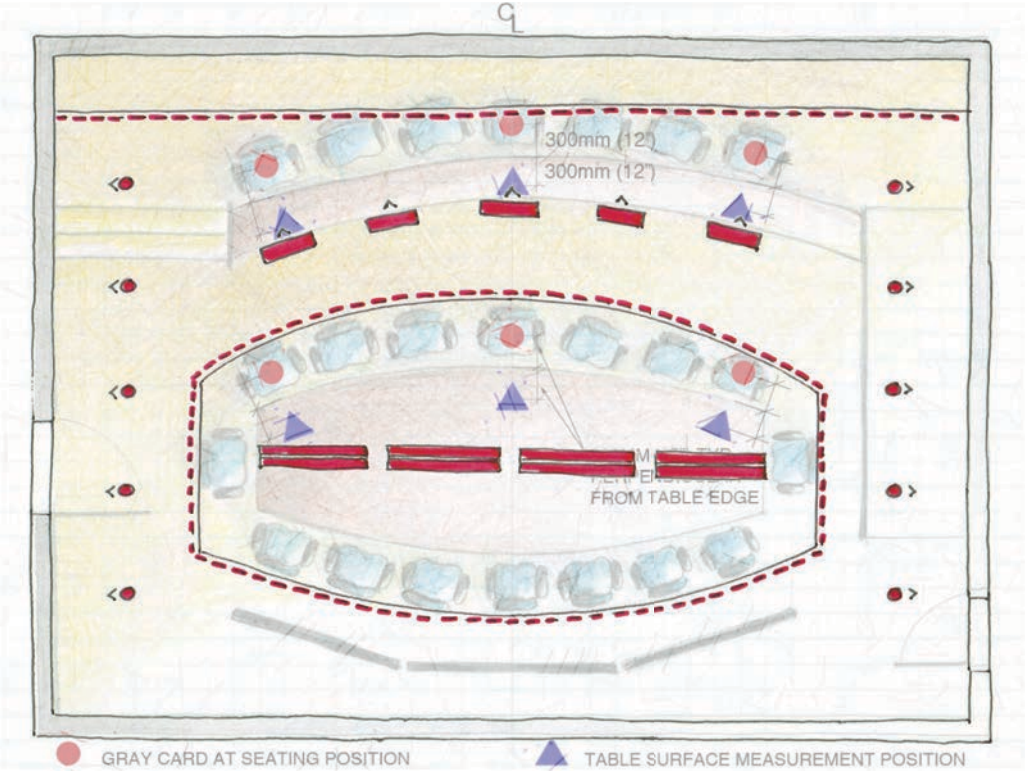
Luminaire and Optics – Indirect Lighting

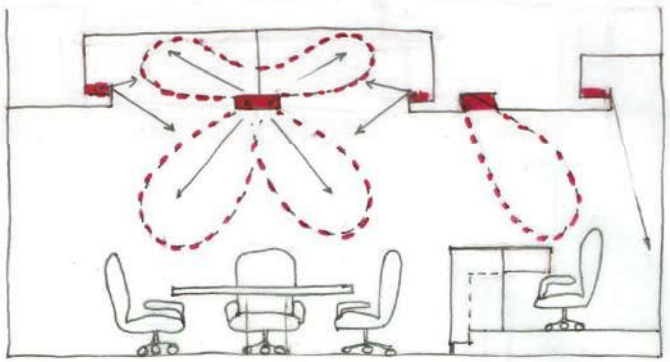




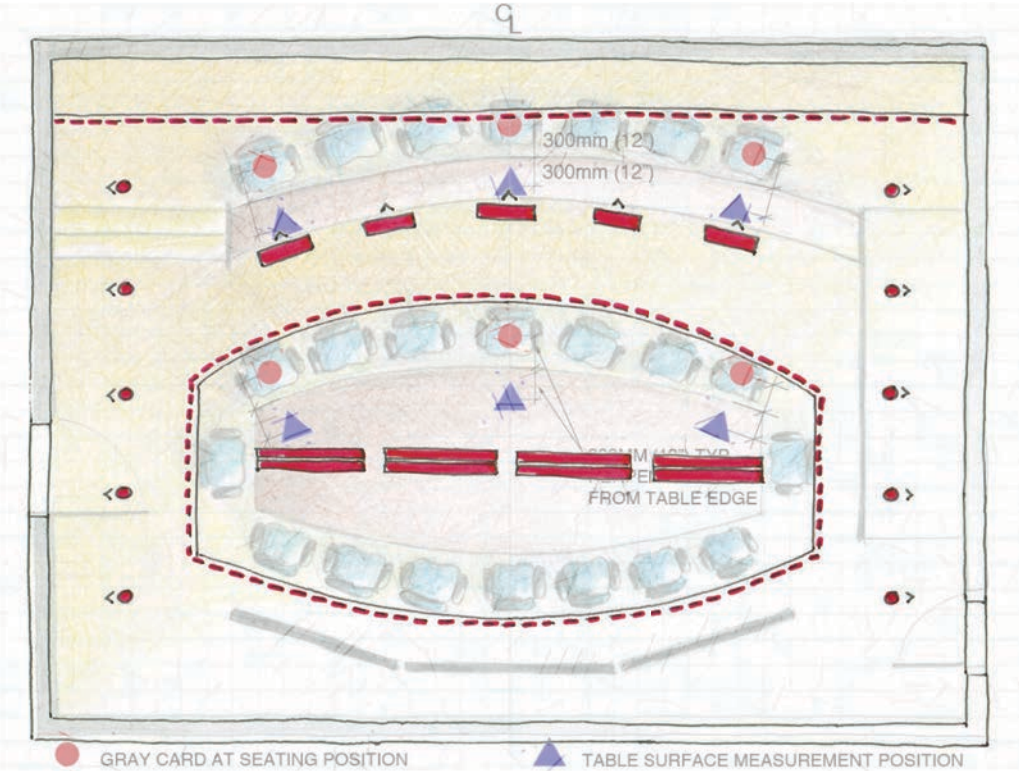
Luminaire and Optics – Layered Lighting

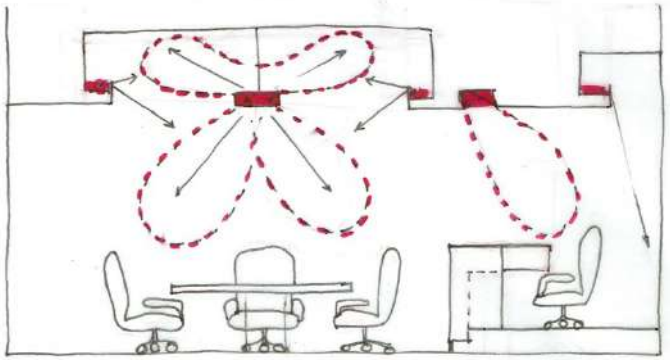
- Most lighting designers will tell you to layer your lighting…
- Use asymmetric lighting for facial key light, indirect for fill light, and wallwashing for backlighting.
- Using more than one approach can improve your results and minimize problem areas, particularly with more complicated space types.
- Indirect cove lighting can minimize spill light on projection screen displays.





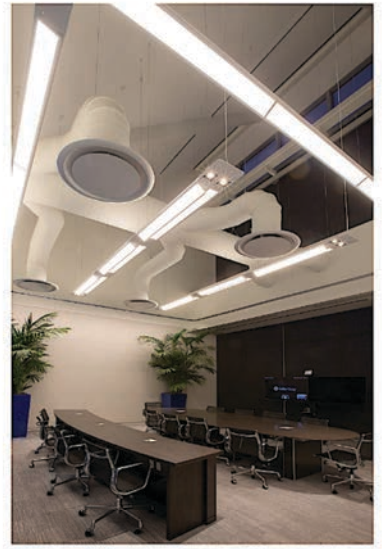
Luminaire and Optics – Layered Lighting

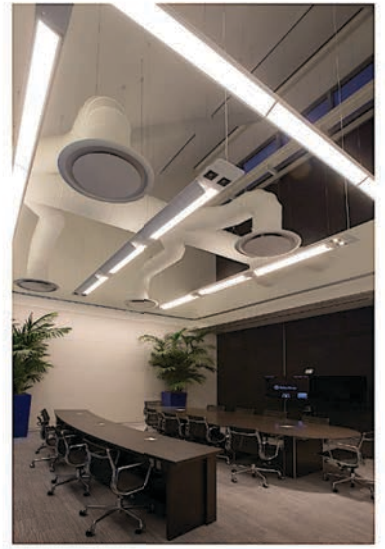


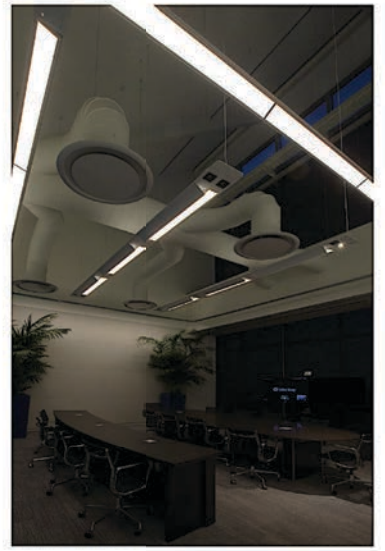


Luminaire and Optics – Layered Lighting

- Integrated modular lighting systems with field aiming – especially with space with high ceilings.
- Don’t forget that the geometry of luminaire to face changes dramatically.







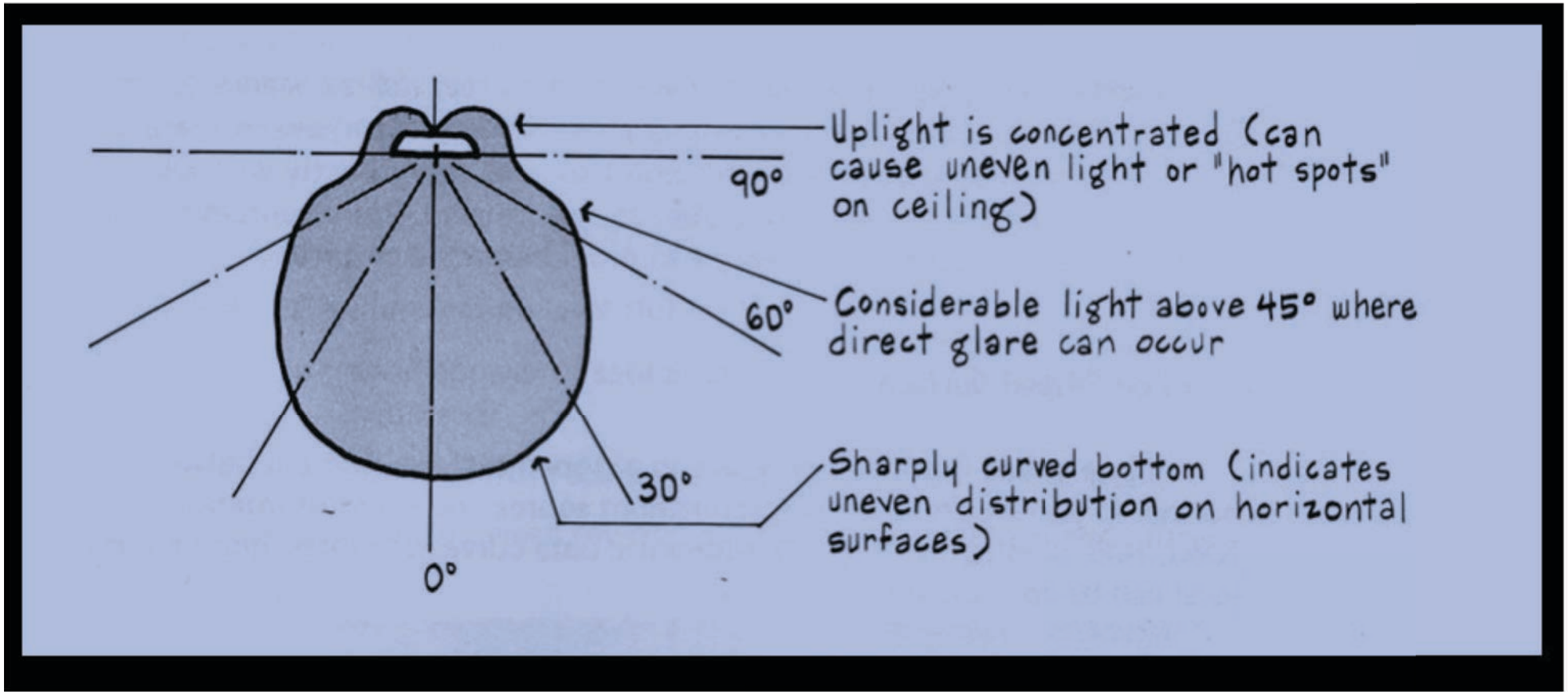
Luminaire and Optics – Glare

Angle from Vertical	VDT Intensive	VDT Normal
55°	300 cd	—
65°	220 cd	300 cd
75°	135 cd	185 cd
85°	45 cd	60 cd

INDIRECT CEILING LUMINANCE RATIOS (Large open-plan spaces; does not apply to private office)		
Max/Min Ceiling Uniformity	**Application**	**Caveat**
8:1	Typical installation using standard performance products	4:1 is more desirable, 2:1 is most preferable
10:1 or 12:1	Acceptable for high performance products placed 12 to 15 feet apart	Acceptable if the gradient is smooth (gradual) so that visible contrast is not created in computer screens

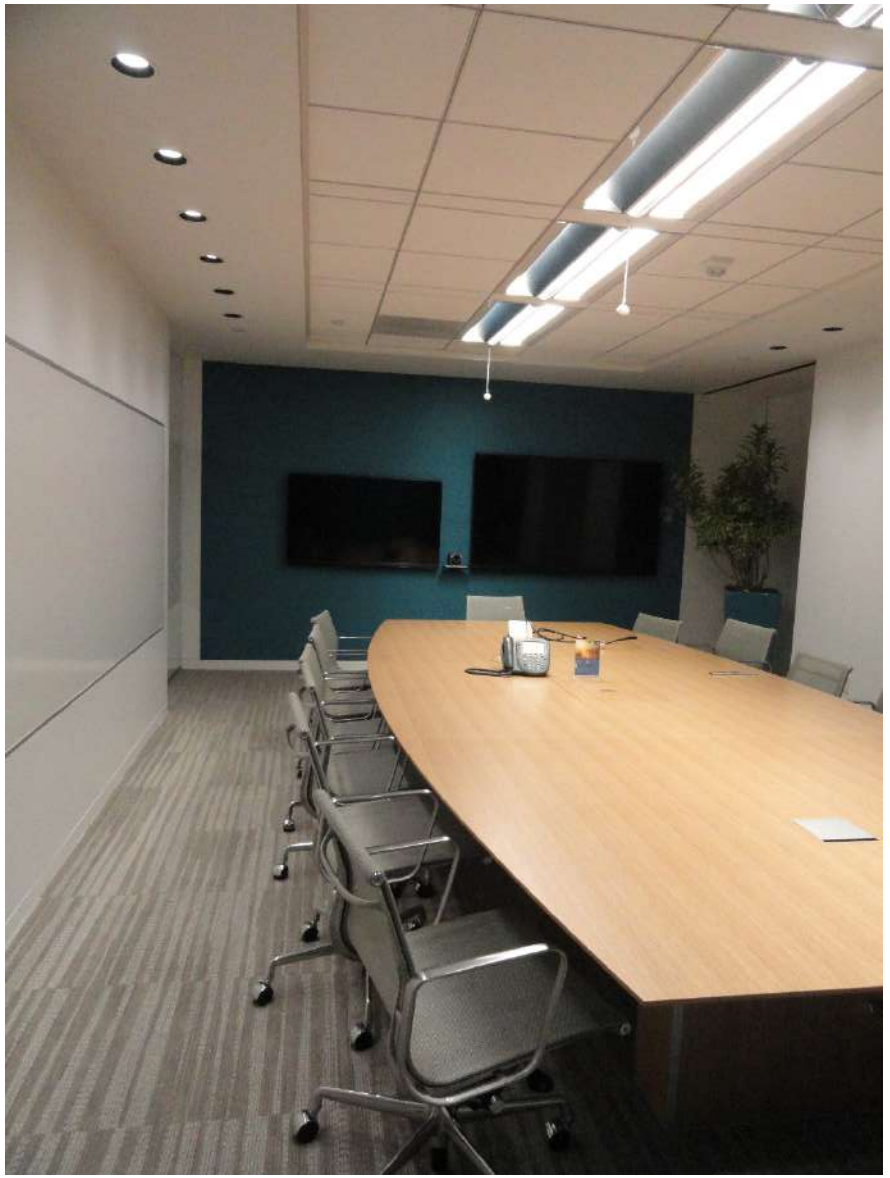
…..who remembers RP-1-05….

Luminaire and Optics – Photometry and Glare



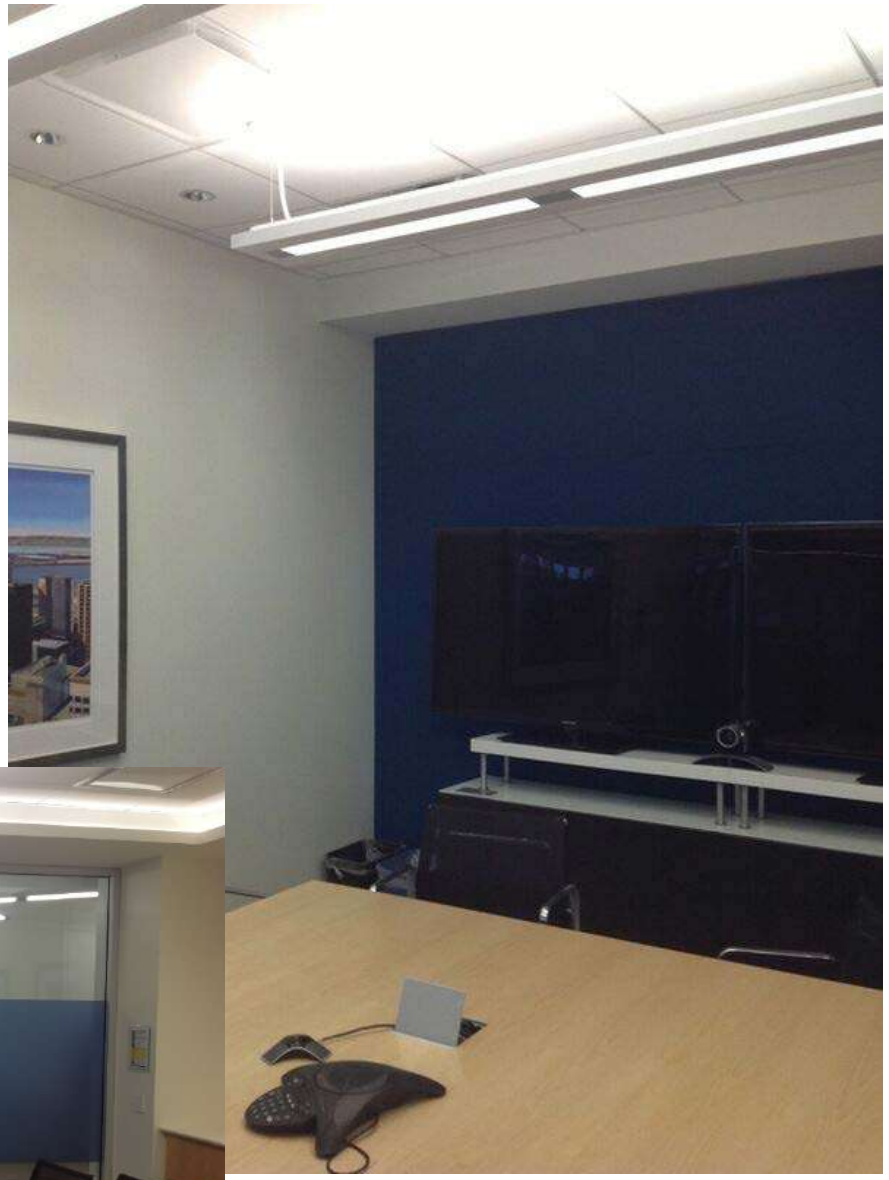
Luminaire & Optics – View/Glare

- Numerous fixture options exist that have minimal brightness as seen from the camera view
- Consider adding control circuits to limit forward facing fixture output



Luminaire & Optics – View/Glare

- If it is out of the camera view higher luminance ratio can be tolerated
- Don’t forget that lighting outside the room could cause problems.



Controls

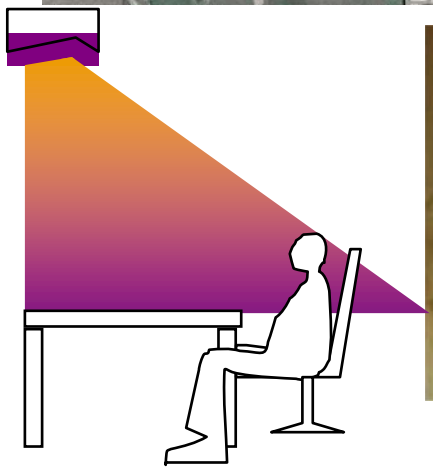
- Controls are critical to ensuring the lighting is right for the VTC experience
  - Adjust proper luminance ratios
  - Provide flexibility to use the space for multiple activities
  - Set the correct CCT, if that capability is included
  - Help the space meet energy code requirements

Controls

- Control systems consist of:
- End user Control
  - Wall-mounted keypads
  - AV touch screen
  - Personal tablet or smartphone
- Dimming controllers/panels
  - Internal to wall mounted controls
  - Remote located dimming panels
- Interface to AV control system and other building systems

Controls

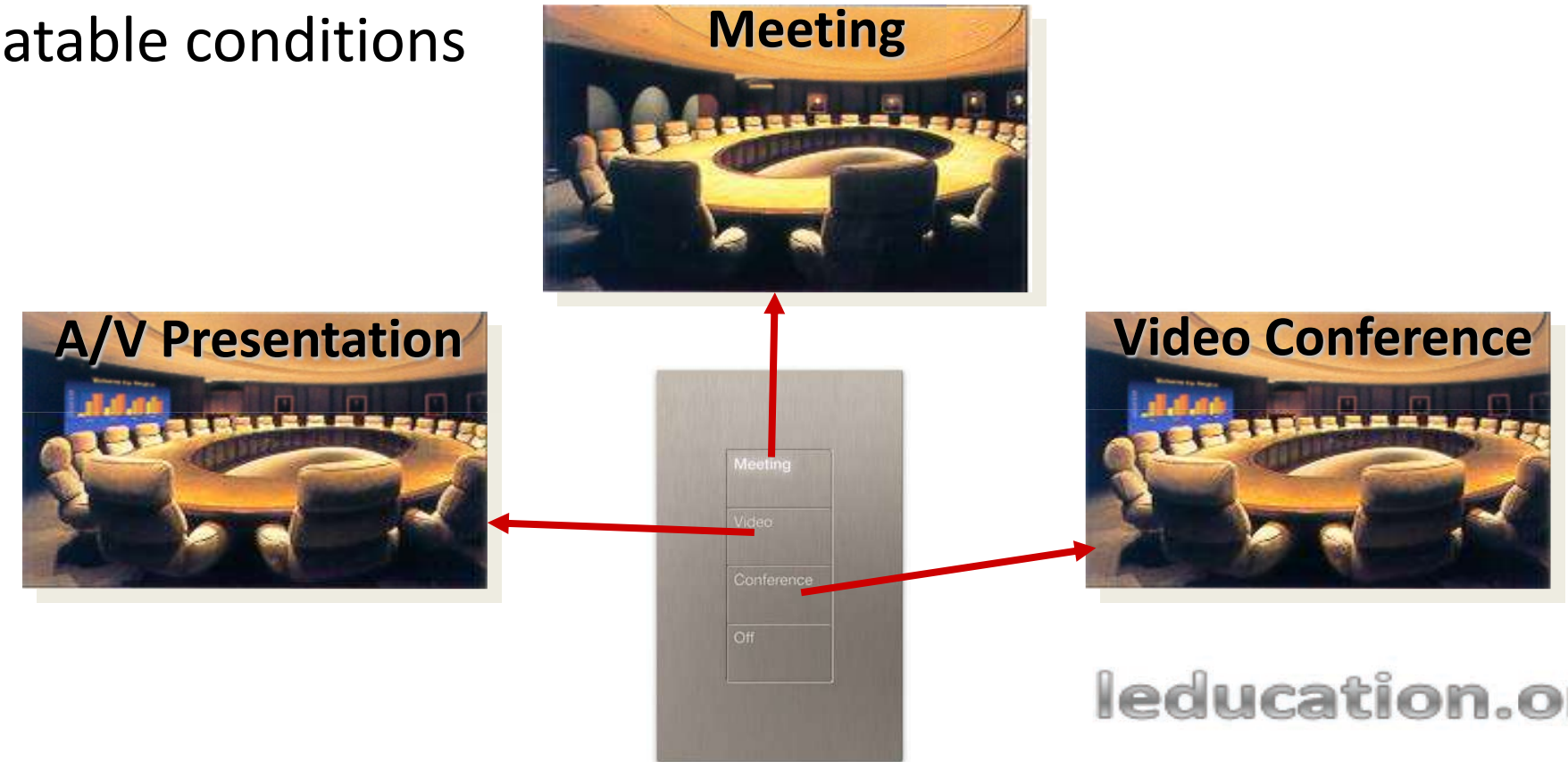
- For controls to be effective
  - lighting is designed in layers
  - Each layer is a control “zone”



- Typical Layers / Zones
  - Ambient / general illumination
  - Videoconference Task Lighting
  - Lighting of vertical and perimeter surfaces
  - Motorized window shades

Controls

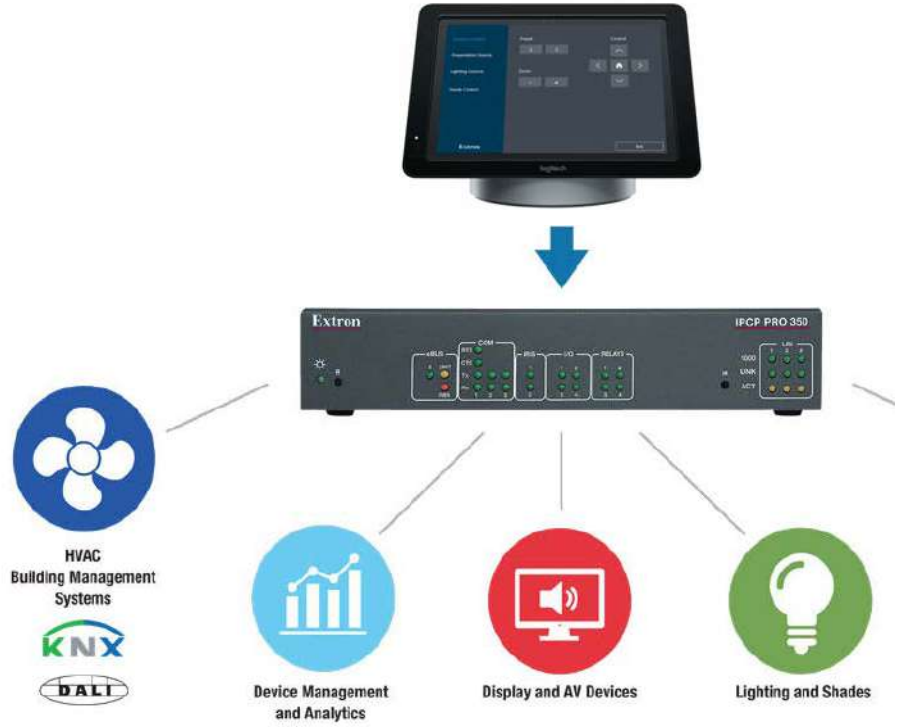
- Preset Dimming - scene control
  - Simple user control
  - Repeatable conditions



Controls

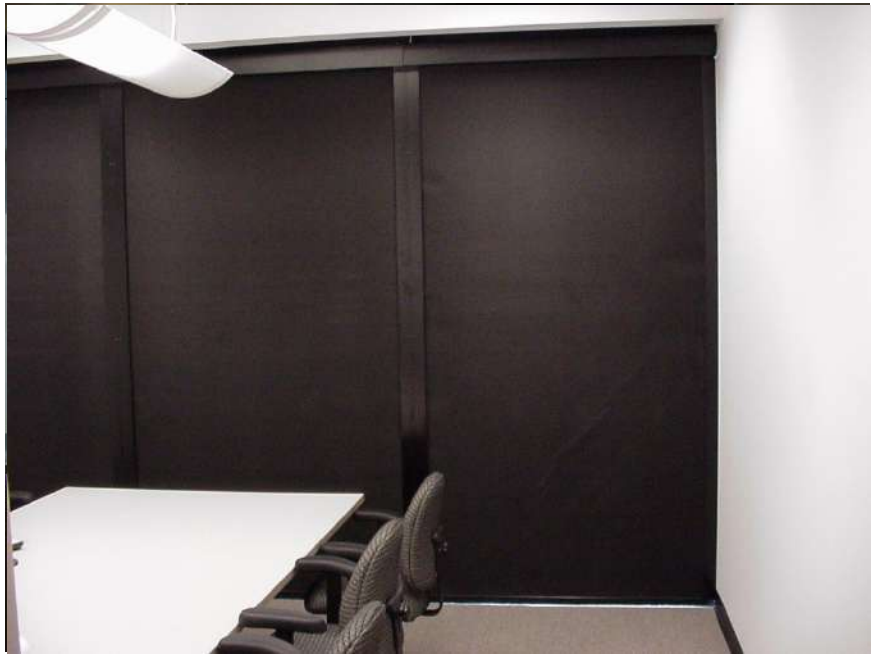
Integration with Audio Visual

- Touch screen control systems
- Integrate all aspects of the room
  - Lighting
  - Window Shades
  - HVAC
- Communication techniques
  - Digital interface
  - TCP/IP or RS 232 communication
  - Wireless control



Controls

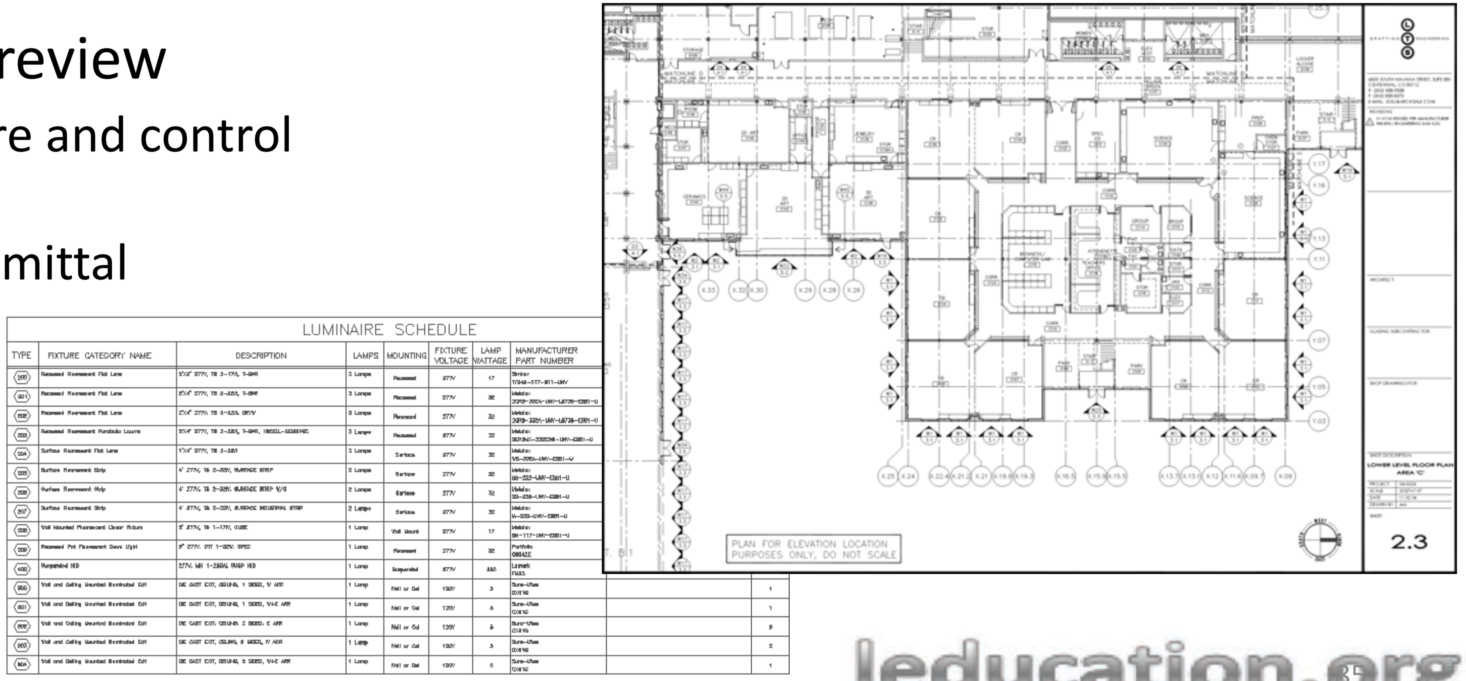
- Automatic window shade control
- Incorporate into VTC preset
- Eliminate glare on screens and camera
- Assure the benefits of daylight when not in VTC mode



LEDucation

Controls

- Compatibility
- Coordinate control protocol with
  - Driver protocol
  - Shade protocol
- Shop drawing /Submittal review
  - Concurrent review of fixture and control submittal
  - Review Window shade submittal

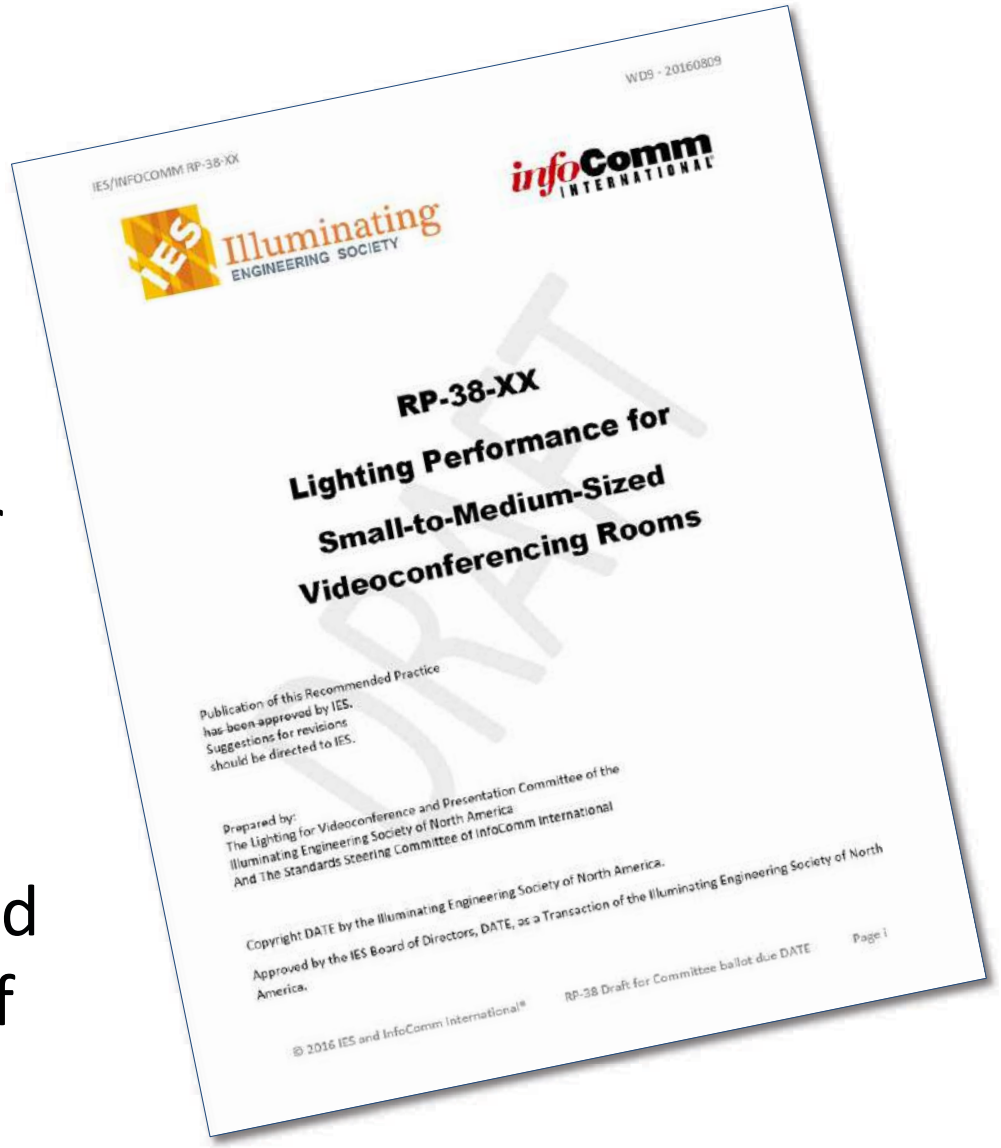


ANSI/IES/AVIXA Standard RP-38

- Conformance
  - Testing
  - Documentation
- Calculations
- Design

Why a Standard?

- Promote better communication via video
- Provide a reference and guidance for professionals (design, construction, assessment, and support of videoconferencing rooms)
- Performance-based, not design-based lighting criteria (design and testing of room lighting and finishes)


IES/INFOCOMM RP-38-XX

WD9 - 20160809

Illuminating ENGINEERING SOCIETY

infoComm INTERNATIONAL

RP-38-XX

Lighting Performance for Small-to-Medium-Sized Videoconferencing Rooms

DRAFT

Publication of this Recommended Practice has been approved by IES. Suggestions for revisions should be directed to IES.

Prepared by:
The Lighting for Videoconference and Presentation Committee of the Illuminating Engineering Society of North America
And The Standards Steering Committee of InfoComm International

Approved by the IES Board of Directors, DATE, as a Transaction of the Illuminating Engineering Society of North America.

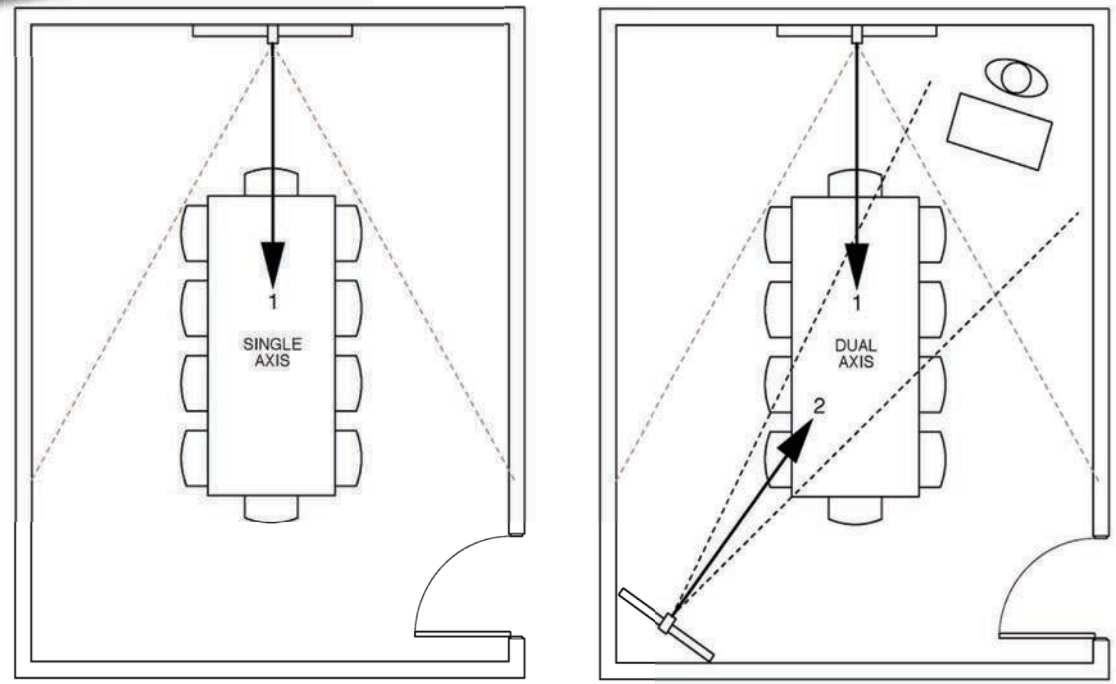
Application of the Standard

- Optimum performance for participant viewing of displays, presenter, and task area
- Optimize lighting for cameras for improved image quality
- Enhance videoconference communication capabilities, comfort, and productivity
- Testing Procedure and Conformance Report

LEDucation

Scope

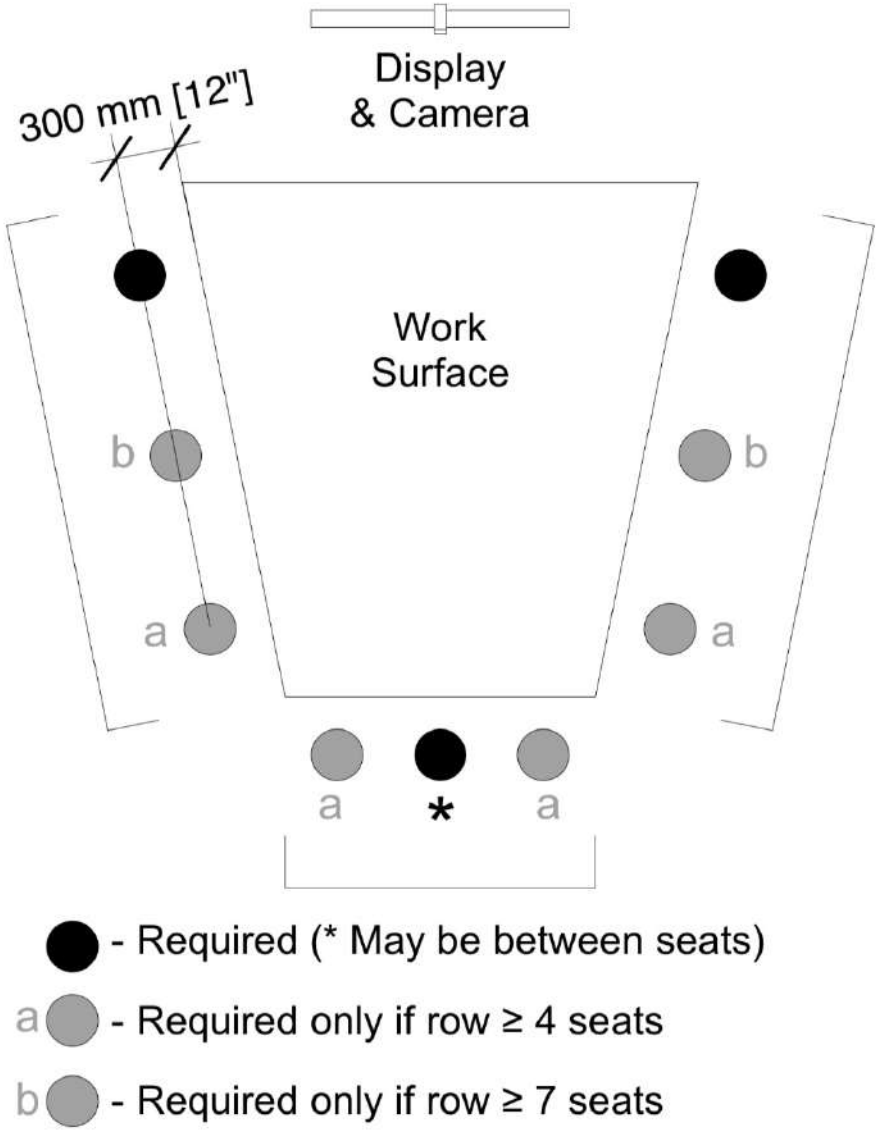
- Small to medium sized rooms
- 25 seats or less
- New and existing rooms
- Fixed or portable technology
- Telepresence rooms
- Single axis orientations



leducation.org

Participants

- Selected seats only
- Single table:
  - Minimum one on each side
  - One or two more seats in rows that have more than 4 seats



LEDucation

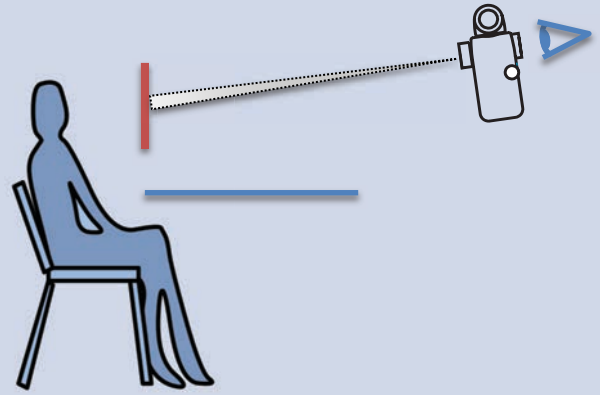
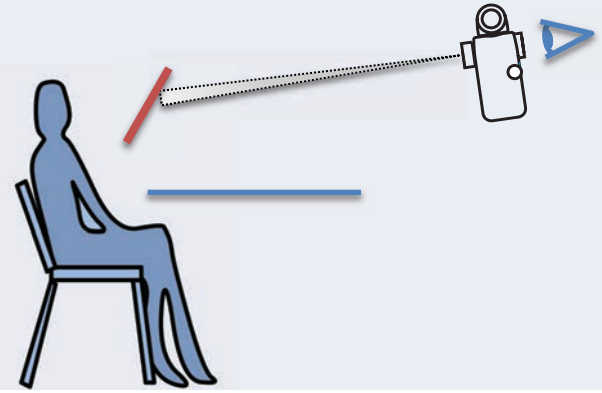
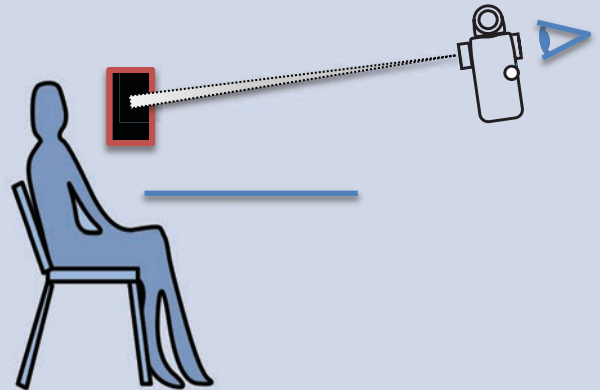
Participant Measurements

Key – Vertical

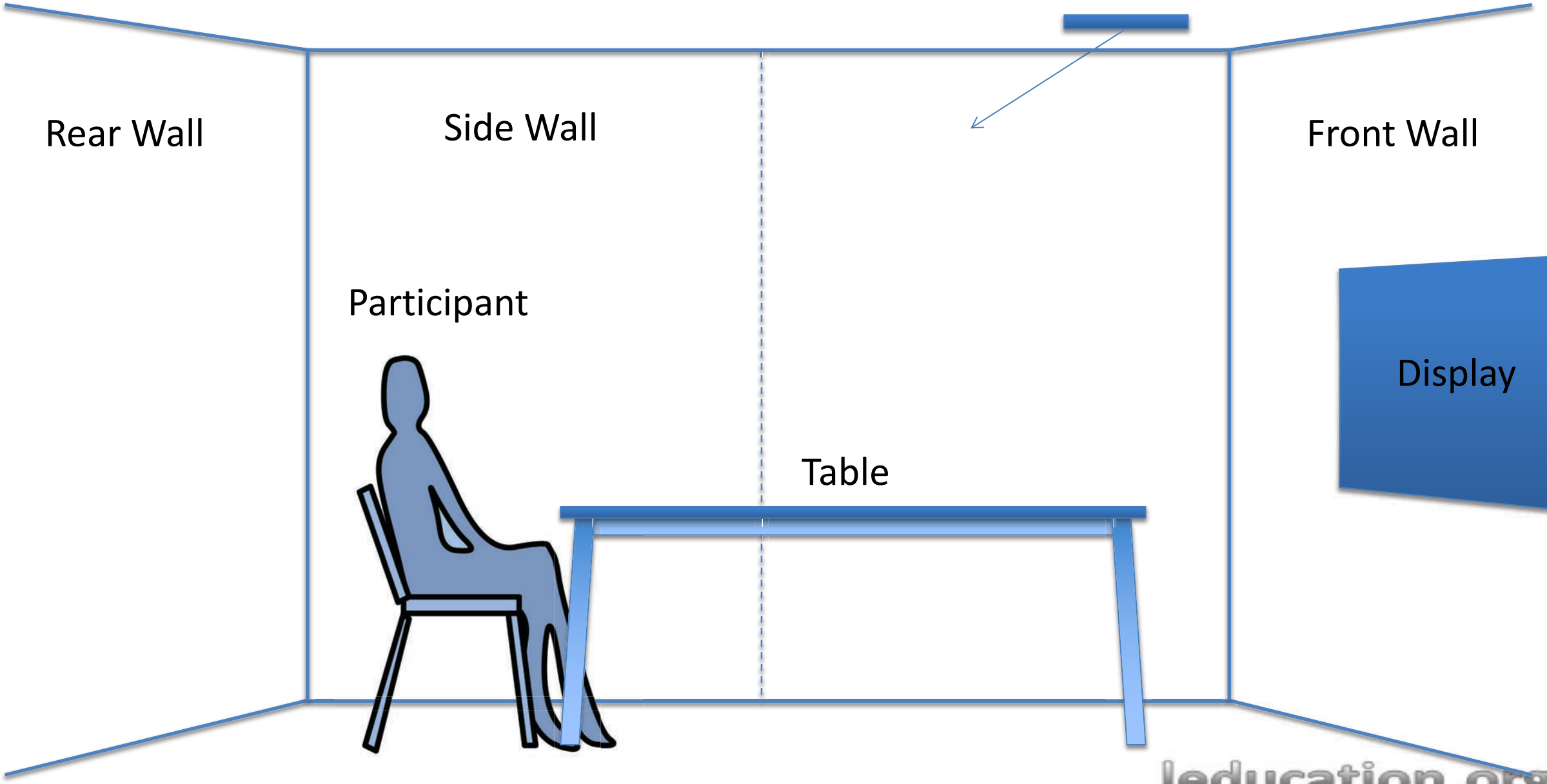
Fill – 45° Down

Side – Vertical

Left and Right

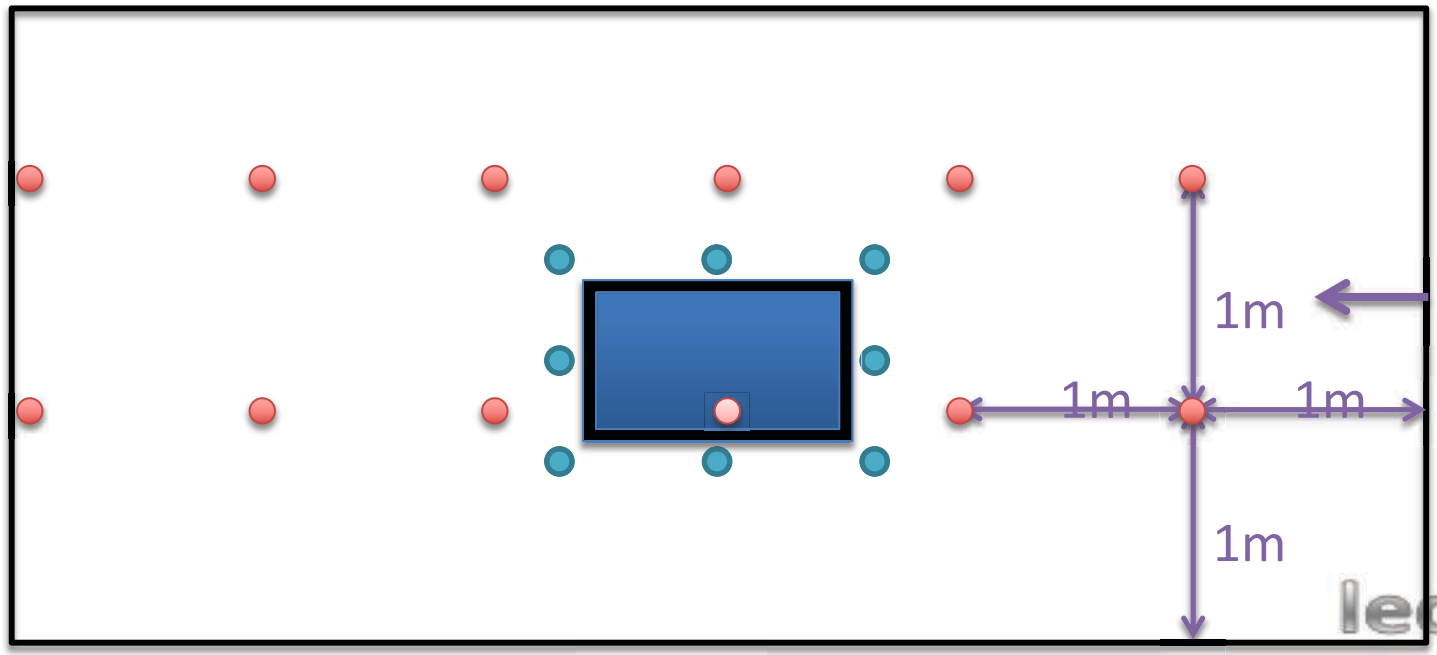
Participants | Measurements & Calculations		Performance Criteria
Luminance On 18% gray card - vertical		**11 to 21** cd/sq.m, at each seating position. Target: **15-20** cd/sq.m
Key:Fill Luminance Ratio On 18% gray card - vertically angled		**1.2:1 to 2.5:1**
Left:Right Luminance Ratio On 18% gray card - horizontally angled		**0.33:1 to 3:1**

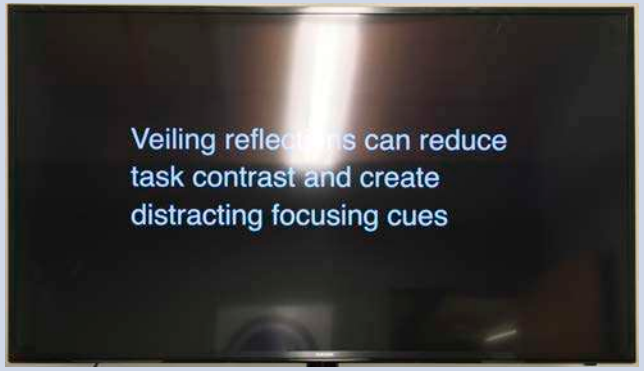
The Room



Walls | Measurements & Calculations	Performance Criteria
Average Vertical Luminance of the Wall Surface • 1m x 1m grid, entire Rear Wall, rear half of Side Walls. • Exclude minimum measured value, then average remaining.	Minimum **30** cd/sq.m
Wall-to-Participant Luminance Ratio Average vertical wall luminance (as above), divided by the average of all participant gray card Key Light luminance measurements.	From **0.7:1 to 1.8:1** or From **2.2:1 to 6:1**
Uniformity, Mean:Minimum Luminance Ratio Average Rear and Side wall luminance (as above), divided by the second smallest wall luminance measurement value.	Maximum **2.1:1**

Front Wall | Measurements & Calculations	Performance Criteria
Average of vertical luminance measurements • 1m x 1m grid, entire front wall • Additional measurements around the display	**9 to 2100** cd/sq.m



Displays | Measurements & Calculations	Performance Criteria
For Direct-View Displays: • **Maximum Vertical Luminance** of display surface area from any seating position 	Maximum **24** cd/sq.m
For Projected Displays: • **Minimum Contrast Ratio** as measured using ANSI/InfoComm 3M-2011 Projected Image System Contrast Ratio	**15:1**

Table

- Measured at required participant locations
- Luminance of table surface 12” perpendicular from edge of the table.

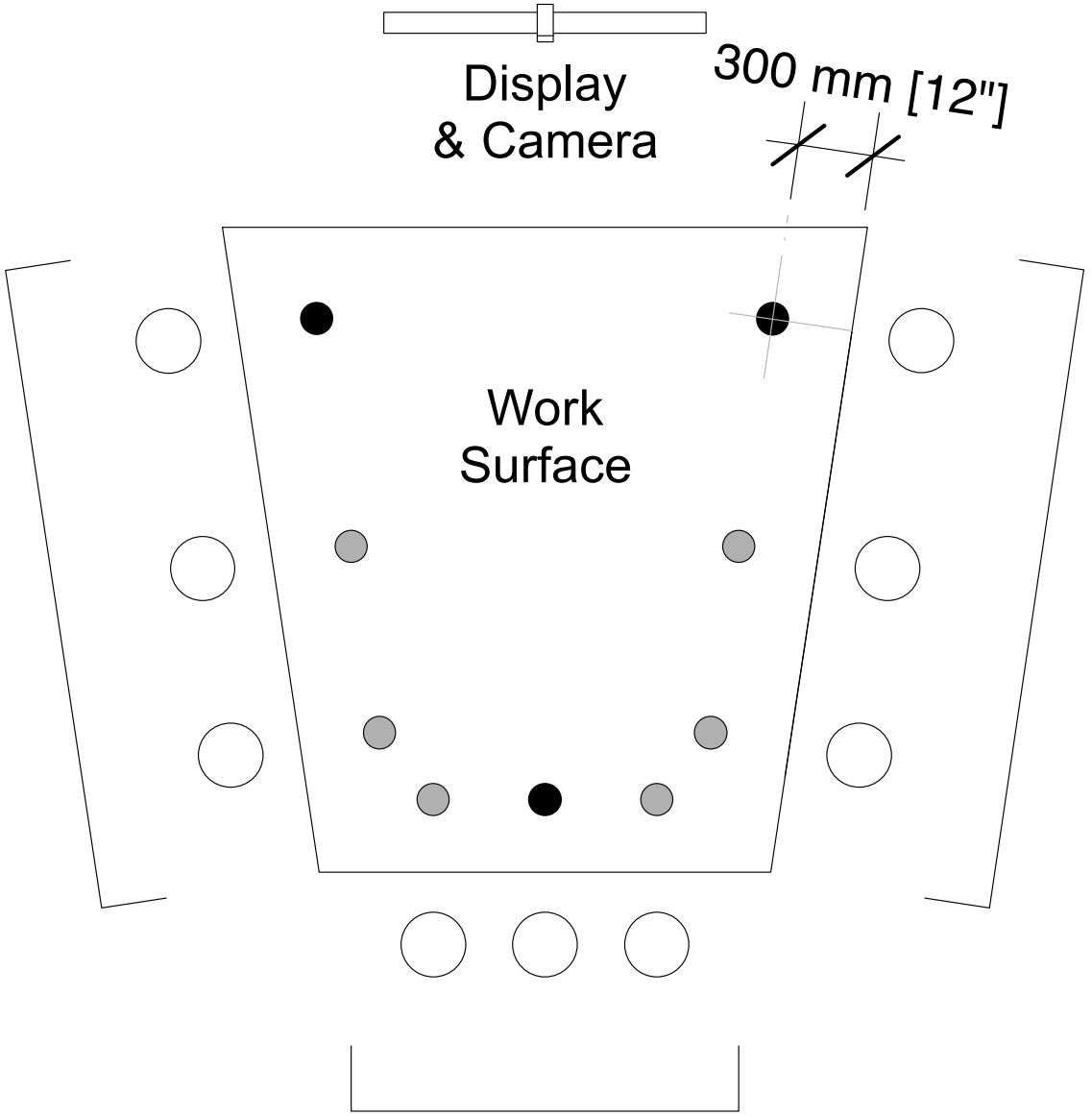


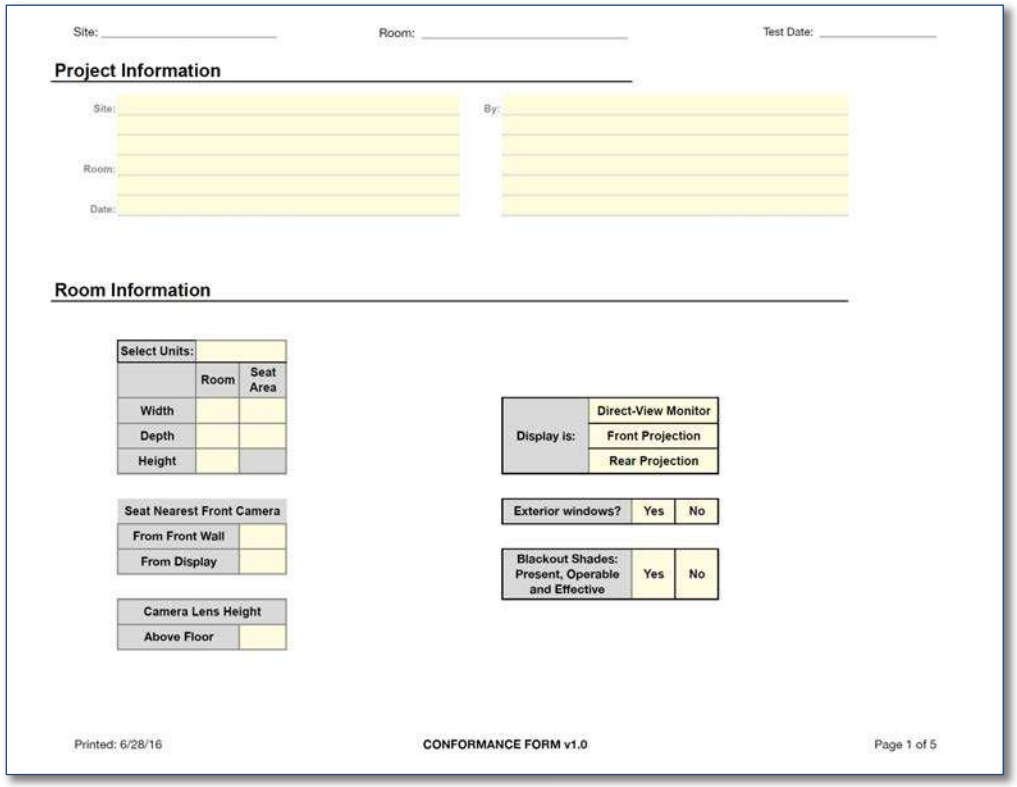
Table | Measurements & Calculations	Performance Criteria
Average of **horizontal luminance measurements** • At 12” from edge of the work surface at each required participant seating position.	Minimum **30** cd/sq.m
Table-to-Participant Luminance Ratio • Average horizontal table luminance (as above), divided by the average of all participant gray card Key Light luminance measurements	**0.7:1 to 1.8:1** or **2.2:1 to 6:1**

LEDucation

Mandatory

Project and Room Information

- Location, Date, Tester
- Room Measurements (width, depth and height)
- Exterior Windows
- Blackout Shades



Site: _____ Room: _____ Test Date: _____

Project Information

Site: By:

Room:

Date:

Room Information

Select Units:		
	Room	Seat Area
Width		
Depth		
Height		

Seat Nearest Front Camera	
From Front Wall	
From Display	

Camera Lens Height	
Above Floor	

Display is:	Direct-View Monitor
	Front Projection
	Rear Projection

Exterior windows?	Yes	No

Blackout Shades: Present, Operable and Effective	Yes	No

Printed: 6/28/16 CONFORMANCE FORM v1.0 Page 1 of 5

leducation.org

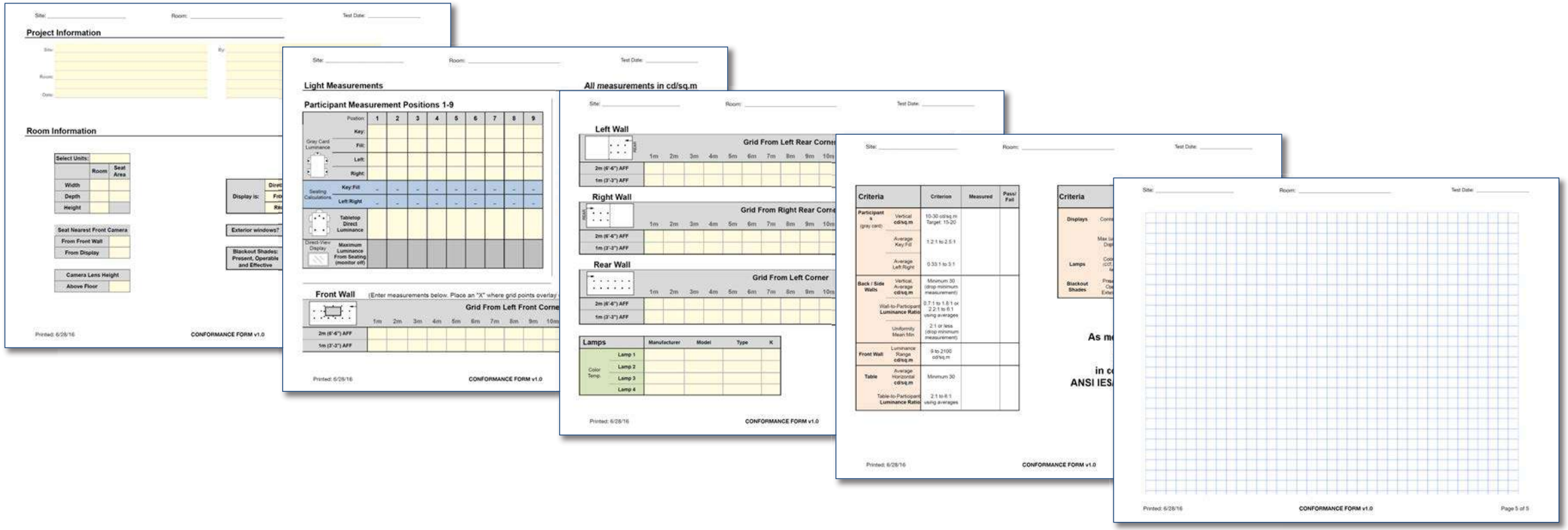
Element	Measurements & Calculations	Performance Criteria
Lamps	Correlated Color Temperature (CCT) Measured or from manufacturer	Lamps/Luminaires within **5% (+/-2.5%)** Kelvin
Exterior Windows	Blackout shades installed and operable on all exterior windows	• **All** shade perimeters masked to minimize daylight leakage • **No** outside view from primary camera position • **No** visible daylight

LEDucation

Mandatory

Conformance Form

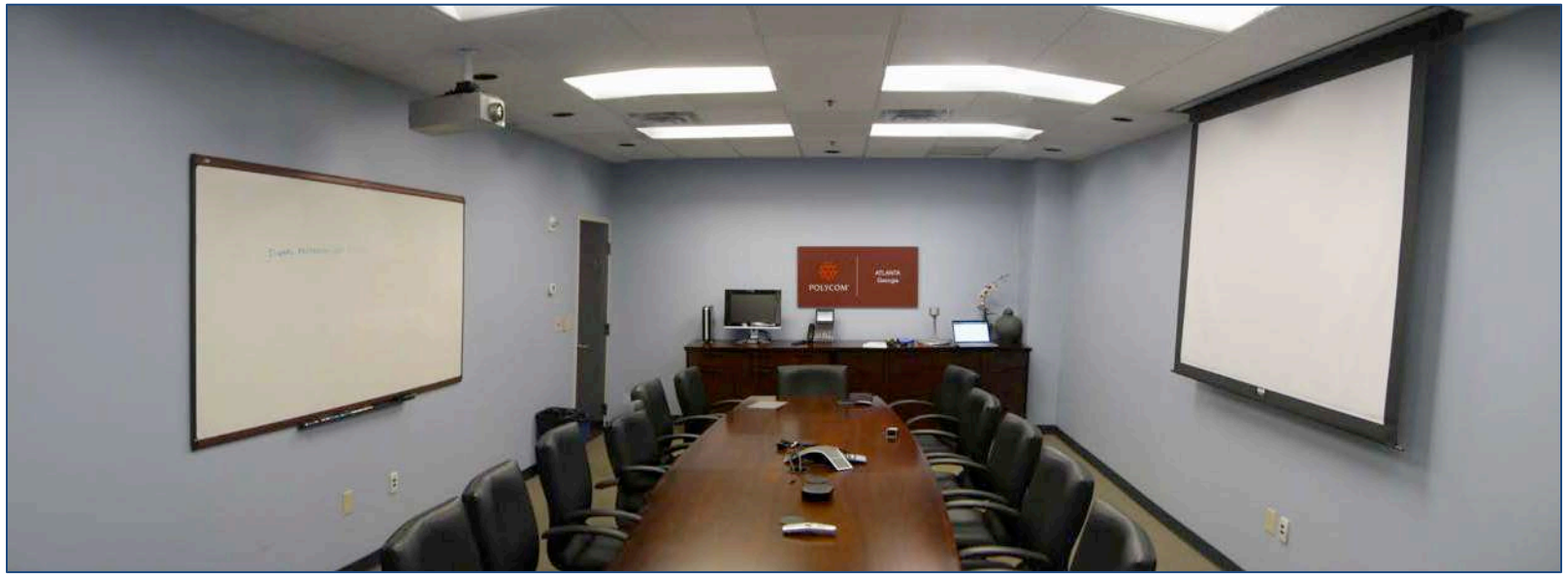
Electronic and/or paper, included with Standard.



Mandatory

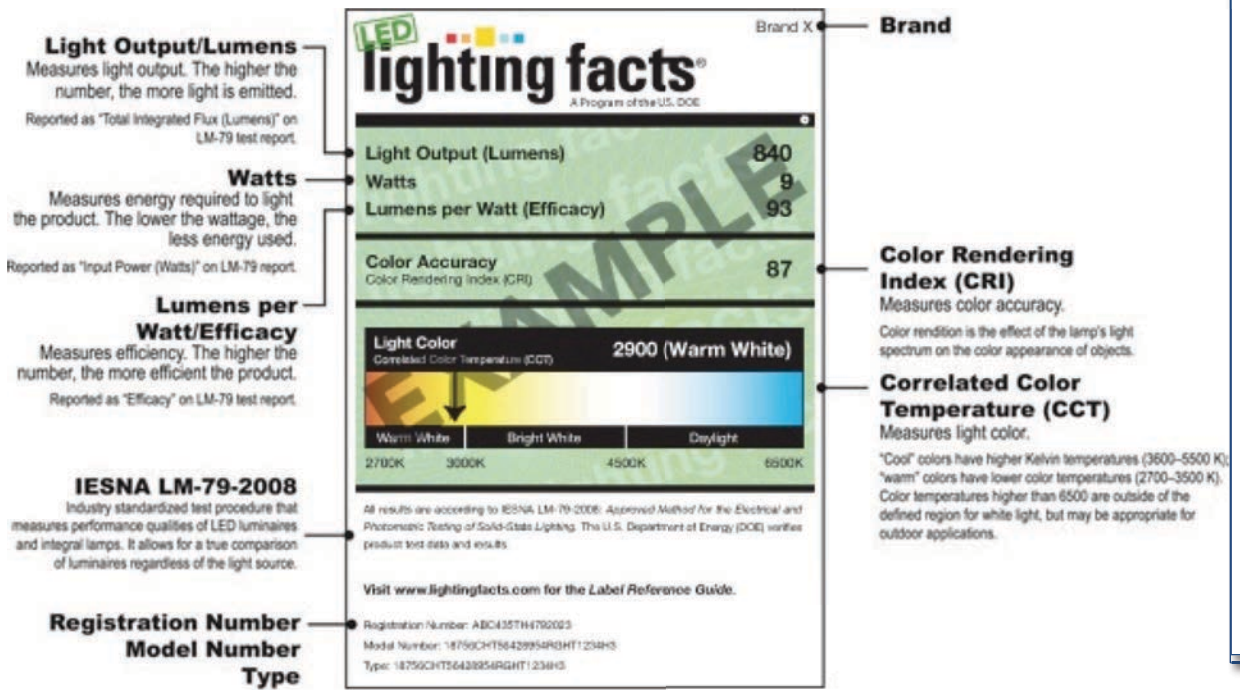
Photographs

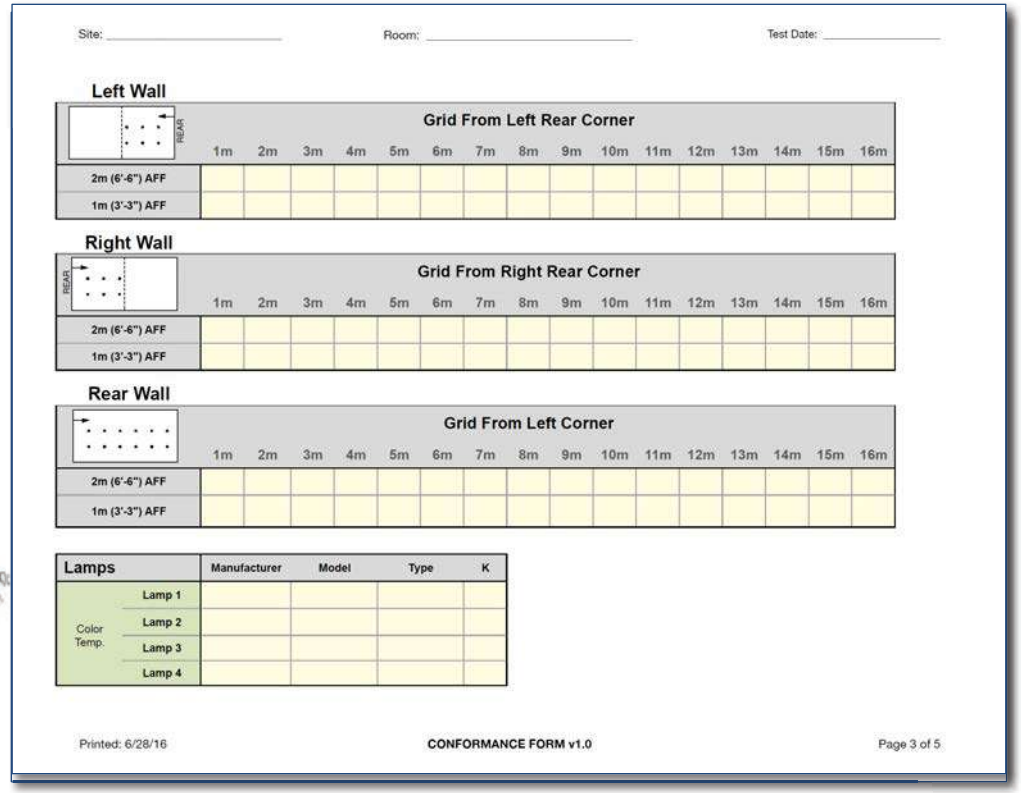
Room Front and Rear



Lamps

- Color Temperature (CCT) in Kelvins (K)





Mandatory

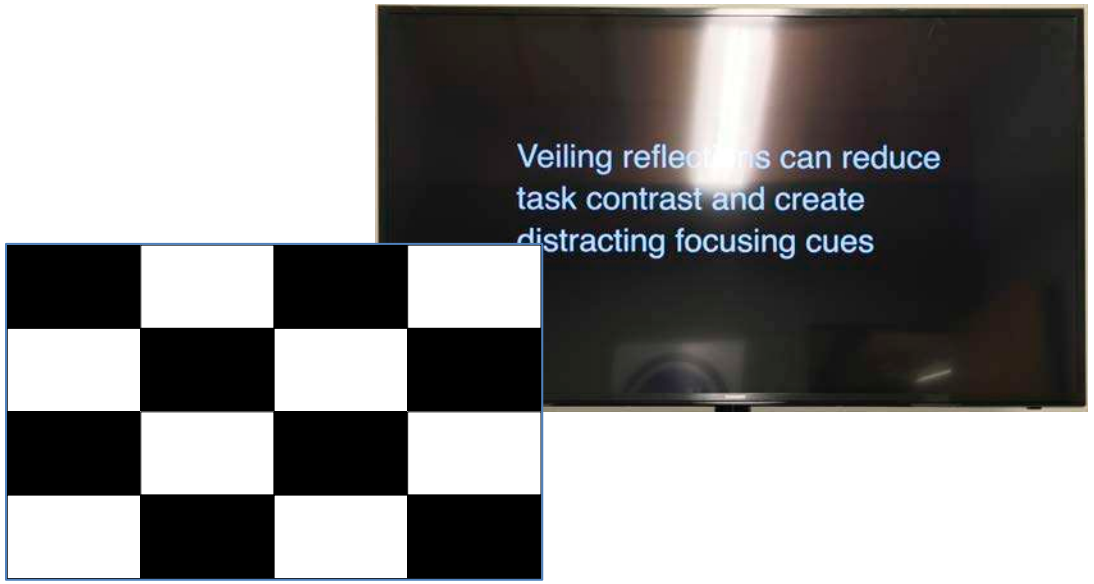
leducation.org

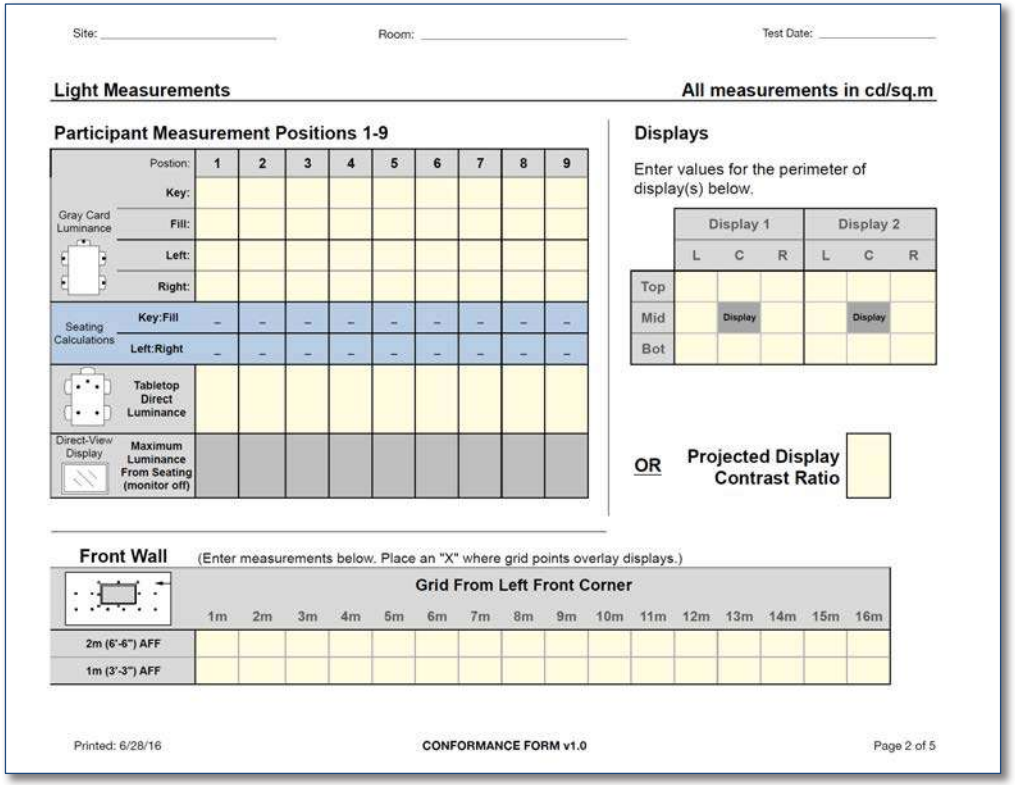
LEDucation

Mandatory

Display Contrast

- Direct View - Maximum Luminance of Reflections
- Projection – Contrast Ratio
  - ANSI/INFOCOMM 3M-2011





Site: _____ Room: _____ Test Date: _____

Light Measurements — **All measurements in cd/sq.m**

Participant Measurement Positions 1-9

	Postion:	1	2	3	4	5	6	7	8	9
Gray Card Luminance	Key:									
	Fill:									
	Left:									
	Right:									
Seating Calculations	Key:Fill	–	–	–	–	–	–	–	–	–
	Left:Right	–	–	–	–	–	–	–	–	–
	Tabletop Direct Luminance									
Direct-View Display	Maximum Luminance From Seating (monitor off)									

Displays

Enter values for the perimeter of display(s) below.

	Display 1			Display 2		
	L	C	R	L	C	R
Top						
Mid		Display			Display	
Bot						

OR **Projected Display Contrast Ratio**

Front Wall (Enter measurements below. Place an "X" where grid points overlay displays.)

	Grid From Left Front Corner															
	1m	2m	3m	4m	5m	6m	7m	8m	9m	10m	11m	12m	13m	14m	15m	16m
2m (6'-6") AFF																
1m (3'-3") AFF																

Printed: 6/28/16 — CONFORMANCE FORM v1.0 — Page 2 of 5

This concludes The American Institute of Architects Continuing Education Systems Course

leducation.org