Fundamentals
105 Lighting Design Process

Presented by
Shaun Darragh LC, MIES
Senior Lighting Specialist
July 28, 2020

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●2

Before we begin…

During the Class

- Attendees will be muted
- Please use the chat feature in the control panel to submit questions to LDL staff
- The presenter will pause to address questions every ~10 minutes
- Please participate in the online polls.

Following the Class

- Please take the short survey
- A recording and the slide deck will be posted on LDL's webpage
- Reach out to LightingDesignLab@seattle.gov with comments or questions.

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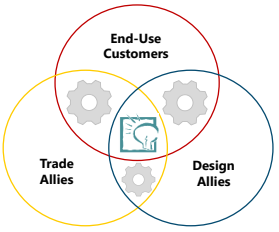
Who We Work With



It takes a village…

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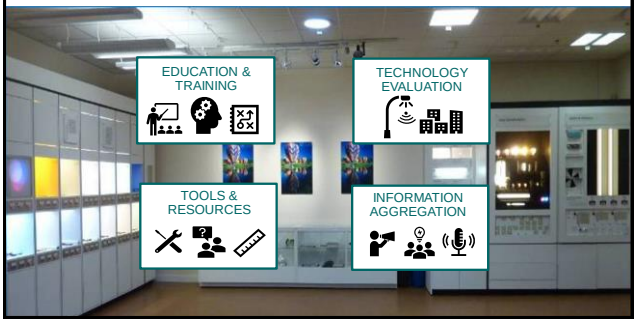
LDL's Four Core Service Areas



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Shaun.Darragh@seattle.gov

- More than 30 years in the lighting industry as an architectural lighting designer, instructor, daylighting and sustainability specialist, lighting control system consultant, and theatrical designer.
- Has taught and consulted on sustainability issues, lighting, and daylighting for the Lighting Design Lab and University of Washington Architecture Department

Selected Projects

- King Abdullah University of Science and Technology
- Masdar Headquarters
- Pearl River Tower
- Canyon Ranch Spa Club
- Amgen Helix Campus
- Reebok World Headquarters
- Reno Sparks Convention Center
- Pacific Place Retail Center
- Ala Moana Retail Center
- REI Denver Flagship Store
- Boeing Commercial Airplanes Offices
- Real Networks Headquarters
- Tommy Bahama Headquarters
- Microsoft B16/17
- San Francisco PUC Headquarters

Selected Awards

- Amgen Helix Campus
- Amgen Helix Pedestrian Bridge
- Canyon Ranch Spa Club
- Harvard University 60 Oxford
- King Street Station
- Lighting Design Lab
- Methodist Hospital Research Institute
- Microsoft B16/17
- One Cambridge Center
- Pacific Place Retail Center
- Reebok World Headquarters
- Reno Sparks Convention Center
- Real Networks Headquarters
- SFPUC Headquarters
- Tommy Bahama Headquarters

AIA COTE Top 10

- REI Flagship Store Denver
- King Abdullah University of Science and Technology
- San Francisco PUC Headquarters
- Manitoba Hydro Place

●7

Learning Objectives

- Understand the key concepts in lighting design strategy and development
- Understand the basics of developing visual lighting hierarchies
- Understand how and why to select target light levels and related criteria
- Understand the most common types of project delivery and milestones

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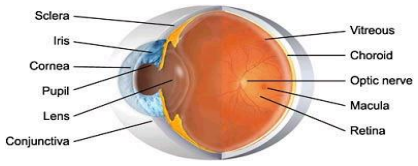
Pop Quiz

How would you best describe your role?

●9

Why are we all here?



As much as 80% of our environmental perception is visual.

Courtesy: IESNA

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Light is intensely personal

Johannes Vermeer
Woman Writing A Letter

Edward Hopper
Morning Sun

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How Does It All Work Together?

Let's look at four simple elements:

- Generators
- Modifiers
- Encoders
- Interpreters

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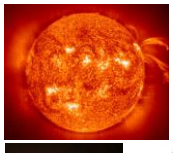
Generators



Courtesy: NASA, Candles.com, Xicato, Philips, Sylvania

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Modifiers

REI Denver Flagship
Mithun

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Encoders

Courtesy: Health Magazine

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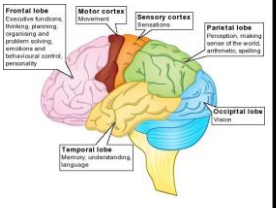
Interpreters



Courtesy: Stanford University

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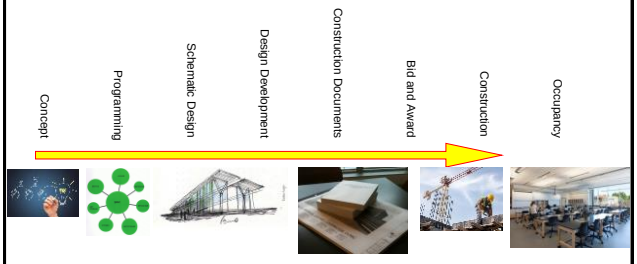
Traditional Design Process



Courtesy: Tadao Ando, Schacht Aalani

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Lighting Design Process

Courtesy: CJ Brockway

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Integrated Design

Every building system impacts every other building system

Sometimes it seems we're successively approximating our way to success.

Be prepared to do unfamiliar tasks.

Naturally, all of these things will need to happen in an already compressed schedule….

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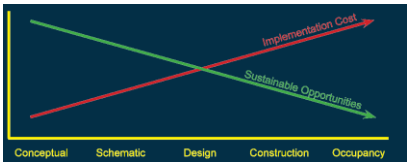
Integrate Early



- Owner
- Architect
- Engineers
- Lighting Consultant
- Specialty Consultants
- Contractor

The integrated design team needs to be assembled and engaged in the process from the beginning.

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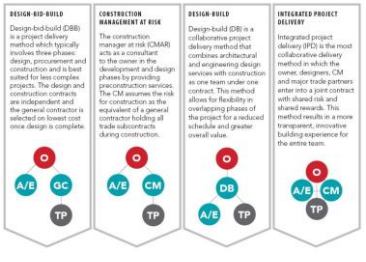
Project Methodologies

- There are several prevalent project delivery models
- Retrofit projects may follow hybrid approaches, but most will share some level of commonality.



Courtesy: McCown Gordon Construction

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Pop Quiz

Does project delivery method impact the Design process?

●23

Lighting Quality

I don't know what it is, but I know it when I see it……

Courtesy: IES

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Quality in Three Categories

- Bad: the lighting system suffers from a quality defect.
- Indifferent: the lighting system has no quality defects
- Good: the lighting system is technically correct and excites the spirit.

Courtesy: Peter Boyce, Journal of the IES

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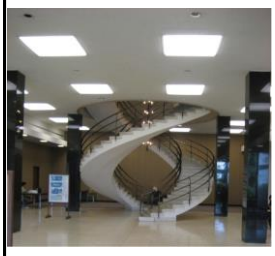
Quality in Three Categories



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Pfeiffer Associates, Milhuri

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Architecture

- Form
- Composition
- Style
- Best Practices
- Codes & Standards

King Abdullah University of Science and Technology
HOK

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Economics and the Environment

- Installation
- Maintenance
- Operation
- Energy
- Materials
- Decarbonization

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Human Needs

- Visibility
- Task performance
- Visual comfort
- Social communication
- Mood and atmosphere
- Health, safety, and well being

- Physiology
- Circadian Entrainment

SFPUC Headquarters
KMD Architects

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Light For People!

Consider the needs of human vision before the needs of a light meter.

Make sure that your client understands the difference early on.

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What is lighting design?

- A concept
- Meeting visual needs
- Defining space
- Selecting luminaires
- Selecting controls
- Making it all work together

- Art
- Science

King Street Station
Reed and Stem, ZGF

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Who makes choices about lighting?

Architects

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●32

Who makes choices about lighting?

Lighting Designers

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●33

Who makes choices about lighting?

Engineers

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Who makes choices about lighting?

- Lighting Designers
- Electrical Engineers
- Manufacturers Agents
- Facility Operators
- Interior Designers
- Electricians
- Architects
- Owners
- End Users

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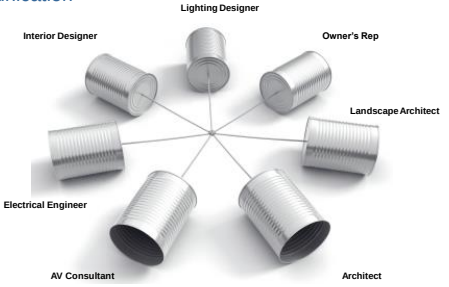
Communication



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Think Inside the Box

How many pounds of power do we have?

How many pounds of light do we need?

Where can we most effectively apply the light and power?

How many pounds of light can we afford?

Establish project parameters early

Make sure that everyone understands the project goals and needs and is working towards them together.

- Owner
- Architect
- Interior Designer
- Engineers
- Other Consultants
- Contractors
- User Groups

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Pop Quiz

What is the most important consideration for any lighting design?

●38

What is needed to convey for construction?

- Basis of Design
- Code Review Documents
- Lighting Plans
- Reflected Ceiling Plans
- Lighting Details
- Luminaire Schedules
- Control Plans
- Control Schedules
- Calculations
- CSI Specifications
- Cut Sheet Packages
- Energy Code Forms

Microsoft Building 43
NBBJ

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That's great but where do we begin?

Pan Pacific Yokohama
Hirsch Bednar

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Fundamental Questions

Begin at the beginning….and go on till you come to the end: then stop.

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Fundamental Questions

- What are the critical visual tasks?
- Who is using this space?
- How will users be impacted?
- Where are the surfaces that are most important?
- Why are we doing the lighting (expectations)?
- When does the lighting need to be engaged?

Courtesy: Brooklyn Woods

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What is the primary purpose for the lighting?

- Working tasks
- Way finding
- Recreation
- Aesthetic
- Safety

Canyon Ranch Spa RTKL

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What are the primary tasks

Courtesy: Eclipse Dental

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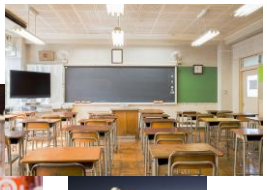
Where are the primary tasks?

- Vertical
- Horizontal
- At grade
- Higher up



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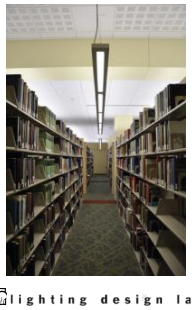
What are the dominant surfaces?

- Walls
- Ceilings
- Specific Tasks?



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Pfeiffer Associates, Milhun

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Where are the dominant surfaces?

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What is lighting design?

- Fundamentally it's integrating the visual field
- Understanding how light interacts with surfaces
- Understanding how that interaction affects human perception and physiology
- Applying light and lighting equipment to most effectively meet stated project goals.

Midtown21
LMN

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Just put the light…and shadow… where you want it …

'You just chip away everything that is not David'

-Michelangelo…(well, maybe…)

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●49

Pop Quiz

How do we commonly perceive brightness?

●50

Analyze your project

- Project Type
- Project Scale
- Visual Tasks / Needs
- Surface Opportunities
- User Demographics
- Special Uses?
- Special Requirements?
- Budget
- Owner's Goals
- Code requirements

Plymouth Church
LMN

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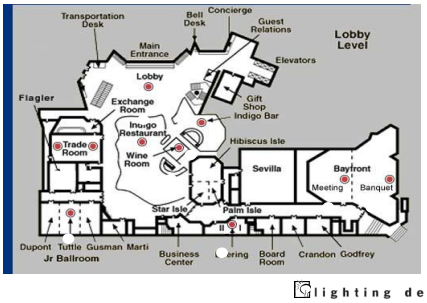
●51

Lobby floor plan analysis



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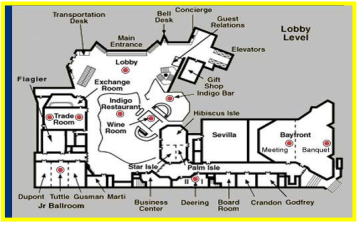
Lobby floor plan analysis

- Locate entrance and egress points
- Identify main destinations
- Identify main circulation routes



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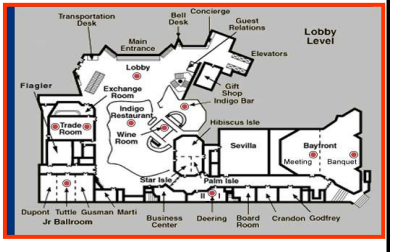
Lobby floor plan analysis

- Locate secondary destinations
- Locate secondary circulation routes
- Locate areas to highlight for interest



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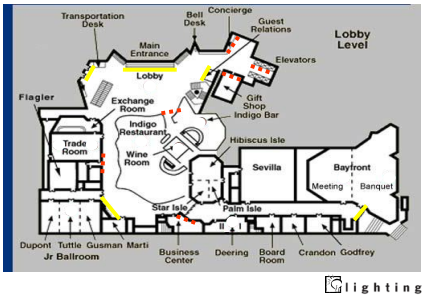
Lobby floor plan analysis



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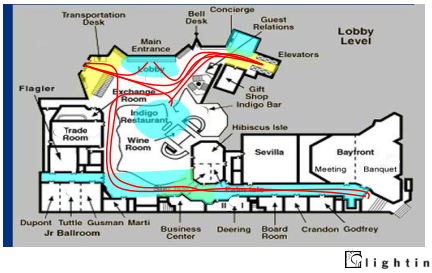
Lobby floor plan analysis

Identify main circulation routes



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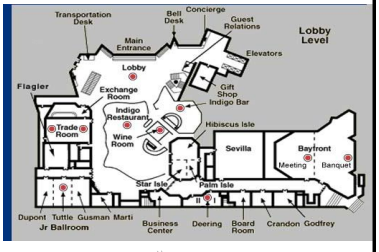
Lighting Hierarchy

- Which areas should have the highest emphasis
- Medium emphasis
- Low emphasis



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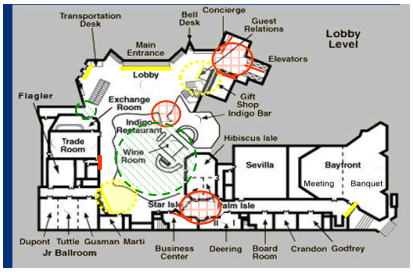
Lighting Hierarchy



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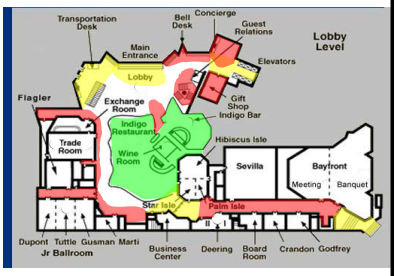
Lighting Hierarchy

A hierarchy may suggest:

- Light levels
- Surfaces to be accented
- Specific Task locations
- Wayfinding Routes
- Destinations



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Fundamental Toolkit

Intensity
- Candela
- Lux

Direction
- Accent
- Ambient

Chromaticity
- Color Temperature
- Color Spectrum

Surfaces
- Color
- Texture

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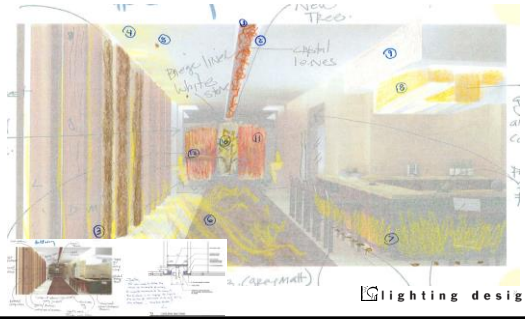
●60

Develop Concepts



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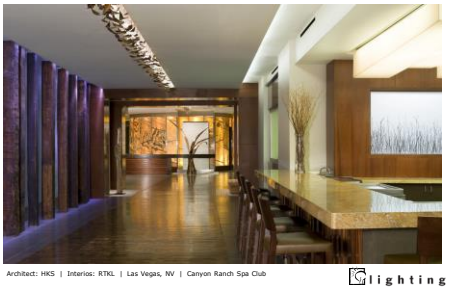
Delivery



Architect: HKS | Interios: RTKL | Las Vegas, NV | Canyon Ranch Spa Club

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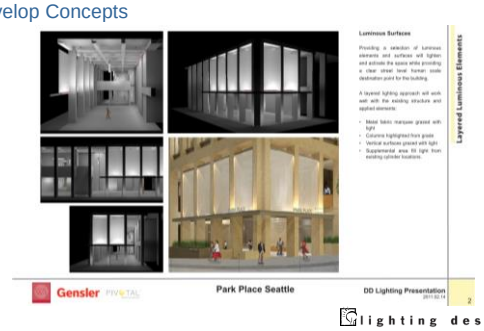
Develop Concepts



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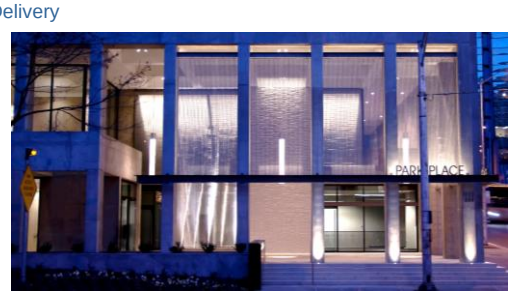
Delivery



Park Place
Gensler

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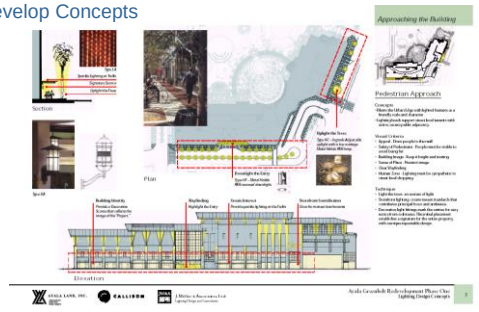
●64

Develop Concepts



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Delivery

Ayala Greenbelt Mall
Callison

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●66

Develop Concepts

Stacks

The stacks in this area are existing metal stacks that stand 7' – 6" above finished floor. The reading material in the stacks will be illuminated by a fluorescent, direct/indirect stack light mounted on uni-strut and supported on the metal braces that support the metal stacks. This lighting system allows the ceiling to be free of penetration while ensuring even illumination of the stacks as well as providing uplighting for the ceiling plane

- Design Light Level: 15-20 fc
- Design Light Level at Vertical Surface of Stacks: 15-45 fc
- Allowed Lighting Power Density: 1.2 watts/sf
- Lighting Control: Relay switched with sweep and over-ride

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Pfeiffer Associates, Mithun

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Present Concepts

●68

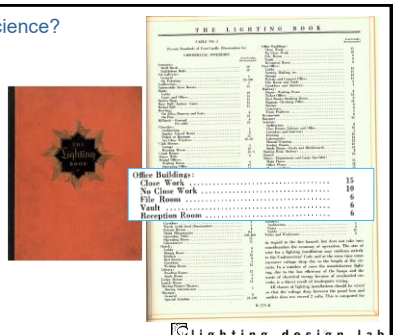
Pop Quiz

How important is it to iteratively develop concepts and review them with the team?

●69

So….what about the science?

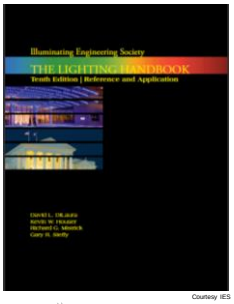
- We have a hierarchy, and know what we want to highlight, what about the specifics?
- Most commonly that means picking target light levels.



●70

So….what about the science?

- IES to the rescue – but there are others….
- THE IES develops and published a variety of recommended practice documents that provide guidance on things like target horizontal AND vertical illuminance.



Courtesy IES

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So….what about the science?

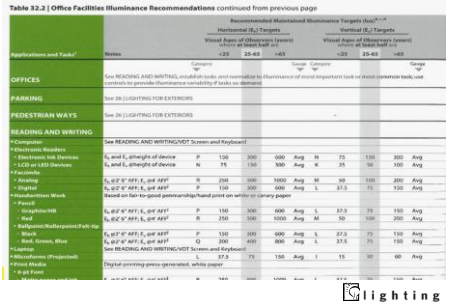
Table 32.2 | Office Facilities Illuminance Recommendations continued from previous page

Applications and Tasks[a]	Notes	Recommended Maintained Illuminance Targets (lux)[b,c,d]									
		Horizontal (E_h) Targets				Vertical (E_v) Targets					
		Visual Ages of Observers (years)				Visual Ages of Observers (years)					
		<25	25-65	>65	Groups "up"	<25	25-65	>65	Groups "up"		
OFFICES	See READING AND WRITING, establish tasks and illuminance of most important task or most common tasks; use controls to provide illuminance variability if tasks so demand.										
PARKING	See 36 | LIGHTING FOR EXTERIORS										
PEDESTRIAN WAYS	See 36 | LIGHTING FOR EXTERIORS										
READING AND WRITING											
• Computer:	See READING AND WRITING/VDT Screen and Keyboard										
• Electronic Readers											
• Electronic Ink Devices	E_h and E_v @height of device	P	150	300	600	Avg	N	75	150	300	Avg
• LCD or LED Devices	E_h and E_v @height of device	N	75	150	300	Avg	R	25	50	100	Avg
• Facsimile:											
• Analog	E_h @ 2'-6" AFF; E_v @4' AFF	R	250	500	1000	Avg	M	90	100	200	Avg
• Digital	E_h @ 2'-6" AFF; E_v @4' AFF	P	150	300	600	Avg	L	37.5	75	150	Avg
• Handwritten Work	Based on fair-to-good penmanship/hand print on white or canary paper										
• Pencil											
• Graphite/HB	E_h @ 2'-6" AFF; E_v @4' AFF	P	150	300	600	Avg	L	37.5	75	150	Avg
• Red	E_h @ 2'-6" AFF; E_v @4' AFF	R	250	500	1000	Avg	M	50	100	200	Avg
• Ballpoint/Rollerpoint/Felt-tip											
• Black	E_h @ 2'-6" AFF; E_v @4' AFF	P	150	300	600	Avg	L	37.5	75	150	Avg
• Red, Green, Blue	E_h @ 2'-6" AFF; E_v @4' AFF	Q	200	400	800	Avg	L	37.5	75	150	Avg
• Laptop	See READING AND WRITING/VDT Screen and Keyboard										
• Microforms (Projected)		L	37.5	75	150	Avg	I	15	30	60	Avg
• Print Media	Digital-printing-press-generated, white paper										
• 8 pt Font											

Courtesy IES

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●72

Other Resources?

https://www.lightingdesignlab.com/resources

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●73

So….what about the science?

Figure 52. Determination of Illuminance Categories[A]

Orientation and simple visual tasks. Visual performance is largely unimportant. These tasks are found in public spaces where reading and visual inspection are only occasionally performed. Higher levels are recommended for tasks where visual performance is occasionally important.

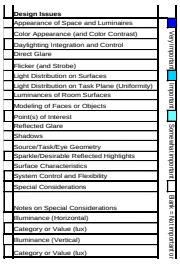
A	Public spaces	30 lx (3 fc)
B	Simple orientation for short visits	50 lx (5 fc)
C	Working spaces where simple visual tasks are performed	100 lx (10 fc)

Common visual tasks. Visual performance is important. These tasks are found in commercial, industrial and residential applications. Recommended illuminance levels differ because of the characteristics of the visual task being illuminated. Higher levels are recommended for visual tasks with critical elements of low contrast or small size.

D	Performance of visual tasks of high contrast and large size	300 lx (30 fc)
E	Performance of visual tasks of high contrast and small size, or visual tasks of low contrast and large size	500 lx (50 fc)
F	Performance of visual tasks of low contrast and small size	1000 lx (100 fc)

Special visual tasks. Visual performance is of critical importance. These tasks are very specialized, including those with very small or very low contrast critical elements. Recommended illuminance levels should be achieved with supplementary task lighting. Higher recommended levels are often achieved by moving the light source closer to the task.

G	Performance of visual tasks near threshold	3000 to 10,000 lx (300 to 1000 fc)



Design Issues	Very Important	Important	Somewhat Important	Blank = Not Important or not applicable
Appearance of Space and Luminaires				
Color Appearance (and Color Contrast)				
Daylighting Integration and Control				
Direct Glare				
Flicker (and Strobe)				
Light Distribution on Surfaces				
Light Distribution on Task Plane (Uniformity)				
Luminances of Room Surfaces				
Modeling of Faces or Objects				
Point(s) of Interest				
Reflected Glare				
Shadows				
Source/Task/Eye Geometry				
Sparkle/Desirable Reflected Highlights				
Surface Characteristics				
System Control and Flexibility				
Special Considerations				
Notes on Special Considerations				
Illuminance (Horizontal)				
Category or Value (lux)				
Illuminance (Vertical)				
Category or Value (lux)				

Courtesy IES

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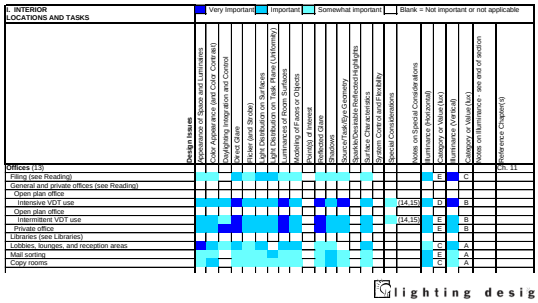
●74

Design Considerations



I. INTERIOR LOCATIONS AND TASKS	Design Issues	Appearance of Space and Luminaires	Color Appearance (and Color Contrast)	Daylighting Integration and Control	Direct Glare	Flicker (and Strobe)	Light Distribution on Surfaces	Light Distribution on Task Plane (Uniformity)	Luminances of Room Surfaces	Modeling of Faces or Objects	Point(s) of Interest	Reflected Glare	Shadows	Source/Task/Eye Geometry	Sparkle/Desirable Reflected Highlights	Surface Characteristics	System Control and Flexibility	Special Considerations	Notes on Special Considerations	Illuminance (Horizontal)	Category or Value (lux)	Illuminance (Vertical)	Category or Value (lux)	Notes on Illuminance - see end of section	Reference Chapter(s)
Offices (13)																					I				Ch. 11
Filing (see Reading)																					E		C		
General and private offices (see Reading)																					I				
Open plan office																					I				
Intensive VDT use																			14,15		D		B		
Open plan office																					I				
Intermittent VDT use																			14,15		E		B		
Private office																					E		B		
Libraries (see Libraries)																					I				
Lobbies, lounges, and reception areas																					C		A		
Mail sorting																					E		A		
Copy rooms																					C		A		

Courtesy IES

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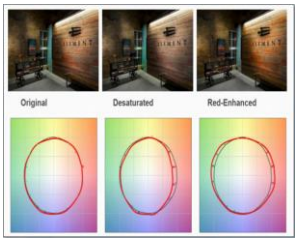
Color Quality of the Light

- Spectral Power
- Color Temperature
- Color Rendering
- Color Fidelity
- TM 30

- Light and Human Perception Class
- https://www.lightingdesignlab.com/resources



Courtesy PNNL

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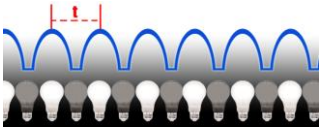
Flicker

- All light sources can flicker under the right circumstances
- LED sources may be particularly susceptible with low quality drivers or in specific cases.
- This may be ok, mildly annoying, hugely annoying, or disastrous.
- In some cases (think LiFi) very high frequency flicker is desirable)



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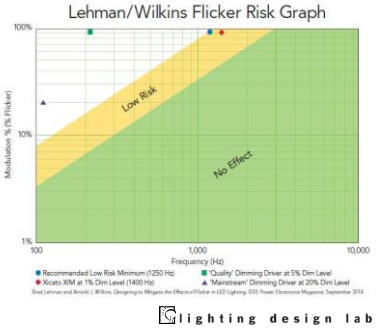
Flicker

- Is it flicker, flutter, shimmer, or other?
- % flicker = amplitude
- Amplitude and frequency both matter.
- Check at multiple dimmed light levels.
- Do the research upfront to ensure compatibility
- When in doubt ask for samples and test



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Control and Flexibility

- Almost all luminaires are now dimmable
- Dimming control is the way to fine tune and extend the range of the project.

UC Davis Lecture Halls
Various Buildings

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Why use advanced lighting controls?

- Flexibility
- Productivity
- User Satisfaction
- Aesthetics
- Maintenance
- LEED / WELL / LBC
- Energy Savings
- Energy Codes

Tommy Bahama Headquarters
SHB

NLC Fundamentals Class
https://www.lightingdesignlab.com/resources

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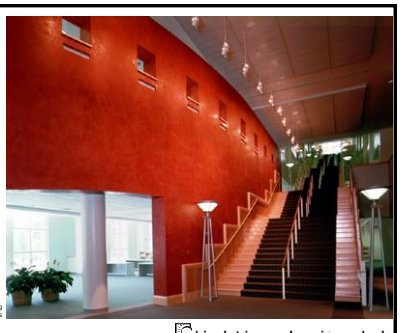
Architectural Surfaces



UMB Health Science Building
Perry Dean Rogers

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Context and Meaning

Courtesy: Advanced Lighting Guidelines

King Abdullah University of Science and Technology
HOK

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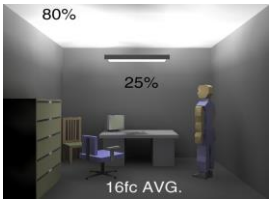
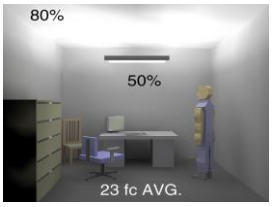
Surfaces

Room Surfaces must be considered as part of the lighting system in any space. They are effectively primary or secondary reflectors.





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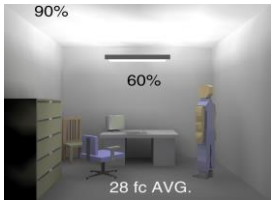
Surfaces

Color contrast can add visual interest to many spaces.



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Surfaces

Typical Reflectance Values

- ACT Ceiling Tile: 70-90%
- White Paint: 70-90%
- Light Carpeting: 40-50%
- Dark Carpeting: 5-20%
- Brick: 10-30%
- Wood: 10-60%

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Architectural Surfaces

Reebok World Headquarters
NBBJ

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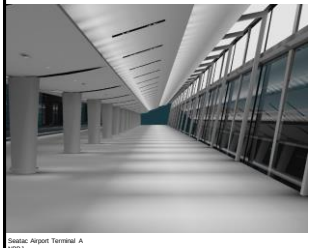
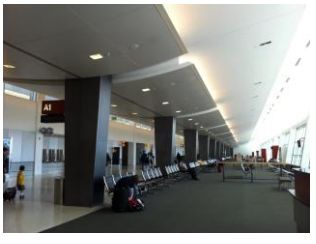
●86

Architectural Surfaces





Seatac Airport Terminal A
NBBJ

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Pop Quiz

How can we effectively use lighted surfaces in architecture?

●88

Simple Steps to Better Lighting

- Effective Daylight
- View to Horizon

SFPUC Headquarters
KMD Architects

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●89

Simple Steps to Better Lighting

- Light Surfaces
- Consider Brightness Perception
- Consider Context
- Consider Composition

Seatac Airport Renovation
Weinstein Copeland

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Simple Steps to Better Lighting

Seatac Airport Renovation
Weinstein Copeland

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Simple Steps to Better Lighting

- Manage Contrast
- Balance the Visual Field

UW MEB
2GF

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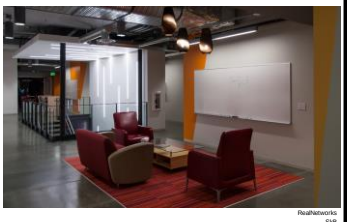
Simple Steps to Better Lighting

- Select appropriate light
- Put light where it's needed
- Let Shadow live where it's appropriate
- Accept natural variability



RealNetworks
SMB

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Simple Steps to Better Lighting

Lighting Controls

- Basically all energy codes now require significant lighting controls.
- Widespread adoption of LED technology makes dimming an obvious choice
- Allowing users to select their own light levels generally leads to enhanced satisfaction – and lower light levels.

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Less Simple Steps to Better Lighting

- Consider Color Spectrum
- Tunable Color
- Black body curve dimming

Children's Hospital
ZGF

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The documentation class(es)….

- Concepts Narratives and Sketches
- Basis of Design
- Schematic Drawings
- Code Review Documents
- Lighting Plans
- Lighting Details
- Luminaire Schedules
- Control Plans
- Control Schedules
- Calculations
- CSI Specifications
- Cut Sheet Packages
- Energy Code Forms

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●97

And now – a few words from LDL

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●98

Upcoming LDL Online Events

LDL Course	Delivery Date	Time
Audit and Retrofit Techniques	August 11	10:00 - Noon
Introduction to Codes and Standards	August 25	10:00 - Noon
Promoting Energy Efficient Lighting Systems	September 8	10:00 - Noon
What Went Wrong?	September 22	10:30 - Noon

Today's slide deck and previous online courses can be found on our website

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Visit us online

OR

Email Us
lightingdesignlab@seattle.gov

Todays slide deck will be posted here!

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We'll *SEE* you on the next call… ☺

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●102