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Designing Supportive Environments For Low Vision: Effective Tools and Techniques

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Questions related to specific materials, methods, and services will be addressed at the conclusion of this presentation.

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1. Understand the relationship between low vision and lighting quality and quantity.
2. Discover the basic tools and design rules that can have the greatest effect in supportive visual environments.
3. Compare current recommended practices for designing for low vision populations with general design codes and standards.
4. Learn about lighting considerations to help design healthy visual environments for seniors and other low vision populations.

Photo - Larry Lefever: RLPS Architects

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IES Lighting for the Aged & Partially Sighted Committee

- **Scope:**
  - Continually monitor and discuss current issues dealing with older adults and it's implications for lighting.
  - Evaluate empirical research data from published works from research experts, evidence based results as well as design practice to better inform the RP-28 document.
  - Work with other related IES committees and other professional organizations to better address the older adults lighting needs.

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- **The RP-28 recommended practice serves as guidance to a wide range of users:**
  - Individuals
  - Design professionals
  - Owners/managers of commercial buildings and facilities serving older populations
  - Code and regulatory agencies and legislative bodies
- **Addresses:**
  - Illuminance levels
  - Lighting design and environmental issues affecting older adults and low vison population for most common spaces
    - Including outdoor/site, commercial spaces, lodging and residential spaces and senior care facilities

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- RP-28-16 is a pioneering document
  - Recognized in other countries as the go-to document.
- RP-28 is a living document which can now be updated on a yearly basis.
  - This is critical as research and practical use of new lighting technologies provides new information almost on a daily basis.
- Inclusive of current research and design practice to help older adults maintain a quality of life into their advanced age.
- *"Loss of Independence* has been identified as the greatest fear of aging, so seniors will be looking to maximize their aging vision."

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RP-28-16: What's New?

- Low vision population considered
  - reflected in the new name
- Emphasis on special considerations for increasing visibility
- Changes in illuminance levels
- Health (significance of light on health)
- Advances in LED and its implication for energy and quality of light/health potential
- Design guide--Application
- Controls and area-specific strategies

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1. **Introduction**
2. **Quality and Quantity of Lighting for Vision: S**ource-Dependent Factors; View Dependent Factors; and Considerations to Improve Visibility.
3. **Design Guide:** Design Issues Common to all Space Types; Consideration by Area; Transitions Spaces between Exterior and Interior Spaces; Interior Common Spaces; Commercial Spaces; Lodging and Residential Spaces; Senior Care Facilities; and Visually Based Work and Classroom Accommodations for Those with Traumatic Brain Injury and Photosensitivity.
4. **Light Sources:** Qualitative and Quantitative Characteristics: Choosing Light Source Color; and Labeling.
5. **Daylight:** Advantages of Daylight; Daylight Availability; Understanding Daylight Distribution; Daylighting Analysis Methods; and Guidelines for Good Daylighting Design.
6. **Light for Health:** Circadian System; Sleep Disturbances in the Aging Population; Seasonal Depression (SAD); Hazards of Light Therapy, and Vitamin D3.
7. **Lighting Controls:** Code Requirement, Lighting Control Technologies, Area-Specific Strategies for Senior Care Facilities.

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NIBS Low Vision Design Committee (LVDC)

- Established in November 2011
- Scope:

"Address the needs of all occupants of the built environment, including those with low vision, through improvements in designs and operational procedures for new and existing facilities to enhance the function, safety, and quality of life. Identify existing knowledge and needs for further research to accomplish these objectives."

- The Institute's Mission:

" . . . to serve the nation and the public interest by supporting advances in building sciences and technology to improve the built environment."

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Aging Eye

VISUAL SYSTEM, EYE DISEASES, VISUAL FUNCTION

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- What is low vision?
  - 20/70 acuity or worse after correction (glasses or surgery)
  - Worse than 20/60 acuity in the better eye which can not be corrected

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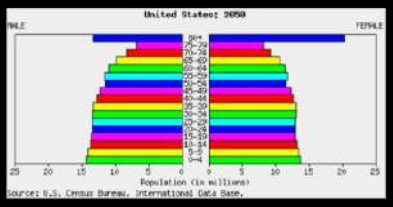

- Population aged >=80 years
  - from 9.3 million in 2000 to 19.5 million in 2030

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The clinical problems as we age

- Natural age related issues
  - Reduction in retinal photoreceptors (Rods)
  - Lens hardens (Presbyopia)
  - Lens yellows (Opacification)
  - Pupil gets smaller (Pupillary Miosos)
  - Floaters
  - Dark adaptation slows (Delayed rhodopsin regeneration)

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Disease

- Cataracts
- Glaucoma
- Retinal Detachment
- Age Related Macular Degeneration
- Diabetic Retinopathy
- Retinitis Pigmentosa

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- What do all these have in common?
  1. Reduced amount of light entering eye
     - More light is required in general, loss of value contrast
  2. Increased light scatter in eye
     - Greater likelihood of glare (Direct & Reflected)
  3. Reduction of blue wavelengths of light
     - Circadian rhythm is compromised

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In United States from 2005 to 2014 for Ages 65 to 85
Ten Leading Causes of Nonfatal Unintentional Injuries

Centers for Disease Control and Prevention, National Center for Injury Prevention and Control (CDC). 2016. Web-based Injury Statistics Query and Reporting System (WISQARS) [online]. Nonfatal Injury Data https://webappa.cdc.gov/sasweb/ncipc/nfilead.html.

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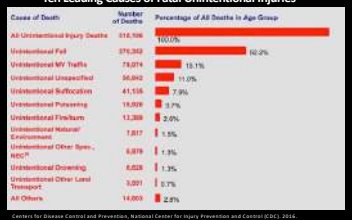

Centers for Disease Control and Prevention, National Center for Injury Prevention and Control (CDC). 2016. Web-based Injury Statistics Query and Reporting System (WISQARS) [online]. Nonfatal Injury Data https://webappa.cdc.gov/sasweb/ncipc/nfilead.html.

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20yr old eye

70-Year Old Eye Needing 1.25 D Near Add

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- Physiological & Psychological effects
  - Perception of quality of life (Psychological)
    - At the top of the list of public health fears for Americans is vision loss (21%)
      - Americans say their biggest concern about low vision is losing their ability to live independently (75%)
    - Impaired Concentration and Learning
    - Pain Perception
    - Decreased Productivity
    - Depression

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    - Links to facility satisfaction, quality of life = care demands ($$$$$$$$)

American Foundation for the Blind

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- Physiological & Psychological effects
  - Circadian Disruption – Fragmented Cycles (*low 24-hr amplitude)*
    - Poor sleep** and higher stress (Eismann et al.,2010)
    - Increased anxiety and depression (Du-Quiton et al.,2009)
    - Increased smoking (Kageyama et al.,2005)
    - Cardiovascular disease (Young et al.,2007; Maemura et al.,2007)
    - Type 2 diabetes (Kreier et al.,2007)
    - Higher incidence of breast cancer (Schernhammer et al.,2001; Hansen,2001)
    - Higher incidence of prostate cancer
      - W.H.O – Shift work a probable carcinogen

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Design Guide

OPPORTUNITIES

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Prescriptive

- Illuminance targets (See table 1)
- Value Contrast
  - 30pts critical locations
- Uniformity ratios
  - Ceilings/Walls: 3:1
  - Task/Surround: 1.5-3:1
  - Ext. Walkways Max/Min: 10:1

General Recommendations / Awareness

- Space Planning
- Color & CRI (hue, saturation, value, SPD)
- Value Contrast
- Surface Sheen, Texture & Patterns
- Luminaire Appearance
- Daylighting
- Light Distribution Patterns
- Surface Luminance
- Glare Control
- Circadian Applications

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- **IES RP-28 Recommended Maintained Illuminance Levels** (partial)

- Table 1 in RP-28-16 as printed contained footcandles errors.
- Errata #1 corrects those errors.
- If you have a printed copy of RP-28-16 please make sure to include the Errata in the Table 1 section.

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ASHRAE/IES 90.1 – 2013 thru 2016

Higher LPD's provided for Visually Impaired:

Table 9.6.1 (Pages 95 – 99)

Space type:	Typical	Visually impaired
• Dining/Activity Areas:	.65	2.65
• Corridors:	.66	.92
• Lobbies:	.90	1.80
• Restrooms:	.98	1.21
Building Type	**Typical**	**Visually Impaired**
• Living Room/Recreation:	.73	2.41
• Chapel	1.53	2.21

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–Exterior Building Challenges

- Walking Surfaces
- Obstacle avoidance
- Level Changes
- Reflective surfaces
- Transitions
- Signage & Wayfinding

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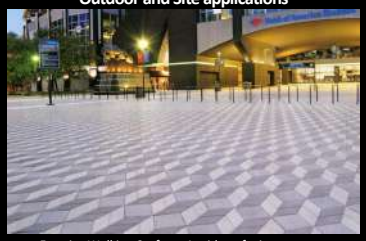
Outdoor and Site applications



Exterior Walking Surface: Avoid confusing patterns

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Outdoor and Site applications

- Vertical mirrors at entry way create optical illusions leading to accidents.

- Transparent panels lack
- definition and create hazards.

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Outdoor and Site applications

Highly Visible Wayfinding

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Outdoor and Site applications

- Transit Center Parking

- Transit Center Lobby

Photographer: Loren Nelson, Designer: Daren Vandeberg of Reyes Engineering

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Safe Pathways / Obstacle Avoidance

- Contrast + Light

Photo: Yadira Fuentes-Pagan

- Highlighting Potential Hazard

Photo: Eunice Noel-Waggoner

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Safe Pathways / Obstacle Avoidance

- Value comparison of old & new concrete

- Walking surfaces should be medium to dark in value

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Safe Pathways / Obstacle Avoidance

- Contrast needed @ ramps & curbs to alert for trip hazards

- Avoid tapered steps or add a handrail at the location.

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Transitional Zones

- Bright daylight outside

- Very dim entry vestibule with glass doors lacking definition.

Eyes of older people, and those with low vision, adapt more slowly from daylight to interior lighting.

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- Interior Building Challenges
  - Space Planning
  - Signage & Wayfinding
  - Floor patterns / Finishes
  - Transition zones
  - Value contrast
  - Lighting

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Interior Common Spaces

Space Planning: Be Consistent!

- **Intuitive locations (i.e. reception desk, services, etc.)**
- **Consistent Bathroom locations**
- **Avoid Circular routes.**

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Interior Common Spaces

Highly Visible Wayfinding

- Contrast between letters and ground
- Contrast between sign and wall

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Interior Common Spaces

Bring signs to the user

- Use good contrast to repeat info at eye level.
- Light from the side or internally to avoid shadows

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Interior Common Spaces

- **Use high contrast features and accents**
- Highlight destinations
- Delineate boundaries

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Interior Common Spaces

Floor Patterns and Finishes

Pattern conceals the edge of the steps

Reflective surfaces are difficult to decipher

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Interior Common Spaces

Direct Glare

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Interior Common Spaces

Strong shadows from window mullions can change throughout the day

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Interior Common Spaces

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Interior Common Spaces

Photo courtesy: Jeffrey Totaro/EwingCole Architects

- Integration of daylight and artificial light
- Pendant direct/indirect
- Cove light providing diffused ambient light
- Good contrast between dark furniture against a medium value carpet
- Eating utensils against a white table cloth

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Interior Common Spaces

- Integration of daylight and electric light
- Pendants light the central circulation and seating areas.
- Coves light the wall surfaces.

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Interior Common Spaces

- Entry Cove light
  - Accentuates the entry door
  - Lights the key hole and room numbers
  - Provides light on visitors faces for ease of recognition

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Interior Common Spaces

- Our eye adjusts to the brightest spot in the visual field.
- Signage and obstacles disappear in the shadows

Consistent lighting for circulation

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Example Design - Corridor

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Example Design – Corridor

- LLF: .8
- Surfaces: 80/50/20
- Wall Zone: 12"
- +30" Workplane

Requirements:
- IECC 2018 / ASHRAE 90.1-2016
  - LPD: .66 w/ft²
  - LPD Low Vision: .92 w/ft²
- RP28-16
  - Min. E_h: 10fc (Night) 20fc (Day) (+30" workplane)

Results: (LED Downlight)
- LPD: **.5 w/ft² (Beats all LPD's)**
- Min. E_H: **20-21fc**

Results: (CFL Downlight)
- LPD: .90 **w/ft² (Beats Low Vision)**
- Min. E_H: **20-21fc**

LED DOWNLIGHT
- 917 Delivered Lumens
- 15w
- 62° Beam
- Qty 45

CFL DOWNLIGHT
- 1600 Delivered Lumens
- 37w
- 65° Beam
- Qty 33

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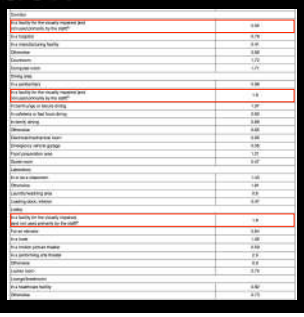

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Example Design - Restrooms

Common Solutions:

- Single Glary fixture on ceiling or over mirror

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Example Design - Restrooms

Better Solutions:

- Removed the vanity overhead luminaire
- Replaced the existing mirror with an illuminated LED mirror
- Replaced glary globe with surface mounted LED fixture
- Replaced existing handrails with new handrails with integrated amber LEDs controlled by motion sensors

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Example Design - Restrooms

AREA	FLUOR	LED
Center sink HOR	18 fc	90 fc
Center sink VERT	12 fc	170 fc
Face VERT	20 fc	190 fc

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Light & Health

CIRCADIAN SYSTEM

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Lighting characteristics affecting the visual & circadian systems

Cool During the Day

Warm at Night

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Lighting characteristics affecting the visual & circadian systems

Characteristic	Visual	Circadian
Quantity	Sensitive to both low and high light levels depending on task	Sensitivity depends on environmental / experimental conditions
Spectrum	Photopic peak sensitivity is 555 nm; Scotopic peak sensitivity is 507 nm	Peak sensitivity to short-wavelength (459 – 508 nm in animal models, 459 – 464 nm in humans)
Timing	Responds at any time	Magnitude of response will vary depending on circadian time
Duration	Very short response time	Responds to intermittent pulses or single long-period pulses (requires longer duration than visual system)
Spatial distribution	Distribution is important	Distribution is much less important as long as light reaches the retina

Modified slide from IES "Light and Health Seminar"

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Equivalent Melanoptic Lux (EML)

- EML expresses the ability of the light source spectrum to stimulate the iRGCs relative to the standard photopic stimulation of the visual system.
- (Used by the WELL Building Standard)

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Lighting characteristics affecting the visual & circadian systems

Example resident room schedules (Based on LRC Model)

7 am – 2 pm: 6000K – 0.3 CS

2 pm – 6 pm: 4100K – 0.2 CS

6 pm – 8 pm: 2700K – 0.15 CS

Nightlight option: 2400K

(CS = Circadian Stimulus)

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The Springs at Carmen Oaks, Lake Oswego, OR

Morning

Evening

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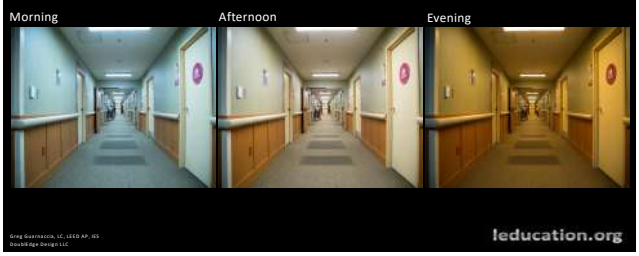

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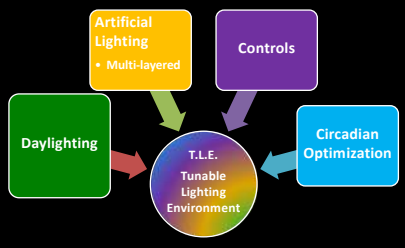

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Key Points

- ❑ Aging population + prevalence of low vision
- ❑ The aging visual system and eye diseases cause visual impairment affecting one's visual functions
  - Perception of the visual environment, color vision, contrast, acuity, daily tasks, mobility
- ❑ Consider lighting for visual needs
  - Consider higher illuminance (RP-28-16 Table 1) for safety and visibility with attention to glare control
  - Consider contrast (luminance, value) for safety and visibility
- ❑ Consider lighting for non-visual biological/circadian needs
  - ❑ Benefits of daylight integration
  - ❑ Light intensity, spectrum, timing, distribution & duration (electric light sources … LED)
- ❑ Consider controls for safety and well being

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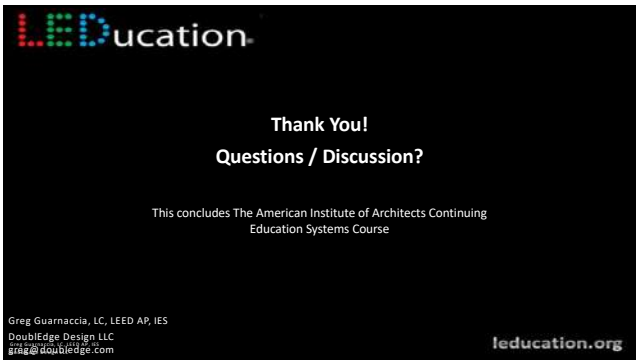
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Thank You!
Questions / Discussion?
This concludes The American Institute of Architects Continuing Education Systems Course
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