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LIGHTING, VISUAL QUALITY, and ENERGY EFFICIENCY

Description:
Lighting has a significant effect on how we perceive our world, and maintaining visual quality is an important factor in aiding our perception. Maintaining visual quality means being mindful of the type, color, and quantity of light provided in a given space or area and encompasses a range of issues for both general and special populations, such as assuring that enough light reaches the eye, maintaining even lighting levels across the floor, and heightening security. Lighting also uses a significant amount of energy in buildings, which can contribute to how the above issues are managed; but there are steps that can be taken to promote energy efficiency and ensure that the public is healthy and safe.

Visual Quality: One aspect of maintaining visual quality is assuring that there is enough light for users to see and perform their daily tasks without eye strain. The impact of low visual quality negatively affects people with normal vision, but is particularly challenging for the older population and people of all ages with vision loss.

> *The Aging Eye:* Eyesight weakens over time. Glare is poorly tolerated by older people, as are extreme differences in lighting levels. With age, the pupil decreases in size and the lens thickens. The eye of a typical 60-year old lets in only one-third of the light that is received by a typical 20-year old's eye.
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> *General Public:* Many of the lighting designs that are beneficial for older people also help younger-aged people with vision loss. The Web site, Better Medicine (http://www.localhealth.com/article/vision-loss/causes) lists numerous causes of vision impairment among people of all ages; and the American Foundation for the Blind reports that "more than 25 million Americans report experiencing significant vision loss," including 57,696 legally blind children (http://www.afb.org/default.asp).

These demographics, tied with an overall aging of the general population, including people with vision loss, call for awareness to eyesight issues and visual quality in both newly-constructed buildings and existing spaces that serve all populations.

Energy Efficiency: According to the U. S. Environmental Protection Agency,[1] in the average U.S. home, lighting accounts for about 20 per cent of the electric bill; and the U. S. Energy Information Administration[2] reports that lighting accounts for 21 per cent of overall electricity use in commercial buildings in the United States. Improving lighting efficiency has both direct and indirect benefits. For example,

"over 23 per cent of the electricity used in California is for lighting; in commercial space, five percent of the electricity used for air conditioning eliminates heat that is generated by lighting."[3] As a significant source of energy use, lighting presents an opportunity for capturing energy savings through the use of energy-efficient equipment. High-quality, energy-efficient lighting is possible if the proper equipment is used for a given application and if the characteristics of the affected population are considered.

Most facilities are phasing out the use of inefficient incandescent lighting, using fluorescent, LED (light-emitting diode), and metal halide technologies in its place. More efficient versions of existing fluorescent lighting are available as well. However, not all types of lighting are appropriate for every application. For example, the best form of lighting for a cafeteria in a senior housing complex is different from what is best for a bedroom in a single-family home. Thus, it is important that a project's design staff be familiar with *both* lighting quality and energy efficiency.

Natural daylight is an important consideration from both a lighting-quality and energy-efficiency perspective. The use of daylight to minimize internal lighting needs is a common strategy in reducing a building's overall energy use. In addition, the use of daylight in both residential and commercial facilities can help maintain circadian rhythms and overall health.

Exterior lighting systems support both navigation and security. Visual quality for exterior systems assures that pedestrians and vehicles can identify points of entrance and exit from a facility, and that potential hazards (for example curbs and stairs) are lit well enough to either negotiate or avoid. Exterior lighting can also discourage criminal activity and allow security surveillance systems to function properly.

The quest for security should not result in over-lit exteriors which show light trespass (where lighting spills over property lines) and contribute to sky glow (night brightening of the sky caused by outdoor man-made lighting and natural atmospheric and celestial factors). Local municipalities may also have legislation addressing sky glow, especially in rural or recreational areas.

As with interior lighting, older technology (such as mercury vapor systems) in exterior lighting can be replaced with more efficient systems, such as metal halide or LED, which use equipment that precisely directs light to ground level where it is needed.

References:

[1] U. S. Environmental Protection Agency, *Lighting Products*: http://www.energystar.gov/index.cfm?c=lighting.pr_lighting.

[2] Energy Information Administration—Independent Statistics and Analysis, "Energy Use in Commercial Buildings, 2003," Use of *Energy in the United States Explained:* http://www.eia.gov/energyexplained/index.cfm?page=us_energy_commercial.

[3] California Energy Commission, *Public Interest Energy Research (PIER) Program*: http://www.archenergy.com/lrp/default.htm.

Benefits:
There are numerous benefits to maintaining visual quality and energy efficiency in lighting systems:

For consumers:
- Health, safety, and self-care:
  - Maintaining appropriate levels of lighting, as well as the elimination of glare:
    - Reduces the risk of falls, missteps, and other accidents for people of all ages and functional levels, including older adults, younger people with visual loss, children, and others.
    - Supports the ability of all people to be self-caring and self-managing.
    - The use of daylight, in place of artificial light, contributes to the maintenance of healthy circadian rhythms.

For the community:
- High quality lighting reduces the number of maintenance call-backs.

- Energy-efficient lighting systems reduce energy costs and demand on the electrical grid.

- High-quality exterior lighting promotes site safety and security.

- Exterior lighting that minimizes "sky glow" nighttime light pollution has positive implications for the environment and individuals' health.

Impediments or barriers to development or implementation:
Obstacles to achieving a space with a high quality, but energy-efficient, visual environment include lack of information, funding, and misconceptions:
- In designing new spaces, the design team may not be aware of the special lighting needs of the older adult population or of other population groups with visual impairments. However, numerous design guides and information exist on how to improve lighting to meet the needs of individuals with visual impairments.

- Homeowners, as well as building and facility operators, are not sufficiently knowledgeable about the cost differences between conventional lighting options and newer energy-efficient lighting options. However, the incremental cost of installing a high-quality, energy-efficient lighting scheme is minimal; using high-efficiency lighting fixtures typically has an attractive payback and will pay for itself over time.

- Fluorescent and compact fluorescent lamps contain a small amount of mercury, and the fear of mercury keeps some users from adopting this option. In addition, disposal of these lamps must be treated with care; and all facilities should comply with the requirements of federal, state, and local legislation regarding the disposal of lamps and ballasts. However, compact fluorescent lamps are a relatively simple energy-efficiency retrofit, and many retailers have implemented take-back programs to properly recycle and dispose of spent lamps.

- Some individuals believe that fluorescent lamps (both linear and compact) give poor light quality by casting the room in a greenish glow. However, great improvements have been made in fluorescent lighting in the past ten years, including an improved array of colors available and minimization of flicker and hum from fluorescent ballasts.

- Some consumers have had poor experiences with compact fluorescent screw-in lamps and feel they do not provide high enough lighting levels. Manufacturer packaging for screw-in compact fluorescent lamps tends to recommend a 4:1 wattage reduction (for example, a 14-watt compact fluorescent light bulb to replace a 60-watt incandescent light bulb), which often results in under-lit spaces for older adults and others with visual impairments. Instead, a 3:1 ratio (i.e., 20-watt compact fluorescent bulb to replace a 60-watt incandescent) is recommended to ensure that enough light is available and to assure that the lamp is not replaced with a higher-wattage incandescent lamp out of frustration.

Resource—examples:

- South Mall Towers, Albany, New York: "Lighting Case Studies," *Delta Portfolio—Demonstration and Evaluation of Lighting Technologies and Applications,* Vol. 2, Issue 4: http://www.lrc.rpi.edu/programs/delta/pdf/Vol-2-4-SouthMallTowers.pdf. "This high-rise urban residence for low- to moderate-income seniors and disabled adults uses new and retrofit age-sensitive lighting to provide a safe and comfortable environment. The lighting makes the most of the visual capabilities of seniors at minimal cost for maintenance and energy use. Designs include lighting for one-bedroom and alcove apartments, as well as common areas such as the lobby, community room, and corridors." http://www.lrc.rpi.edu/publicationDetails.asp?id=187.

- Illuminating Engineering Society of North America—2009 illumination awards for interior lighting design, outdoor lighting design, and energy and environmental design, as well as a list of projects receiving merit awards: http://www.iesna.org/PDF/Awards/ia/2009%20Recipients.pdf.

Resource—written and web:

- Illuminating Engineering Society of North America: http://www.iesna.org/.

- Illuminating Engineering Society: *Lighting Education Fundamentals,* a seven-module instructional course: http://www.iesna.org/edoppts/instructional_materials.cfm.

- Lighting Research Center, Rensselaer Polytechnic Institute , Troy, New York: www.lrc.rpi.edu/programs/lightHealth/AARP/index.asp.

- Mariana Gross Figueiro (2001), *Lighting the Way: A Key to Independence.* Troy, New York: Lighting Research Center, Rensselaer Polytechnic Institute. "This publication answers common questions about vision and lighting posed by older adults, and offers practical solutions to them, their families, and their caregivers": http://www.lrc.rpi.edu/programs/lighthealth/aarp/pdf/aarpbook1.pdf.

- Lighthouse International, New York City: "an organization dedicated to preserving vision and to providing critically needed vision and rehabilitation services to help people of all ages overcome the challenges of vision loss through clinical services, education, research, and advocacy." www.lighthouse.org.

- International Dark-Sky Association: an educational and environmental nonprofit organization dedicated to advocating for natural night skies and understanding the impact of nighttime light pollution on nocturnal animals, astronomers, circadian rhythms, physical health, and other factors; preserving the nighttime environment through quality outdoor lighting; providing leadership concerning the problems and solutions related to light pollution: www.darksky.org.

- *Residential Energy Consumption Survey* (RECS), RECS Public Use Microdata Files. Washington, DC: U. S. Energy Information Administration, Independent Statistics and Analysis. A national survey that collects energy-related data for occupied housing units; analysis produces estimated consumption and expenditures data for the country's 111.1 M occupied housing units. http://www.eia.gov/emeu/recs/recspubuse05/pubuse05.html.

- *Lighting Research and Technology,* international peer-reviewed journal that publishes high-quality, original research on the subject of light and lighting. Published by SAGE Publications in association with The Society of Light and Lighting: http://www.sagepub.com/journalsProdDesc.nav?prodId=Journal201818.

- The Society of Light and Lighting, the largest professional organization representing the worldwide interests of those involved in the art, science and engineering of light and lighting: http://www.cibse.org/index.cfm?go=page.view&item=68.

- American Foundation for the Blind: extensive information and resources about vision loss. http://www.afb.org/.

Resource—technical assistance contact names:

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