DAYLIGHTING, DAYLIGHT SIMULATION AND PUBLIC HEALTH:
Low-Energy Lighting for Optimal Vision/Visual Acuity and Health/Wellbeing

**Design Team**
Drexel University: Dr. Eugenia V. Ellis, Dr. Jin Wen, Dr. Caroline Schauer, Dr. Neal Handly, Dr. Don McEachron
Drexel Smart House Team: Nick Calcagni, Jameson Detweiler, Eric Eisele

**Industry Partners:**
3M Corporation: Tom Hanschen • Lutron: Pekka Hakkrainen • Belfer Lighting Group: Bruce Belfer

**BAU Architecture:**
David Kratzer, Susan Frostlin • MS&R | Architecture & Interior Design: Garth Rockcastle

---

**Introduction**
Recent research indicates that lighting has become a public health issue (Pawley, 2004). Studies have shown that people working in natural light are more productive, more effective, and happier than those who work under artificial light. Natural lighting in the Emergency Room at Hahnemann shown that people working in natural sunlight are more productive, more effective, and happier than people who work under artificial light. Natural lighting is a Renewable Resource that can be utilized to promote health and conserve energy. Disturbing the circadian rhythm can lead to jet lag, seasonal affective disorder (SAD), delayed sleep phase syndrome (DSPS), and may lead to more serious conditions such as cancer (Roberts, 2001). In industrialized nations, it is estimated that up to 20% of the workforce are involved in some kind of shift work (Whitfield, 2006). Studies indicate limited exposures of shift workers to light at night (LAN) and increased incidences of breast cancer and colon cancer (Pawley, 2004).

**Research Process**

1. **Inventory** lighting in the Emergency Room at Hahnemann and waiting room during the day and evening hours, noting light source, illumination levels and light source.
   - Map the waiting room to establish several key locations for measurement.
   - Determine a time scale for measurement, i.e. hourly.
   - Measure the density of persons waiting in each area.
   - Measure the number of types of treatment rooms in the ED with both ambient and task lighting sources.

2. **First Floor Emergency Department Hahnemann Hospital**

   - **Daylight Balancing**
     - ED compensation to ensure consistent lighting levels

3. **Prototype Development**
   The Composite Solar Light Engine and Luminaire will be used to evenly distribute natural daylight supplied by a commercially available light harvester to building interiors with limited access to the exterior. Through sophisticated building environmental controls, illumination levels will remain constant with exterior weather conditions, the color temperature of the light emitted will match natural daylight and change throughout the day to match diurnal conditions. Lighting controls will be dynamically adaptable to match personal preferences, and the lighting level will have the ability to be adjusted manually or turned off when no illumination is desired. The goal is to manufacture the Composite Solar Light Engine and Luminaire in Pennsylvania using local resources.

---

**Research Questions**

**Energy Use**

- **Natural daylighting is a Renewable Resource**
  - Maximize the use of daylighting in the Indoor Environment to promote health and conserve energy.

**Vision/Visual Acuity and Light Quality**

- **Daylight output** can be measured in terms of luminance per square meter or lumen.
  - Although light intensity may be equivalent, some light sources provide a better quality light.

**Health Applications**

- **Promote maintenance of natural Circadian Rhythms**
  - Alzheimers’ and Dementia residents — natural daylighting reduces wandering and agitation.
  - Night Shift workers — prevent Seasonal Affective Disorder, Delayed Sleep Phase Syndrome and cancer.

**Technology**

- **Inexpensive lighting solutions** to supplement natural daylight such as LED, OLED and fluorescent.
  - Milmic: the full spectrum of natural daylight while maintaining consistent lighting levels.

---

**Bibliography**


