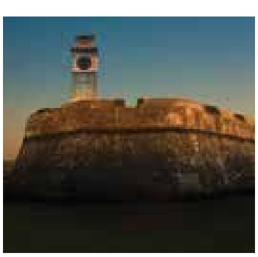
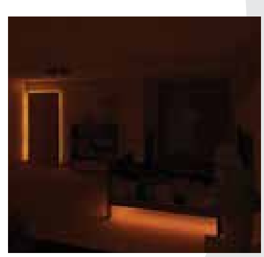
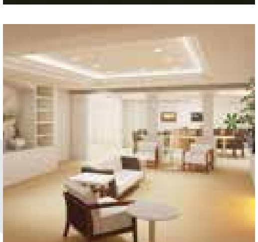
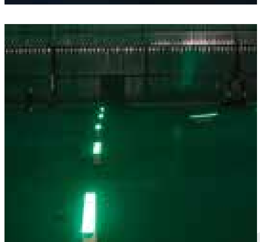
Five Projects in Five Pages

The research initiatives that follow show the breadth of the Lighting Research Center's work

BY REBEKAH MULLANEY



Established in 1988 by the New York State Energy Research and Development Authority (NYSERDA), the Lighting Research Center (LRC) at Rensselaer Polytechnic Institute in Troy, NY, has been pioneering research in energy and the environment, light and health, transportation lighting and safety, and solid-state lighting for almost three decades. LRC lighting scientists with multidisciplinary expertise in research, technology, design and human factors collaborate with a global network of leading manufacturers and government agencies, developing innovative lighting solutions for projects that range from the Boeing 787 Dreamliner to U.S. Navy submarines to hospital neonatal intensive care units.

Each October, the LRC holds its annual Partner-Alliance Event, open only to LRC Partners and Alliance members. One of the highlights is the presentation of major LRC projects conducted over the past year. Inspired by last years' presentation entitled "30 projects in 30 slides," we bring you "five projects in five pages"—offering a glimpse into some of the recent and ongoing work conducted by LRC researchers.

Photo: Anja Leidel

The proposed lighting effects rendered here factor in sight lines and wayfinding.

1

GALLE FORT, SRI LANKA

The Galle Fort is a fortified city on the southwest coast of Sri Lanka, built in 1588 by the Portuguese, then extensively fortified by the Dutch during the 17th century. Listed as a World Heritage Site by the United Nations Educational, Scientific and Cultural Organization (UNESCO), the fort is one of the world's best examples of South Asian and European architectural styles and traditions. The LRC is developing a multiphase outdoor lighting design for this site, and in spring 2015, the LRC project team traveled to the Galle Fort to meet with the local heritage society, gain input from area officials and residents, and document conditions at the site.

The following lighting design objectives have been set:

- Convey the strength and impenetrability of the fortress as guardian of the city and its people.
- Connect the pathways, monuments and landmarks through lighting.
- Maintain lighting below the line of sight for general passage along the skywalk on the rampart walls.
- Draw the eye upward with more dramatic lighting at taller structures and monuments.
- Allow the rampart walls to whisper the history of the Galle Fort.

The LRC team is currently developing the final iterations of designs and specifications. For more information on the project, please refer to the LRC Partners Poster: *http://www.lrc.rpi.edu/resources/newsroom/pdf/2015/GalleFort_8511.pdf.*

Photo: Adam Frelin

LRC graduate students built a prototype of the lighting for the public art project.

2

BREATHING LIGHTS

In 2014, Bloomberg Philanthropies invited mayors of U.S. cities to collaborate with local artists to develop innovative projects that engage residents and attract visitors. A total of 237 cities submitted proposals to the Public Art Challenge, affirming the many ways in which the arts can celebrate, address and advance critical urban issues. "Breathing Lights" is one of only four projects nationwide selected to receive funding in the form of a $1 million grant.

"Breathing Lights" is a collaboration among the New York cities of Albany, Schenectady and Troy. Led by local artist Adam Frelin and architect Barbara Nelson, this multi-site installation aims to regenerate interest in once-vibrant neighborhoods that currently have high vacancy rates.

"Breathing Lights" will illuminate hundreds of vacant homes nightly over a two-month period, filling each window with a diffuse glow that pulses with the gentle rhythm of simulated breathing, transforming vacant structures from pockets of shadows into places of warmth. The project will culminate in a regional summit on vacant homes and neighborhood revitalization for residents, prospective buyers and investors, policy makers and other key stakeholders.

Graduate students in LRC's Lighting Workshop built a working prototype of the lighting. They collaborated in the development of the control system, tested diffusing light materials, experimented with different color temperatures of light, evaluated and proposed power sources, and created a full-scale mock-up. LRC staff continued to work with the project team to finalize and install the lighting. Illumination kits consist of miniature LED striplights bound in adhesive fabric, affixed to interior window frames. The lights, powered and controlled by batteries and rheostats, will shine through windows covered in diffusion material.

Photos: Lighting Research Center

An LRC website assists in luminaire selection and placement.

3

LIGHTING PATTERNS FOR HEALTHY BUILDINGS

Robust daily patterns of light and dark synchronize the human circadian clock to local sunrise and sunset. Disruption of this 24-hour rhythm of light and dark affects every one of our biological systems, from DNA repair in single cells to melatonin production by the pineal gland to our sleep quality. Circadian disruption is most obviously linked with disruption of the sleep-wake cycle—feeling sleepy during the day and experiencing sleep problems such as insomnia at night—but is also linked with increased risk for diabetes, obesity, cardiovascular disease and cancer. Beyond the many health benefits of circadian entrainment, light also has an acute alerting effect, like a cup of coffee. The constant, unvarying dim light found in many homes, offices, hospitals and schools means that humans in modern society are not experiencing the robust light-dark patterns necessary for circadian entrainment and optimal daytime alertness.

A team of researchers at the LRC comprised of Kassandra Gonzales, Russ Leslie and Mariana Figueiro have created a portfolio of lighting patterns, available via interactive website, to help lighting professionals select and place luminaires that will support circadian health and well-being, along with vision and orientation needs. The patterns are based upon the 24-hour lighting scheme proposed by Figueiro, which recommends high circadian stimulation during the daytime, low circadian stimulation in the evening, good lighting for visibility, and night-lights with horizontal and vertical cues to improve postural stability.

Applying the results of the LRC's circadian stimulus (CS) research, the new website—"Lighting Patterns for Healthy Buildings"—allows users to view lighting patterns showing the base case and new lighting design analyzed for CS. Each pattern presents lighting plans, renderings and generic luminaire information useful for providing healthy lighting throughout the 24-hour day. The project team chose two target populations that can benefit most immediately from healthy lighting: older adults in long-term care facilities and children in schools, but the basic principles are applicable to the general population.

The project was sponsored by the Light & Health Alliance: Acuity Brands, Cree, GE Lighting, Ketra, OSRAM Sylvania, Philips Lighting and USAI Lighting.

For more information, *visit http://lightingpatternsforhealthybuildings.org*.

Photos: Lighting Research Center

High CS values for daytime (left) and low CS values at night will comprise a 24-hour electric lighting cycle.

4

CYPRESS COVE

Sleep problems are all too common among older adults, especially those in long-term care facilities, and may contribute to depression, weight gain and, according to recent research, the onset and progression of Alzheimer's disease. Conversely, healthy, high-quality sleep improves overall health and well-being.

LRC Light & Health Program Director Mariana Figueiro began conducting research on her first R01 grant from the National Institute on Aging in 2010 and soon discovered that a tailored light treatment consisting of a robust light-dark pattern that changes in color and intensity over 24 hours can improve nighttime sleep and behavior in older adults with dementia. However, at that time, lighting technologies that would allow for widespread implementation of her research findings were not yet available.

Fast forward to 2015, when Figueiro was asked for a lighting recommendation for the new Cypress Cove memory care facility in Fort Myers, FL. The LRC project team was working on a lighting design for the facility using circadian stimulus (CS), a new metric developed by LRC researchers, to design and specify the lighting. LED technology and controls had vastly improved since Figueiro's initial research, and the LRC project team scoured the market for manufacturers of suitable products that could effectively meet the CS recommendations.

Today, thanks to major advances in lighting and control technologies, residents of Cypress Cove will soon enjoy the benefits of lighting designed to entrain the circadian clock. Currently under construction, the new facility will house 24-hour cycled electric lighting that will provide high CS values for daytime activities and low CS values for evening hours—the first real-world implementation of a lighting scheme based upon Figueiro's research. USAI Lighting's Color Select wall washers and recessed downlights will be used to control quality, color and quantity of the light in common area spaces. Additionally, Ketra's G2 high-output linear accent luminaires and N3 satellites will be used to control the lighting and enable the dynamic circadian content, while Ketra's X1 touchpads will provide an elegant interface between the lighting system and its users.

The lighting principles and technologies utilized at Cypress Cove can potentially be transferred to benefit other populations: newborns in the NICU, students in schools, office workers, and eventually, the general public in their own homes.

For more information about LRC Light & Health research, visit *www.lrc.rpi.edu/programs/light-Health/index.asp*.

Photo: Lighting Research Center

Linear lighting elements were tested in full-scale evaluations.

5

LINEAR AIRFIELD DELINEATION

Airfields are complex networks of runways and taxiways, used by aircraft as well as ground vehicles. Collisions on the airfield are disastrous, so aviation authorities have developed a carefully-designed system of lighting to delineate runway and taxiway edges, centerlines and stop bars where aircraft must wait for clearance before entering a potentially active runway. Despite the specifications of light source intensity, color and spacing, the inherent complexity of the airfield environment has caused many pilots to report seeing a "maze" of lights while taxiing at night.

In principle, more continuous delineation of runways and taxiways should help pilots better identify the airfield configuration, especially at intersections and decision points where making the wrong choice can be hazardous. Building on studies from roadway delineation safety, researchers at the LRC have been working with the Federal Aviation Administration (FAA) to investigate the potential of linear light source elements to convey visual information to pilots. LRC studies show that more continuous delineation allows pilots to identify runway and taxiway configurations more quickly and from further away, allowing them to adjust their speed accordingly.

Initial experiments used static images of taxiway intersections to measure how long study participants took to identify the configuration geometry. The length of elements and spacing between them were varied systematically, and the results suggested that linear elements could result in shorter identification times than discrete point sources, or that linear elements could be spaced further apart to achieve the same identification times. A preliminary model for trading off length and spacing of lighting elements was developed.

The LRC followed these initial investigations using simulations with dynamic animations of a pilot's view when approaching a taxiway intersection. These tests included the FAA's commercial airline cockpit simulator. Full-scale mock-ups using actual linear lighting elements were also tested and are underway at an airfield in collaboration with the Ohio State University. Importantly, the results from all of these investigations are consistent with the predictions of the LRC's mathematical model relating linear element length and spacing to response times, providing a useful tool for airfield design incorporating this type of delineation. ☐

THE AUTHOR

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