LED WATCH

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WHERE IT'S NEEDED, WHEN IT'S NEEDED

Greater energy savings will result from lighting systems targeted to their environment

The full potential of solid-state lighting (SSL) to dramatically reduce lighting-energy use will only be realized if breakthrough innovations change the way light is delivered to people. Improvements in lighting-energy efficiency through one-for-one lamp and luminaire replacements are becoming more widespread, partly because they're easy to implement, but the deepest energy savings will come from innovative systems that deliver the desired quantity and quality of light where it's needed, when it's needed. Such systems require advanced design and implementation approaches that go beyond current practices to include such things as novel form factors, adaptive control of light output and spectrum, creative types of user interfaces and new takes on architectural integration. Since 2014, the U.S. Department of Energy (DOE) has devoted a portion of its annual R&D budget to funding projects that focus on developing those systems. Three such projects currently underway each target a different key setting:

At the Hospital. Lighting accounts for more than 31 billion kWh of annual electricity use in U.S. hospitals, with patient rooms comprising a large portion of that use. This creates significant opportunity to save energy by developing and implementing healthcare lighting systems that are more efficient than the linear fluorescent, compact fluorescent and halogen systems that currently predominate. The design of patient-care spaces has been rapidly evolving, adapting to changing healthcare practices as well as to emerging evidence about the importance of the environment in promoting healing. In response to evidence that environmental stressors can negatively impact the immune system and thus slow the healing process, healthcare design teams have worked to create environments that are more pleasant and hospitable and that can adapt to diverse tasks such as reading, watching television, and social interaction between patients and visitors, as well as to the examinations and other critical tasks conducted by medical staff.

Accompanying the desire to create healthcare environments that are less institutional is an increasing interest in applying biophilic design principles, which employ elements of the natural world—such as sunlight and natural forms and shapes—that have beneficial health effects. There's also a growing awareness among designers that the body's circadian rhythm is best supported by light that shifts in spectral quality in a set pattern over the course of the day. On top of that, light must have adequate color quality in order for doctors, nurses and other health professionals to do their jobs properly.

To address these factors, Philips Research North America is developing

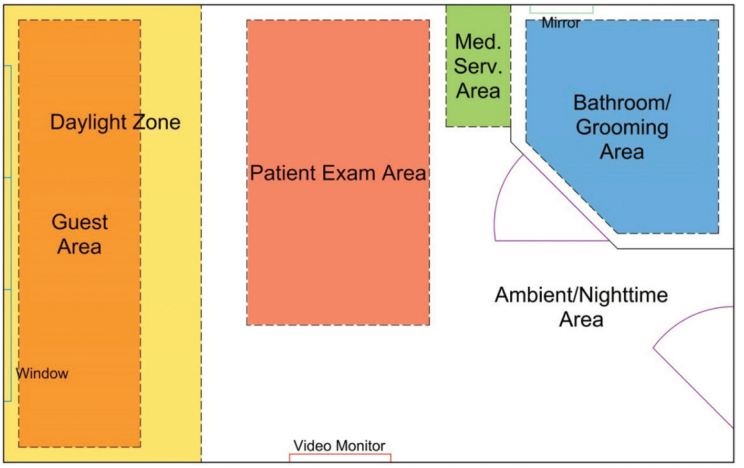

Figure 1. Floor plan of patient-suite application used for the DOE funding opportunity.

an innovative patient-suite lighting system (**Figure 1**) that's energy efficient and meets all of the lighting needs of patients, caregivers and visitors. The system will be built upon application- and stakeholder-driven value propositions that consider design best practices, end-user and owner attitudes and expectations, visual and nonvisual needs, health and wellbeing, and policy and regulatory requirements.

In the Classroom. Flat-screen monitors, sofas, remote-controlled cameras, live-streaming video from mobile devices, small work pods with movable furniture and whiteboards—these are all elements of the classroom of the future. At all levels of education—from kindergarten through college and grad school—the classroom has been changing dramatically. No longer a static environment with a single point of focus, it's becoming a dynamic setting where several activities may be taking place simultaneously in different parts of the room, with a number of different educational technologies in use at any given time. The explosive growth of online educational tools, project-based learning and individualized instructional plans has radically altered the school environment.

These new paradigms and technologies create new challenges in requiring lighting that can adapt to the visual needs of students and teachers, as those needs change throughout the school day, while also minimizing glare and visual distraction (see *LD+A*, February 2015). Add to this the growing classroom trend of increased usage during evening hours, often by adult learners or nontraditional college students, and it's easy to see why new lighting systems are needed—systems that can adapt to the specific demands of the visual tasks being performed and the people performing those tasks, as well as to the differing lighting requirements based on the time of day.

At the same time, our understanding of lighting's impact on the learning process is growing, with emerging evidence that dynamic lighting systems, which allow for variations in illuminance and color quality, can improve student attentiveness, comfort and group interactions.

In that context, RTI International is working in partnership with Finelite, Inc., to develop novel SSL luminaires for advanced lighting in the classroom, which is currently dominated by linear fluorescent fixtures (**Figure 2**). In the process of carrying out the project, the researchers will demonstrate the benefits of dynamic lighting and collect feedback from educators, administrators and other key stakeholders on the potential benefits of such a system in an education setting.

In the Office. The visual needs of office workers today are much more complicated than in the past. With the proliferation of new technology, many visual tasks now focus on vertical displays, and a rapidly increasing number of tasks are carried out on mobile-device displays that can assume any orientation, at any location. There are also ongoing changes in the way office work gets done, with a greater emphasis on teamwork and collaboration. This means that office environments—which, like classrooms, are currently dominated by linear fluorescent lighting—must be flexible enough to not only accommodate effective personal workspaces, but to also facilitate teaming and collaboration.

This collaboration sometimes takes place between people in different facilities working from individual work stations—which has freed videoconferencing from being limited to specially designed conference rooms and allowed it to occur throughout the entire office. And as globalization continues, international collaborative work is likely to take place at any hour of the day or night, requiring lighting systems that provide flexibility in inten-

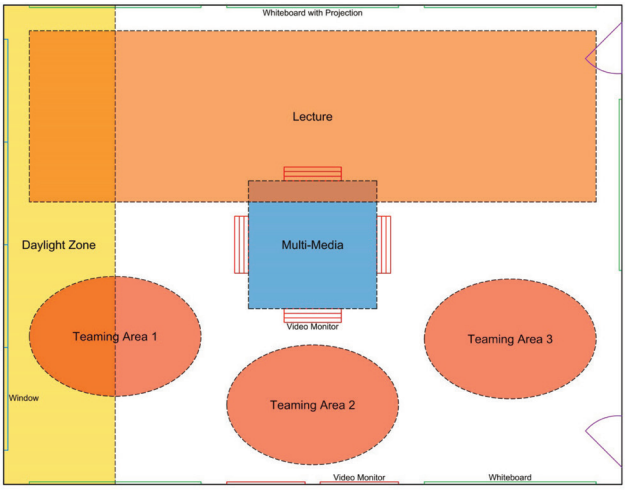

Figure 2. Floor plan of classroom application used for the DOE funding opportunity.

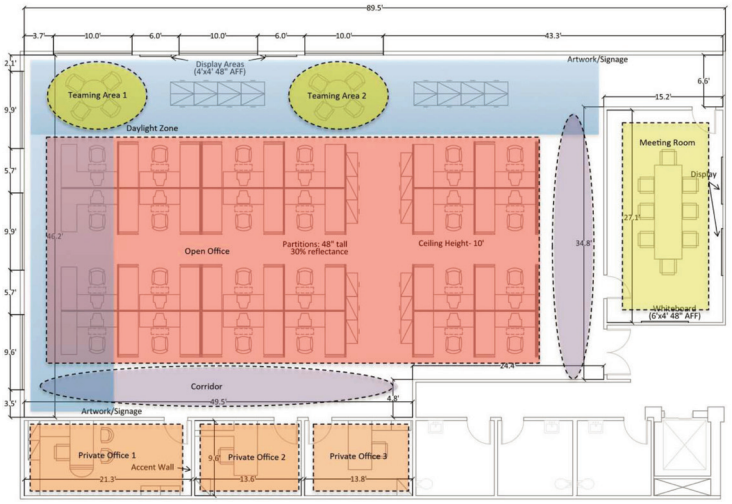

Figure 3. Floor plan of office application used for the DOE funding opportunity.

sity, distribution and spectrum.

To get deep energy savings from office lighting requires that it adapt to occupancy and daylight availability, ensuring that the proper quantities of light are being delivered when needed, and that lighting energy is minimized when there's sufficient daylight. Variations in the spectral composition of daylight throughout the day, coupled with the possible beneficial and deleterious effects of electric lighting, make office lighting systems with variable spectra desirable. But controls that combine automatic lighting changes with some adjustability by occupants are necessary, in order to avoid user dissatisfaction.

With this in mind, Philips Research North America is working to develop an innovative LED office lighting system that integrates light delivery, optics, and controls for energy efficiency and occupant health and wellbeing (**Figure 3**). The office portfolio developed will maximize energy efficiency while providing spectral tuning and control functionality.

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We expect to learn a lot from these DOE-funded projects, which may bring opportunities for user feedback and in-field studies that deepen our understanding of new directions in lighting even further. When a technology is as multifaceted as SSL, it's only by exploring new directions that we can make sure it achieves its full potential—not only to save energy, but to change the very concept of what "lighting" is all about.

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