Will the traditional definition and requirements of “roadway lighting” change with the emergence of driverless vehicles? Will safety be less of a concern, since “driver error” would become less of a factor, or none at all?

Frazer: Roadway lighting systems’ design and deployments will still be driven by safety and economics. What is changing are the answers to the question: “What tools and technologies do we have that cars increase safety?”

In the not-too-distant future, pedestrians, bicyclists and vehicles will all interact dynamically with the infrastructure. Crosswalks may brighten as a pedestrian approaches, roadway lighting may be dimmed or even be extinguished in times of low to very low traffic. Color temperature changing fixtures may be employed. All of these scenarios are being envisioned by standards developers, as without communications and other interoperability standards none of these sensors and devices could talk to one another.

When we look at vehicles, specifically, it’s a two-step parallel process. First, there are “connected vehicles,” which you drive. What’s added are alarms that warn you if you’re too close to another vehicle or pedestrian, and braking systems that automatically engage if you do ignore the warning.

At the other end of the technology continuum, the autonomous vehicles of today contain tens of thousands of dollars of sensors, radars and vision systems. Autonomous vehicles are much more sophisticated and are still quite a ways off from mass adoption, but signs and pavement markings are used by autonomous vehicles, and these need to be “seen” by the vehicular-based sensors, so lighting will still be required for both humans and for the machines.

Smith: A distant tidal wave is approaching the street and roadway lighting industry. Not next year, or even within the next decade, but 20 to 30 years from now the market for streetlights will face serious and adverse consequences from the disruptive technology represented by the saturation of fully autonomous vehicles on our roads.

In April 2016, the Ford Motor Company issued a press release whose title started with the words “No Lights, No Problem,” referring to developments in Ford’s autonomous vehicle that use a navigation system called LiDAR (Light Detection and Ranging) for “seeing” at night. Tests at Ford’s Proving Grounds in Arizona concluded that vehicles could be operated at night in complete darkness.

In addition, technological improvements to automatic emergency braking (AEB) systems over the coming years will result in all systems being fully operational in total darkness—another step forward in removing the need for optical street lighting for vehicle crash avoidance. More than 20 automobile manufacturers, working with the National Highway Traffic Safety Administration, have committed to making AEB a standard feature on all cars by 2022: 99 percent of new cars sold will then come with AEB and by 2025 all trucks on the market will be AEB equipped.

Technological disruption to the market for streetlights will almost certainly be gradual—until after the predicted point of 2040 when most cars sold are fully autonomous, according to IEEE. Lighting for toll plazas, tunnels and limited access highways will become unnecessary. Eventually, remaining streetlight inventory will be limited to two primary functions. The first will be street lighting...
dedicated to pedestrian and bicyclist safety and security. The second will be street lighting used for aesthetic or architectural reasons to promote a desired ambiance—such as turn-of-the-century globe lighting in an urban center.

Romero: Lighting [will be] focused on the pedestrian’s needs. The main reason for roadway lighting within a city is to increase the sense of safety, and for drivers and pedestrians to be aware of one another. Although automated cars will not require lighting to necessarily “see” pedestrians, uniform lighting will still be needed in pedestrian areas and cityscapes for safety and visibility of vehicles and hazards.

Salpietra: Roadway lighting will continue to evolve at an even more rapid rate, with technology delivering higher quality light, which will make cameras (both CCTV and on-board) more efficient. Population trends show that people are moving toward city centers, which will put pressure on superior street lighting design for both pedestrians and vehicles. We suspect that safety will forever be a top tier issue, and we will see increased redundancy in both driverless vehicles and street lighting systems.

Bullough: There’s no doubt that the requirements for roadway lighting will change with the advent of driverless cars, but until or unless dedicated facilities for autonomous vehicles are set up akin to slot car or train tracks, even driverless driving will require vision, and vision requires “lighting.” Such lighting systems won’t necessarily deliver “light” in the traditional anthropocentric sense, but could include bands of nonvisual optical radiation. Still, as long as human and machine drivers coexist on the same roads, visible light will remain essential for safe nighttime driving. And even in the machine world, the principles of good illuminating engineering will still apply. Cameras are in no way immune to glare, for example. Common sense measures like shielding lights from view will always be helpful.

The rise of driverless cars may be an opportunity to refocus scientific inquiry on pedestrians, a woefully neglected part of our transportation environment. Indeed there is an emerging science of nighttime aesthetics that also addresses needs for visual performance, perceptions of safety and security, and that recognizes that the night itself can be both beautiful and functional. If by RP-type metrics one means simply “road surface luminance/illuminance” then these are not inherently scientific in and of themselves. At the Lighting Research Center, we’ve been exploring science-based metrics to provide leverage to balance quantity with spectrum and distribution to support both functionality and aesthetics. And the sooner we accept that painting building façades in saturated colors does not guarantee aesthetic success, the better.

Bullough: The short answer is “yes,” but more importantly perhaps will be the where and how of those luminaires. Even in the present era of human-driven vehicles, the performance of vehicle-mounted lighting is increasing. Autonomous luminaires, also known as adaptive headlights, allow drivers to use their high beams all night long without guilt. That’s because they use cameras to locate other vehicles and dim their intensity specifically in the direction of those other drivers, thereby minimizing glare. They’re already a reality on cars outside North America and likely to become a reality here soon. Keeping lights on the vehicles rather than the roadside could provide a terrific opportunity to reduce unwanted impacts of nighttime lighting.

Romero: The illumination level may be lower, but we will still need to pay special attention to the uniformity. The uniformity of the lighting is even more important than the amount measured on the ground. In some cases, there may be fewer street-lights, or we may only illuminate dangerous intersections or high traffic areas. Higher illumination levels and control of fixtures will still be needed in areas where crime may be a problem and street lighting with smart systems will be the best option.

3. Will driverless vehicles be a boon for certain segments of the lighting industry? For example, will the controls market benefit due to the need for vehicle-to-infrastructure communication?

Frazer: Absolutely. V2I is not just the vehicle-to-infrastructure but also the connected pedestrian and connected bicyclist. These last two will use a mobile phone as a proxy for a person, so yes, there will be a plethora of new data points available to systems designers. This information can be used to better provide the right amount of light at the right time.

Bullough: Certainly, driverless vehicles will expand market opportunities for communications systems between vehicles and the environment. But who exactly will reach these new markets? My magic eight-ball says, “Cannot predict now.” If vehicle lighting and sensing systems displace some of the traditional roadside illumination currently present, those opportunities might not involve a lot of luminaire control except of autonomous headlights themselves. But I am confident that we will see more V2I communication telling both human and machine drivers about their environment—from work zones, to dangerous curves ahead, to masses of pedestrians leaving sports arenas late at night. Despite

99% The number of new U.S. autos sold by 2022 expected to have automatic emergency braking as a standard feature

Source: National Highway Traffic Safety Administration
The year by which 75% of vehicles on the road will be autonomous

Source: IEEE

many questions about how this game-changing technology will ultimately be implemented, autonomous vehicles clearly offer opportunities for safer and more economical movement of people and goods, and for commercializing the support systems and technologies they will use.

Romero: The integration of controls and Li-Fi in fixtures will definitely be the future. With Li-Fi communication, we can view a map in real time with exact locations of each vehicle with information input from fixtures, people, etc. This will increase visibility for use in traffic reports, construction, emergency vehicles, etc. The communication between fixtures and central public safety systems over the Internet is a huge opportunity to expand fixtures and controls capabilities in this market. Li-Fi internet speeds reach up to 250 GB per second, allowing the concept of a smart city to become a reality. Personal gadgets and wearable devices, cars, smartphones, streetlights, homes and other devices could be interconnected.

Salpietra: The most successful lighting companies in the future will be the ones who have the greatest expertise in control technology. V2I systems will be part of the next generation of lighting control technology, and outdoor luminaire manufacturers will have to control delivery of light in increasingly unique and creative ways.

Smith: The controls market will certainly benefit from autonomous vehicles, in response to the need for V2I communication systems. Yet it seems unlikely that streetlight poles will be used to support communications infrastructure. Other signaling devices may involve the eventual elimination of traffic lights and stop signs, replaced with other stationary signaling devices that use laser or sonar to control traffic. Even a police officer directing traffic at a construction site may end up using a hand-held signaling device to control the AVs.

Pole maintenance costs, together with competing methodologies for dealing with communications over unlit roads, will likely drive states to employ vehicle-to-infrastructure systems that do not rely on existing pole locations dedicated to streetlights.

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