

## **Proposal for a new LED road lighting concept**

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In his paper “The Road Not Taken” presented in Lighting 2000 conference Mark Rea suggested that paying more attention to peripheral vision would change road lighting design. He argues that vehicle forward lighting should be the primary source of illumination for the roadway surface and that pole-mounted lighting should be the primary source of illumination for areas adjacent to the roadway. The arrival of LED luminaires for road lighting make such an approach easily achievable. In a single LED road lighting luminaire there are a number of LEDs with built-in optics. Thus, LED street lighting permits higher optical versatility and precision than the previously used single light source luminaires. Therefore, it is possible to focus the light where it is needed. But where is it needed?

The current road lighting method aims to produce even luminance distribution on the road surface. In practice the highest luminance levels are found in the middle of the road and in the vicinity of the luminaire poles (Figure 1). Thus, the highest luminous intensity is directed towards the centre of the road and the driver’s eyes, harming visual performance, whereas a lower luminous intensity is directed towards the peripheral driving environment that needs attention. It is proposed that lighting of traffic routes and subsidiary streets should aim to produce luminance levels on the road surface which are

longitudinally uniform but vary crosswise so that the highest luminances are at the edges of the road, while the luminance level in the central area is lower (see Figure 1). Thus, the luminous intensity is focused on the areas where the targets requiring visual attention are – pedestrians, approaching deer, etc. – whereas the luminous intensity directed towards the centre of the road and drivers' eyes is lower. The headlights provide supporting light to the central area of the road while driving.

Figure 1. Current road lighting method in practice (left) and proposed concept (right). Headlights are excluded.



In practice the proposed luminous environment may be produced with a lighting device comprising two optical elements/modules: a first optical element, configured to direct light from a light source onto one side of road, and a second optical element, configured to direct the light from the light source onto the other side of the road, so that the luminance of the road edges is higher than that in the middle of the road. The lighting device should aim to provide a luminance distribution on the road that is longitudinally uniform but varies crosswise.

It is expected that lower luminous intensity towards the driver's eyes will lead to lower glare ratings and a lower level of pulsating light caused by the road lighting. It is further

expected that a higher luminous intensity aimed towards the peripheral driving environment would help in detecting the key targets needing attention, e.g. pedestrians. Emphasising the edges of the road by means of higher luminance may also help in conceiving of the road environment and steering, as there is research evidence indicating that drivers rely particularly on the inside of each curve while steering. Making drivers more aware of the peripheral traffic environment may also affect driving speed. Increasing traffic speed has been indicated as one of effects or benefits of current road lighting method. However, in order to reduce pedestrian accidents and noise level, many urban or suburban areas aim to reduce traffic speed. Thus, in urban areas road lighting that would improve visual conditions without encouraging speed increase would often be welcomed. It is thus expected that the proposed lighting environment would provide better driving conditions for the driver and thus a safer traffic environment for all road users.

There is research evidence indicating that people feel safer when they are able to walk in a spotlight than when they are walking either between spotlights or towards a spotlight in a dynamically controlled street lighting environment. It is thus expected that pedestrians and cyclists would feel safer when a higher luminous intensity is directed towards the edges of the road. A higher luminance in pedestrian zones would also promote the detection of obstacles and orientation and recognition. Higher luminance may also be connected with higher glare. However, as pedestrians and cyclists have significantly lower speeds, they tend to focus their sight closer ahead and are therefore less exposed to glare than drivers are. It is thus expected that the proposed lighting environment provides more benefits than disadvantages and provides a more comfortable traffic environment for cyclists and pedestrians.

As the proposed concept aims to produce a luminance distribution on the road surface that varies crosswise it is in conflict with the spirit of the current road lighting standard.

However, the practical realisation may be deployed within the current standard. Whether the proposed method meets expectations should be carefully studied. An examination should also be performed of whether the disability glare caused by the headlights of an approaching vehicle would be affected by the changes in the luminous environment caused by the proposed concept. In order to meet the requirements of ecological validity the study should include the headlights of both vehicles, in addition to the road lighting. Besides these kinds of objective measurements, subjective measurements should also be conducted. It should also be studied of whether better driving conditions would allow a lower luminous flux and energy to be used.

In conclusion, it is suggested that limited road lighting resources should be concentrated in those very traffic zones where pedestrians and cars meet. Illuminating the central part of the road surface has been dictated by the single light source technology and car focused design approach. However, it may not be the best solution for enhancing the visibility of pedestrians and the road space and the current road lighting method deserves critical re-evaluation.

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