Changing Course on 'Benefits'

by Peter R. Boyce

Gauzy claims about lighting's effect on productivity, safety or health won't carry much weight without hard evidence

Decisions in life are often a matter of striking a balance between benefits and costs. This is certainly the case for decisions about lighting installations. Too often, this leads to a race to the bottom because while the economic and environmental costs of lighting can easily be quantified, the benefits cannot. As a result, the emphasis in too much lighting practice is simply to meet illuminance recommendations at minimum cost, the recommended illuminance being taken as a proxy for benefits.

This is not because the benefits of good lighting are never mentioned. Rather, they are often alleged to occur, but they appear as remote but desirable goals, such as improved productivity, greater safety, better health, greater well-being and so on. There is nothing inherently impossible about such claimed benefits, but they do tend to vanish like the Cheshire Cat when faced with a demand for evidence.

The problem with such benefits is twofold. For some, the problem is that they are not easily defined quantitatively. Take productivity as an example. For a manufacturing process, quantifying productivity may not be much of a problem, but for office work it is. What is the productive output of an office? Is it how many e-mails are produced per day or should it be something higher up the scale of office functions, such as the number of problems solved per day? Similar difficulties face other claimed benefits. For well-being, the very term is vague, having different meanings for different people, none of which are easily quantified.

Probably, the benefit that can be most easily defined and quantified is safety on the road. This can be expressed as the reduction in the number of accidents or the number of fatalities and personal injuries occurring over a period of time. But then the second problem is evident. This is the fact that road accidents depend on multiple factors, lighting being just one of them. Indeed, many road accidents in daylight have been categorized as "looked but failed to see." Similar concerns about multiple causal factors are apparent with claims about productivity, health and well-being.

THE TASK AT HAND

So what does this complexity imply for the future of lighting practice? Should we forget about any attempt to quantify the benefits of lighting and accept that, outside of a few very specific situations, lighting will inevitably become a commodity with developments driven by value engineering? My answer is no. What we should do is recognize the impossibility of quantifying remote and poorly defined benefits and concentrate on what lighting, and only lighting, can do. By this I mean to enable the human visual system to operate in an effective and flexible manner so that it can deal with whatever task it is asked to perform. And these tasks can vary widely from seeing fine detail on-axis, through perceiving color and brightness, to controlling movement guided by peripheral vision. And these tasks can all occur under the same installation at different times. Consider road lighting as an example. The driver uses peripheral vision to steer the vehicle and detect the presence of pedestrians as well as foveal vision to read road signs and examine the movement of other vehicles. This means road lighting needs to enable a high level of performance for both on and off-axis vision.

In case anyone should think this proposal is original, it is necessary to point out that we have been here before when considering the difference between task performance and visual performance. Most apparently, visual tasks have three components: visual, cognitive and motor. The visual component refers to the process of extracting information relevant to the performance of the task using the sense of sight. The cognitive component is the process by which sensory stimuli are interpreted and the appropriate action determined. The motor component is the process by which the stimuli are manipulated to extract information and/or the actions decided upon are carried out. These three components interact to produce a complex pattern between stimulus and response leading ultimately to task performance. Every task is unique in its balance between visual, cognitive and motor components and hence in the effect lighting conditions have on task performance. It is this uniqueness that makes it impossible to generalize from the effect of lighting on the performance of one task to the effect of lighting on the performance of another.

This concept led to the development of the RVP model of visual performance. This model has been found to be predictive of the effect of lighting changes on such diverse activities as data input in an office and the detection of pedestrians on a crosswalk. The model is based on reaction time measurements of a very simple visual function, the detection of presence on-axis. By minimizing the cognitive and motor components of the task, the full effect of lighting on vision is exposed. It can then be argued that any tasks that require on-axis vision will benefit if this visual function is performed faster, although exactly how much will depend on the task structure.

What I am suggesting is that a similar approach should be taken for other visual functions, but before that can happen it is necessary to recognize a fundamental limitation imposed by the present system of photometry. This is simply that light is defined by the spectral response of the fovea, which is the small central area of the retina that contains only two of the five photoreceptor types in the eye. This means that, as currently defined, illuminance and luminance do not accurately reflect the visual system's spectral sensitivity when peripheral vision is used, or when other photoreceptors are involved, as in the perception of brightness and color.

Before seeking to quantify the lighting conditions necessary to achieve flexible and effective operation of the visual system, it would be a good idea to modify the photometric system so that it more accurately reflects the spectral reality of vision. This implies that there will have to be multiple forms of illuminance or luminance used in lighting design, each form reflecting the spectral sensitivity of the visual system relevant to the visual function being assessed. This will, inevitably, make design more complicated, but it will also make it more realistic.

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WHAT IT MEANS FOR STANDARDS

Adopting a system of multiple photometric definitions also poses a problem for bodies, such as the IES, that produce lighting recommendations. First, they will have to decide on what visual functions are relevant to the desired benefit for a number of specific applications, e.g., what visual functions are relevant to safety on the road at night. Then, they will have to support research to determine a suitable level for each function. Finally, they will have to find a way to handle applications where multiple conflicting visual functions are involved.

Preparing lighting recommendations in this way will be difficult, but any organization with claims on professional status should accurately reflect the state of knowledge in its field. Knowledge of the visual system has come a long way since the V(λ) function currently used to define illuminance and luminance was introduced 90 years ago. It is time this knowledge was reflected in lighting recommendations.

ACTION PLAN

To summarize, there are a number of actions required to more clearly demonstrate the benefits of lighting. They are:

1. *Stop making vague claims about the effects of lighting on productivity, safety and health unless supported by clear epidemiological evidence and a plausible mechanism involving lighting.*
2. *Accept that for many activities, lighting conditions are just one factor amongst many that influence the outcome.*
3. *Recognize that the main role of lighting is to change visual function and that optimizing visual functions should be the basis of lighting recommendations.*
4. *Identify what visual functions are relevant to achieving the desired benefits for a range of common activities.*
5. *Measure the effect of the amount, spectrum and distribution of light on these visual functions.*
6. *Develop lighting recommendations for a range of common activities based on optimizing the relevant visual functions.*
7. *Support the collection of field data to test the benefits of different forms of lighting as predicted by the performance of the relevant visual functions.*

If these actions produce a greater understanding of what lighting can and cannot do, a number of consequential benefits will accrue. First, lighting will be recognized as a true profession in that the people who practice it will be seen to have an expertise founded on a core of knowledge. Second, lighting practitioners will know how to make the most of whatever lighting can do by selecting appropriate light levels, light spectra and light distribution patterns. Third, the benefits of lighting will be made manifest rather than being a chimera, much desired but never seen, like world peace.

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