# Achieving visual contrast in built, transport and information environments for everyone, everywhere, everyday

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The paper describes human vision in more detail and why providing luminance contrast is important to universal design. The paper also presents a new research-based innovation to measure luminance and make it a mainstream concern for everyone, everywhere, every day.

Vision is our dominant sense and is the process of deriving meaning from what is seen. Half the human brain is devoted directly or indirectly to vision, (MIT 1996). In the brain, neurons devoted to visual processing account for about 30 % of the cortex, as compared with 8% for touch and 3% for hearing, (Seyens 2019). About 80% percent of our perception, learning, cognition, and activities are mediated through vision. This is why people with acquired brain injury often also acquire a vision impairment.

The visual process generates appropriate motor, and/or cognitive responses to the world around us, (Brainline 2019). Visual contrast sensitivity is a crucial part of this process (different to acuity) allowing detection of objects and discriminating objects or details from their background. Visual contrast in an environment, is therefore an important part of how people experience and interact with the world around them.

Poor visual contrast has a significant impact on people with a vision impairment. Older people are also affected as visual function declines with age. If we consider contrast nosing on stairs, or contrast markings on glazing as examples, it is clear that visual contrast is important for the safety of all users. Providing good visual contrast benefits everyone and is an important part of universal design. In the built environment, visual contrast is often referred to as luminance contrast, as it is assessed by measuring and then comparing the luminance reflectance values (LRV) of surfaces.

Worldwide, luminance contrast has been recognised in standards and codes for new buildings, transport and information, as the most relevant measure of how a person visually perceives their environment. Luminance contrast is recognised as a mainstream issue that is crucial for safety, amenity and accessibility. However, luminance contrast is a tiny fraction of compliance requirements.

Prescribed luminance measuring techniques involve expensive, bulky equipment that typically uses a controlled light source (spectral component inclusive (SCI)). Expensive bulky equipment is a barrier to use, especially for such a tiny component of compliance. Controlled light source measurements do not reflect ambient lighting, or how an environment is experienced by users. The consequence is that ‘compliant’ new buildings and transport often fail to achieve acceptable luminance contrast outcomes. In existing buildings, public spaces and transport, surfaces become damaged and dirty such that luminance contrast is diminished. The consequence is a poor visual environment affecting safety and accessibility.

SCI measurements measure ‘colour’ accurately and are unaffected by surface conditions, such as texture and finish. Another limitation of SCI measurement is that it does not account for the amount of available light falling on a surface and thus the amount of light available to reflect to our eyes.  In contrast, specular component exclusive (SCE) measurements are sensitive to surface conditions and ambient light, better reflecting how users are experiencing the environment. Examples include, pools of light and dark due to shadowing during the day, glare from excessive light, effect of texture and reflectiveness of surfaces.  (Konica Minolta 2020).

The hypothesis for the research started with the basic premise that if a photograph captures what we “see”, can we analyse the digital data to establish a specular component exclusive (SCE) luminance reflectance value?  With exponential development in the sophistication of digital photography, mobile technology and App software, a solution seemed possible. Extensive desk top research explored the fields of photometry, colorimetry, display and print technologies, including methods, conversions and algorithms for working with digital data. Different data formats and algorithms were then assessed and compared taking measurements from different devices in different light conditions, using a test card with different finishes and colours.  Raw data values for luminance and luminance contrast provided good consistency across devices, and narrowed the range of options.

The next phase of the experiment utilised a Konica Minolta LS150 photometer and a TES-1334A luxmeter to assess a range of common scenarios encountered in the built environment, such as step nosings, TGSIs, signage contrast.  Different algorithm-derived LRVs, and algorithm validity was checked using the ISO 21542 formula (ISO 2011).  The ISO formula includes for the amount of light falling on a surface (lux); the amount of light being reflected off a surface to our eyes (candelas/m$^2$ (cd/m$^2$); and the luminance reflectance value (LRV). Thus, if the values for lux and candelas/m$^2$ are known, the validity of the algorithm-derived LRV can be assessed.  One of the tested algorithms provided consistent validation with the ISO formula, confirming the initial hypothesis, and validating the data type and algorithm to derive an SCE LRV.

A basic portable device application, *Get Luminance,* (Box50 2019) was developed for iOS and Android to use on site to check LRV and calculate luminance contrast using one of the four main calculation methods in use worldwide.  The four methods are: Bowman Sapolinski; Michelson; simple difference; and proportional difference.  This free tool seeks to be a disruptive technology that encourages widespread onsite testing to improve safety amenity and accessibility, with the aim of achieving visual contrast for everyone, everywhere, every day.

Keywords: Visual contrast; luminance; measuring tool; site testing

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