Creating the perfect shade of white can be a painstaking process for paper, textile, and plastic manufacturers. Image Source: Unsplash user Celia Michon

White may appear to be the most simple of hues. It is the color of wedding gowns and unpainted canvases, lab coats, and freshly fallen snow, suggesting cleanliness, freshness, and purity. It's a blank slate, a new start, an untainted surface. However, producers of products like paper, textiles, and plastics know that whiteness can be complicated, requiring precise manufacturing in order to obtain the ideal shade. From the selection of raw materials to the monitoring of processing methods, creating the perfect white is often an exacting endeavor.

Across industries, whiteness indices are an invaluable part of determining what that perfect white is and ensuring that it is consistently produced. However, as modern manufacturers increasingly turn to optical brighteners to enhance their products, the accuracy of standard spectrophotometric whiteness assessment may be compromised. Choosing sophisticated color measurement instruments and methods that can account for the effects of optical brighteners in paper, textiles, and plastics is essential to capturing accurate, meaningful data.

Modern whiteness indices seek to create standards of whiteness based on how humans perceive it. Image Source: Unsplash user Adam Birkett

The Subjective Nature of Whiteness Indices

A number of whiteness indices have been developed over the years that offer standardized ways of quantifying whiteness using instrumental color analysis. Although it may seem logical to assume that there is a static color we can objectively identify as “white” based on 100% reflectance values across the visible spectrum, this is in fact not the case; what the human eye perceives as “perfect white” is typically different than a theoretical “perfect white.” Richard S. Hunter and Richard W. Harold write:

The earliest studies [on quantifying whiteness] merely used average reflectance through the visible spectrum as the scale of whiteness. This was hardly satisfactory, since whitening by addition of blue dyes lowers average reflectance but increases visual whiteness. We now know that individual preference for whites makes optical criteria of whiteness variable from one observer to another.[1]

It is important to note that these individual preferences are not simply a matter of “liking” one shade more than another, but a difference in perception of what constitutes a true white in the first place. As Hunter and Harold note, for example, materials with blue dye added to counteract yellowness tends to be perceived as whiter, even—and especially—when the blue dye creates a bluish tint rather than simply neutralizing yellowness. As such, modern whiteness indices attempt to quantify perception of whiteness rather than measuring "objective" whiteness, which explains why there are multiple whiteness indices and ongoing changes to existing indexing formulae. By using these indices, you can evaluate your products according to standards that take the psychophysical process of color perception into account, making them more meaningful than a theoretically objective standard that ignores how humans process color information.[2]

Optical brighteners can interfere with standard spectrophotometric color measurement due to UV-excitability. Image Source: Unsplash user Neven Krcmarek

The Challenges of Measuring Optically Treated Materials

Modern spectrophotometric color measurement instruments, like those offered by HunterLab, come pre-programmed with a variety of whiteness indices, allowing you to easily capture index data as part of your product development or production processes. However, it's important to remember that whiteness may be perceived differently depending on material, which means that obtaining correct whiteness index data is contingent on choosing the right index for your application. It's also essential to select an instrument ideally suited for your methodological needs, particularly if your application presents advanced challenges like analyzing materials treated with optical brighteners.

Optical brighteners, also known as fluorescent whitening agents, are an increasingly popular method of optimizing perception of whiteness and protecting materials from yellowing. These UV-excitable brighteners work by "absorb[ing] light predominantly in the ultraviolet range and emit[ting] light in the visible range, thereby causing a brightening of the substrate by emitting more than 100% of the incident visible light."[3] In other words, optical brighteners make things look whiter.

Although highly effective for whitening, optical brighteners may also render traditional whiteness measurements inaccurate, skewed by the effect of the fluorescent components interacting with the UV light in the instrument. While UV filters can eliminate this effect, they can also potentially cause mismatches between whiteness index measurement and a human perception of whiteness. In order to correct for this and allow you to obtain meaningful color measurement, some spectrophotometers are designed with advanced UV calibration and control capabilities. By calibrating the instrument to a UV standard and controlling the amount of UV light emitted by the instrument, you are able to capture accurate whiteness index data that will closely correspond with viewer perception. Thus, it is critical to select an instrument that allows for precise UV control to ensure you can evaluate your products for whiteness and consistently create your desired white and near-white hues.

HunterLab Innovation

HunterLab has been a leader in spectrophotometric technologies for over 60 years. Today, our renowned product range includes portable, benchtop, and in-line options designed to meet the high standards and diverse needs of our customers. Our commitment to innovation has led us to develop solutions to even the most advanced color measurement challenges, including the problems posed by optical brighteners in paper, textiles, and plastics. Contact us to learn more about our renowned spectrophotometers and let us help you select the right instruments and methods for your needs.

1. *The Measurement of Appearance*, 1987, https://books.google.ca/books/about/The_Measurement_of_Appearance.html?id=vK5DK9vqyCgC&redir_esc=y
2. "Standard Practice for Calculating Yellowness and Whiteness Indices from Instrumentally Measured Color Coordinates", 2015, https://www.astm.org/Standards/E313.htm
3. "Optical Brighteners: History and Technology", October 2000, https://www.iiconservation.org/node/2144