The end goal of implementing a color quality process is to get the color you want, or your customer wants, in the final product through an efficient and streamlined process. If the color of a product doesn’t meet the standard, customer satisfaction is compromised and the amount of rework and costs increase. Establishing color tolerances objectively within the color quality process is an effective way to ensure color consistency and accuracy throughout the supply chain and from one batch of materials to the next.

A color tolerance is a limit to how big the difference in color between a sample and standard is allowed to be for the sample to be considered acceptable. Using color evaluation instrumentation, tolerance values should be defined internally or between supplier and customer, and used in quality control to determine if the sample passes or fails inspection. To establish a color tolerance, certain steps should be taken:

1. Define A Color Standard: What Color Do You Want The Final Product To Be?
   A standard should be defined internally or between supplier and customer. Using color evaluation instrumentation, measure the color you would like to match for the final product and record its color values.

   Visual assessments are performed as a starting point to define a tolerance range. To begin, gather samples or color batches that appear similar in color to the standard and visually assess them using a light booth. These samples or batches should be noticeably different from the standard to help identify the greatest difference in color still considered an acceptable match to the standard. Once the visual assessments are completed, choose all of the color samples that are considered visually acceptable.

   Please note, the sensitivity of the human eye varies from person to person, causing color to appear differently to each individual. Therefore, it is recommended to use a committee of people, either internal or from the customer, to confirm these visual assessments and maintain consistency.

3. Define Tolerance Values: What Is The Range For Acceptability?
   Using the color samples chosen in the visual assessments, take measurements using a colorimeter or spectrophotometer. Record their color values as DL*, Da*, Db*, DC*, Dh, and DE. In most cases, CIE values are used to establish these. The color with the values furthest from the standard color can be used as the maximum limit and the standard’s color values can be used as the minimum limit. Color that falls within this tolerance range is considered acceptable, while color that falls outside of this tolerance range is rejected.

   Please note, these values should be reevaluated throughout the manufacturing process and continuously refined to identify the ideal tolerance values for your application.

4. Establish A Tolerance System: Rectangular, Circular, or Elliptical?
   Tolerance values should correlate to the human eye so that color is both visually and numerically acceptable. This ensures consistency from one batch of materials to the next. For this, it is recommended to use CMC or DE2000 tolerance systems because the ellipsoids in these systems are based on the color discrimination threshold of the human eye. Both systems were established to address the weaknesses of other tolerance systems and improve accuracy.
GUIDE TO DEFINING COLOR TOLERANCES
IS THE COLOR DIFFERENCE BETWEEN A SAMPLE AND STANDARD ACCEPTABLE?

If using the rectangular tolerance system of L*a*b*, tolerance values should be established for each component DL*, Da*, and Db* to identify which coordinate, if any, has exceeded the limit. ∆E*, the total color difference, can be used provided the user evaluates individual attributes as well. This system, however, is not recommended because the human eye sees color as an elliptical, not as a rectangle or box. Color that falls near the edge of this tolerance box may be numerically acceptable but visually unacceptable to the observer, causing a disagreement between instrument and observer. This disagreement also occurs with CIE DE*ab, a circular tolerance system, and is not recommended.

The below images illustrate a set of samples compared to a standard in SpectraMagic NX software. The cube, or box, refers to CIE DL*, Da*, and Db*, the circle, or sphere, represents DE*ab color difference, and the ellipsoid represents DE2000. Ellipse or ellipsoidal color difference formulas are more representative of how the human eye perceives color.

To learn more about the element of color and color measurement practices, please visit us online at http://sensing.konicaminolta.us.

REQUEST A COLOR CONSULTATION

Request a consultation with one of Konica Minolta Sensing’s experts to learn how to develop and implement an effective color quality process within your organization.

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