

COLOR CONCEPTS

"EXACT" COLOR

By Gary G. Field

THE OBVIOUS OBJECTIVE?

Who would not want "exact color"? Indeed, this was the unquestioned objective during the early days of photomechanical color reproduction. The originals at that time primarily consisted of artists' sketches and drawings prepared specifically for purposes of reproduction. Given that it was practical to prepare such artwork in a manner that suited the reproduction scale requirements and the printed color gamut, then "exact" reproduction was a reasonable objective.

The introduction of color photographs as originals for photomechanical reproduction changed everything. These early originals ranged from the 1907 Autochrome additive color sheet film transparency to the 1936 Kodachrome subtractive color 35mm transparency. Color prints such as those produced by the 1925 Carbro process also were increasingly supplied as color originals.

What had changed was the fact that the photographic originals were, in fact, color reproductions that were not necessarily faithful to the original scene. More to the point, however, was the desire of photographers, designers, and art directors to artistically reinterpret the color photograph.

THE "EXACT" COLOR CASE

There are several cases where "exact" or facsimile color is a desirable objective:

- **Commercial artwork.** Artist-created drawings, paintings and the like that specifically are intended for reproduction purposes.
- **Fine art.** Although not intended for reproduction, they are frequently reproduced in catalogs, postcards, posters, and similar printed matter. Polaroid once ran a "replica painting" business that used a photographic imaging process.
- **Medical and similar photographic reproductions.** Textbooks and related teaching or reference aids must represent the medical condition (e.g., skin cancer) as accurately as possible. Instructional materials from the fields of architecture, design, agriculture, and others where color judgments are being taught also must be accurate.
- **Product color, especially merchandise samples.** For such color-sensitive items as clothing, an accurate catalog representation is critical. Same-size reproduction of the available colors showing texture, knit pattern, and weave is more accurate than photographs of models wearing the clothing.
- **Color photographic prints.** The color gamut of some reflective color photographs will be such that it may be possible to achieve an "exact" reproduction. In many cases, however, the saturation and lightness (density) of certain photographic colors will exceed what is possible with standard process color reproduction methods.

EXACT COLOR DEFINED

The definition advanced for spectral color reproduction in Robert Hunt's classic article on objectives in color reproduction best applies to the exact color concept. Spectral color reproduction refers to situations where the spectral reflectance curve of the original and the reproduction are identical for each color within the image. Technically, this condition is possible only when the original and the reproduction consist of the same colorants. In other words, a spectral color reproduction could be made of an existing printed image if the inks used in the subsequent reproduction were identical with those in the initial image. This is almost never the case.

Colorimetric color reproduction occurs when an original and the reproduction appear visually identical under a given light source for a single observer. In such cases, the original could be a painting or a photograph and the reproduction a photomechanical print. The colorants differ but, under the defined conditions, individual image colors appear the same in original and reproduction.

The just-described situation is called a metameric match, meaning that paired original and reproduction colors have the same CIE tristimulus values. As a practical matter, the comparison must be made under industry standard lighting by an observer whose color vision matches that defined by the CIE standard observer.

The distinction, therefore, between spectral and colorimetric color reproduction is that in the former case a match between original and reproduction will exist regardless of the illumination and the observer whereas in the latter case a match will only occur for a specific observer under a single light source.

COLORIMETRIC (EXACT) COLOR PRACTICALITIES

Variations in standard color viewing illuminants caused by fluorescent tube age, the wide tolerances applied to "standard tubes," and operational or installation-related conditions can influence the "goodness of match" from location to location. A match obtained at the printing plant may not necessarily be repeated at the customer's office.

An earlier pair of essays addressed the differences between real observers and the CIE standard observer. This means that a number of observers making comparisons of original and reproduction under the same illuminant can legitimately disagree on the "goodness of match." The "correct" judgment, of course, is that of the customer.

This discussion, until now, has put aside the question of whether it is possible to even achieve exact (colorimetric) reproduction. This will depend upon the comparative color gamuts of the original and the reproduction system. There are, therefore, two practical concerns relative to exact color reproduction: (1) Is the gamut of the reproduction system sufficient to allow colorimetric reproduction of a given original? and (2) Can the vagaries associated with the illuminant and observer aspects of colorimetric reproduction be reduced or eliminated?

BETTER COLORIMETRIC (EXACT) COLOR

Several practical steps can be taken to ensure that the metamerism-related concerns of colorimetric color reproduction are reduced:

- Use the maximum practical level of GCR (gray component replacement) to substitute black for visually equivalent combinations of chromatic inks. The resulting colors, which will be visually unchanged, will behave less as a metamer. This means that the colorimetric match will apply over a wider range of viewing conditions and observers than the non-GCR case.
- If economically possible, use supplementary chromatic inks to expand the gamut to suit that of the original. This strategy is known as high-fidelity color and, apart from gamut expansion, metamerism will be less than the traditional three chromatic colors case.
- Play very close attention to the illumination conditions used for making color judgments. Ensure that they comply with the ISO standard and use a color temperature meter to monitor the output of the fluorescent tubes. Replace