Abstract

This is a three-part series on “Color Preference, Printed colors, and PSA Certification.” The intended audiences are brand owners, designers, and print buyers. Part 1 of the series discusses print buyer’s color preference. Part 2 demonstrates on how printed colors are affected by lighting and substrates, including OBA brightened substrates. Part 3 discusses proof-to-print match under the influence of OBA, and the role of PSA, a RIT printing certification schema, that examines a printer’s ability in implementing standard-compliant workflows to achieve proof-to-print match and help build trust between print buyers and printers.

Part 1 -- Print buyers’ color preference

Color is a visual sensation resulted from the observer’s color vision, the viewing condition, and the object or color of interest. Color preference is influenced by the observer’s color vision and his/her experiences.

Preference is a choice of an individual in a decision-making process. For color preference, the decision-making is often subjective. For examples, color preference applies to a housewife in selecting the color when painting her living room, to a customer in selecting the color of a new car, and a brand owner in deciding the color of a new product package.

Because color enables product sales, color packaging is overwhelmingly preferred over monochrome packaging. Figure 1.1 is a breakfast cereal box, courtesy of Kellogg’s, with and without color.

Figure 1.1 Breakfast cereal box with (left) and without (right) color
Figure 1.2 is a drip brew coffee, Courtesy of Folger’s, with full color (left) and without color (right). It should become clear that the feeling of “wakening up in the morning” could be a very different experience without packaging color.

In general, print buyer’s color preference is no different than people like you and me, i.e., we prefer “clean and bright” colors. Figure 1.3 is a visual comparison between “clean and bright” color (left) and “dirty and dull” color (right). If the original photograph of the rose is good and the color separation is made proper, then the choice of paper and ink densities are key factors that influence print quality.

To further elaborate, Figure 1.4 is a bonsai scene captured in sunset that gives the image a long shadow and an overall warm tone.
Figure 1.4 Bonsai scene captured in sunset

Figure 1.5 shows the same bonsai with the yellow colorcast removed. As a result, the greens are greener, grays (at the top of the photograph) are more neutral, and the wall appears to be whiter and brighter.

Figure 1.5 Bonsai scene with the yellow colorcast removed

To summarize, print buyer is a collection of many stakeholders, i.e., brand owner, sales, marketing, procurement, packaging design, engineering, operations, quality assurance, etc. These stakeholders may very well have different motivations and preferences. Overall speaking, print buyers prefer clean and bright color while controlling printing costs. This is why print buyer’s preferences must be translated into job specifications, including design, color separation, paper stock, and printing aims. Job specifications should include the use of a color proof to verify visual expectations prior to print production.

In the next module, we will demonstrate how lighting conditions and substrates affect printed colors.
**Part 2 -- How printed colors are affected by lighting and substrates**

Part 2 of the series on “Color Preference, Printed colors, and PSA Certification” demonstrates how printed colors are affected by lighting and substrates.

As mentioned before, color is a visual sensation resulted from the interaction of three factors: (1) observer’s color vision, (2) the viewing condition, and (3) the color of interest. Let’s focus on the second element, viewing condition, by taking a close look at how we perceive a pictorial color image under three different lighting conditions (outdoor, tungsten, and indoor D50).

Figure 2.1 (left) is the visual sensation of the reference image, Asian model, viewed under an outdoor daylight condition. Figure 2.1 (center) is the same image viewed under an indoor tungsten condition. Figure 2.1 (right) is the same image viewed under the indoor D50 simulated daylight condition.

This demonstrates that (1) color is affected by lighting conditions; (2) outdoor daylight is not always available, and (3) the indoor D50 simulated daylight can be standardized and is convenient. As a result, ISO 3664 (2009) compliant viewing booths are required for critical color appraisal in the graphic arts industry.

Can we tell if a viewing booth complies with the ISO 3664 standard? One way is to read the specs sheet of the viewing booth. The other is to use a specially formulated ‘color pair’, known as the D50 metamers (Note: Metamers are two dissimilar colorants with different spectral response characteristics). By placing the D50 metamers in a viewing booth (Figure 2.2), the color pair only matches each other under the standard D50 lighting condition (left), and mismatches under other lighting conditions (right).
We should realize how important lighting is in visual examination of color, and how easy it is to standardize the viewing condition. Let’s take a close look at how substrates influence printed colors and the concept of print quality.

Figure 2.3 is a visual simulation of same color separation printed on three different substrates, i.e., newsprint (left), SuperCal (center), to Premium Coated (right). Notice that printed colors on newsprint is duller with limited tonality and color gamut; printed colors on SuperCal offers whiter white with more tonality and color gamut; and printed colors on Premium Coated paper extends the parameters of white paper, tonality, and gamut further.

Print quality has two definitions: (1) product grade, and (2) conformance to specifications. Product grade, in restaurant businesses, implies different dining expectations, including ambience, tastes, services, and costs. Fast foods, e.g., McDonald, represents one end of the dining expectations and a 5-Star restaurant represents the other.

Product grade, in printing businesses, implies visual expectations of printed products, including the observer’s color vision, graphic design, printing, and costs of choosing the paper stock. The visual simulation of printed colors on different substrates should drive home that substrate has the greater influence on print quality.

Print quality also means “conformance to specifications.” This is why reference printing conditions (RPCs), datasets, and process control parameters are needed in the form of international printing standard. When implemented, repeatable color is possible from time-to-time, press-to-press, and location-to-location.

This is also the reason why the visual simulation of printed colors on three different substrates is possible when reference printing conditions (RPCs), including paper white
points, and their respective ICC profiles are standardized and available in color management applications.

Now, we turn our attentions to how printed colors are affected by OBA brightened substrates. You may ask what’s OBA and why it matters to us as print buyers?

OBA, stands for Optical Brightening Agent, is a fluorescence additive that absorbs UV radiation and re-emits the energy in the short wavelength region of the visible light. OBA, when used in detergents, causes washed cloth perceived to be whiter and cleaner.

Figure 2.4 illustrates how printed colors are influenced by substrate with OBA (left) and without OBA (right) under the D50 lighting condition. Specifically, noticeable color differences are perceived as colorcast in unprinted substrate, highlight region of the image (background), and near-neutral colors (table top).

![Figure 2.4. Visual comparison of printed colors on paper with OBA (left) and without OBA (right)](image)

In this module, we learned the importance of standardizing the viewing condition, and the importance of job specifications, including paper and printing aims, if we want printed colors to be preferred, repeatable, and predictable.

When OBA brightened papers are specified, they cause two concerns. First, they affect printed colors, including greys and solids, thus, limit the usefulness of printing standards that define printing aims relative to fixed papers. Second, OBA brightened papers cause color mismatch between non-OBA proofs and OBA prints and limit the trustworthiness of color proof between printer and print buyer.

In the next module, we will discuss proof-to-print match under the influence of OBA, and the role of PSA, a RIT printing certification schema, that examines a printer’s ability in implementing standard-compliant workflows to print by number, achieve proof-to-print match, and help build trust between print buyers and printers.
3. Proofing-to-print match and the role of PSA

Finally, Part 3 of the series on “Color Preference, Printed colors, and PSA Certification” discusses and demonstrates how to achieve proof-to-print match under the influence of OBA and the role of PSA.

The best way to tell the story is to describe OBA brightened paper as a game-changer. This means that before OBA brightened papers are in demand, printing paper, proofing paper, and the printing aims are aligned. “Printing conformance is achieved by press calibration and “proof-to-print match” is achievable by color management. But, this is not the case anymore when print buyers started to demand OBA brightened papers.

When printing on OBA brightened paper, printers have difficulties in achieving printing conformance because OBA brightened papers influence printed colors. Moreover, the ISO 12647-7 compliant proof that matches the dataset, as shown in Figure 3.1(left), no longer matches the OBA brightened print (right).

![Figure 3.1 Proof that matches the dataset (left) and the OBA brightened print (right)](image)

As mentioned before, print buyers prefer clean and bright colors. They like the appearance of the OBA brightened print. They are disappointed that the proof that matches the dataset does not predict the printed effect accurately. This also means that following old standards and old color management rules do not solve new problems and that finding new solutions requires thinking outside the box.

Three changes are necessary to achieve proof-to-print match under the influence of OBA. The first change is the development of the development of the ISO/DIS2 15339-1 (2013), i.e., the use of the tristimulus linear correction to reconcile color differences between the white point difference of the target dataset and that of the actual printing condition. The second change is the development of the ISO 13655, i.e., the use of M1 measurement mode to assess the effect of OBA in printed color. The third change is the use of the substrate-corrected dataset as the source color space in a color proofing workflow. When all three changes are implemented in the new printing and proofing workflows, we begin
to see, as shown in Figure 3.2, that the substrate-corrected proof (right) removes colorcast in the proof (left) and align closely with the OBA brightened print (center).

Figure 3.2 Proof that matches the dataset (left), OBA brightened print (center), and the SCCA proof (right)

The method was tested in a RIT thesis in 2012 (Carlos Carazo) and was further tested in a color proofing round-up by four proofing vendors (Chung, 2013).

To summarize, OBA is a blessing to print buyers who want brighter and colorful appearance of printed colors while controlling costs. OBA is a variable in paper that affects the appearance of printed color that causes two concerns in printing conformance and in proof-to-print match. But, the new ISO standards, ISO 15339 and ISO 13655, and the substrate-corrected dataset help closed the gaps.

This brings us to the last point of the presentation, what is PSA and why PSA helps build trust between print buyers who prefer OBA printed color and printers who need to demonstrate printing conformance and proof-to-print match.

First, PSA is a printing certification schema, requested by the U.S. printing industry and developed by RIT, that attests a printer’s color workflow conforming to international standards and proof-to-print match. We can say that PSA addresses printer’s needs. Second, PSA was developed with print buyer’s interest in mind, i.e., PSA focuses on color conformance instead of conformance to process control aims. Together, PSA addresses benefits of the printer and the print buyer and helps build trust between them.