Spot colors are becoming more and more advanced in the marketplace.

Communicating Spot Color

By Jay Sperry

The flexographic printing community more, often than not, incorporates spot colors in the printing workflow. As spot color separations continue to become more complex, including many screens, vignettes, and overprints, predictability of spot color reproduction is becoming an increasingly valuable asset. The printing industry has long relied on color guides, such as the Pantone Matching System (PMS), to help identify color expectations with customers, marketers, and graphic designers. Although existing color guide systems have many advantages, they often collapse in contract package proofing and print prediction systems.

This article provides a framework for improved spot color management by first reviewing CMYK process color management and relating spot color workflow based on existing infrastructure. It will discuss color standards and quantitative definitions, followed by a presentation of current research at Clemson University exploring substrate and pigment profiles as well as spot color proofing workflows. Lastly, a review of existing procedures and suggestions for getting started today improving spot color communication and management will be provided.

CMYK COLOR MANAGEMENT

Let's quickly review how ICC profiles are used today by many flexographic printers for managing CMYK color reproduction. A defined ink set, traditionally CMYK, is defined and standardized for a consistent supply chain. Flexographic plates are prepared to a known set of curves and specifications. These plates are run on a flexographic press on identified substrates under documented pressroom conditions. A set of known CMYK test swatches is reproduced throughout this defined printing workflow, and these targets are measured with a spectrophotometer to record color information. This series of color measurements creates a look-up table for converting CMYK artwork of a known source color space to the destination of the printer or press. This is enabled by workflows that have grown to utilize a standardized file format, ICC profiles, to correct for color differences across substrates and printing systems.

Some quick limitations are discovered when applying a similar workflow for spot color management. Package printers use many spot colors, and to "print test" any color that is intended to be used in production is an inefficient use of resources. Furthermore, incorporation of the color measurement file into multiple workflow systems is non-existent outside of some proprietary products.

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The Sonoco Institute of Packaging Design and Graphics at Clemson University is a newly created initiative to leverage Clemson's strengths in the Packaging Science Department with those of the Department of Graphic Communications to provide a state-of-the art facility for Clemson students and industry partners within the impressive Harris A Smith building. Facilities and faculty are specialized for the delivery of first class undergraduate and graduate curricula. They provide cutting-edge industry services through workshops, seminars, symposia, and product testing and development, as well as top-level industry sponsored research, development, and demonstrations of new technologies. To get involved, visit Clemson.edu/sonoco_institute.

CURRENT RESEARCH AND INVESTIGATION

Studying being done at Clemson University has focused on the following:

- Identifying the required information about a printed spot color to predict its reproduction through a definition.
- Creating a standardized format for communicating spot color definitions.
- Integrating the use of these color definitions within color management systems.

TABLE 1.
Early results of predictive spot color reproduction.

Preliminary Chroma Prediction	Chroma
Substrate 1	0.9
Ink on Substrate 1	89.0
Substrate 2	1.7
Delta Substrate Chroma	.8
Slope*	-5.2
Predicted Ink Chroma	84.8
Actual Ink Color Chroma	84.1

*Increase of Substrate Chroma of 1 = 5.2 Decrease in Resulting Ink Chroma

- Providing means for translating customer color requirements into standardized spot color definitions.

There has already been substantial work done within standards committees to utilize a common file format for creating standard spot color definitions. This file would include:

- Spectral definition of the printed solid spot color.
- Spectral information for tone reproduction, from 10 percent through 90 percent
- Spectral opacity information for the solid spot color and tone steps by printing said color over white and a standardized black.

Specific research activities need to be completed to utilize this file format across a range of workflows and applications. It is understood that a formulated spot color printed across a range of substrates will drastically change final appearance. Identifying and characterizing pigments used to create the range of spot colors found throughout the flexographic industry is heavily developed by ink formulation software and industry experts. It is predicted that the creation of substrate definitions for attributes that impact spot color reproduction integrated into a standard file format for use in predictive models would be desirable. This color definition would be based on a standard substrate, a standard drawdown process, a known pigment and ink formulation, and a known destination substrate.

Typical ICC CMYK Color Management	Proposed Spot Color Management
Defined CMYK Ink Set and Parameters	Defined Ink Formulation
Plate Calibration, Known Pressroom Conditions	Printed Drawdown on Characterized Substrate
Output Color Management TestChart (IT8/7.4)	Color, Tone, Opacity Defined in Spot Profile
Color Measurement, Profile Generation	Defined Production Substrate Profile
Workflow Configuration, Process Control	Simulation of Spot Color Reproduction

Existing ICC profile color management for CMYK enables more advanced spot color management.

SUBSTRATE PROFILES

It is assumed that substrates can be characterized for properties that affect color reproduction. These properties can be quantified using standardized measurement protocol. It is hypothesized that these properties can be assembled into a standardized file format that can be called upon in workflows and color management systems for predicting how a known spot color definition will reproduce. The known spot color definition needs to include the defined substrate profile used when creating the color standard.

What are substrate characteristics that can affect color reproduction? Some obvious choices include:

- CIE LABCH color
- Light scattering and absorption curves
- Liquid absorption
- Roughness
- Gloss

The challenge comes when developing mathematical prediction models of how these attributes work together to affect final color appearance of, not only the solid color, but the entire tonal range and multiple spot color overprints.

Some preliminary tests were completed in the Fall of 2008 with a Clemson student research group to perform a short experiment taking four ink colors (red, orange, purple, and green) across four substrates: coated SBS (solid bleached sulfate), uncoated SBS, opaque white poly, and cast gloss pressure sensitive. Substrates were quantified using the metrics listed above. Color change (ΔL, Δc, Δh) of each ink across specified substrates was quantified. The correlation of each substrate characteristic with ΔL, Δc, and Δh in each color ink was evaluated for coefficient of determination, or $R2$, through simple linear regression. If the substrate characteristic could be used to predict the lightness, chroma, or hue of the ink, a favorable $R2$ value would appear, and those characteristics were selected for the model.

Some preliminary calculations were made based on interesting findings in this investigative research project. The model was put to work using existing packaging samples, and it was found to predict certain elements of color change very well. This example is outlined in Table 1. This early result is used to generate interest for a larger research effort that is currently underway.

TABLE 2.
CIE LABCH is not enough information to ensure visual correlation.

Delta EAB	D65/10°	D50/10°	Instrument 2	Instrument 3	Instrument 4
Red	9.52	4.85	0.79	3.39	2.09
Green	10.3	5.86	0.88	2.67	2.56
Yellow	4.86	7.93	1.61	2.59	1.22

* Reference color was measured with Instrument 1, D50/2°
** Instruments 2, 3 and 4 used D50/2°

GETTING STARTED TODAY

As more research and development is completed to streamline and integrate spot color management, there are steps to take today to improve your existing spot color workflows. Let's begin to remove the weakest link within the chain of spot color management. That starts with the initial color standard. The pressroom can only be accountable for the amount of information that is provided from the broker or customer. There are tools available today to begin to push proper color definitions up the supply chain to the customer and designer level. When developing spot color standards, consider including color standards for some steps within the tonal range, and overprint information.

There are testing (or laboratory type) systems in place at Clemson and at many other facilities, that utilize flexographic plates, mounting materials, anilox rollers, and doctor blades to reproduce test-prints at realistic production speeds on production substrates. Moving forward, the research outlined above allows the color standard to be printed on a standardized substrate, not production substrate, but then use production substrate profiles to calculate color values.

Once the standard has been approved, the next practical step to improve communication is to accurately define the color measurement. Make sure to capture spectral data as your root color value, and decide on the illuminant and observer functions to be used for distribution. When communicating CIE LABCH of your color standard, include the illuminant, observer, and instrument used in determining these values, as it will drastically influence the visual color (Table 2).

If the color is going to be used in screen-work, which is most often the case, it is very important to include a reference color value for the screen-work as well, for instance 50 percent. There are several ways to tackle this problem: with dot area, density, CIE LABCH, or spectral. The pressroom and prepress operators most often times are already required to measure the color of the solid in CIE LABCH or spectral to calculate a ΔE. The easiest way to incorporate control of the screen value is to work within the existing system for solid color control, which is to publish a standard color value for the 50 percent (or custom) tone, and have the supply chain use this color reference as the standard against which to measure ΔE. This information is used for troubleshooting color reproduction and to ensure the proof is produced to a known customer expectation.

How does this information help the supply chain?

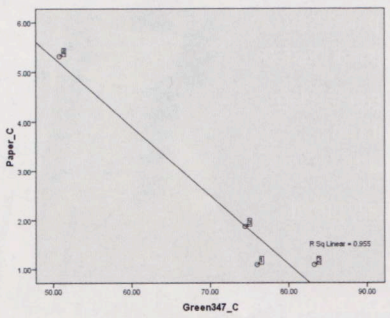
- Quicker makeready and less waste in the pressroom.
- Right-the-first-time/quicker time to market for new graphics and colors.
- Accurate contract proofing eliminating customer confusion.
- Provides a metric for process quality control/repeatability for packaging graphics.

In prepress, try to include accurate spot colors, and spot color screen-work, in-line with CMYK contract color proofing. Once accurate color references are identified, it is just a matter of incorporating those specifications within the proofing RIP and objective quality control system.

In the pressroom, begin to train operators, management, and quality control how to use color measurement and Delta E reporting to assist makeready and production consistency. Digitally capture and store this information to identify improvement areas, and track and trend pressroom color management capabilities. Emphasize measurement protocol, including instrument settings, calibration methods, and measurement backing material to ensure accuracy and visual correlation to results.

SUMMARY

This article reviewed current limitations in the marketplace for spot color management, tools and workflows that can enable better prediction for color control, and research currently underway to improve total color accuracy throughout the supply chain. Also mentioned were several things companies are already doing today, or could be doing today, to begin to improve spot color communication and spot color control. Clemson provides an open forum for you to participate, so if you have any questions or comments please don't hesitate to stay in touch and get involved. ■



Relationship of substrate chroma to change in ink chroma.

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