THE Quality Control Scanner

MONTHLY PRACTICAL IDEAS FOR IMPROVING YOUR QUALITY AND PRODUCTIVITY

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Color Control on Press: Times Are Changing

By Miles Southworth

Pleasing the customer is still the successful printer, separator, advertiser or publisher's objective. Today, the customer who purchases color printing expects to be highly satisfied with the product—delighted by the reproduction. During the prepress stage, the color proof that indicates the desired results was accepted by the customer. The printing must match that color proof, and each printed product from the pressrun should appear identical in hue, saturation and brightness.

Customers will not accept wide color variations in their products. Deming would tell us, as we already know, that our printing process has some variation. Although the customer would prefer not to see any variation, some is accepted, provided it does not degrade the product. Just how much hue, saturation, brightness, register and sharpness variation is noticeable and how much is tolerable is determined by the customer.

To keep the color consistency within the customer's tolerances, all the production steps must be controlled. Within each job and from job to job, consistency is an attribute that customers desire. In an attempt to find it, customers will change printers and separators. Your company will be out of business quickly if you cannot meet or exceed your customer's expectations.

This author has spent over 25 years investigating color variation, color consistency, customer's color desires, printing press variations, separation optimization for printing conditions, materials variations, proofing calibrations and control, as well as miscellaneous variation causes. The goal is to find the ultimate control tools so that the customer is consistently assured of good color reproductions. While we in the industry have learned a tremendous amount and have improved our process control and instrumentation, we still have a way to go before unwanted color variability is eliminated.

People are more sensitive to hue changes than they are to saturation or strength changes. Advertisers want hue consistency. When producing acceptable color, keep the:

- apples red, not too orange or blue
- sky blue, not purple or cyan
- grass green, not yellow or blue
- blue jeans navy, not purple
- correct corporate color hues, such as Kodak yellow, IBM blue, DuPont green and 3M red.

Within your customer's tolerances, hue consistency is the most important variable to control. Keep color hue within your customer's tolerances and you will be a successful, profitable printer. Failure to control color hue will result in piles of waste, excessive press makeready time and no profitability, not to mention, lost customers. With today's technology, instrumentation and process control knowledge, hue consistency is possible and expected. Customers are learning not to accept mediocrity. Often, they do not complain loudly; they do not want to offend the separator or printer. They just change suppliers.

Vary SID to control color

In 1983, *The Quality Control Scanner*, Vol. 3, No. 4, proposed and presented evidence that press operators intentionally vary solid ink densities (SID) throughout the pressrun in order to maintain the color consistency of overprint solids and tints. A statistical approach to hue control was an unfamiliar concept. Up to that time, people assumed that inconsistent solid ink density caused inconsistent overprint hues. Therefore, maintaining consistent solid ink density would result in consistent overprint hues. As you might guess, our hypothesis that the solid ink densities are varied to maintain consistent overprint hues was not met with overwhelming acceptance. However, our theory is slowly being proven true.

In that same newsletter, supporting research was reported. Gaston's investigation proved that people could notice hue variation more quickly than solid ink density variation. Felix Brunner's testing showed that dot gain change had a significantly greater effect on a halftone density than variation of solid ink density. He determined that achieving a 5% dot gain decrease in the magenta would require a 27% decrease in the solid ink density—a change that no longer would produce an acceptable red overprint. A 1982 Graphic Communication Assn. (GCA) study found that 16 press crews produced identical hues of red even though their products varied in strength, dot gain and trapping.

In 1984, *The Quality Control Scanner*, Vol. 4, No. 6, concluded that as the dot gain changes during a pressrun, the overprint tints change markedly. The press operator tries to maintain or reestablish the match between the printing and the OK press sheet by varying the amount of ink being applied to the substrate. This tutorial suggested that for more accurate control, instrumentation should be utilized. To determine when the overprint is changing hue, the overprint hue can be measured using a densitometer with three filter readings. *The Quality Control Scanner* proposed measuring selected images in the printing on the OK press sheet or proof and comparing these readings with readings taken from similar locations on the press sheets. By comparing the figures, the press operator can determine which direction to change which ink in order to reestablish the color balance for consistent hue. The primary control on the press is SID. Controlling it for consistency to compensate for other printing variations yields a consistent hue in the overprints.

COSAR built an XY point locating table as part of the COSAR AutoSmart™ densitometer. The software allowed the user to more accurately control hue. The instrument can rapidly, automatically and precisely measure identical press sheet locations.

SWOP

In 1975, the Specifications for Web Offset Publications (SWOP) program was started to help improve magazine color reproduction with recommendations and specifications for production standards. An industry committee was formed. The approach taken was to control the production steps and minimize variation by standardizing proofing and later, printing conditions. As the committee learns more about variation and control, the SWOP program continually improves magazine quality.

Guidelines were established for color proofing densities. After printing conditions were studied by the GCA Print Properties Committee, Felix Brunner, DuPont and 3M in the '80s,

windows of dot gain acceptance were established for proofing and printing.

Ink densities and acceptable variations were established for proofing and printing. The 1988 SWOP booklet, page 15, states that the proof densities can vary by 0.14 in density as compared to the center point of the International Prepress Association (IPA) Hi-Lo Color References. While on press, the solid ink density range variation can be 0.14 above or below the center point at the Lo of the SWOP Hi-Lo Reference. That is a range of 0.28 as measured on the solid ink patch for each process color. These densities are measured using a densitometer calibrated with the GCA T-Ref™ and the Status-T densitometer response.

The exemplary work of the SWOP committee over the last 15 years has paid dividends in both greatly improved color quality and productivity. The number of ad complaints has dropped significantly. Advertisers are much happier with their color reproductions. Doug Landon of Time-Warner reported at Spectrum (*The Quality Control Scanner*, Vol. 10, No. 11) that even though some proofs did not meet SWOP standards, the press operators could match the color proof on press by adjusting the ink densities. He stated that by "running to the numbers" Time-Warner can now let the printers do the color OKs.

The next step for improvement

In the present phase of the color control process, state-of-the-art technology and knowledge should be used to improve the accuracy of the measurement and control process. Since we know that the average observer is more aware of a color hue change than of a strength change, why not measure "hue?" We have a clue that it is justifiable to measure hue because the "just-noticeable-difference color ellipses" in a CIE (Commission Internationale de l'Éclairage) chromaticity diagram are smaller in the hue direction than the dominant wavelength direction. What are not known at this time are the acceptable hue variations for given conditions, products or industries. However, with existing handheld spectrophotometers and colorimeters, it is possible to specify colors in a color space with much more accuracy than with a densitometer. The amount of hue change and its direction can be indicated. It is also possible to measure the color strength or saturation change.

Even though it has been shown that press operators intentionally vary the ink density to compensate for the 100+ variables on a four-color lithographic press, it continues to be easy to fall into the old trap of measuring the solid ink density and trying to keep it consistent. It is dead wrong to assume that a consistent solid ink density for each process color will assure consistent hue. Although the solid ink density is the one press variable that the press operator can control, dot gain shifts, paper differences, ink batch changes and trapping variations will cause the overprint hues to change. In order to control the color hue in a way that is similar to the way it is seen, spectrophotometers and colorimeters can be used to measure the hue and saturation. When we establish some industry tolerances for acceptance, we can establish the production specifications for acceptable products.

The latest instruments come with calibration references that are traceable to the National Bureau of Standards. This means that they are accurately calibrated so that other industry references, such as the IPA Hi-Lo Color Reference, may no longer be needed. Different brands of instruments that are certified to meet specifications will agree with one another. Today's instruments have increased inter-instrument agreement. Therefore, the need for secondary standards may become unnecessary.

Instrument systems and software are available from Cosar, DuPont, Gretag, Hunter, Macbeth, Tobias, 3-M, X-Rite and others to automate the data collection process. When we can quickly gather more information with more accuracy and using less manual labor, we will be able to gain valuable knowledge about our processes and their variation sources. Once each press can be characterized, we will be better able to control it. This instrumentation will help identify the root causes of variation to the point that the causes can be eliminated. It is only a matter of time before all customers will specify their tolerances in colorimetric terms. Some already do. If you are the printer doing work for informed customers, you don't have a chance to succeed unless you use process control instrumentation that is similar to the customer's. Achieving an accurate color or product match to a given specification will depend on its accurate measurement with the correct instrumentation.

Software and scanning instruments can take the time consuming work out of press control. Press sheets can be read automatically and the data analyzed by the software for statistical process control (SPC) decision-making and data base construction. If it is required by the customer, a product profile can be produced for each pressrun.

The next logical step is to close the loop. That is: the instrument will automatically take the measurement and make the necessary changes to keep the product within acceptable specifications. When this works successfully, there will only be acceptable products. This will result in the productivity and quality ultimate. Everyone will benefit from this utopian condition. You must stay abreast of this changing technology.

More research

The printing/publishing industry needs to do more research to determine acceptable specifications for given industries, products or services. For example, it may become necessary to match within a specified tolerance amount the reproduced color of a catalog product and the actual product sample color so that the catalog is acceptable. This could prevent returns that companies, such as Spiegels or Sears Roebuck, currently receive because the product arrived at the customer's home, and the actual product's color appearance did not match the reproduction in the catalog. In the future, an advertising agency may specify that their ad for product X not vary in hue more than so many units or vary in strength by so many units. At this point in time, we are just starting to learn how demanding our customers are going to be. Apple Computer, for instance, set up an entire set of specifications for all their printed products. Suppliers must now prove that they have process controls in place before they are able to bid on Apple printing. We will continue to tract the progress of color control on press and keep you apprised as our knowledge of color control grows.❑

Helpful Color Measurement References

"Color Measurement" by Catherine M. Stanulis, *High Volume Printing*, June 1990, pages 61-66, 69, is a tutorial on the use of spectrophotometers, colorimeters and densitometers for color measurement including a review of the latest equipment. This is the first part of a four-part series on color, standards and measuring techniques in the graphic arts.

"Controlling Printed Image Color with Colorimetric Measurement" by Dorothy J. Donahey of Hunter Associates Laboratory Inc., *High Volume Printing*, August/September 1989, pages 26-27, 117-118, examines the science of color measurement (colorimetry), its application to the graphic arts industry and HunterLab's role in colorimetry.