Characterizing output devices for a color-managed work flow

by Brian P. Lawler

Some of the challenges encountered when developing a color-managed work flow include the measurement and description of output devices.

While it may be possible to describe output devices generically, it is unlikely that generic descriptions will fit the most critical standards for color management.

An example of the problem is the common SWOP standard, one which is used by default in many applications, including Adobe Photoshop.

SWOP stands for *Specifications [for] Web Offset Printing.* It is based on a periodic study of over 100 printing presses in North America, and is maintained by a committee of monitors. Curiously, it is a standard designed for the production proofing for printed materials for advertising in *web offset printing.* It is not a standard for sheet-fed printing. A standard for sheet-fed is only now evolving (it's called GRACOL, and it has not received wide acceptance yet – these things take years!).

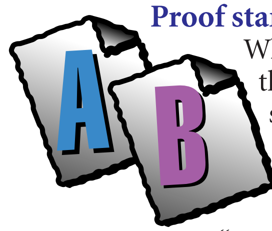
The SWOP standard is an *average.* It remains a good standard because it runs right down the statistical middle of the performance of a large number of pretty good web presses. If you use the SWOP standard, you'll be blessed by a very consistent process. And, most SWOP inks, though manufactured by a large number of ink manufacturers, are quite close to the SWOP standard, and this really helps to keep the results consistent.

Magazine publishers rely on the SWOP standard to ensure the salability of advertising. When commercial publications are printed using the SWOP standard, advertisers are nearly – but not completely – guaranteed that an advertisement in one publication will match the same advertisement in another publication printed in another plant.

Sheet-fed printers, though they often rely on the same SWOP standard, introduce variables into the printing process that can seriously skew the results of printing to the "standard." The most common deviation from the SWOP standard is the use of screen frequencies finer than 133 (the SWOP standard); most sheet-fed printing is done with 150!

Sheet-fed printers may change the order of inks when printing, or they change the brand or manufacturer of their process inks. Unlike publications, which really *must* abide by the standard to ensure the salability of printed advertisements, sheet-fed printers change things on the fly, creating a moving target for those who prepare to standards.

Proof standards vs. print standards



When we describe a file as fitting the SWOP standard, we are really specifying that it is *proofed* to SWOP standards, not printed standards.

Proofs that are intended to "match" the output of SWOP-standard publications are usually quite reliable. But, these proofs use expensive consumable materials, and often involve the creation of film just to make the proof.

Trends of recent years are forcing us away from such expensive proofs and toward fully-digital – and less expensive – proofing processes. These digital processes include:

- **Dye-sublimation printing**
- **Ink-jet printing**
- **Toner-based printing**

These processes are proving worthy, and are meeting with considerable success. However, the pigments used, and the printing characteristics of digital proofing technologies are not as close to the SWOP colors as are photomechanical proof pigments perfected over many years to match printing inks on-press more closely.

Printing in North America

When we print using SWOP, we are essentially committing to print in North America with the pigments and processes used here.

Asian and European color standards for printing vary significantly from North American standards, and this causes printing from SWOP proofs to be unreliable when printing is to be done outside North America.

Japan has a printing standard – called *Japan Standard* or *DIC,* and European printers generally use the *Eurostandard* ink set. The Japanese color set is characterized by a golder yellow; Eurostandard inks use a rhodamine red, which is more rosy-red than the magenta used in North America.

People using the incredibly-popular Epson ink-jet printers are encountering the gold-yellow "problem" with Epson inks whenever they attempt to proof using that firm's standard ink sets. This "problem" however, is better understood when you realize that the inks Epson manufactures are very close to the standard used in Japan. It is a subtle-but-important difference that affects all of who use these inks for North American (SWOP) proofing.

Other problems sneak into the process, too.

The SWOP standard also assumes commercial publication-grade glossy paper. There are additional standards for uncoated and newspaper printing with the same ink sets. These are called *SWOP – Uncoated,* and SNAP *(Specifications [for] Non-heatset Advertising Printing).*

Whenever sheet-fed printers use better or lesser-grade papers for printing – and this is more common in sheet-fed than it is for publications printers – the “standard” goes out the window.

Ink quality and consistency

When sheet-fed printers use *internal standards* (remember – no sheet-fed industry standard yet exists), they develop *process consistency.* This consistency is developed by using the same trusted inks in the same order on trusted papers – most of the time.

Most high-quality printing firms have developed process consistency because it saves time and trouble, and any system of working to standards results in fewer jobs needing to be run again.

Firms with several presses *must* have inter-press standards. This means that printing on one press is comparable to printing from another press. This doesn’t mean that the output from different presses matches exactly, but that it is predictable and consistent.

In many printing plants there are presses reserved for the highest-quality work, while other machines are used for general commercial printing where the standards may be lower.

Moving to color management

Whenever a printer works to *internal standards,* the resulting printing is better. When a printer works to *industry* standards the work can be measurably better when compared to printing from other plants.

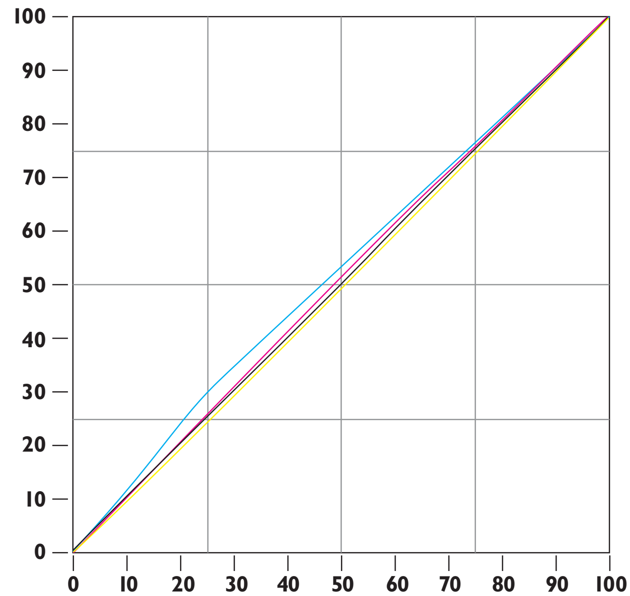
When color management is adopted, plates, paper, film and printing remain consistent, “variables” become less variable, and the color characteristics of the job are modified in the original document, causing the color to be corrected for the press and paper actually being used.

This makes it possible to fine-tune the process for any combination of paper, press and inks and to get more reliable results from a variety of machines.

Linearize the platesetter first

Whenever preparing a target proof or press run, the PostScript imager – whether it be a film imagesetter or a computer-to-plate system should be linearized first.

The process involves using software (usually supplied by the equipment manufacturer) to ensure a straight-line input vs. output “curve” for the system. This ensures that any variability in the machine will be reduced to a minimum before the test job is run. It also ensures that the variability of the imaging machine is minimized.



This linearity diagram shows how the four colors of an imagesetter can be off slightly. Linearization software can correct such flaws in linearity, making the process of profiling a proofing or printing device much easier.

Proofing machines can also be linearized using commercial software. The overall objective is to set a known standard for printing that can be the benchmark for all proofing or printing in the future.

Linearization should be carried out for each range of halftone frequencies used in your production printing process. The linearity of an imagesetter can change when halftone screen frequencies change due to slight variations in the dot-rendering methods and angles used by the RIP to draw halftone dot patterns.

Color targets

When characterizing a printing machine – whether it is a proof printer or a press, we begin by printing a test target with as few as nine colors, or as many as several thousand.

These targets vary with the profiling software used. In general there are hundreds of colors, arranged into blocks that test the performance of the primary cyan, magenta and yellow components, and then various combinations of these colors.

The target will also include patches for solid black, plain paper, and combinations of process colors that yield difficult-to-print colors. All of these color patches, when analyzed later by profiling software, help to measure the anomalies of the printing device.

Print targets "to the numbers"

When preparing a printed color target, it is extremely important to print to *internal standards* for densities.

The X-Rite DTP-41 instrument, a semi-automated spectrophotometer. This device reads strips of specially-coded color patches generated by most color profiling software. It is very fast, requiring only minutes to complete a set of hundreds or thousands of readings.

Press operators call this "running to the numbers" because it sets internal standards as the priority, rather than visual adjustments made by the operator.

A written record of solid ink densities must be made when producing such target runs so that the density values can be matched again and again after the profile is created.

Without such records, the profile made will not describe a repeatable process.

Allow for dry-down, then measure

After printing the targets, it is wise to allow the press sheets to dry according to "normal" internal standards of production. Though colors do not change much from wet to dry, they certainly do change, and it is best to simulate actual production as much as possible when profiling.

If a UV or IR drying system is part of normal production, then it is best if the target printing be passed through the same drying process that normal printing endures in production.

Once the paper has reached a state where the targets can be read, profiling can proceed. The procedure involves reading the color patches with one of several color spectral instruments.

In the illustrations on this page are a hand-fed semi-automated instrument and a fully-automatic instrument. These tools vary in price from about $3,000 to over $6,000, not including the profiling software to drive them.

Reading the color patches can be completed in less than 20 minutes when using an automated instrument.

The hand-fed device allows for much faster results, but requires that a person attend the instrument to feed the target strips into its motorized aperture opening.

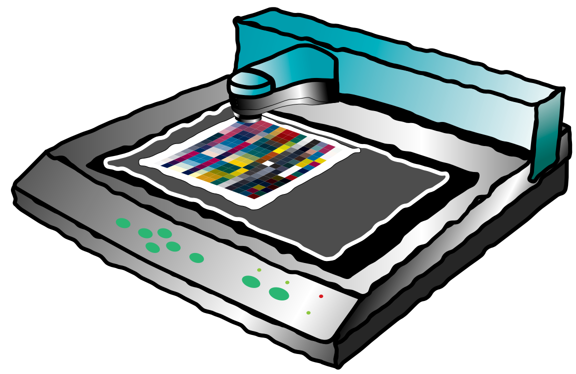
The quality of the readings is more than adequate for the needs of profiling printing machines.

Digesting the spectral information

Profiling begins with a comparison of the original pattern colors created by the profiling software, and the resulting colors as printed.

The profiling software then uses the comparative information to build a corrective profile that describes the performance of the measured printing device so that color destined for that device can be made more predictable and repeatable.

The result of the profiling software is an ICC color profile which represents the printing device, and all of its many color, press gain, paper absorption and other qualities. The profile is in essence a description of what happens to colors when printed on that device.



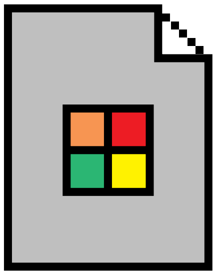
GretagMacbeth's Spectroscan is a fully-automated instrument for reading color patches for profiling. The measurement instrument, called a Spectrolino, can be removed from the automated table for monitor calibration and profiling, and for hand-held readings. Another version of this instrument includes a transparency illumination feature.

The ICC – *International Color Consortium* – is a trade association made up of organizations and individuals whose products control the display and delivery of color on all types of devices.

The profiles created by profiling software follow a prescribed set of functions defined by the ICC. A profile can be one of several types:

- **Input profile (scanner, camera, monitor)**
- **Monitor profile**
- **Output profile (proof printer, press, film recorder)**
- **Device-link profile (two or more profiles linked together to act as one)**

ICC profiles actually make a color translation between one color environment and another. They can convert RGB (red-green-blue) color into CMYK



The product of profiling software is an ICC Profile. These profiles are cross-platform capable (they are usually written in plain ASCII code), and acceptable to a wide range of graphic arts software. Apple calls its process ColorSync; Microsoft uses the term ICM for its version of the color management engine.

(cyan-magenta-yellow-black) color, or RGB into monochrome. The possibilities include:

- **RGB – RGB**
- **CMYK – RGB**
- **CMYK – CMYK**
- **CMYK – RGB**
- **RGB – Monochrome**
- **CMYK – Monochrome**
- **RGB – Hi-Fi color (5 to 8 process colors)**
- **Hi-Fi color – RGB**

ICC profiles can be used to make a simple scanner-to-monitor color conversion, for example. They can be much more sophisticated, however, and can make color separations for printing in four or more colors (up to eight colors).

Included in the process instructions embedded in the profile can be color separation methods like Under Color Removal and Gray Component Replacement controls, or total ink limit controls.

Profiles can also be built into linked sets that perform chains of color processes as they work. For example, a linked profile set can be built that converts RGB color to proofer color with a simulation for a press built-in. The result of this linked profile set would be a proof that very closely follows the color capabilities of the press while being printed on the proof machine.

Putting color management profiles to work

Once the profiles are built and stored, they become available to application software that can manage color in production.

Popular graphics applications like Adobe Photoshop, and Illustrator acknowledge and use ICC color profiles to maintain control over the color of illustrations and images.

Page layout applications like *InDesign* and *QuarkXPress* also support color management, and can apply it in ways that respect the color of an original image while converting its color to that appropriate to the output device and printing process.

We are striving to work independently

Device-independent color is the key to success in the future of graphic arts color. If possible, we want to scan all images and store them in original scanner RGB color (CIE-Lab is OK, too).

After the images are saved in RGB color, they can be placed into page layout applications, and then printed to any device for which there is a profile in the system. The original color is modified on-the-fly using the ICC color profile. The original images are not modified in the process.

The future is – colorful!

While this color management technology is exciting, there are obstacles to a universal acceptance of managed color in the printing process.

Color management is becoming critically important to the success of printing in all segments of the graphic arts industry.

■ This is one of a series of essays I have written on graphic arts and computer subjects. Subjects range from dot gain and halftone screens, to preparing files for the World Wide Web.

For access to the others, please direct your browser to my site on the World Wide Web:
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