ANOTHER GRAY AREA: A “MANUFACTURING” APPROACH TO COLOR MANAGEMENT

By Richard Romano
For decades, printers’ approach to color management has been highly subjective. A proof is examined in a light box, compared to a press sheet, color keys are adjusted, and that was it. In some cases, that works fine, but it can introduce errors and result in a job that may not be repeatable. For example, a job that needs to be reprinted may need to precisely match the first run. If a different operator handles the second run, any variation can result in an unacceptable job. What’s needed is to change color printing from a subjective “craft” process to an objective “manufacturing” process.

It is one of the industry's great ironies that after all these years of advances in color management, we’re still having many of the same conversations and the same problems.

“Color management isn’t any more or less complicated than it was 10 years ago,” said Jim Raffel, Color Management Consultant and CEO of ColorMetrix, a provider of color management consulting services and software. “It’s that we’re applying it to so many different spaces and trying to get all those spaces to agree.” This is certainly the case when we’re printing the same content across different printing technologies, such as offset, digital, UV, and dye-sublimation.

A more methodical approach to color management has become even more necessary today, as offset and other analog print processes are complemented, supplemented, and downright replaced by digital technologies, be they inkjet or toner-based.

Even when we’re using a single process, we can still have color matching problems. As a result, we need to make color management objective and repeatable. Fortunately, there are tools and methodologies available today that can achieve that.

**Measure for Measure**

A fundamental part of color management is accuracy. Given that the human eyeball isn’t an especially effective measuring device, a spectrophotometer is a must.

Repeatable color printing involves:

- **Calibration**—Bringing the press to a known printing condition (G7 for example).
- **Characterization**—Profiling the press while in a known printing condition (ICC profiles).
- **Control**—Monitoring the press to keep it in a known state so color can be reproduced accurately—also known as correcting for “drift.”

The last step is often neglected. “I see very few printers control the process, so they stay within the tolerance of a color profile or where the calibration was made,” said Mark Geeves, Director of Sales and Marketing for Color-Logic, a developer of color communication systems and software for special effect printing applications. In other words, they don’t continuously monitor the press to ensure that it is not “drifting” out of accurate color (see below).

The basic calibration process is:

- Print color patches.
- Measure the values you printed.
- Compare them against target values.
- Use the DFE to apply or make calibration corrections.

Let’s unpack that.
Calibration Time

First of all, calibration is not synonymous with color management, although the former is an essential part of the latter. Merriam-Webster defines “calibrate” as “to standardize (as a measuring instrument) by determining the deviation from a standard so as to ascertain the proper correction factors.” When it comes to a printing press, this means determining how it prints color in relation to a known standard.

What follows is a very simplified explanation of press calibration, but it will give you an idea of the overall procedure.

You first need to decide on a reference print condition. In other words, which print standard are you going to use to manage your color? The most common print standard for digital and litho is GRACoL, while for publication printing it is SWOP. There are others such as CGATS 21, and, in Europe, FOGRA. For the purpose of this article we’ll stick with GRACoL. But other standards are used in basically the same way.

Calibration begins with a target, or something to aim at. A common, albeit informal (and poor) target is often provided by the customer. The customer will then say, “Match that.” This, however, is the exact opposite of what we mean by “an automated approach to color management.” Using a customer’s previous job isn’t a particularly objective methodology, nor do those printed samples contain enough data to be effective.

So we’re going to look at more rigorous procedures, and a better target.

There are a few ways to calibrate. For an offset press or other analog process, we use the tone curves used in making a plate or other imaging process. For a digital press, we use ICC profiles and apply color management in a digital front end.

A good target to use is one favored by G7, such as the P2P color target (see illustration). In a nutshell, you print this target on your press, measure the color patches that you printed, and then compare these values to what the patches’ color values should be. Let’s look at this in slightly more detail.
You print this target and adjust the inks so they come as close as possible to matching the ink colors specified in the print standard (this is called “targeting”). Then you print and, using your spectrophotometer, measure the patches on a typical substrate to discover how your printing device prints.

These obtained values are then compared to the reference values. Take one of the solid patches, say, cyan. Your measurement tells you that your press’s cyan L*a*b values are L=53, *a=-35, and *b=-48. However, the reference (or “real”) L*a*b values provided with the color target itself are L=55, *a=-37, and *b=-50. (A detailed look at L*a*b is beyond the scope of this article. Basically, it’s an objective way to define color in terms of three components. This differential is what we need to correct for.

These values are then imported into calibration software. It then generates print curves. Long story short, the software takes your measurements, generates a tonality curve, and compares that with what it should be according to the G7 specification.

The G7 methodology uses a Neutral Print Density Curve (NPDC), defined as “the relationship between measured neutral density and original halftone percentages on a printed gray scale.” This is known as “G7 Calibration,” and the goal of G7 Calibration is to achieve tonality and contrast, either through tone curves, ICC profiles, or a combination of both.

You have a couple of options here. For an offset press, tone curves are sufficient because the inks and other attributes are very close to the GRACoL print condition.

Digital equipment may be able to print a larger color space (see below), or the inks may not act like typical offset inks. As a result, curves alone are not sufficient for many digital output devices. This is where “color management” comes in. By comparing measurements of the current printing condition to those of the desired printing condition (which we did in the calibration step), a digital front end will use ICC profiles to get the color as close as possible to the desired print condition. If you have a production file and you send it to your RIP, you select “GRACoL” and the RIP does the rest.

If you are adopting the G7 methodology, you’ll need to go a bit further and do multiple calibrations to ensure that the NPDCs closely match the G7 standard. The G7 methodology is perfect if you’re trying to match similar output across different output technologies (offset vs. digital): as long as a device can hit the standard NPDC, it will by definition have a common visual appearance.
Courage In Profiles

Calibrating your press is one thing, but different substrates accept ink in different ways. Colors printed on uncoated stock will look different than on coated stock, and even various coated stocks will differ. You’re not going to calibrate your press to every new stock, but you should linearize the press for different stocks.

This happens via color profiles. A color profile is the correction data—what we obtained during the calibration and measurement step—for a given ink set printed on a given substrate on a given press. When you RIP a file, you select the profile that matches the ink, substrate, and press combination, and the RIP software will make all the necessary adjustments to the ink densities.

If you have calibrated and profiled everything correctly, the digital front end (DFE) will simply apply the corrections as files are processed. Adjustments will be made in the print controller and that data sent to the RIP to generate the appropriate output.

Calibrating the press and creating color profiles doesn’t have to be complicated, but they do require specialized skills and knowledge; this is why many printing plants hire color management experts to handle these processes, as they are beyond the capability of the average press operator. Calibrating and profiling also take time; a press calibration takes a couple of hours.

The missing piece of color control is often ensuring that the calibration is still effective. Printing equipment can “drift,” or vary the densities of the ink over time. After six months or so, if you reprint and measure the color patches, their L*a*b values may vary from those obtained during calibration. This means that when the RIP makes ink density corrections, they may be wrong.

It’s best to repeatedly monitor and measure. “When a digital press drifts, many printers have a very quick procedure to pull the machine back,” said Ron Ellis, G7 and Process Control Expert, and GRACoL Chair. “Building a profile takes an hour, but a linearization usually takes about 10 minutes. Quality control is the big deal.”

Some equipment drifts more than others. Offset presses are remarkably consistent compared to digital, and toner-based digital presses tend to drift more than inkjet. “Litho often has a once-a-year calibration,” said Ellis. “As long as they’re matching proofs and hitting their numbers, many printers won’t [calibrate] again until they have their G7 renewal calibration, or if they can’t match their proof.”

One Ring to Rule Them All

A common challenge today is controlling color across disparate printing processes. A large print campaign may have one element printed on an offset press, another on a digital press like an Indigo, and a third on a wide-format inkjet machine. These three processes use vastly different imaging systems and inks, so achieving a common visual appearance can be like getting cats to walk in a straight line.

G7 can help out here, as its calibration methodology is the same for any imaging technology—offset, flexo, gravure, inkjet, toner, you name it. It is also ink- and substrate-independent. Think of it as “one ring to rule them all.”
Extended Gamut Inks

Standards like GRACoL are excellent for getting consistent color, but have limitations when printing equipment uses “extended gamut” inks. Digital printing, especially wide format inkjet, print more than CMYK, adding light cyan and magenta, and additional colors such as green, orange, violet, blue, and even red. This means that if you are RIPping files to the GRACoL standard, the RIP ignores the extra colors and “dumbs down” your output. Thus, you’re not printing all the colors you could potentially be printing, and are producing output that is less vibrant than it could be.

“While GRACoL is the common go-to profile used by litho and digital presses, it doesn’t have a large gamut,” said Ellis—and, as the GRACoL Chair, he should know. It’s great, but, he said, “The minute I have a device that can print bigger than GRACoL, I’m cutting down the colorfulness of my device. If I turn off color management, I get output that is more vibrant, but no longer color accurate or gray-balanced.”

To remedy this, in December 2016 Idealliance released XCMYK, a new profile and color space that is, essentially, GRACoL for expanded gamut printing. “It’s built for digital, but can also be used for offset,” said Ellis. “If you’re doing digital, you’re trying to get the widest gamut you can.”

To be clear, the XCMYK specification is still a CMYK-based color space and doesn’t take into account the orange (O), violet (V), green (G), and other color inks found in many wide-format printers. Rather, the raison d’être of XCMYK is to boost the CMYK ink densities to yield more vibrant output compared to GRACoL.

Any Color You Like

It’s a safe bet we’ll still be talking about color management in 10 years’ time, but at least we’ve reached the point where consistent, repeatable, objective color output is more achievable than ever.
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Richard Romano is Senior Analyst for WhatTheyThink.com, the news and information portal for the graphic arts industry, for which he curates the Wide Format topic page, and contributes other news and feature stories, as well as market research and technology reports. He also cohosts, with Dr. Joe Webb, WhatTheyThink’s monthly economics webinar. He also contributes to other industry publications, such as Wide Format & Signage, Printing News, Inkjet’s Age, the SGIA Journal, PrintPlanet.com, and more.

He is the author or co-author of more than a half dozen books, including This Point Forward: The New Start the Marketplace Demands; The Home Office That Works! Make Working at Home a Success—A Guide for Entrepreneurs and Telecommuters; “Does a Plumber Need a Web Site?”; and Disrupting the Future. He is currently at work, with Dr. Joe Webb, on a new book called The Third Wave, which will be published at PRINT 17. Many moons ago, Romano was the co-editor of The GATF Encyclopedia of Graphic Communications.

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