**Color Management Through Measurement**

by Raymond Cheydeur

**WHY DO WE MEASURE?**

"Measurement is the first step that leads to control and eventually to improvement. If you can't measure something, you can't understand it. If you can't understand it, you can't control it. If you can't control it, you can't improve it." — H. James Harrington

The quote above encompasses some of the major reasons we measure in many aspects of printing. Put another way, in the printing industry we measure for process control, production understanding and quality improvement. These are the easy answers on why we measure. Measuring proofs and final jobs allows us to maintain process control and can provide the understanding to keep us in control of the print process and provide an overall gauge on quality.

Two of the more important reasons we measure are not covered directly by the quote—saving money and meeting contractual obligations. Numerous studies have shown that workflows involving measurement reduce setup time and thereby cut waste. Measuring also saves time by allowing better information to flow both upstream and downstream and sets better expectations upfront, which reduces costly changes in the pressroom.

Contractual requirements increasingly state either an overall expectation of meeting a reference printing condition (i.e.: GRACoL®, SWOP®, FOGRA 39, etc.) or, for brand colors, actual values for the solid color values with an associated tolerance for the printing condition.

**WHAT AND WHERE DO WE MEASURE?**

In printing, we have traditionally measured density and dot area (tone value). These metrics are directly related to the printing process and have served well as a means to maintaining process control. When we say we measure density, the next question needs to be: What status are you using? In North America, we most often measure in status 'T', without any polarization filters, and include paper as part of the measurement values. In other parts of the world, different status types may be used along with a polarization filter. Because of this, never assume you know what the density aims are unless they are specified.

Today, density alone is rarely enough, so colorimetry should be part of the mix. Fundamentally, many specifications now rely on a definition of gray along with associated $L^*a^*b^*$ values for gray and process colors. In addition, as noted before, some customers supply colorimetric aims for their brand colors that also are usually part of the printing contract.

The easiest way to accommodate the need for both density and colorimetry is with a spectrophotometer. In the pressroom, these may come in the form of a handheld instrument or...
commonly today, a dedicated press-side device that can scan and measure all the values required in one pass and provide reporting at the end of the job. In some cases, these are part of a bigger system where there is closed loop control of the press directly from the measuring system.

Where we measure is extremely important as well. It is critical that actual control areas be included as part of the job. On an offset press, this is most often accomplished as part of a color bar that runs the length of the printed area on the sheet, with control patches for each ink zone on the press. For package printing that may have many individual spot colors, control patches are often placed on the flaps of the package. A control wedge for proofing that may have many individual spot colors, control patches are often placed on the flaps of the package. A control wedge for proofing is often used to verify compliance with a proofing specification. In all of these cases, you can see that the control areas are well defined and not part of the actual job image itself. In some cases, measuring with the job can be valuable, but typically for process control purposes, having discrete process control elements are required for useful, repeatable measurement results.

Colorimetry is also required for color profiling and device characterization. In prepress, virtually all proofing systems are accompanied by at least one dedicated handheld scanning spectrophotometer and many also are using automated page spectrophotometers that can read thousands of patches in just a few minutes, greatly accelerating the calibration and characterization of both proofers and presses.

ISSUES WITH MEASUREMENT

“The only man who behaved sensibly was my tailor; he took my measurement anew every time he saw me, while all the rest went on with their old measurements and expected them to fit me.”
— George Bernard Shaw

As the quote above reminds us, one of the primary problems with measurement is actually doing it! In the past, it wasn’t totally unexpected to walk into a pressroom and when asked to see their densitometer, have it pulled out of a drawer where it was clearly gathering dust! Fortunately, those days, or perhaps those operators, are no longer with us. However, it is important to remember measurement data must be taken and used properly to achieve process control goals.

As we mentioned earlier, one of the benefits of measurement is better communication of expectations along the workflow. For that to be beneficial, there are certain elements of communication that are critical to ensuring measured data are of value.

DENSITY:
- Status,
- Absolute or minus paper,
- Filters used,

COLORIMETRY:
- Illuminant,
- Observer (printing typically uses D50/2, many industries use D65/10),

ALL:
- Backing (white, black or self backing),
- Tolerance, type and range,
- Instrument geometry (printing typically uses 0/45 geometry, many other industries use a diffused sphere).
Without a standard there is no logical basis for making a decision or taking action.

- Joseph M. Juran

Included in the All section above is the word tolerance. Of the areas of concern in measurement, this may be the least understood. In this case, we are using tolerance to define a measure of acceptability for the completed job. A customer may desire a very narrow tolerance and a printer might prefer a large tolerance. The problem can arise when the customer and the print producer cannot agree on the tolerance requirement.

The most likely reason for this is a requirement that is either poorly stated or unreasonable for printed production. This may require some education because small color measurement tolerances are achievable in some manufacturing processes but are not needed or easily achieved in many printing processes. The problem in printing is that all imaging devices have some degree of fluctuation that also can be influenced by types of colorants and papers being used (each of which has its own color tolerance)—only two of many variables. Remember, a contractual requirement without an acceptable tolerance for the particular printing condition indicated is not a contract you want to sign.

On top of all of these things, one must consider the instrument itself. Substituting an inexpensive instrument in the ink kitchen, where precise measurements and repeatability are key, will likely end up with errors stacking up right from the start. Another source of error in instrument use is poor maintenance of the calibration reference—or no calibration at all. In a recent survey of instrument repair, a significant portion of the devices sent for service needed nothing more than cleaning. Most manufacturers also recommend annual recertification of an instrument, which gives an assurance of instrument performance. Other considerations in choosing the right instrument include appropriate aperture size for the line screen, handheld or press-side, manual or automated, filter choices, etc.

Another potential source for error in measurement comes from the paper—or more accurately, the paper, the viewing environment and the instrument. In a nutshell, the increasing use of fluorescent brighteners in papers has created a problem for the printing industry. If the printing paper and the proofing paper have significantly different amounts of optical brightening agents (OBAs), there can be a mismatch from one evaluation station to another. This includes the viewing environment and the measurement data (if the data are taken from an instrument using different illuminants). The key here lies in consistency, which leads us to standards.

STANDARDS

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Standards evolve but usually slowly and generally when they can improve the science they are based on. A simple example of this is the meter. Originally defined in 1791 to be one ten-millionth the distance from the Earth’s equator to the North Pole, it has been updated multiple times and as of 1983 it has been defined as the distance traveled by light in a vacuum in 1/299,792,458 of a second!

Standards for measuring in the printing industry evolve as well. Recently ISO has released updates to the ISO 5 series, which defines densitometry and for the first time recognizes the dual use of a spectrophotometer for density and colorimetry, and ISO-13655, which defines the use of spectrophotometry and colorimetry. These are not just of interest to scientists and
manufacturers. In 13655, for the first time, multiple measurement instrument sources have been defined including:

- **M0** Assumed to be tungsten but can be used to identify any unknown source;
- **M1** D50 or a practical equivalent to deal with paper fluorescence;
- **M2** UV cut-defined for the first time; and
- **M3** Polarization with UV cut-defined and included for the first time.

ISO-13655 defines more than this, and it is the rule book for instrument manufacturers and specifications groups to point to for making measurements. X-Rite, for instance, has released a new standard for all of its graphic arts instruments called XRGA, which incorporates these new changes in the standards. These updates in standards and specifications really do, as the quote above states, provide a logical basis for making a decision and taking action.

**CONCLUSION**

In a distributed workflow environment and in environments where an increasing amount of work is done with electronic data exchange, the requirement for measurement has never been higher. Instruments as well as the standards and specifications that govern their use are on a continual march toward improvement. A look at current specifications around measurement will help you tools to better manage your day-to-day printing as well as provide additional ways to cut waste and increase customer satisfaction.

### ABOUT THE AUTHOR

Raymond Cheydleur, OEM technical manager and color integration specialist, has worked with X-Rite for more than a decade. Currently, he works to integrate the technical resources within X-Rite with OEM partners to create new solutions. Prior to X-Rite, he ran a test digital imaging facility for Eastman Kodak and a successful photo studio in Chicago. In addition, he has managed both large and small photographic production facilities. Cheydleur is chairman of ANSI/CGATS SC3 on metrology and participates in the U.S. delegation to ISO on graphic arts and photographic standards.

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