Measurement in the 21st Century

By Ray Cheydleur

A LOOK BACK TO THE 20TH CENTURY
Before I discuss measurement in the 21st century, I will take you on a short trip down the memory lane of my use of measurement technologies. In the 20th century, or more precisely 35 years ago, I worked in a small custom photo lab in Rochester, N.Y. There we measured density with a Macbeth densitometer with a spinning filter turret, with no defined ISO or CGATS density status. This was strictly for process control of the photo processes.

Next, I worked in a large corporate photo lab where we used a Kodak Visual Negative Analyzer, which electronically scanned, reversed and displayed a positive full-color image of a negative on its video screen. This was the equivalent of today’s soft proofing monitor for finding the proper corrections prior to printing a color negative.

My next jump in the world of measurement was the late 20th century, when I was maintaining photographic and digital print equipment, now with true status densitometry: a strip reading Status A densitometer for photographic paper, a spot reading Status M densitometer for photographic negatives and a strip reading Status T densitometer for digital printing. We also used an emissive colorimeter for calibrating our monitors, though this was before ICC profiles.

Just before 2000, I made the transition to the printing industry and worked on quality control for offset, newsprint and digital printers. At the same time, this was when ICC color management really came on the scene and spectrophotometry made the jump from industrial applications to printing. I believe that my journey from manual tools to increasing automation is not that different from many practitioners in the late 20th century. It marked the start of the transition from pure process control to product color control.

However, this was a double-edged sword. Moving from simple density measurements of perhaps 44 patches for calibrating a digital printer to making an ICC profile with (at least) 918 patches made measurement automation a requirement, not an option.

In 1997, it was not uncommon for a simple ICC profile to take at least two hours between measurement and computation!

21ST CENTURY MEASUREMENT
In the offset pressroom, the beginning of the 21st century signaled the transition from just densitometric process control to using both densi-
sity and colorimetry. This was marked by the widespread introduction of the spectrodensitometer: instruments that at their heart are spectrophotometers but report density with options for reporting colorimetry and or spectrophotometry.

At the same time, in the prepress arena we saw the rise of digital proofing, particularly varieties of inkjet proofing, which were aided by new, inexpensive strip-reading spectrophotometers. These new instruments performed two functions: process control (either density or colorimetry based) for calibrating the printers, and ICC profile creation for matching the device to a final printing condition. This next step of measurement automation reduced ICC profile creation to less than an hour—a 2x increase in productivity in less than three years.

With these trends firmly in place, the next step is increased automation. In the pressroom we’ve seen dramatic increases in automated pressroom control. These include automated color bar reading devices that might also include closed-loop feedback for control of the press or sophisticated full-sheet spectrophotometers capable of providing color information on any element of the image. These tools not only provide increasing amounts of automation, but when combined with powerful software, they cut makeready times and provide complete reporting of the press run.

Increased speed and integration is also a trend in prepress. The iisiXL sheet-reading spectrophotometer can read a full tabloid sheet of paper with more than 2,000 patches in less than five minutes. When combined with today’s fast computers, this can reduce the time necessary to create an ICC profile to less than 10 minutes. Multiple manufacturers of inkjet printers now offer built-in spectrophotometers, which are used for calibration, profile creation and proof verification, all of which can be totally automated.

In digital printing, we are seeing a move away from simple scanner and densitometric calibration to sophisticated colorimetric calibration, coupled with digital front...
ends that are fully color managed and use ICC profiles as a key part of their control. In the latest digital presses, we are witnessing a move from inline densitometers to an increasing use of inline spectrophotometers to perform all the required measurement processes. This not only provides increased quality, but also reduced maintenance, as the press is self-monitoring.

WHAT ABOUT PACKAGING?
I’ve intentionally left out any discussion of packaging in this discussion. Partially this is because packaging is part of the prepress/offset/digital print processes discussed before and partially because package printing often involves unique substrates and inks. These processes deserve their own article, but I will mention a few highlights.

In addition to all of the trends that I’ve described, we are also seeing specific requirements in this field. The increasing use of metallics and unique surface finishes often require measurement techniques more often found in manufacturing: sphere and multi-angle devices. These devices measure multiple attributes using different illumination designs than the 0:45 or 45:0 designs traditionally used in printing. The sphere measures both color, which we have been talking about, and appearance, which can have many attributes but might include factors such as texture and gloss. Multi-angle devices offer similar options and combined with the appropriate software can tell even more about characteristics like metallic paint flake orientation and additional surface effects.

STANDARDS AND SPECIFICATIONS
The world has largely moved to a standards-based printing process. Whether these standards are true standards, like the ISO 12647 series, or printing specifications, like GRACoL or SWOP, they also have an impact on the measurement process. In the past, many specifications were judged by requirements for certain density and TVI aims, but final certification of a system was based primarily on a visual assessment. Today that has changed. Specifications are now primarily numbers-driven and those numbers
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The standards for instrumentation continue to evolve. ISO 13665-2009, *Spectral measurement and colorimetric computation for graphic arts images*, redefined some fundamental design choices for instrumentation, including defining new illumination and filtering options. This is a welcome step forward but requires communication of these parameters and potentially a requirement for updated instrumentation. The CGATS and ISO density standards (CGATS.4 or the ISO 5 series) have also been updated to reflect the changes in ISO 13665 and the use of spectrophotometers for both color and density measurements.

**MARKET IMPACT**

The impact of all of these changes has been a shift from a purely density- and tone value-based process control primarily performed as part of startup or make-ready to end-to-end print control based on the color requirements of the customer. Many brand customers today have a sophisticated supply chain workflow that incorporates color standards in each production step, from creation and specification to packaging and print. Each step of the process is monitored and suppliers must report compliance to have the job accepted and to retain the customer.

**THE NEXT STEPS**

Predicting the future is usually a job best left to New Year’s Eve party games, but I think we can highlight some easily identifiable trends:

1. **Automation** Each step of automation results in both increased speed and lower operator requirements. The pace of automation in the printing industry is increasing across all steps of the workflow.

2. **Color** Controlling the press primarily by color measurement rather than density attributes is becoming the norm. The often-voiced complaint in the past that “the pressman doesn’t have L*a*b* controls and has to use density” rings hollow today. No digital printer is managed solely by density, and new tools offer many ways to control an analog press using color. More importantly, customers are specifying and measuring jobs according to requirements based on color, not density. Expect this trend to continue and accelerate.

3. **Appearance** This is already a requirement in many industries and in packaging. Expect that additional requirements based on appearance metrics will be coming for all types of printing.

4. **Communication** This isn’t a prediction but actually a requirement. As more options in measurement and requirements to report them arise, better communication of the results will be an absolute necessity.