Virtual Proofing: Is Your Proof Remotely Accurate?

The landscape of alternatives in remote digital proofing has evolved rapidly, resulting in lower purchasing costs and improved accuracy and speed.

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If your business involves communicating color and collaborating closely with customers, you have likely considered or already implemented some form of remote proofing—soft, hard, or hardly acceptable. Herein we focus on contract-quality remote digital color proofing, leaving analog proofs/overnight courier solutions out of the picture.

The landscape of alternatives in remote digital proofing has evolved rapidly. Clearly, the market is no longer dominated by proprietary, single-source proofing systems. Instead, today's color managed proofing alternatives redefine the notion of "system" as an integration of best-in-practice components. This, in turn, has dramatically lowered purchase and operating costs, while simultaneously improving both accuracy and speed—a rare confluence of benefits indeed!

Most new generation proofing systems are also "open architecture." This means more flexibility and control in tailoring a solution for specific needs in terms of ease-of-use, color gamut, purchase and operating costs, format, speed, etc. Individual components are easily changed or upgraded, preserving much of the original investment and the time/effort to install, learn and implement the system within your organization—a significant portion of the real, total system cost.

Let's look at recent developments and their impact on remote color proofing solutions.

Watching the Hard Proofing Process

Hard-copy proofing, local or remote, remains the reference standard for contract-quality prepress color proofs. Customers can sign their names on something physical, providing their contractual obligation to pay for a job if it matches the proof.

Cost-effective remote hard copy proofing has become possible somewhat recently largely due to developments in well-designed, commercial-grade inkjet printers. Note "commercial-grade" specifically excludes low-end desktop units and other devices lacking the ink capacity, paper handling, speed, etc., required for proofing. Until recent times, the majority of inkjet printers were cost-prohibitive, unreliable, inconsistent, and/or of insufficient quality for proofing.

Today, proofing-capable inkjet printers address issues formerly plaguing their acceptance for contract-quality proofing. Gamuts are large enough to address the color space printable by most offset presses. Color accuracy and repeatability, with proper software and operation, are excellent. Fading and color shifts have dramatically improved. Reliability is good and results are less influenced by environmental conditions. Proofing papers and inks are available manufactured and quality-controlled to tolerances demanded in contract proofing (vs. consumer grade). Recent test results from independent, international proofing competitions—like that sponsored by the IPA—validate this conclusion.

Looking for a Monitor-Based Standard

Monitor-based remote proofing has gained broader acceptance due to its key role in rapid paced workflows. Monitors have been an important component of graphics and design workflows for ages and many companies have used at least some basic form of electronic document content proofing via PDF documents for years.

Hard-copy proofing, local or remote, remains the reference standard for contract-quality color proofs. Customers can sign their names on something physical, providing contractual obligation to pay for a job if it matches the proof.

Using monitors as the "output device" for contract quality color proofing, locally or remotely, places them into an entirely different role in the workflow. A virtual image on the monitor defines approval from you that what you saw is what you will pay for.

To ensure accuracy between different sites, monitor contract proofing, like all proofing systems, requires calibration and closed loop validation of monitor calibration status so color can be repeated and verified. That's essential. If this is achieved, monitor proofing may be a viable option.

There is no doubt monitor soft proofing has some ability to accurately represent what comes off the press, but implementation requires costly systems to control both what you see at your site and at the remote or customer's site. It only works with a good monitor, when the customer continually checks monitor calibration, and if the viewing environment around the screen is correct.

Even if you can get two displays doing the same thing, at the end of the day do you have a fingerprint system in place where you really know the system views were the same? If the job is disputed and goes to legal review, can you reproduce the conditions at the moment of digital sign-off?

That being said, Time, Inc., has implemented monitor based soft proofs for some of its magazines and reports the systems work to their satisfaction. Time has the ability to require and implement the controls to help assure all of their vendors have implemented systems that will work.

Most of us will never enjoy that level of cooperation, where the client initiates the program, but monitor-based proofing will continue to grow because, if done right, it can save costs and reduce turnaround times.

With monitor-based solutions, stringent requirements have to be imposed on the ambient conditions and hardware, with particular attention on controlling monitor settings, in order to create an acceptable soft-proofing environment. For instance, the gamut of many of today's high-end monitors is insufficient for completely displaying the commonly used ISO coated printing standard. While there are already standards for testing and verifying the color gamut and tolerances in hard-proofing (ISO standards and media wedge analysis), they are only now being created for monitor-based proofs. Consequently, soft proofing is currently used more at the layout stage and for intermediate proofs for content.

Hal Hinderliter, in discussing Cal Poly's Graphic Communications Institute's "Specifications for the Applications of Image Displays" (SAID) project, presents a very compelling argument that monitor color control is still in need of better definition. Much of the following is abstracted from Hal's rationale for improved monitor proofing standards.

Although many displays use additive light sources with a wider color gamut than four-color subtractive, reflective prints, RGB monitors still have difficulty with some colors—fluorescent and metallic inks in particular. Spot colors are tough to reproduce as well, and some monitors can even fall short of RGB working spaces. High quality CRTs sometimes provide ways to adjust individual RGB guns. Otherwise, most CRT and all LCD calibration (although the LCD has excellent edge to edge consistency) is limited to observing the current condition of the monitor and writing a look-up table or profile to compensate for color inaccuracies.

In the past, many users created profiles using an inadequate number of color patches, although that has been rectified with new standard and/or proprietary targets. However, the resulting range of profiles in the market causes real issues in correlation of vendor-supplied display profiles.

There are a number of measuring devices for profiling displays from basic colorimeters to sophisticated incident light instruments. Colorimeters work well for routine comparisons of similar colors and for adjustment of small color differences under constant conditions. Spectrophotometers with incident light measurement capabilities work well and can measure a true white point. The quality and accuracy of measured results varies widely between instrument manufacturers, products and price levels. The highest accuracy is achieved with a laboratory spectroradiometer, but at about $25,000 this is less than accessible to many end-users.

Another key factor driving monitor soft proofing is the market forces driving the display manufacturers. Years ago, the graphics industry had substantial influence on display manufacturers. Today, general computer display needs, video and film production users, and gamers drive most of the requirements for new products. Ironically, the wide gamut display requirements in these applications could have a strong negative impact on virtual proof accuracies. New video buffers drive 14 or 16 bits per color, ahead of the graphic industry's general 8-bit working standard, an open door to quantization errors.

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As with hard-copy systems, the CIE (see discussion below) reference standards need updating. The L*u*v* scale developed in 1976 to measure self-luminous colors may not be entirely suitable for new technologies, such as LED light sources. Other "standards" have similar issues—the ISO 12646 *Displays for color proofing* was written before the advent of LCDs, and mandates very dark ambient light conditions. The ISO 3664 *Viewing conditions for graphic technology and photography* has monitor recommendations that are too vague and relies on CIE L*u*v*.

A number of other variables influence the appearance and accuracy of a monitor soft proof. Monitors used by a client might be CRT instead of LCD, each having radically different color responses. There are no minimum brightness requirements for monitors. Instead, viewing booths get "turned down" to suit the monitor. Calibrator accuracy throughout your locations may vary from spectrophotometers costing more than $1000 to $50 colorimeters to visual adjustment by the monitor operator. The ambient viewing conditions are rarely verified or logged. GRACoL, spots, and other color systems are not easy matches. While SWOP colors are a relatively easy match, specifications from SWOP's application data sheet allow a ±3 delta E drift (for a possible total 6 delta E).

What does all this mean? It means that while a well-monitored (couldn't resist) system will work for some applications and environments, a number of additional variables continually conspire to make color consistency between locations challenging and changing.

It's no surprise that Cal Poly's GrCl proposed that the SAID project develop a new standard to "quantify the accuracy of a computer display system, using objective measurements correlated to new research on human perception."

The ICC Conundrum

Whether you're using hard or soft-copy proofing, lively debate continues on the software approach to managing and controlling these devices. While many view an ICC (International Color Consortium) based solution as the preferred approach to defining and matching color, the viability of other approaches challenges this notion.

The main emphasis of the ICC has been standardizing the format for ICC Profiles that create a map between the source or target color space and a profile connection space (PCS). The PCS is a device independent profile connection space such as CIE L*a*b* or CIE XYZ. This effectively establishes the link between a device dependent color space, say that of the printing press or the inkjet proofing device, and the device independent space of the PCS. Mappings may be calculated using tables, to which interpolation is applied, or through a series of parameters for transformations.

The color space definitions used in ICC transforms were defined by the CIE (Commission Internationale d'Eclairage). They created international color standards and definitions such as the CIE L*a*b* and XYZ color spaces, based on research conducted in the late 1920s. This groundbreaking work measured the nonlinear response of the human eye to mixtures of blue, green and red light and attempted to define a standardized way of describing the admittedly complex physiological/psychological human perceptual experience of color. The basis for the CIE's initial work has been adjusted several times since the original "standard observer" tests were conducted, but many color scientists still question if this color space truly matches human perception. Nevertheless, while CIE color standards are recognizably imperfect, they are the internationally accepted reference standard for measuring and defining color.

In fact, the standardization work of the CIE and ICC, along with advances in a broad range of technologies, are what allowed color management to gain ground in the 1990s. Device-independent color descriptions allow monitors, proofers and presses—from different vendors—to talk to each other using a common language. Today, just about any proofing system can reproduce a file based on ICC profiles. Not only is it easier to replicate work on the press, if the customer's monitor is calibrated and transformation applied correctly, the hard proof will more closely approximate what is on the screen.

But, does an ICC workflow measure up to the stringent criteria of a standard, and does it deliver the most accurate results possible? Let the controversy begin! At first glance, an ICC approach would appear to be the standard in digital proofing. However, closer examination reveals an ICC-centric solution may not result in maximum quality demanded for contract-quality remote digital color proofing. As the name itself suggests, a contract proof must be of legally binding character. Consider that a proof costing a few dollars may be the basis for a print job worth $100,000 or more.

Not all ICC products are created equal, thus it is important to understand the limitations of ICC-based solutions and their impact on your remote proofing system.

The Process of the ICC Profile

A key goal of ICC technology was to create a standard format for color information exchange. The quality of the profile, however, was not defined nor measured. It is highly dependent on a host of variables including you, the operator or user of software (including who and how it is installed and configured), the operating environment, and the software developer/manufacturer.

Not all ICC products, profiles, or implementations are created equal. The "standard" has too many dialects for clean information interchange and, as such, results vary between systems. Significant time, effort and expense are required to align them. Analogously, while there is a standard to measure miles per gallon, your mileage may vary.

Despite these variables, ICC based solutions are incredibly important to the industry, and thousands of workflows operate daily incorporating these principles. Consequently, it is important to understand their limitations and the impact on your remote proofing system.

▸Profiling and CMM not standardized: Programs generating ICC profiles are not standardized between manufacturers. The resulting number of combinations and interpretations virtually guarantees different results between systems. The CMMs (Color Matching Method, or processing "engine" converting the color spaces) are also not standardized between operating systems and color-managed applications, thus the same color job processed by two different systems does not match.

▸Calibration and profiling combined: ICC based printer calibration and profiling are not strictly separated. New profiles must be regularly rebuilt as temperature, humidity, paper, inks, printer age/performance, etc., change. In contrast, keeping profiles separated allows simple printer recalibration to address these variables.

▸Loss of black channel: As a rule, much of the graphic arts workflow in the United States uses CMYK data. The use of ICC profiles in color space transformations requires CMYK data from the source color space be converted to the desired output color space via a three-dimensional CIE conversion color space. The information in the K or black channel within the file is lost when cyan, magenta, yellow and black become represented by three numbers related to color appearance.

Consequently, the newly constructed K channel output by the ICC transform has nothing to do with the K channel in the original. The type, drop shadows, key vignettes, etc., are lost. This is akin to grinding whole grains of corn into flour, then trying to remake kernels from the flour. It might be similar, but it certainly isn't a kernel.

▸Complex to use: At first glance, the ICC approach seems simpler than generating and editing color profiles using other approaches. However, this situation changes when users impose high demands on quality, accuracy and consistency of the proof. For example, changing the paper white point of the target substrate, without changing other values, is a complex undertaking. The lack of separation between profiling/editing/calibration further complicates matters. The on-going cost, variability, repeatability and hassle of updating ICC profiles for hours on end, when calibrations change, is a significant cost to operations.

▸Labor intensive for remote proofing: The lack of consistent separation of calibration and profiling can make remote proofing with ICC-based systems complicated. Frequently the operators at the remote location have little or no technical color management training and often do not understand the impact of changes they make to the environment (e.g., "Whew, that monitor proof looks much better now that I adjusted the brightness and contrast control…"). To obtain contract proof quality with remote ICC-based systems, proofer profiles would have to be optimized at each location, possibly iteratively, and then edited manually, assuming the regular availability of highly qualified staff at that remote location.

Device Link Profiles Answers ICC Limitations

If ICC based proofing systems were entirely acceptable, higher quality, more cost-effective alternatives would not exist. Yet, particularly for remote proofing applications, they do.

Remote proofing nirvana sounds great, but requires support for two hallmarks of good proofing—accuracy and consistency. From an accuracy standpoint the requirement is clear—the proof must match the press—no better, no worse, period. In remote proofing, accuracy becomes more complex. The whole system is only as accurate as the combination of all the parts. Real standardization of color becomes critical.

You also need to assure accuracy across all remote locations. To achieve this, there must be a common reference standard. ICC profiles accurately define what an individual printer is doing. They don't define what that printer should be doing, only what it is doing. And you can be sure every printer is doing something differently. Multiply this across multiple printers in multiple locations and… well, you get the picture. Pretty tough to make all devices match an unknown standard.

The ICC process takes the printer profile, combines it with the inkjet proofer profile, and generates its overall conversion algorithm. With only one output printer, you're in luck. But, as you add more devices, that conversion file sent to all proofers is compromised, as is the accuracy between locations.

To output a file identically on two proofing systems, it is essential for calibration, profiling and editing to be strictly separated. Think about printer drivers for each device model, defining how it is supposed to print when it leaves the manufacturing plant, brand new. During system installation each individual printer is recalibrated to this known reference standard. Periodically a test chart print is measured with a spectrophotometer, automatically compared to last week's chart, numerically quantifying and correcting any differences. With a known standard, all devices are commonly referenced, allowing them to behave identically. This ensures both accuracy and repeatability.

This approach also separates digital proof printer calibration from the characterization of the printing press. Since the inkjet printers are already tied to a common standard, the same press profile at each printer location achieves identical results. ICC profiles require separate profiles for each inkjet printer tied to each press you're comparing it to—difficult, at best, to manage.

Establishing individual printer profiles, and maintaining closed-loop printer calibrations to those profiles, ensures the printers always correspond to the color space in which the profile was created. Thus, any inkjet printer belonging to the same printer family, operated with identical paper and inks and settings, will always match any other printer—any time and any place. Remember, both accuracy and repeatability of the entire system are directly related to consumable and operational quality and consistency—it is important to recalibrate often and use the best possible media, inks, and technical service personnel.

Using a "separated device profile" solution, the remote end receives the necessary profiles for the printer calibration from the sender and merely has to ensure that the output device operates within the specified tolerances—by assuring it has been calibrated correctly.

This calibration approach achieves identical color renditions across multiple locations for a given combination of proofing system and target color space. This is essential if identical results within very close tolerances are to be obtained over an extended period of time, or if proofing systems at different locations are to produce exactly the same color renditions.

Some systems provide the option to compute the original and target values directly in CMYK—without the detour via CIELAB—meaning the black channel properties of the original data are retained in the proof. This ensures that the visual match to the print remains identical, even after color transformation. The color space of a print job and its specific combination of printing process, press, ink and paper, etc., can be transformed to another color space at any time reproducing accurate colors under totally different printing conditions. For example, SWOP offset data can be automatically converted into PSR gravure data.

A further benefit of some device link approaches is their compatibility with ICC-compatible approaches. Well-designed solutions can produce more consistent results from existing ICC profiles.

The clear-cut separation of calibration, profiling and editing has the advantage that no color management specialist is needed at all when using industry standards. If custom profiles are needed, a specialist only has to generate a single optimized color profile once. In remote proofing scenarios this single profile is distributed and used at all locations, greatly simplifying the process of achieving color consistency across all locations.

The ICC concept still makes sense, of course, especially when it comes to calibrating RGB scanners and monitors. There are, however, major limitations with regards to digital proofs of contract proof quality. A device link approach offers a solution that does better justice to the high demands of a contract proof while retaining compatibility to existing ICC profiles and practices.

Summary

There is no question that remote proofing systems have been proven to work both in competition shootouts and real-world production environments. But, like PDF workflows a few years ago, it takes planning, good process control, and system management at each location to achieve accurate, consistent proofs.

Both hard- and soft-copy remote proofing are viable processes. With the correct practices and products to ensure proper operation, such as referenced calibration, profile validation, and media/consumables materials quality control, results are excellent. Given these, you can achieve both accurate and consistent proofs every day, locally and remotely, between any number of systems. With the right tools and controls your remote proofing systems can be much more than remotely accurate. IPA