Color Proofing in the Digital Realm

Emily Sangmeister

Arizona State University

GIT573: Color Metrology

Professor Westover

May 4, 2020

Abstract

Proofing is an integral part of the printing process, in order to ensure acceptable reproduction before creating the final printed material. This technical report will cover remote digital color proofing as it exists today. Additionally, the history of color proofing, different types of color proofing, and the technology needed to properly manage and reproduce color will be discussed, as well as the implications behind these concepts. The purpose of this report is to convey the need for color proofing in the design and print industries and the efficiency of doing so remotely to save on cost and valuable time.

Table of Contents

Color Proofing in the Digital Realm

According to The Law Dictionary (n.d.), a color proof is a “full-color test print to show exactly how colors will look in the actual final printing.” This gives the designer, printer, and client one final chance to identify and correct any errors before the final print job begins. Although color proofing began as a physical copy to review, the growing digital design industry—as well as advancements in color management techniques—have increased the quality of digital proofs to provide a faster, efficient, and still accurate reproduction of a design to serve as a sample of a final finished product.

Why is Color Proofing Important?

Color proofing is an essential part of the print and design process. It enables everyone involved in the creation of printed material to verify that the final product will look as intended. This saves time and money during the printing process, because both the client and the creator(s) can provide input on the proof and approve or reject the color beforehand to certify the highest quality reproduction of the original design as possible.

Providing a client with an inaccurate color proof can negatively effect the relationship between the client, designer, and/or printer, can change the view of the consumer about the company and potentially drive away business, and make the client, designer, and/or printer seem unprofessional or less knowledgeable about their work. Therefore, it is incredibly important to understand how to most accurately create and view a color proof before approving the printing of the final product.

A Brief History of Color Proofing

Creating a printing proof has been common practice for the entire history of printing. This was once called a press proof (Bear 2019). The intention of a press proof “was to print a fast, economical single copy of a job to show the customer, before spending the time and materials to make printing plates, ink up the press, and adjust ink and water balance” (Adams 2004). Press proofs required the client to view them under incredibly specific viewing conditions, usually with the use of special light boxes and slips of paper that would only look uniform under the correct conditions (Sharma 2018). By the 1970s, manual proof presses “were replaced by laminated photographic systems” (Adams 2004). These systems could provide an even more accurate reproduction of the original, at an even lower cost than the press proof (Adams 2004). Technological advances throughout the 1990s had “made large-format inkjet proofs the most common type of contract proof” by 2004 (Adams 2004).

Since the mid-2000s, digital color proofing has become another technological advancement that has increased efficiency and decreased cost in the printing process. There are several types of digital proofs, including soft-proofs (including onscreen and PDF proofs), inkjet proofs (a fast and basic print, mostly used for pinpointing formatting errors rather than color accuracy), and high-end color digital proofs (using color management to gauge color accuracy) (Bear 2019). The high-end color digital proof is also known as a contract proof, and “it represents an agreement between the commercial printer and the client that the printed piece will match the color proof” (Bear 2019).

Soft Proofing versus Hard Proofing

Remote digital color proofing (“soft proofing”) is faster and cheaper than hard proofing (sending out a physical copy), but it also has several other benefits. For instance, digital color proofs are embedded with color profiles that ensure proper color management. In contrast, printed proofs may be viewed under less-than-ideal lighting conditions, which can create false flags or let incorrect colors come to be approved without the aid of additional instrumentation and materials. Proper color management removes this entirely, because it “tells the computer monitor what you are going to do with the file so that it can simulate the final outcome on screen” (Pike, I. via Fenton n.d.).

Between appropriate color management and following the accepted printing standards, the final completed product should be nearly identical to the digital color proof, saving time and money for everyone involved in the production process. However, improper color management will negatively impact the color proof and can lead to more work and strained relations between the client and designer.

The Advent of Remote Color Proofing

As advancements in technology continue to progress, color proofing can now be done remotely. According to Howard Fenton (n.d.), “remote proofing is when a service provider sends a digital file to a customer or a designer who views it at their site." This means that the proof no longer needs to consist of a physical copy (hard proof) sent to the client, saving time and money (Fenton n.d.).

The concept of remote color proofing has been around since the late-1990s (Fenton n.d.). However, it was not until high-speed Internet access was widely accessible that it became more widely accepted and used as an alternative to hard proofing (Fenton n.d.). The most cost-efficient way to provide a client with a soft proof remotely is via PDF, as .jpgs may compress the proof and alter the color quality (Fenton n.d.).

Another major factor in remote color proofing is color management. There are many different solutions available today to provide the highest quality color reproductions available, including standardized color profiles that are included in design programs such as Adobe Photoshop and InDesign. In recent years, several patents have been published for color management systems specifically designed for remote color proofing.

In 2009, Harrington et al. filed a patent outlining a "method for remote proofing of DFE color architecture" (Harrington et al. 2009). This process would involve "taking into account job and printer settings while maintaining vector objects" in order to create a PDF/X color proof (Harrington et al. 2009). The patent states, "this functionality automates and streamlines the proofing task of the end user because there is no need to find and load the correct ICC profile on the proofing system" (Harrington et al. 2009). Although this patent would seem to alleviate some of the work involved in properly embedding a color profile for color management of proofs, it also takes away control from the user to provide an accurate reproduction of a design, which may cause issues later in the design or printing process.

In 2015, Yuanzhen and Yin filed a patent for a "color simulation method for digital proofing." This patent describes a process in which "color information and a dot gain value in actual printing process conditions are measured," and "the dot gain value is utilized to directly perform dot gain on an electronic file before, during, or after Raster Image Processing (RIP)" (Yuanzhen & Yin 2015). The patent attempted to offer an easier process in color simulation for digital proofing by providing a more accurate representation of color.

The following year, a patent was filed regarding “improved color management method for digital proofing” (Yang & Qi 2016). The process detailed steps involving:

> “printing an IT8 color test table by means of printing equipment, adopting digital output equipment to print an IT8 color test table in a condition without color management, utilizing a color test spectroscope to test the two IT8 color test tables and then obtaining an ICCProfile of the printing equipment and ICCProfile of the digital output equipment, performing color adjusting on a color management platform, obtaining a corrected ICCProfile of the current printing equipment in a current state, and printing a digital proofing draft by means of the digital output equipment in a condition of the finally determined ICCProfile” (Yang & Qi 2016).

This method combines both hard and soft proofing techniques in order to properly produce a digital proof that is as color-accurate as a hard proof.

Color Management and Remote Digital Proofing

An integral component of a remote digital proof is the inclusion of an ICC (International Color Consortium) profile, which is embedded in the file to guarantee that it will be viewed with its intended color settings (Sharma 2018). Each ICC profile contains a tag table for the intended output device, which includes the profile description, the XYZ primaries, chromatic adaptation, lookup tables, and other necessary information to ensure the colors are reproduced faithfully when compared to the original. If the color produced is not deemed close enough to the original, the culprit may be the color profile used for output.

Due to current available technology, two “standards of color difference for printing quality assessment” exist and are measured using ΔE (delta E) (Liu et al. 2011). This measurement is calculated using the Pythagorean Theorem (which always results in a positive number), with values derived from the L*a*b* values of two different colors—or the lightness, red/green, and yellow/blue values of a given color (Sharma 2018 pp. 78, 85-88). The range of the first standard is from $\Delta E \leq 1$ (unnoticeable to the human eye) to $6 < \Delta E \leq 12$ (strong reaction to difference by the human eye) (Liu et al. 2011). The range of the second standard is from ΔE ≤ 0.5 (unnoticeable to the human eye) to 6.0 < ΔE ≤ 12.0 (strong reaction to difference by the human eye) (Liu et al. 2011). Essentially, the lower the value of ΔE, the closer in color the reproduction.

In addition to these standards, there are several quality metrics used when evaluating the quality of a printed reproduction of an image (Pedersen et al. 2011). These are often perceptible by the naked eye, but professional printers will also use instruments such as spectrophotometers to maximize accuracy (Sharma 2018 pp. 33). The six major quality metrics as outlined by Pedersen et al. (2011) are:

- Color (hue, saturation, and color rendition, except lightness)
- Lightness (set apart from color; described from light to dark)
- Contrast ("the perceived magnitude of visually meaningful differences")
- Sharpness ("the clarity of details and definition of edges")
- Artifacts ("noise, contouring, and banding," can degrade image quality)
- Physical ("paper properties and gloss")

All of these qualities, including the calculated ΔE between two colors (usually the original and the color displayed in the color proof), are essential to proper color reproduction. Moreover, professionals will often use devices, such as densitometers, colorimeters, and spectrophotometers to calculate accurate measurements of color (Sharma 2018).

Although there are many accurate ways to reproduce color, the resulting perception of the color may vary. Chromatic adaptation is the human eye's ability to change its idea of a color (usually white or a more neutral tone) to fit the context of a given image, specifically if the image is printed, projected, or displayed on a non-white surface. (Sharma 2018). Metamerism is a similar occurrence, where two colors may appear to be identical under certain lighting conditions (such as fluorescent or tungsten lighting), but completely different under neutral lighting conditions, such as daylight (Sharma 2018).

Proper Monitor Calibration for Remote Digital Proofing

In addition to ICC profiles and ΔE calculations to ensure accurate color reproduction, proper monitor calibration is incredibly important in remote digital proofing (Sharma 2018). This includes the monitor for both the original design and the display of the client receiving the digital proof. Most monitors have many different display settings that can be based on the user’s preferences, but this does not guarantee that the colors shown on these monitors are accurate.

Regularly calibrating a monitor will nearly guarantee proper color reproduction, but it is up to the client to include this in their scheduled maintenance routine. Not having a properly calibrated monitor can delay production and greatly increase costs for perceived errors that may not exist if the proof were to be viewed with a different display. Most monitor calibrations are performed using software that can measure the display output colors and alter them to fit within a set standard condition, usually via a lookup table (Sharma 2018).

There are, however, “hardware calibrated monitor systems” available that already contain everything needed to perform this calibration (Sharma 2018). These professional grade systems correct the white point of the display by changing “the parameters of the video amplifiers inside the display” (Sharma 2018). Using hardware to calibrate a monitor can set the white point to its proper location without altering the brightness of the display (Sharma 2018).

Benefits of Remote Digital Proofing

Although many clients may still prefer hard proofing, in the form of a physical copy they can hold in their hands, technology has advanced to the point where remote digital proofing has grown in popularity (Bear 2019). This has happened for several reasons, the most important of which is the reduction in cost (Bear 2019). Because a proof can be created and displayed accurately without the cost of print materials such as ink and paper, digital proofing is a valid, cost-effective solution.

Additionally, remote digital proofing has led to proofs being available to the client nearly instantaneously, without having to wait for a courier or delivery service to physically move the proof from the designer to the client. This means the client can provide immediate feedback, streamlining the process and getting to a final product faster. Between saving materials, money, and time, remote digital proofing is an efficient choice for the design and production of products.

Drawbacks of Remote Digital Proofing

A major drawback to remote digital proofing is the possibility of a display being improperly calibrated, making the colors incorrectly reproduced and drastically changing the appearance of the proof. Because of this, many clients still insist on having a hard proof that they can view under more controlled lighting conditions. Monitor calibration can be a complicated, involved, or expensive process that many companies may not deem worth doing when other options are available.

Another drawback of remote digital proofing is user error. The designer may accidentally change output settings upon rendering a proof or the client or printer may unintentionally alter something about the image before or after the proof is verified, creating a miscommunication that could lead to mistakes in the final product. Having a printed proof would avoid this possibility entirely.

Implications of Remote Digital Proofing

As previously mentioned, remote digital proofing can help streamline product production, but it requires proper communication between the designer, client, and printer in order to achieve the highest quality final product possible. Additionally, this form of proofing is only effective if all of the mechanical devices involved are properly calibrated and can understand the information being transmitted. It is the responsibility of all parties involved to keep their devices up to date and calibrated to maximize productivity.

Conclusions

This report has described in detail the principles of color management and how it applies to remote digital color proofing. In order to properly reproduce material to be released in a printed format, one must pay close attention to their document setup as well as any output settings to ensure the closest reproduction possible. The evolution of print proofing from physical (hard) proofing to digital (soft) proofing has hinged on the advancement and accessibility of technology, to the point where the process has become more streamlined and cost-effective with nearly identical results.

In order to create an accurate digital color proof for remote digital proofing, the designer needs to be aware of their use of color management profiles for both input and output before sending the proof to the client. The client then needs to ensure that their monitor is properly calibrated in order to display colors accurately before they can confidently review and approve of the digital proof.

Many patents have been filed in the past decade to improve the color management process, and even automate some aspects of color management. However, this may take some control away from the designer, providing a less-than-ideal proof for their client, which can negatively impact the professional relationship. Having full control of color profiles signifies that the digital proof will be the highest quality and most accurate reproduction possible.

Thoroughly understanding the concepts outlined in this technical paper will aid professionals in nearly every aspect of the process of design and print. Remote digital proofing can help streamline the production process, saving both time and money for the client. There are various benefits and drawbacks to remote digital proofing, but its convenience and efficiency can greatly improve the workflow of everyone involved in the design process.

References

Adams, R. (2004). Color management for proofing. *Sign Industry*. http://www.signindustry.com/computers/articles/2004-08-16-GIA-ColorMgmtForProofing.php3

Bear, J.H. (2019). Digital proofs prevent printing snafus. *Lifewire.* https://www.lifewire.com/digital-proof-printing-1074656

Fenton, H (n.d.). The status of remote proofing. *Fenton on Prepress* via *IN3.org*. http://in3.org/fenton/RProofing.htm

Harrington, P., Rumph, D., Espinoza-Pardo, E. (2009). Method for remote proofing of DFE color architecture. Espacenet Patent Search. https://worldwide.espacenet.com/publicationDetails/biblio?FT=D&date=20090901&DB=EPODOC&locale=&CC=US&NR=7583405B2&KC=B2&ND=1

Liu, S., Sun, Q., Wei, B., and Chen, S. (2011). Quality assessment of digital proofing and discussion on standards of color difference. *2001 4th International Congress on Image and Signal Processing*. https://ieeexplore-ieee-org.ezproxy1.lib.asu.edu/document/6100532

Pederson, M., Bonnier, N., Hardeberg, J.Y., and Albragtsen, F. (2011). Image quality metrics for the evaluation of print quality. *SPIE-IS&T Electronic Imaging*. https://www.imaging.org/site/PDFS/Reporter/Articles/2011_26/REP26_2_EI2011_PEDERSEN_7867_1.pdf

Sharma, Abhay (2018). Understanding Color Management, 2nd Edition. Wiley.

What is color proof? (n.d.). *The Law Dictionary*. https://thelawdictionary.org/color-proof/

Yuanzhen, C. and Yin, F. (2015). Color simulation method for digital proofing. *Espacenet Patent*

Search.
https://worldwide.espacenet.com/publicationDetails/biblio?FT=D&date=20150121&DB=EPODOC&locale=&CC=CN&NR=103079027B&KC=B&ND=1