

Color Viewing Booths Provide *Critical Color Evaluation Environment*

UNDERSTANDING THE TECHNICAL SPECIFICATIONS OF COLOR VIEWING STATIONS

By Dan Reid

If your business depends on providing high quality color printing or proofs, how do you ensure your viewing conditions do not strongly influence your judgment? Sure you might have special 5000K lights to check color output, but how do these 5000K lights compare to the reference white point? If you have a large shop or enterprise of print plants, how do you ensure the viewing conditions are similar in intensity and color rendering quality at various locations?

If a viewer perceives a color shift when a print is viewed under different light sources, then the paper/ink combination may be susceptible to illuminant metamorphism. Basically, some paper/ink combinations are more sensitive to the spectral energy of the light source. The introduction of Epson's pigment inks and papers are arguably the most publicized combination that illustrates this

Viewing the two prints under Tungsten lighting both prints look fairly similar. Engaging the Ultraviolet bulb clearly shows that the left print has optical fluorescent brighteners added while the Fine Art paper does not glow like the adjacent print.



phenomenon, though other combinations are susceptible too.

A $L^*a^*b^*$ color model represents the typical color response of the human eye. Yes, this is a very big generalization because each person responds to color differently, but a larger assumption is the reference light source those calculations are based on. Most ICC/ICM profiling software use a $L^*a^*b^*$, D50, 2 degree observer as the translating color space in color conversions. This means that all conversions are based on spectral D50 light source. If the actual light source deviates from this assumption, color may appear distorted to the viewer.

Some have braved the tumultuous waters of implementing color management in hopes of reducing the discrepancy from computer screen to print or ensure predictable and consistent color across devices and media. Few realize the importance of their viewing environment when evaluating color output.

The environment you view prints under has a profound effect on color perception. Strongly colored objects or walls near your computer monitor or viewing area can influence your perception of color. The type of light source used in the viewing area is another significant factor. Cool white fluorescent bulbs look quite different from a tungsten soft white bulb. The light illumination level, or lux, can vary considerably too between bulb types. Though these problems seem insurmountable, there are steps to minimize surprises.

It is clearly evident that a high amount of ambient light impedes the match from Apple's Cinema to the light box. Too much ambient light hinders the match to the monitor. Reducing the ambient light intensity to around 32 lux eliminated the flare and ambient light contamination. The match between the Cinema Display and the light box is almost ideal.

Our guide through these treacherous waters is the governing bodies of ANSI (American National Standards Institute) for the U.S. and the more international association, ISO (International Standards Organization). These committees take years to approve the standards we can follow to ensure universal color communication. I will focus on a recently updated standard, finalized last year, which focuses on evaluating digital output. Another standard, still in the works, addresses computer display "soft proofing" comparison to digital output.

What are you looking at?

The first question you must ask before researching viewing booths is what are you hoping the device will help solve? Are you struggling to have your computer screen simulate print output more closely or are you more concerned with matching an original artwork (painting, photograph, object) to the digital reproduction? Maybe you're concerned with how your inkjet prints compare to a contract proof? Lastly, do you need to evaluate how different light sources affect color and tonality? Determining your goals before hand will help narrow viewing booths that meet your goals as some products do not meet each challenge successfully.

ISO 3664:2000 is an updated recommendation for critical evaluation of digital output. The goal of the updated standard

is to provide tolerances within which the viewing environment should conform. The recommendation defines the variables of room (ambient) brightness, viewing booth white point and brightness level, surrounding surface colors and tolerances within each variable. The ISO 3664:2000 intentionally does not go into detail on how to "soft proof" output on a computer display, instead focusing on the environment for critical comparison of digital reproduction to an original or proof.

Without exception, the best viewing environment to assess color and tonality is that in which the image will be finally seen. When this is known, proper targeting ensures the best quality reproduction. Unfortunately, it is unlikely that you will always know where the prints will be viewed.

The revised ISO standard is designed to communicate color viewing conditions, disregarding the actual viewing environment, to reduce color communication errors. Tolerances for light source simulators provide for validation of conformance and necessary calibration.

So what targets and tolerances should I aim for?

ISO 3664:2000 uses the CIE reference illuminant D50 as the target white point of the viewing area. A big consideration of the ISO committee was compatibility

with current color measuring hardware and software used to create ICC compliant profiles based on L*a*b* D50.

Consideration was given to another illuminant cousin to D50 since most light booths cannot achieve an exact spectral match to the reference illuminant even with filtering. The F8 illuminant was proposed to replace the D50 reference illuminant agreed upon in the original version, ISO 3664:1975.

It is relatively difficult to get a spectral power distribution close to D50 from a fluorescent light bulb. A characteristic flaw of fluorescent tube design is distinct spikes in greens and purples of the visible spectrum and a drop off in the ultraviolet (UV) spectra.

CIE F8 illuminant has the same a white point of 5000 Kelvin degrees but a spectral distribution found typical of fluorescent D50 simulators bulbs. After much research, the committee agreed that backward compatibility with the original specification of D50 and current color management

products was paramount and outweighed the advantages of using the F8 illuminant instead.

Surprisingly there is another design available using filtered tungsten halogen bulbs instead of fluorescent light tubes. A filtered tungsten halogen bulb design achieves a better spectral match to the D50 reference illuminant. Both Gretag-Macbeth and Tailored Lighting offer products that use filtered tungsten halogen technology.

The ISO 3664 revision lists two levels of illumination in evaluating digital output, one for critical comparison and the other for realistic light levels. The first luminance level is significantly higher than found in normal viewing environments in order to help distinguish small differences in color and tonality when compared to a reference. The P1 illumination is recommended when comparing originals or proofs to final output. The higher illumination level helps assess the darkest tones in the image and detect small differences in color and tonality. The lower illumina-

tion level, P2, more closely resembles illumination levels common in offices, galleries, and stores.

Although it is impossible to accurately predict the final illumination level in which the image will be viewed, the committee agreed the lower illumination level, P2, is fairly representative of the range of illumination levels typically encountered. Using this lower illumination level, color and tonality appraisal will be more in line to typical commercial and residential lighting levels.

The recommendation for P1 (critical comparison) is 2000 lux \pm 500 lux and should be within \pm 250. In contrast, P2 illumination is 500 lux \pm 125. For viewing areas 1 meter square, the illumination may not fall off more than 75 percent from the luminance level in the center. For larger areas, the requirement is reduced to 60 percent.

By now, you are probably mumbling, "What is a lux and how do I calibrate to these intensities?" Lux is a measurement of lumens per square measure.

Any incident lightmeter with a diffuser head over the sensor can measure luminance levels.

GTI and Just-Normlicht provided units with dimming sliders or buttons. A bigger question I asked myself was what slider or button setting would meet the target P1 or P2 luminance levels?

I grabbed my Gossen LunaPro F meter and used the conversion table from EV (exposure value) to lux listed on the meter's back. For instance, 2800 lux is EV 9 while EV 8 is 1400 lux. If I can get the viewing booth's illumination close to an EV 8.5, then I will be within tolerance of 2000 lux target level. No, this is not super-precise, but all I am looking for is way to get the luminance level in the ballpark.

Manufacturers lax on conformance

The manufacturers I requested product info and evaluation units from each claimed conformance to the ISO 3664:2000 specification. Not unlike manufacturers that claim support for Colorsync technologies (a broad state-

Special Section

ment with little definition), there was great deal of variance between the manufacturers support for the ISO standard. It's most likely true for some, if not all, of the evaluation units sent, that they conformed to *part* of the recommendation but I feel *all* failed to provide viewing environment that met the recommendation completely.

ISO 3664:2000 recommends manufacturers measure and list conformance with the reference illuminant and luminance level. ISO 3664:2000 recommends using CIE Publication No. 51.2:1999: "A method for assessing the quality of daylight simulators for colorimetry" in order to determine how close the simulator bulbs match the reference illuminant. CIE Pub. 51 categorizes deviations from the target illuminant on a scale of A to D. ISO 3664 explicitly states viewing environments shall fall within category C and should fall within B. It goes on to recommend categorical listing displayed on the device. Several viewing booths that claimed conformance to ISO 3664:2000 failed to provide a category listing on their devices. Most did not provide calibration instructions at all let alone calibration equipment.

Another large factor in the quality and stability of a viewing booth is the hours used and number of times the bulbs are turned on/off. When a bulb is turned on the life span is quickly diminished. A common mistake is turning on and off the booth to reduce hours used. Ironically, this reduces the bulb life span more than just leaving the booth turned on. Not all manufacturers factor in this variable.

Some of the reviewed booths did not come with a usage meter. ISO 3664:2000 recommends a light booth to include a meter to list hours used. At the very least, the manufacturer should specify average hours of use the lights are expected to remain within specification.

Some of the reviewed viewing booths wisely offer a UV bulb that can be activated in conjunction with other light sources to determine the presence of fluorescent brighteners in papers. Papers that did not have optical brighteners were not affected by the UV bulb.

Reality check, product review

Comparison of booths by calibrating luminance levels:

GTI Soft View is probably the most recognized manufacturer of light booth products for the graphic arts and photography communities. Building upon their highly successful SoftView line,



GTI Softview

new models are easy to assemble and operate. The SoftView sent for this review has by far the smallest footprint, occupying little space on my desk. The booth allows booth reflective and transmissive originals to be viewed. A couple of masks are included to allow both hard copy and transmissive viewing at the same time. The masks go over the transmissive viewing area so there isn't any illumination from behind the print.

The digital display on the GTI unit displays the hours of use. I would have liked an option to dim the digital display or turn it off since the display cycles between lamp hours and illumination level, which is distracting.

The viewer offers a positive and easy method of adjusting light intensity incrementally for both reflective and transmissive independently. Using up and down arrows provides a precise method of dialing in the exact intensity level to match your target luminance level. The intensity level is remembered every time the viewer is turned on. An audible indicator confirms changes in intensity levels as you push the up or down arrows.

GTI designed the booth to be placed close to the computer display. Removable sidewalls exclude light from hitting an adjacent computer screen and ambient light from contaminating the viewing area.

The GTI unit was very easy to get the luminance level close to 500 lux. I looked on the back of my photometer meter and read EV 7=700 lux while EV 6=350 lux. I set the EV to 6.5 and adjusted the intensity until it nulled on the meter I measured an EV of 8 2/3 (EV 9=2800 lux) This confirms the booth is capable of achieving both intensity levels of ISO 3664:2000. The booth lacks a UV bulb to evaluate fluorescent brighteners impact on color. GTI can fit a UV bulb in the unit upon special request.

Just Normlicht Color-Match 5000 Duo

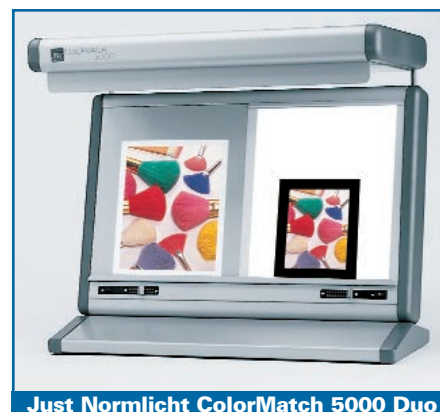
The Color-Match 5000 Duo is a unique color viewing station. Designed for the professional needing to compare transmissive originals to prints, the viewing booth has a large transmissive viewer equipped with a dimmer control to adjust the intensity to match either your monitor or balance the illumination intensity to the reflective light source.

The Color-Match 5000 Duo uses an indirect lighting method to ensure glare-free viewing. A single fluorescent tube matched to 5000K illuminates the reflective prints. A separate dimmer slider is provided to adjust the intensity to match either your transmissive original or computer display brightness. Small magnets and copyholder help keep the print flat at the correct viewing angle. A cover slide at the top unit shields light from contaminating the transmissive viewing area when comparing to a print.

A notable deficiency, the Color-Match 5000 does not have sidewalls to shield ambient light or adjacent computer screens.

Just-Normlicht Color-Match 5000 combi model allow either reflective or transmissive viewing but not at the same time. The Duo model allows both transmissive and reflective source to be viewed simultaneously.

The maximum intensity setting on the booth had a distinctly different color temperature when compared to a lower setting. Calibrating to 2000 lux was achieved by dimming the intensity



slightly. Surprisingly, the color temperature mellowed out at 2000 lux and looked more consistent with the lowest setting registering close to 500 lux. The calibration of each illumination level of ISO 3664:2000 P1 and P2 were easily met. No UV bulb is provided to check fluorescent brighteners impact. The Color Match 5000 also does not include an hours of use meter. Instead, Just Normlicht recommends replacing the bulbs annually.

Pantone Color Viewing Light [PVL-511] (5 bulb version)

The Pantone Color Viewing Light is available in three- or five-light configurations. The three-light viewer includes two D50 fluorescent tubes, two "cool white" fluorescent tubes, and two

incandescent bulbs. The five light viewer adds D65 and UV light bulbs.

When you first turn on the viewing booth, the digital display notifies you to wait 90 seconds. All of the lights turn on and, once the unit stabilizes, they all shut off.

The viewer is equipped with an electronic display and touch pad. Using the touch pad the operator can select which illuminant to simulate. The display indicates the light source and the remaining hours of operation before needing replacement. The digital control panel monitors the use of each bulb much like an odometer. After a preset amount of time, the display will notify the operator that the bulbs need to be replaced. The Pantone light booth is intelligent enough to consider the number of switching intervals.

An additional indicator on the unit provides quick verification if the bulb needs replacement. A diode on each illuminant touch pad indicates if the illuminant can be trusted. Normally the diode is green but when the diode turns yellow the bulb will need to be replaced in less than 100 operating hours. Red indicates the bulb needs to be replaced and should not be trusted.

The booth wisely restricts the operator to only viewing one illuminant at a time. The exception is UV exciter bulb in the five-bulb unit. The UV bulb can be engaged while viewing with a reference illuminant. The UV bulb made it very easy, by itself and with illuminant A (incandescent), to see the proofing paper I was using had fluorescent brighteners. Placing a Fine Art paper under the same conditions did not exhibit the "glowing" of the proofing paper had under the UV bulb.

Pantone's light booth provides an automatic switching mode to compare the effects of different illuminants. Only one automatic cycling program is allowed so different lighting combinations need to be programmed each time.

The Pantone Viewer is ideal for evaluating three dimensional objects. Prints are laid flat horizontally on the floor of the booth. There is no provision for copy holding at an angle. Each illuminant is arranged with one bulb towards the back of unit with the other bulb in the front. The UV bulb (only available in the five light unit) is dead center with the incandescent bulbs on each side of the UV bulb. Sidewalls are neutral gray and extend enough to exclude ambient light



and shield the viewing light from contaminating an adjacent computer screen.

There is no electronic dimmer provided. The Pantone viewer is ideal for comparing the metameric effects of different illuminants but is not designed for comparison to computer screen soft-proofs since the intensity of the unit can not be adjusted.

The Pantone booth was designed to meet ASTM (American Society Testing Materials) D1729 standard, "Standard practice of visual evaluation of opaque materials," and not ISO 3664:2000. The D1729 standard is applicable only in the US and not internationally. Viewing booths that meet the ISO 3664:2000 standard also comply with the US D1729 standard.

What about my monitor?


ISO 3664:2000 intentionally did not go in-depth into the complexity of proper calibration and optimization for current CRT, and increasingly, LCD technologies. ISO 12646 Color proofing using a color display will address procedures to optimize color display performance prior to characterization (ICC profiling). A working draft outlines a procedure to validate if a monitor's color volume includes the printer color gamut. This recommendation is far from becoming a standard. Visit www.iso.ch for the status of proposal.

In real life CRT luminance levels are normally much lower than the brightness levels in a viewing booth. The current recommendation in ISO 12646 working draft is to have at least 75 cd/m² luminance level but should be greater than 100 cd/m². The brighter the monitor the less compensation is needed at the viewing booth to equalize perceived brightness levels. I have been running an old Lacie 21/108 at 100 cd/m² for several years without screen savers and can still achieve a brighter luminance level.

Conclusion:

Calibrating each viewing booth that had adjustable intensity to approximate 2000 lux I noticed distinct differences in the perceived white points of each booth. Though each booth claims a D50 white point and relative spectral match, I noticed differences. I placed the same proofing paper in each booth to evaluate the light source's qualities. The Just-Normlicht Color Match 5000 appeared to have the most balanced light source of the group. Both the Pantone and GTI booths appeared to have a slight, but discernable, color casts.

The GTI and Just-Normlicht booths were designed to hold a sheet at a 45 degree angle. The Pantone booths do not provide a copy holder. Prints are laid flat across the bottom of the booth. I had difficulty situating my angle of view so glare was not a problem with the print laid flat horizontally on floor of the booth. The booths that had a copy holder were much easier to view and did not have this problem.

Though there are a couple of different designs available none made it easy to calibrate and meet the ISO recommendation. There could be enough variance in light intensities between multiple booths in a shop that could pose a problem for consistent viewing conditions. At this point, calibration is done visually and no statistical data is provided to validate a manufacturer's claimed conformance to the D50 reference illuminant. I would like manufacturer's to provide the classification A – D used in CIE Pub. 51 to determine the accuracy of the simulator bulb. Unless a shop invests or has access to a spectroradiometer it is impossible to determine if the booth meets at the onset, or after extended use, the target criteria of ISO 3664:2000. 

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