# How to Ensure Effective Color in Today's Manufacturing Processes (And why it's more Important Than Ever Today)

By

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Scientists will describe color as the quality of an object with respect to light. But, as any one of us knows, our human response to color is very emotional. When skillfully used by designers, color creates the kind of harmonious balance and appeal that helps sell everything from personal care products to automobiles to wallcovering.

Precisely because of this blend of science and emotion, color remains difficult to manage across the entire manufacturing supply chain cycle. Much can happen to impact the color from the time a designer creates it until it is inspected on a factory floor. Multiple processes are required for successful color development throughout its long and complicated cycle. This paper covers technological advances in the most significant areas of color development – color matching and color quality control – as well as how the latest color communication system integrates these tools into an overall virtual color environment that benefits the entire supply chain quite literally from mind to market.

**The way it was: a short history of managing color across industries and locations**

Describing color has always been a subjective and expensive process for all parties involved in the production of color. Suppliers, particularly those separated by time zones and language barriers, experience the most difficulty.

In the 1980s, manufacturers alleviated some of these difficulties by measuring the physical standards with a spectrophotometer in one location and then distributing the "color" of that standard to other locations with the data from the spectrophotometer –i.e., in the form of spectral reflectance curves. A physical sample was still needed for visual reference, but the approval of batches was "by the numbers."

Yet challenges in *communicating* color remained. Regardless of how many numbers are assigned to a color, we don't see in numbers. A verbal description doesn't precisely help us visualize what another person means by "fire-engine red," as color is both a physical and psychological response to light. When a paint pigment such as titanium oxide, for example, strongly scatters light, it yields a white effect. When another pigment absorbs certain wavelengths of light, it produces a colored effect. In addition to this physical phenomenon, each viewer brings a different response to the same stimulus. These differences can be due to age, fatigue, color vision defects, gender, or experience.

Consider how human factors impact the color matching process in this typical scenario: the designer struggles to communicate precisely the color he or she has envisioned, using physical samples and describing how the proof should vary from the sample – i.e., *warmer, brighter, bluer*. The colorant supplier tries to match each sample, but still doesn't satisfy the design spec because the sample is only a starting point. Not only is the designer limited to feedback about the sample in the most subjective terms (e.g., by talking about it), but the sample the supplier was given to match may not be the same substrate or pigment coloration as the final product. And the medium matters. Whether it's opaque or transparent, matte or gloss finish, flat or round, plastic or paper, affects perception of the finished color as surely as does the other considerations.

**Embracing the entire color cycle**

Simply put, the color cycle is as complex as it is encompassing. To a designer, color speaks to aesthetics and identity. To a manufacturer, color is precise and tangible. Designers want flexibility and creativity while production needs an exact target and direction to deliver first-run quality.

The latest advances in color technology utilize the power of today's best web-based solutions to address such diverse approaches to color and to capture its complexities in ways never before possible – completely, accurately, *electronically*.

The new electronic medium that leading color developers have embraced provides a comprehensive and inclusive framework that affords everyone throughout the supply chain the opportunity to benefit from shortened time to market, costs reductions, and the overall improvement in color quality. How? In general, the new, web-based color communication system delivers correct color approval throughout a supply chain not by duplicating efforts, but rather by streamlining and enhancing color processes already in place. The specifics of how the latest electronic color communication system optimally works is illustrated by the following:

1. An OEM or component manufacturer selects a color standard and measures it on a spectrophotometer (color measuring instrument).
2. The color standard then appears as a digital image on the computer monitor, which has been calibrated for color accuracy.
3. The standard is then electronically sent to the supplier, where trial color samples are produced and measured on a spectrophotometer.
4. The supplier then electronically sends back its digital sample of the best possible color match to the manufacturer where it is compared to the standard on the calibrated monitor. If the match is not accepted, more color matching is requested and is done by the supplier and digital samples are sent until the manufacturer approves the color match.
5. The manufacturer then receives the final lab sample, usually in less than half the time of a "traditional" color matching trial and error process.

Perhaps the most powerful, inclusive aspect of the new electronic environment is the fact that color now can be communicated digitally and assessed visually. Receivers of a virtual color sample get more than a set of numbers – rather, the receiver sees precisely the color on screen that corresponds to the colorimetric data. Similarly, visual tolerances can be evaluated and set realistically. Everyone, for example, can see how far a particular spectrophotometer reading – such as 1CMC unit - is from a particular color standard.

**How smart is your software?**

As mentioned, the electronic color channel does not completely change the traditional method of color control as much as it streamlines and enhances it. Toward that end, the new system utilizes familiar tools such as the most advanced color-measuring instruments (spectrophotometers) as well as the latest color management software. Yet, in keeping with its overall goal of color process enhancement, the most effective color communication system takes advantage of the latest innovations among these color control devices and incorporates them within its wholly innovative virtual color environment.

Color matching is a prime example. The goal, of course, always is to be on-target, on-color without the need for correction. Yet hours of production time can be spent bringing batches on shade without the appropriate tools to accommodate the real-world variables that make up colorant conditions. Different gloss levels between batch and standard, for instance, can all too easily translate into expensive rejections, particularly in darker colors. And these variables are compounded with the rising popularity in special-effect pigments that more and more manufacturers are choosing to capture discerning, high-end buyers. Mica-based pigments, which create pearlescent and iridescent finishes, add depth and richness to the appearance of a surface by manipulating the behavior of light reflected from the surface. Iridescents actually change hues and shift shades in order to create their unique coloration. In other words, the very characteristics of these high-end coatings that make them in demand are the exact same aspects that make it so difficult to produce in a first-run match.

The good news is that the color-matching technology incorporated into today's color communication system can now accommodate even high-end coatings such as metallic-based and pearlescents. To be sure the system you are evaluating delivers these benefits, look for color matching software that can deliver:

- ✓ **Significantly reduced color-matching times**. Some, such as Datacolor's Pearl color matching software, exhibit first-shot matching rates of up to 90 percent and lab trial reductions of 50 percent.
- ✓ **Reduced raw material costs.** Check out specific functionality rather than general claims; for example, how well does the software provide the ability to store recycles as formulas and colorants. Is it automatic? How can operators characterize recycles? By a single measurement or is it a more complicated process?
- ✓ **Quick and complete color specification and communication with customers and suppliers.** Examine how the color matching software works with other systems such as color quality control as well color-measuring instruments. Is it seamless? Can you link all key parties effectively in a comprehensive network of color management?
- ✓ **Minimized waste and downtime.** Pay particular attention to how the software allows operators to bring the most difficult to match colors, such as metallics, on shade in production. Are "adds" to batches automatically calculated? What about the corrected formula for new batches? Make sure operators can perform invaluable functions such as previewing the effects of "adds" of any colorant to a batch prior to production.

- ✓ **Increased productivity.** No matter how sophisticated, any color matching system is limited in effectiveness if it's hard to learn and cumbersome to use. Look for software that takes advantage of the best of today's computers and features built-in user friendliness. The software also should be backed by comprehensive training and support.

**Color measurement that's well in hand**

Integrating an efficient color-measuring instrument into the system will significantly improve the effectiveness of overall coloring process as well as ensure color consistency in a finished product. Yet in this area of color control, as well, challenges have remained.

One continuing challenge in portable color measuring devices has been a cumbersome user interface. "Traditional" interfaces often use switches that must be toggled in a precise order to customize sample names and screen selections. Also, while just about every portable color measurement instrument on the market offers a wide variety of software tools, many are never used simply because it is too difficult to navigate through the program to access them.

The newest offering in the portable spectrophotometers introduces a radical departure and eliminates many of these challenges by utilizing PDA-driven technology for easy operation. This highly unique approach to color measurement is a prime example of the latest technology to be incorporated into the new electronic color communication system. Why? PDA (Personal Data Assistant) technology delivers the best of both worlds for superior color quality. It allows leading color developers such as Datacolor to integrate software customized for just about any color management applications right into a light, easy to handle color measurement instrument. Plus, it retains all of the navigation features that are standard on a PDA and which make it such a desirable device in general. No more cumbersome toggle switches or default selections. Using a stylus, the user simply taps the screen to input custom sample names or to change evaluation screens. This speeds the color evaluation process while it reduces errors in sample identification and evaluation selection.

Adapting the PDA to a color management application also takes advantage of the memory/storage capacity available with a PDA. In the past, the software offerings that have accompanied portable instruments were confined to basic quality control functions—simple color difference, pass/fail, and color indices--because of memory limitations. Data upload/download to and from a PC has been a mandatory feature of all handheld units.

However, QC and color formulation systems based on PC platforms generate enormous databases of both samples and formulas. Memory limitations have prevented the full utilization of these databases in a handheld application. The integration of the PDA into the new instrument is an answer to that limitation. For instance, the memory capacity of Datacolor's PDA-driven device, the Mercury 3000, makes it possible to accommodate a maximum of 30,000 samples, and to develop more complex programs that can search, retrieve, and manipulate the information that they contain.

**How to ensure precise onscreen reproduction**

As advanced as all other systems components may be, however, the key to providing superior color communication in an electronic medium remains its ability to reproduce color precisely. Once the color standard has been selected, matched, and measured, it is reviewed in a virtual color environment. The efficacy of electronic color communication rests solely on an ability to reproduce the color accurately on screen. And that is made possible by a high degree of monitor calibration and the right color control software designed specifically for this medium.

The monitors in the new virtual supply network are calibrated to such a precise extent that a user can be confident of making the same decisions when viewing electronic images that would be make viewing actual physical samples. What should you look for when evaluating an electronic color system? The following are key considerations:

(1) A single monitor must be able to repeat color day after day, with the same precision.

(2) The calibration must be device independent so that accurate conversion (from computer-based color data to colorimetric data, or RGB ↔ CIELAB) is permitted using virtually any brand of monitor. This enables transfer of color between any two monitors, as well.

(3) Look at how operators of the system are able to manipulate color. They should be able to conveniently create, edit and visually compare colors on screen.

(4) Once the on-screen color is created, the software, in turn, should automatically compute the right colorimetric data. This is the digital "signature" of that color.

(5) The system should also accept measurements by a spectrophotometer and instantly transform the data into visual color on the screen for evaluation or adjustment.

The resulting digital sampling brings an ability to create or evaluate color electronically and to avoid the time-consuming and costly traditional method of mailing colored samples back and forth between sites for approval. Digital sampling technology breaks new ground across all industries, but is particularly important in manufacturing applications where accurate color reproduction is critical to the delivery of a quality product.

Thanks to this ability to reproduce precise color on a computer screen - color standards can now be archived digitally, eliminating problems associated with fading, transfer, or handling. And the digital color data is ready for input to color matching or quality control software, as well as automatically available to the printer, or other end-user, once the colors have been approved.

In manufacturing operations across a wide variety of applications, color serves as a fundamental indicator of quality. Delivering material that is off-color can risk future business, and failing to get the color right "the first time" can drive up labor and raw materials costs significantly, reflecting the quality of the manufacturing process itself. With increasing competition and the move to bring products to market in record time, it is more important than ever to deliver an on-spec color faster and more efficiently. The latest color technology, particularly when housed within a virtual color environment, delivers new efficiencies for the entire supply when managing color throughout the complete production cycle, from mind to market.

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**About the author**

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