When Is It Wise to Use a SmartPhone for Color Matching?

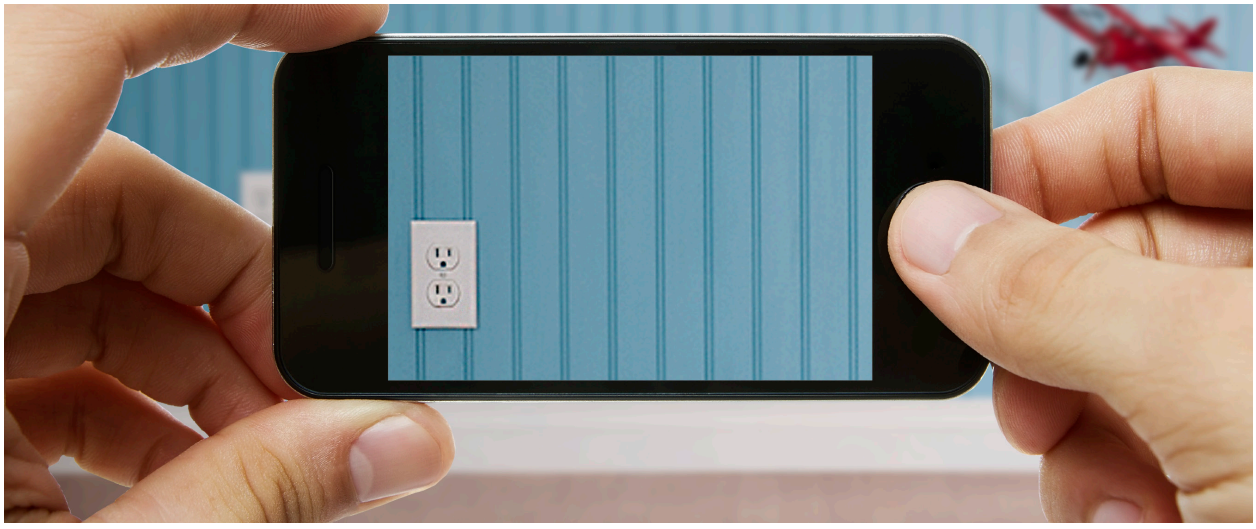
By Matthew Adby and Stefan Knechtle

With today's smart phones, everyone has the ability to capture the colors of inspiration items wherever they find them — royal blue fabric on a sofa, luminous yellow of a flower petal, or even the rusty red on a manhole cover.

But interior designers and tech reviewers say that there is a huge difference between simply identifying a color that catches your eye with a smart phone running a color matching app and using that information to select an exact paint for a project that may cost hundreds of dollars to complete.

Even paint manufacturers that offer free smart phone apps for color matching recommend that customers first obtain small quantities of paints for testing before purchasing all the paint needed to complete a project.

Everyone seems to agree that the most accurate and convenient way of matching colors on site for items like furniture, carpeting, window treatments and inspiration items is through the use of a new generation of pocket spectrophotometers that act as an electronic fan deck for interior designers, contractors, architects and do-it-yourselfers.



Play versus work

"The app makes no bones about the fact that light source, individual perception or other factors could affect the results," wrote Jay Donovan, a reviewer for the TechCrunch website who assessed the accuracy of a color matching phone app offered by a major worldwide paint manufacturer. "A color-calibrated, exact-match, pigment analyzer it is not. But for 'ballparking' your painting plans, (the app) really can help you make some basic color decisions and is a convenient tool for giving you a reasonably accurate palette of complimentary color schemes."

"Good for decor — bad for paint matching," another user wrote recently about the same color matching phone app. "Interesting, but not accurate." Simply put: many smart phones are wonderful at taking crisp and clear color photos, but their manufacturers didn't design them to be used as spectrophotometers for selecting paints. The cameras are designed to take digital photos under the widest possible range of lighting conditions with the least possible demands upon the user for setting shutter times, apertures and white balance.

To do this, engineers have written software with algorithms that automatically set these critical parameters to make the photography quick and convenient. But the settings — and assumptions — for easy general photography often are at odds with the best parameters for precisely measuring a single color.

For instance, smart phone cameras are designed to take a photo anywhere from a distance of about a meter to infinity. But the apparent color of an image can be greatly affected by the distance of the light source from the subject. If you're taking a photo of an interior wall from a distance of a few meters, it's likely there will be some presence of shadows or uneven lighting. So even though the entire wall may be only of one color, there very probably are gradations of shades in the photo — certainly if the camera triggers its flash while the photo is being taken. It's then up to the user to decide which gradation of the color is the desired shade: will it be the brightly lit spot or section bordering on a shadow?

The angle at which a smart phone photo is taken in relation to the subject also comes into play for color matching. The color the wall painted with a satin, semi gloss or gloss paint often will appear to change depending on angle at which the photo was taken, due in great degree to the relative quantity of reflected light from the wall.

And the source of light that illuminates the subject plays a critical role in accurate color matching. Interior designers know well how the color of the wall is changed by natural light streaming in through a window, an incandescent bulb of a reading lamp or a fluorescent overhead light. Each one of these sources of white light has a different signature spectrum of colors, which ultimately alters the way that the color of an object appears to the observer.

One international paint manufacturer that offers a free smart phone app for color matching makes this abundantly clear to anyone using its system. To obtain best match on colors, the manufacturer recommends that users take photos from a distance of about a meter, stand so as not to create a shadow, take the picture as perpendicular to the surface as possible, and ideally use natural daylight for illumination.

These external factors may cause a variation of between 4 and 10 delta E between the exact point that the desired color lies in color space and where smart phone apps may peg the color. Delta E is a single number that represents the distance between two colors in color space, and a delta E of 1 sometimes is the limit where an average human observer can distinguish between two colors, depending on the colors.

As for internal factors, the colors in a photo are altered by camera settings such as shutter speed, aperture setting, white balance, and flash. For instance, colors generally are more saturated in a photo when the shutter speed is reduced and the aperture is opened to admit more light.

But each manufacturer of smart phones has created its own proprietary software and algorithms to automatically adjust settings of embedded cameras — so individuals taking photos of the same scene at the same time with different makes of smart phones would notice variation in the colors portrayed in the shots if they compare them closely.

All of these variables are tightly controlled with an instrument such as CAPSURE, a handheld battery powered device made by X-Rite Inc. that can accurately measure the colors of walls, carpets or inspiration objects and match the sample with an electronic fan deck of tens of thousands of paint chips.

The instrument takes its measurements from a distance of less than 3 cm from the test surface, which is illuminated with a ring of 25 LEDs in a split second that are set an exact angle to perpendicular of the test surface. The configuration of LEDs and sensors compensates for shadows on even rough surfaces such as stucco or fibers such as carpeting.

Sensors and calibration

Another factor that diminishes the precision of smart phone apps is the type of sensor system used by smart phone cameras to detect the colors in a scene, which is vastly different than the system used by the CAPSURE instrument. Smart phone cameras use the most basic system of sensors that essentially only respond to red, green, and blue light (RGB for short). This limitation means that such RGB cameras describe any particular color in terms of only three responses or information points, which doesn't provide any insight into the components of a color or how a color may appear under different lighting conditions.

The CAPSURE uses a much finer spectral resolution that dissects a color sample to obtain eight responses or information points, which greatly enhances its ability to determine how a color was formulated from pigments and how that color may appear under natural daylight, incandescent, fluorescent or other types of lighting. The instrument uses this information to match colors much more precisely with its internal memory of thousands of paint colors.

Further, any instrument used to measure a physical characteristic of an object needs to be calibrated to a set standard if its results are to be trusted. A butcher will place a known weight on his scale when he wants to check whether it reads accurately, and a contractor assumes that the tape measure he uses to cut lumber is accurate to a few millimeters. Measuring colors isn't any different.

The CAPSURE illuminates the test surface with light that is carefully controlled at a known spectral power distribution that covers the whole visible range. Each device is individually calibrated and tested after manufacturing, which ensures an optimal match to the reference paint data stored in the device as digital fan deck.

Photographers who are sticklers for true-to-life color for portraits and landscapes will set physical targets of known colors in their test shots as standards for how a range of colors should appear. These test targets such as the X-Rite ColorChecker give the photographer a way to create a profile that will serve as guidance on how colors should be modified to achieve realistic color.

Although smart phones generally don't come with such color standards, one paint manufacturer recognized the need for users of its smart phone app to create such profiles when they were taking photos for color matching purposes. The manufacturer provides a cardboard target with a hole in its middle surrounded by test colors. The user places the cardboard target over the inspiration item of the desired color and takes a photo from a set distance. This information is then used to help achieve a closer color match.

This extra care promotes better color matches than taking a photo without any standards, but there are still a number of variables in the process that can hinder reliable matches. The CAPSURE has a built-in tile and software to calibrate the instrument in a less than two seconds before taking measurements to ensure precise color matches.

Finally, a smart phone app has very limited use in selecting a particular color from an intricate weave or pattern of several colors. Because it is set to take photos from a distance, the app will average out what the color should be, essentially mixing all of the colors. The CAPSURE is able to pick a specific color at very short distance from a design of up to four colors.

So smart phones running color matching apps are perfect for reminding someone where and when they were inspired by a shade or hue, and a color matching instrument like the CAPSURE is just the right tool to use when someone is ready invest time and money to have that inspiration become reality.

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