TECHNICAL GUIDE

APPLIED COLOUR MANAGEMENT

TIPS & TRICKS FOR MEASURING COLOURS

Second Edition

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Tips & Tricks for Measuring Colours

A modern spectrophotometer is a wonderful tool. With multitasking capacity, it can measure both reflected light from a surface and emitted light from a monitor or a backlit piece of print. And not only that, it can also act as a densitometer.

This makes a spectrophotometer very versatile, but it also shows us that the task of measuring colours has become quite complex. Increased complexity means that there is a potential risk of performing measurements in a less than ideal way, or of getting them just plain wrong. Following is an overview of some of the more common errors users make, along with some suggestions of how to avoid them and to adopt good practices.

Black backing, or not?

When measuring a printed sheet the general advice has always been to measure with a black background to get the best results. There is even a specification for how black this background should be in the ISO 5-3 and 5-4 standards, which require a density of 1.5 +/- 0.2. The reason to use a black background is to minimise the effect of any reflected light from the backing material, and/or from what is printed on the back of the sheet. This is only important of course on thinner substrates and papers. If the substrate is very thick, the lamp in the spectrophotometer won't shine though the material very much.

Many inline or nearline scanning spectrophotometers assume black backing by default, so you should be aware of this when you compare and analyse the measurements. What has become more and more common is to instead use a white background, and while the common practice is to use around ten unprinted sheets for backing, there is actually a specification for the properties of a correct white backing. In the ISO 12647-7 proofing standard it's stated that the white backing substrate shouldn't contain any Optical Brightening Agents (OBA), and that the whiteness should have a CIE luminance value of about 92-96.4 (which is quite a bright white), with a colour difference (chroma difference) that is below C* 3. (More information about OBA, and how to detect it, is provided in the M0, 1, 2 and 3 explained Technology Guide.)

There are several brands and many models of spectrophotometers on the market. Here some samples from vendors including Barbieri, Techkon and X-Rite.

Modern spectrophotometers need to be able to perform measurements according to the M1 measurement mode, with UV-light included in the light source. Here as an example, the Konica Minolta FD-7.

Now, does it really matter what background you use when performing colour measurements? Yes, it does because you may get quite different colour values. The difference between measurements using black backing and white backing can be quite substantial, and cannot be ignored. Always make notes of whether your measurements were made using black or white backing. And if you plan to use externally measured data, for validation or when creating ICC profiles, make sure you know what backing was used when the colour data was captured. Another conclusion from this is of course to never, ever use any random background when you measure colours, be it a desktop of some colour, random previously printed sheets, or whatever. Use either black or white backing, as close as possible to the specifications mentioned above.

Calibration and validation of a monitor

While you don't necessarily need a high end spectrophotometer to calibrate or validate your monitor because a good colorimeter would do, it's tempting to use your spectrophotometer for this as well. But not all spectrophotometers are suitable to measure LCD monitors. This is because some spectrophotometers are very sensitive to the angle at which the device is placed on the monitor. The pattern of the RGB filter in the monitor may cause a type of moiré effect, which can corrupt the measurements considerably. If you are not sure whether or not your spectrophotometer is really suitable for the type and make of your monitor, we suggest that you contact the vendor and ask. Just because the calibration software supports your spectrophotometer doesn't necessary mean that it's a good choice. This is especially true for old X-Rite iOne spectrophotometers which can be prone to this problem. This is a bit unfortunate since this spectrophotometer is one of the most popular and widely sold instruments on the market.

Calibrating a monitor with X-Rite's i1Pro2 Spectrophotometer

Many software packages allow you to check that your monitor is capable of displaying the colours of the simulation standard that you are working to i.e. Fogra 39L

Never, ever only measure once

Another common error when measuring colour is to only measure once, or possibly twice. Instead you should measure at least three times, possibly five or even more. Then look at the measurements, and see if they are consistent. If not, you may need to troubleshoot why there are so many irregularities in the values. It could be that the printed sheet is uneven in terms of density, or that the aperture you are using is not optimum for the type of screen or printing technology used. This situation is particularly common in wide format digital printing and screen printing where coarse screens used, meaning AM screens at below 100 lpi, or when using FM dots (also called stochastic screening) larger than about 75 micron.

If you use a spectrophotometer with a very small aperture for those types of measurements, you have only a few dots involved. Any fluctuation in density or small defects in the print will cause a big deviation in the measurements. You need to use a spectrophotometer with a large aperture, and might even need to change to another manufacturer or make, to get a reliable value. One of the perhaps lesser known manufacturers of spectrophotometers is Barbieri, and some of their models are especially suitable for measuring wide format digital prints.

The secret is not only using a large enough aperture in the spectrophotometer, it's also about how the light source distributes the light during measurements. When you have a large enough aperture, and when the reflected light from the printed substrate represents the actual colour in a good way, the spectrophotometer actually makes a kind of internal averaging of the measurement data for you, and you will have a better and more reliable result from the device.

If there still are some fluctuations in your readings, the best you can do is to make at least three, or better four or five or even ten measurements, and then average them. This will give you a good value that should represent the actual colour, and you will avoid using a single measurement that worse case may be quite far from what the true value should have been. The result will be vastly improved printed colour results.

If you don't have a spectrophotometer with extra large aperture you can try and measure in scan mode. This will give you a series of samples that the spectrophotometer control software will average in the process. The key in this case is not to use too small colour patches. The patches should be at least 10x10 millimetres to offer stable and consistent measurements.

This inkjet and screen print comparison at x5 enlargement illustrates that your spectrophotometer must been selected for the appropriate application.

Measuring transparent materials

While there are many spectrophotometers to chose amongst when measuring prints on paper or other opaque substrates, it's more of a challenge to measure, and colour manage, prints made on glass and/or transparent substrates like plexiglass and films. Again you need to work out what measuring device will give you stable and correct readings.

Some spectrophotometers are technically able to measure in transmissive mode, that is when the light and so the colours are emitted from the substrate through some back lit media. But they may not produce stable or accurate readings. Once you have established that your spectrophotometer can give you correct and stable measurements on transparent substrates, the colour management from there on should be pretty straightforward, and not that different from when printing on more conventional opaque substrates.

Measuring metallic inks or unusual substrates

Now we are approaching the boundaries of the known territory for conventional printing and colour management. Due to the nature of metallic inks, or when printing on metal, the reflected light will appear to have a different colour depending on the angle at which it is viewed. Here you may need to try out a spectrophotometer with a very different light source technology than is used in the more conventional spectrophotometers. The technology uses sphere geometry so measurements are compiled from data captured from several viewing points. When analysing the result, a more relevant measurement can be obtained with much better repeatability than a single measurement using conventional 0/45° geometry. If you measure high gloss substrates, or plastics and textiles, or metallic inks, you will probably find that using a conventional spectrophotometer will produce quite unpredictable and so unreliable data. Working with a spectrophotometer where the light source uses sphere geometry will most likely give you more accurate and predictable measurements.

For printed materials other than paper, it might be necessary or useful to use a spectrophotometer with a lightsource that uses sphere geometry. Here is an example of such a device, the X-Rite Ci64L.

Finally, as with any instrument, you need to make sure your spectrophotometer is fully functional. This means that you have to make sure that it is serviced at the intervals recommended by the manufacturer. This will normally be once per year, but in the meantime it's also a good idea to regularly check that the spectrophotometer performs accurate measurements, and hasn't been dropped or damaged in some way. You can either compare the measurements with the readings you get from another spectrophotometer, if available. Or you can save a print sample in a dark place, take notes on what the measurements were in the first readings, and then compare now and then what they are three, six and nine months later. They shouldn't drift more than DE 1 or so. As with all electronics spectrophotometers can suddenly stop working in the expected way. For quality management reasons you want to ensure you perform colour measurements with the correct settings, using a fully functional spectrophotometer, suitable for the task.

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