CxF® – Color Exchange Format

The universal language for digital color communication

Abstract: In a global world, communicating color data electronically a hot issue. Global workflows and value chains, whether they are found in a B2B or B2C process, as well as in-house digital workflows from designer to press are demanding simple, adequate and effective means to communicate color and appearance. CxF is a new standard allowing seamless, worldwide, digital communication of all commercially significant aspects of color. Furthermore, CxF is defined in a completely open way so that all aspects of a color can be communicated, even when the application and the color communication features required are unknown. For example, every software vendor implementing / supporting CxF is able to extend the information set to the needs of a new application without affecting the general usability. Wherever color communication is mission-critical, CxF should be considered the communication solution of choice

How to communicate color?

Why is color communication standardization a good idea?

Finding the optimal means to facilitate standardized color communications has been in discussion for years, and many different approaches have been tried. Typically, color communication is done today using colorimetric measurement values such as CIE-Lab, XYZ, RGB, density, CMYK, or spectral measurement values. These values are often communicated in proprietary formats that don’t provide for meaningful communication outside of a narrow use. Various organizations have attempted to provide a framework for this communication, but in general they have been focused on narrow industry segments and have not been easily extensible.

Commerce today is based on a worldwide digital workflow. The use of Internet technology in distribution and logistics creates an even greater demand for a standardized color communication method. A new universal language to communicate colors will simplify the process to communicate color no matter where the information is needed.

Device-dependent versus device-independent color spaces

An important aspect in color communications is to differentiate whether device-dependent or device-independent color spaces are used. Generally, the way to communicate colors has been to exchange color recipes or formulations consisting of CMYK or RGB values, or to use named color systems like Pantone®, Toyo or HKS.

When device-dependent color spaces are used for communication, production parameters assigned to those color coordinates must be used to ensure accurate color communications. One example of this would be an ICC profile, whereby the appropriate algorithms, procedures and data exchange standards therefore have been defined by the ICC (International Color Consortium; http://www.color.org). Device-dependent color spaces are specified therein by so-called device profiles. There are numerous other examples of device-dependent color exchange formats from automobiles to textiles, unfortunately until now there has been no common way to define these device-dependent color formulations.

Named color spaces

Other approaches to communicate color are “named color spaces”. This approach is used by companies and organizations like Pantone® , RAL, NCS, Toyo or HKS. In this approach, colorimetric values / spectral values are assigned to color names. The assigned color name is then used to communicate the color.

Appearance effects

Human perception of color is not ultimately defined by a colorimetric measurement value of the sample. As important as the colorimetric value itself may be, also to be considered are the surrounding colors, and the absolute brightness (light level). One possible approach to this problem can be found in the CIE publication CIE 131-1998 (“The CIE 1997 interim color appearance model (simple version) CIECAM 97s”). Other mathematical models are known as well.

Another element affecting the appearance of colors, are angular dependencies of the emission or reflectance, as typically seen on metallic surfaces. This effect is measured using a gonio spectrophotometer. The color has to be defined in that situation by a set of angular-dependent reflectance curves.

In other situations the appearance / perception of the color can be affected not only by the color itself. The substrate the color is printed on or applied to is equally important. Fluorescence effects - implied by the use of optical brighteners - affect the color significantly. In many applications, homogeneousity and structure of the sample are important in color communications. A possible way to solve that problem is to communicate pictures of spot colors in combination with the colorimetric / spectral information.

Other properties affecting the perception of colors are surface effects of the color sample (gloss effects of the color and/or the substrate). These are effects typically measured by a gloss meter built according to DIN 16357. A universal color communication language should support such appearance effects.

Other important aspects in color communication are size, position, and shape of color areas. There are several papers published defining appearance effects based on the simultaneous contrast of colors.

Commercial aspects

Colors used commercially have to be within a certain colorimetric tolerance field. This tolerance is often defined as a dE tolerance using the CIE-Lab, CMC, dE94, dE2000, or FMCII color space. To communicate the color, dE implies the communication of the acceptable color tolerance field as well.

Other factors, such as light resistance, resistance against chemicals, or other physical, chemical, or biological aspects of a color matter may also need to be communicated, depending on the application.

Mathematical and optical conditions

Absolute colorimetric values depend further on the physical / optical configuration used to do the measurement. Measurements done on the same sample using a 45/0° optical system versus a sphere will not match. Other well-known optical setups affecting the measured results include polarization filters, and the physical light source used to illuminate the sample (i.e. D65-flash or A-Tungsten halogen). Therefore, to compare and communicate these measurement conditions the physical optical setup conditions used to do the measurements must be communicated also.

Another important aspect to consider in the communication of colorimetric values, are the mathematical conditions used to do the calculations (observer 2°/10°, light sources D65, D50, A, C, F1...F11). Depending on the illuminating light source the colorimetric values will differ. All commercially available color measurement devices define these conditions. It may be useful in some conditions to do the above-mentioned calculations on the spot. A universal data communication standard must therefore be able to include physical light sources or emissions standards as well.

ANSI standard to communicate colors

One possible way to communicate colors (especially useful to communicate colorimetric values of device profiling charts) using absolute colorimetric values is explained in detail in the ANSI Standard CGATS.17. / ISO 28178:2009 ("Graphic technology Exchange format for color and process control data using XML or ASCII text"). This document took the important step of setting forth a method for explaining how colorimetric and spectral measurement values can be serialized into an ASCII data stream with a simplified mapping to a flat XML structure. CxF recognizes this important work and provides for mapping this data into the expanded language of CxF.

Summary

In general, it is not sufficient to communicate a color recipe, a reflectance curve, or a CIE-Lab value. Depending on the application there are specific needs in the way a color should be communicated. A universal color communication language must be open – to describe and communicate such known and even new, as-yet undefined effects. In addition, this language needs to be able to bridge the gap from one industry to another.

Depending on the application, further attributes need to be assigned to spot colors. Among the infinite list of possible attributes assigned to spot colors are serial numbers, part numbers, color mixtures, price of pigments, light resistance of the color, descriptions, application notes, comments, and many more.

Technical Document

For a technical overview of CxF refer to the document: "CxF_Standard.pdf".

For a schema layout, description of CxF2 versus CxF3, and CxF3 documentation please refer to the documents: "CxF3_Schema_Diagram.pdf" and "CxF3_Schema_Overview.pdf".

For the schema file (.xsd) and a free Windows CXF Viewer download the zip file "CxF3_Schema_and_Examples.zip".

Questions and Answers about CxF Technology

- What do I need to build my own CxF-compatible application?

  The CxF 2.1 and CxF 3.0 Schema are available to all. It is possible to create your own CxF compatible application by implementing the CxF schema. We recommend licensing the free CxF2.1 and CxF3.0 SDK (software development kits) from X-Rite to write CxF compatible applications as this simplifies the process.

- Where do I get the free CxF SDK's?

  You can get the CxF SDK's from X-Rite Inc by submitting a signed [free] license agreement available on the website. Download the license and instructions from the web page (file "CxF SDK License agreement and instructions.pdf") or email mailto:devsupport@xrite.com.

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