International Color Consortium®

White Paper

Level: Introductory

Date: Jan 2005

Reasons to use ICC version 4 in PDF/X

Introduction

This document was produce in response to a request from ISO TC130/WG2 for a white paper that discusses the need for a change to the PDF/X specification to allow (and recommend) the use of ICC version 4 profiles. At the time of writing (January 2005) PDF/X does not allow the use of version 4 profiles however the ICC strongly recommends that support be provided in a future version.

The ICC produced version 4 of the profile format specification primarily to address a number of problems that users were experiencing when using version 2 ICC profiles. This document explains some of the reasons to move to version 4, providing an overview of the subjects in a non-technical way wherever possible - a more complete technical description of the benefits is available from the ICC web site (www.color.org).

Summary of benefits

The bottom line as far as users are concerned is that PDF/X documents will be reproduced more consistently with higher quality colour if they use version 4 ICC profiles. A summary of the technical changes that have made this possible is provided later in this document.

Most colour-capable graphic arts products support version 4 and some users are already using version 4 profiles in their workflows. This usage is increasing and so a number of vendors are shipping version 4 profiles bundled with their products. Many vendors desire to upgrade their profiles to take advantage of the version 4 features and to provide a better user experience. At the same time these vendors desire fully and transparently to support PDF/X. This is now not possible because of PDF/X's lack of support for version 4. If PDF/X adds support for version 4, vendors won't have to make an either-or choice.

The fact that PDF/X officially doesn't support version 4 causes problems right now:

(1) Some products downgrade version 4 profiles to version 2 when creating PDF/X. This has caused several problems, which reduce the value of the PDF/X standard:

   a. **Colour shifts:** when the version 2 profile is a poor approximation of the version 4 profile.

   b. **Profile mismatches:** when the PDF/X document is opened in an application set for version 4.

   c. **Extra color conversions:** when the version 4 profile cannot be represented as version 2 (e.g. sYCC).

(2) Some products embed the version 4 profiles in PDF/X to avoid these problems. This works well in version 4-capable workflows, but undermines the PDF/X standard.

The solution to this pain is to add ICC version 4 support to PDF/X. Over the last three years since the introduction of version 4 of the ICC profile format specification the basic support for version 4 profiles has been developed. This has included development of Color Management Modules, imaging applications, document assembly, proofing and printing applications and profile creation tools. Since these tools are now commonly available and since the benefits of moving to version 4 are significant I suggest that the next revision of the PDF/X family of standards should recommend the use of version 4 ICC profiles.

Technical benefits

The biggest problem faced by users of version 2 ICC profiles is the lack of interoperability between profiles from different vendors.

In general, users are able to achieve good results when input and output profiles are created by software from the same vendor. They have mixed results - in some cases very poor results - when the profiles are made by software supplied by different vendors. This problem is most noticeable for the Perceptual Rendering Intent and is the primary reason that most graphic arts users avoid using the Perceptual Rendering Intent.

Version 4 profiles solve this problem and in addition address a number of other weaknesses as explained in the following sections.

BETTER PCS DEFINITION

The job of the input profile is to define a transform from input device colour values to the profile connection space (PCS). With version 2 ICC profiles there are a number of different approaches taken to creating the Perceptual Rendering Intent table for input profiles:

(1) When creating scanner profiles some profiling software simply adjusts the luminance range of colour values from the scanned input medium. Since this is a luminance scaling only the range of colour values presented by the input profile via the PCS to be the output profile differs substantially from one type of medium to another.

(2) In other cases profiling software maps image colours adjusted for a monitor directly into the PCS. Since the colour gamut of a monitor is significantly different in shape from that of a printer, an output profile that assumes colours have been mapped to a virtual print will clip many of the colours produced by this type of input profile.

(3) Some digital camera profiling software attempts to estimate the colours in a scene. In some cases these colours are mapped to the PCS by a simple luminance scaling. As with (1) it is not possible to create an output profile that provides a good mapping for all scenes photographed as the range of colours presented to the PCS can vary significantly.

(4) Other profiling software maps colours from input to an ideal reflection print as suggested in the specification. For version 2 the ideal reflection print was poorly defined and so even in this case there is some variation in the mapping from one vendor to another.

This situation presents the output profile creator with a dilemma. It is possible to create an output profile that will provide an effective mapping for (say) an input profile for a transparency scan. This output profile will, however, produce a poor result when used with input profiles that perform different mappings to the PCS.

This problem is resolved for version 4 profiles where a full definition of the perceptual PCS is provided along with the characteristics of the ideal reflection print used as its basis. For version 4 the input profile must define a transform for the image from input colour values to the ideal reflection print of the PCS. The output profile should provide a transform from the ideal reflection print to the output device.

The version 4 specification also indicates that the A2B table should provide as far as possible the reverse transform of the B2A table.

Note: this change means that the version 4 Perceptual PCS and Colorimetric PCS are now different from one another.

ADDITION OF CHROMATIC ADAPTATION TAG

The PCS assumes that the ideal reflection print will be viewed in a standard D50 viewing environment. When measurements used to create the profile are made using a different illuminant they must be adjusted using some form of chromatic adaptation. This is a common situation in the case where the input is monitor-like where the measurement data are likely to be made relative to D65. In these situations a chromatic adaptation transform using a 3x3 matrix is usually performed to estimate equivalent colours under D50. Since this process involves estimating human perception of colour (which is a complex process) there are a number of possible choices for this conversion, each of which produces a different result.

In some cases it is desirable to be able to recover the original measurement data, for example in the case where a monitor to monitor colour mapping is required. In order to be able to do this effectively, the chromatic adaptation transform used to map into D50 should also be used to map from D50.

In version 2 profiles there is no way to determine which chromatic adaptation transform the profile creator used. In version 4 information about the chromatic adaptation transform should be provided using the chromatic adaptation tag.

COLORIMETRIC INTENTS ARE REQUIRED TO BE MEASUREMENT BASED

This requirement, along with the addition of the Chromatic Adaptation tag, means that version 4 ICC profiles can be used as the basis for ‘smart CMMs’ where colour conversions from the input to the output devices are calculated by the CMM at the time of output rather than at the time profiles are created. Since both input and output are known when the colour transform is calculated the result can be optimised.

UNICODE SUPPORT

There are a number of tags that hold human readable descriptions. In version 2 there is no support for multi-byte fonts - this was introduced as a version 4 feature.

PROFILE ID

In some cases it is desirable to be able to check whether two profiles are identical and to do so quickly. Version 2 profiles must be checked by comparing the entire

file contents. The addition of the profile ID in version 4 profiles enables quick checking for identical profiles.

DEVICE N COLOUR SUPPORT

Version 2 specification allowed profiles with more than four channels, however the colorants to be used is not defined for anything other than CMYK. This problem is solved for version 4 profiles by the by the introduction of the colorantTableTag that defines the set of colorants by name and PSC colour.

COLORANT LAY DOWN ORDER

Version 2 profile creators cannot indicate a difference in profiles made, for example, for CMYK and KCMY print processes. This is a problem since the lay down order of inks changes the resulting colour. This problem is solved for version 4 profiles by the introduction of the colorantOrderTag that defines the lay down order of the inks.

IMPROVED PROFILE CONSTRUCTS

Version 4 profiles allow the use of more capable lookup tables that provide applications developers with more flexibility making it easier to define accurate colour conversions. In addition, curves can be defined using parameters (parametric curves) rather than sample points ensuring smoother colour results.