White Paper #42

Level: Intermediate

Date: March 2014

Using the *sRGB_ICC_v4_appearance.icc* profile

Introduction

The sRGB v4 ICC appearance profile (the Appearance Profile) is an ICC version 4 replacement for commonly used sRGB v2 profiles. It gives better results in workflows that implement the ICC v4 specification and is intended to be used in combination with other ICC v4 profiles.

As described in other ICC white papers[1] there may be more than one Perceptual Rendering result. For sRGB, two color profiles are provided by the ICC both of which comply with ICC version 4 and provide standard color transforms from sRGB to the perceptual reference medium gamut (PRMG). The two color profiles can be thought of as re-targeting (Appearance Profile) and re-purposing (Preference Profile[2]) as described in ICC White Paper #02. The difference between these two profiles is in the Perceptual Rendering; other Rendering Intents are the same.

The features of the Appearance Profile are that it:

- may be used as re-targeting in perceptual rendering intent,
- produces color-consistent results between prints and display and
- produces more pleasing results in appearance and tone scaling for most images than Colorimetric Rendering.

The perceptual intent should be used when the goal is to re-optimize the source colors to produce a pleasing and consistent reproduction on the reproduction medium while essentially maintaining the "look" of the source image[3]. The perceptual intent will not enhance or correct images.

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[1] ICC White Paper #01: Fundamentals of the Version 4 Perceptual Rendering Intent,
ICC White Paper #02: Perceptual Rendering Intent Use Case Issues, and
ICC White Paper #05: Glossary of terms.

[2] A description and intended use for the sRGB v4 ICC Preference profile is described in ICC White Paper #26: Using the sRGB_v4_ICC_preference.icc profile.

[3] See ICC White Paper #26, Page 1

As many elements are used in the design process to realize pleasing reproduction, many color reproductions exist[4]. There are two main aims:

re-targeting when the second visualization is intended to represent or match the original first visualization, and

re-purposing when the second visualization is independent of (not constrained by) the first visualization and can be optimized for the second visualization condition.

The goal of the Appearance Profile is to provide a ‘consistent color appearance' between the image displayed on the monitor (original first visualization) and the printed output (second visualization). Consistent color appearance aims to achieve a consistent reproduction for the two visualizations by matching color and color tone for the entire area.

The ‘consistent color appearance’ reproduction objective is most useful when users wish to be able to:

- retouch the image on the display monitor,
- produce prints that have a similar look even when printed from different types of printing devices and
- print or view an image that looks similar to the image obtained by image capture or a scanning device that has been prepared for viewing on a display calibrated to sRGB.

General recommendations

Three use cases are described here as examples of color re-rendering of images. For each case a profile and rendering intent is recommended. The three cases are shown in figure 1:

Case 1: an image is intended to be reproduced for viewing in conditions that are very different from that of the input; in this case the 'Preference' profile should be used and Perceptual Intent should be selected.

When the input image is optimal and the objective is to reproduce it under other viewing conditions or on a different medium the following applies:

Case 2: when the difference between source gamut and destination gamut is small, either profile ('Preference' or 'Color Appearance') can be used and Colorimetric intent should be selected. In addition BlackPoint compensation should be used where there is significant difference between the two black points.

[4] According to ICC White Paper#02: Perceptual Rendering Intent Use Case Issues.

Case 3: when the difference between source gamut and destination gamut is large the 'Color Appearance' profile should be used and Perceptual Intent should be selected.

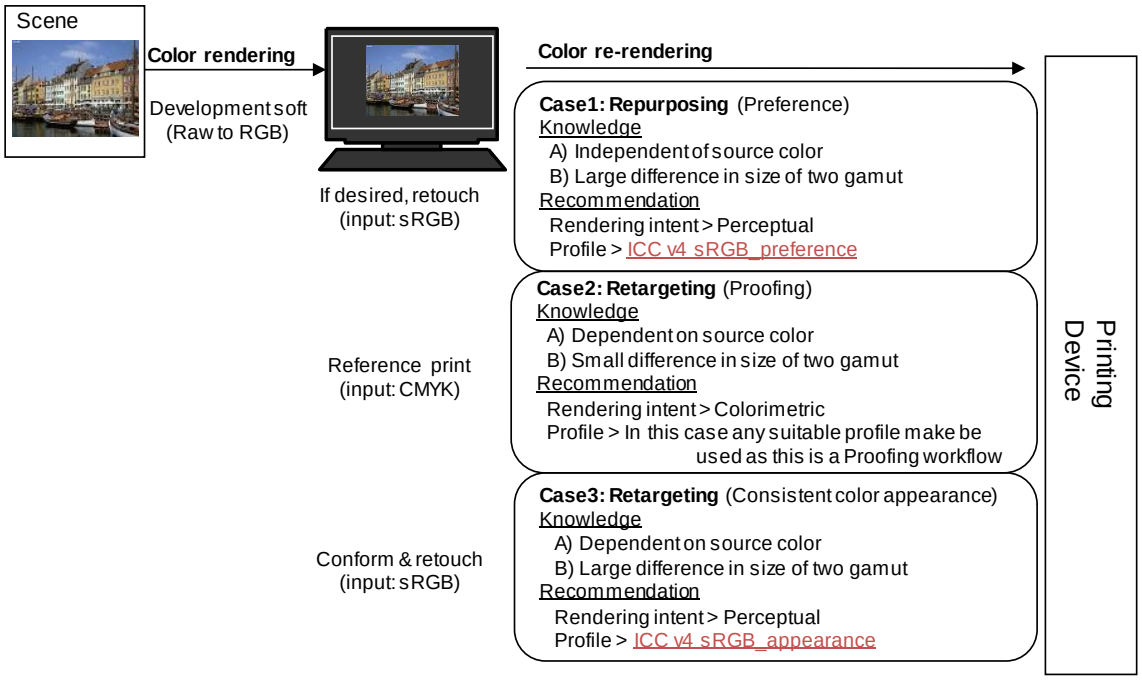


FIGURE 1: USING THE ICC V4 SRGB PROFILE PERCEPTUAL AND COLORIMETRIC RENDERING INTENT

With the standardization of display viewing environments, standardization of color reproduction where colors remain similar to that shown on the display is expected by users. The Appearance Profile can be used in such a situation. This color profile uses sRGB for input and perceptual reference medium (PRM) gamut for output. The relationship between the original image and the output image produced when this profile is used depends to some extent on the selection of color re-rendering for the output profile. Where possible, an output profile with a re-targeting reproduction objective should be selected.

Further examples of workflows for case 3

Background – graphic arts is changing

In conventional graphic arts workflow, images are carefully prepared for print using a reference printing condition specified by organizations such as CGATS, Fogra or Japan Color. The image appearance is usually checked by making a hard copy proof on a printer that has been carefully calibrated to simulate the reference printing condition. In some cases a soft proofing system is created where a wide gamut display is used in a carefully controlled viewing environment and is calibrated to match the reference printing condition. This kind of workflow typically uses print-referred images with Absolute Colorimetric or Relative Colorimetric rendering intent.

Preparation time and skills should be reduced

The time and skill level required to prepare and check these print-referred images can be significant and there is a strong desire on the part of many users to be able to print images that have been prepared for viewing on a display without the added image adjustment step. In these cases the intent is to produce a printed result that matches the appearance of the image displayed on an sRGB display.

Effective digital printing workflows are needed

Increasingly digital print is being used in place of conventional offset printing processes. These printing systems have significant variation in inks and dyes producing significantly different color gamuts. This makes it impractical to produce reference standards for these processes. In these cases there is a strong desire to create documents that use RGB display-referred images directly and to develop workflows which will retarget these documents automatically for the actual printing system to be used. In this case the aim is to produce consistent color appearance across all digital printing systems.

Dual purpose documents for internet and print

With the increasing use of internet publication many documents are dual purpose. That is, they are published as electronic documents intended for viewing on a display and additionally are published in printed form. The aim of the creators of such documents is that both look attractive and have consistent color appearance. When print-referred documents are displayed on screen they generally appear de-saturated and so using a workflow where documents are created using display-referred RGB images and are converted to print retaining a consistent color appearance is desirable.

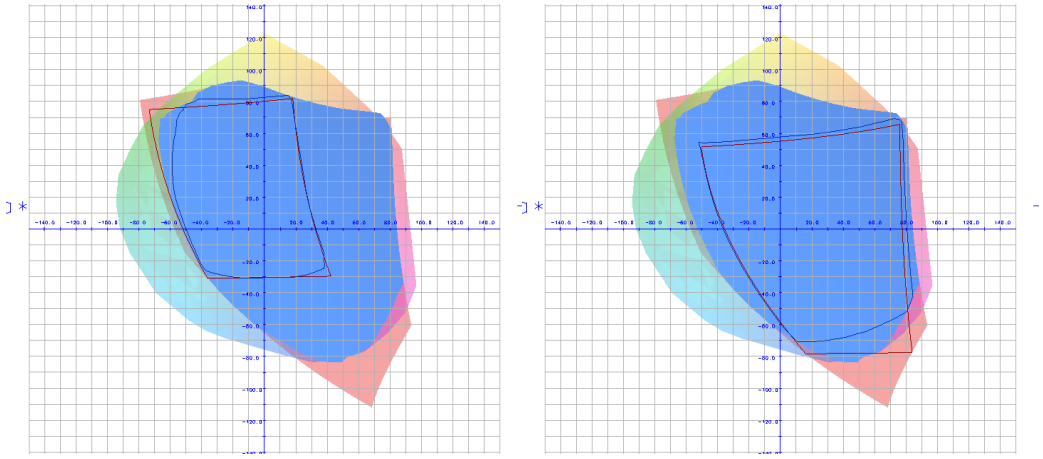
For these and other similar use cases a suitable display-referred color space needs to be adopted. There are many choices but the most commonly used today is sRGB and so the Appearance Profile with its ability to preserve color appearance from display to print using the Perceptual rendering intent is a good choice for this kind of workflow.

Feature and evaluation of profile

The results of the profile evaluation are described in this section.

Shape of the color gamut boundary

The shapes of color gamut of sRGB, PRM gamut and Appearance Profile in CIELAB space are shown below. The shape of the color gamut of the Appearance Profile is similar to that of PRM gamut.



(a) L*=80 (b) L*=50

FIGURE 2: RELATIONSHIP BETWEEN SRGB, PRM GAMUT AND APPEARANCE PROFILE

In figure 2, three gamut projections are shown in the background: the sRGB input is shown in red, the appearance profile output is shown in blue and the Perceptual Reference Medium Gamut (PRM gamut) is shown in full color. The lines on top show the extent of the sRGB input (shown as a red line) and the appearance profile output (shown in blue) for values of L* of 50 and 80.

Round trip evaluation

Round trip provides an indicator as to whether the color profile is used to its fullest capability although the need of color profile depends on the use case and is not necessary for some use cases.

The evaluation of round trip of this color profile is indicated in Table 1. For this color profile's perceptual rendering intent the objective is to ensure that the shape of sRGB color gamut corresponds with that of the PRM gamut. Therefore this color profile is heavily influenced by the position and tonal characteristics (edge line of the boundary) of the primary and secondary color in the color gamut, resulting in an existence of a color gamut with a large round trip error in some regions.

TABLE 1: ROUND TRIP EVALUATION

	Average	Maximum
sRGB_V4_ICC_appearance_beta.icc	0.69	7.16
<Reference>sRGB_V4_ICC_preference.icc	0.25	1.78

There are many other color objectives for this color profile and achieving those targets is the highest priority and so achieving a low round trip error is secondary. This color profile, whose objective is re-targeting, uses a common color gamut for input color gamut and output color gamut. When a low round-trip error is required the colorimetric intent (B2A1) should be used.

Subjective assessment

Subjective assessment was performed using the following sample set and evaluation method. The evaluation result of all color profiles is indicated in Figure 3. Appearance Profile (#A on Fig.3) performs well.

A) Sample set conditions:

- **Printer:** *HP Photosmart 8750* ink jet printer, plain paper
- **Chart:** 10 sRGB images including 3 sRGB SCID images
- **Sample set:** CMM by Photoshop CS4
  Here the inkjet printer profile A and B generated with the commercial profile builder each.

  #A) sRGB v4 Appearance, B2A1 Profile A (+BPC)
  #B) sRGB v4 Preference, B2A1 Profile A (+BPC)
  #C) sRGB v2 (IEC 61966-2.1), B2A1 Profile A (+BPC)
  #D) sRGB v2 (IEC 61966-2.1), B2A0 Profile B

B) Methods:

- **Observers :** 5 persons
- **Viewing Condition:** 5000K lamp, P2(500lx) by ISO13655 and ISO3664
- **Monitor :** *EIZO CG221* on sRGB setup
- **Evaluation method :** Rank order of 'color closeness' (consistent appearance) to the monitor reproduction for sample set

C) Result :

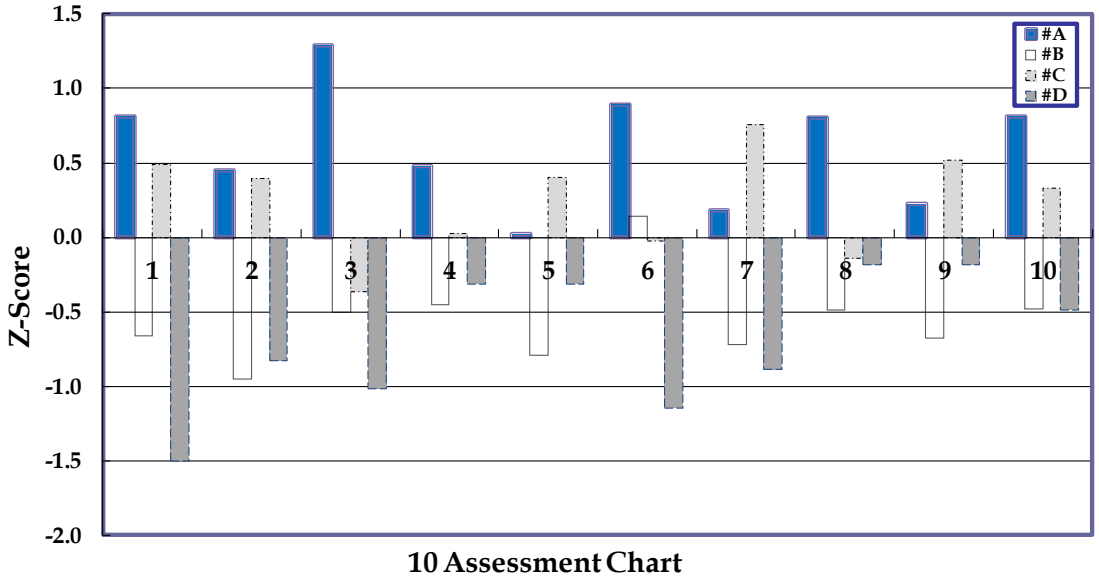


FIGURE 3: Z-SCORE OF SUBJECTIVE COLOR CONSISTENT

Re-targeting: consistent color appearance (Informative)

Consistent color appearance between image on display and in print is assessed.

Five layers for color rendering

The 5 layers for color rendering of profile are indicated in Figure 4. The difference between Colorimetric rendering and Perceptual rendering are clear (different clipping and tone-scaling) The Perceptual rendering is already included in many color rendering concepts as preference, emphasis on optimal tone reproduction, emphasis on saturated color etc, but the appearance of tone is the most important requirement.

The using full PRM Gamut is not necessary for the 3rd layer.

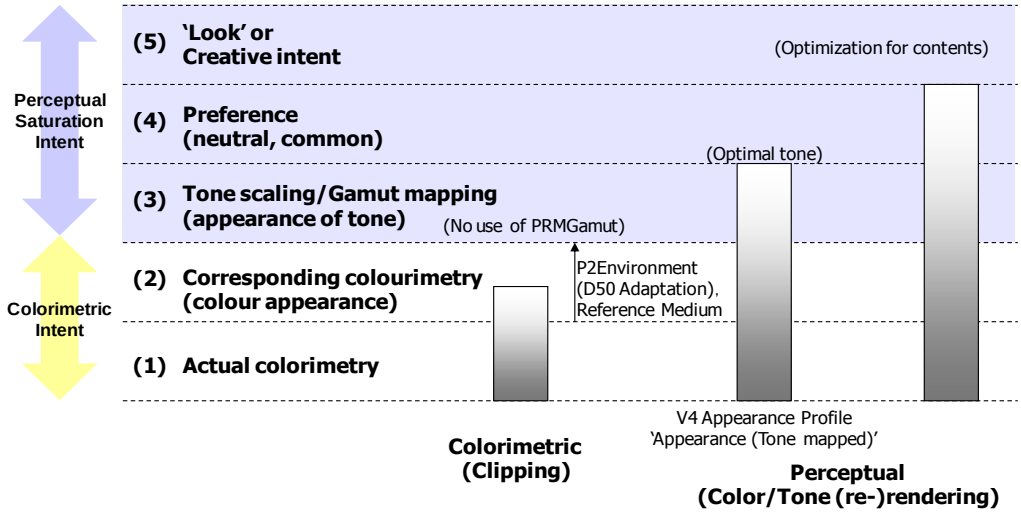


FIGURE 4: RELATIONSHIP AMONG RENDERING INTENTS