



Issues Encountered in Creating a Version 4 ICC sRGB Profile

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- Compare v2 and v4 ICC Specification
- HP Perceptual Intent Reference Medium Gamut Target
 - v4 sRGB Profile
- Implementation of the Media Relative Colorimetric Rendering Intent of the v4 sRGB Profile
- Using the Perceptual vs. Colorimetric Rendering Intent
- Testing the Performance of the v4 sRGB Profile
- Future Steps
- Conclusion

v2 and v4 ICC Profiles Compared




- ICC.1:2001-12 *File Format for Color Profiles** (Version 4.0.0) improves upon the previous version 2 mainly in the following ways:
 - rigorously defines the perceptual and colorimetric rendering intents,
 - allows for multiple rendering intents in input profiles
 - defines the perceptual intent reference medium dynamic range and viewing conditions,
 - thereby enables interoperability for properly constructed profiles.

*available for download at <http://www.color.org>

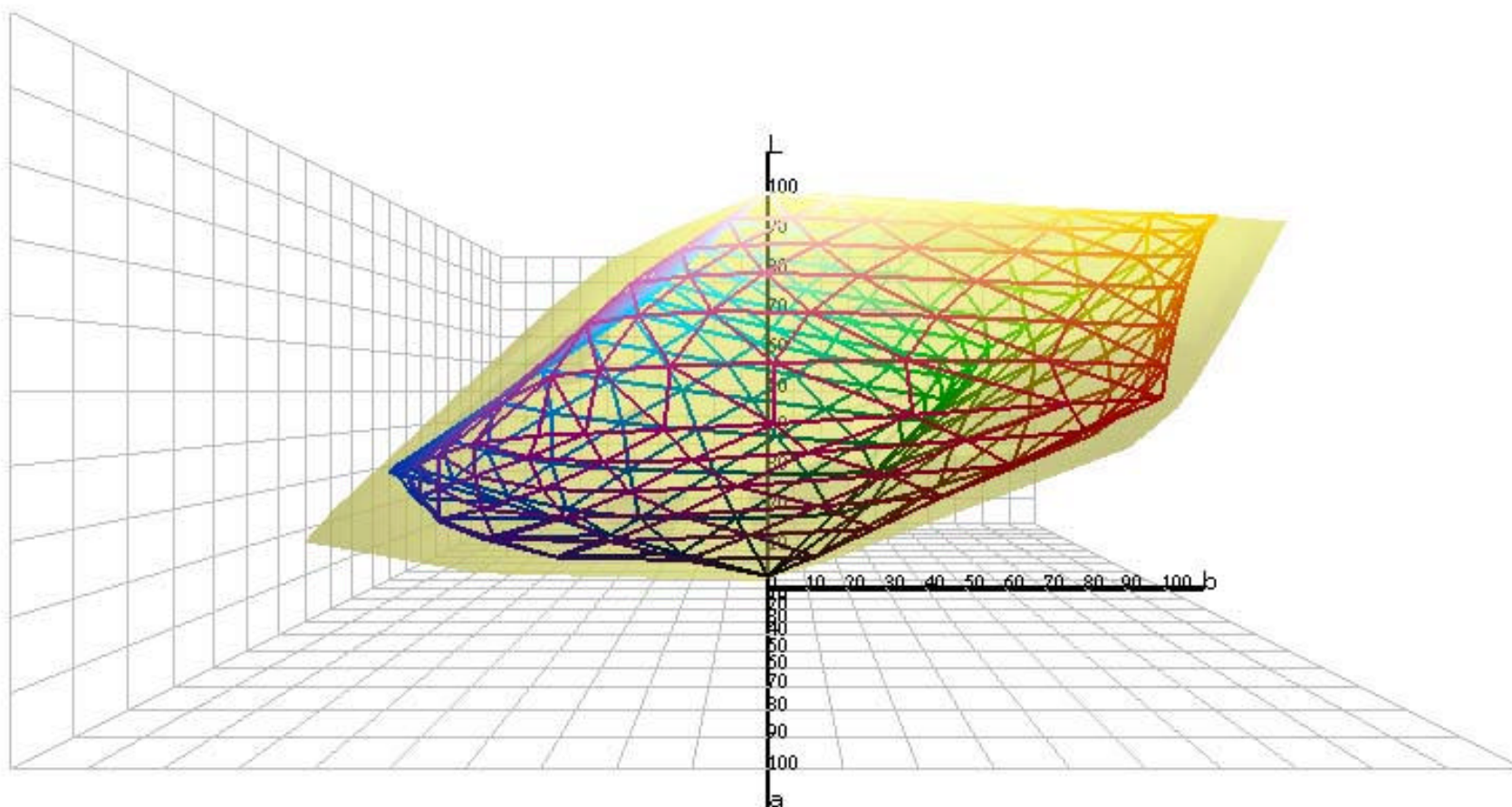
- Any commonly agreed target gamut enables improved interoperability.
- The HP proposal attempts to achieve interoperability while maintaining high-end quality.
- It has been proposed to the ISO TC130 for standardization.

HP Perceptual Intent Reference Medium Gamut



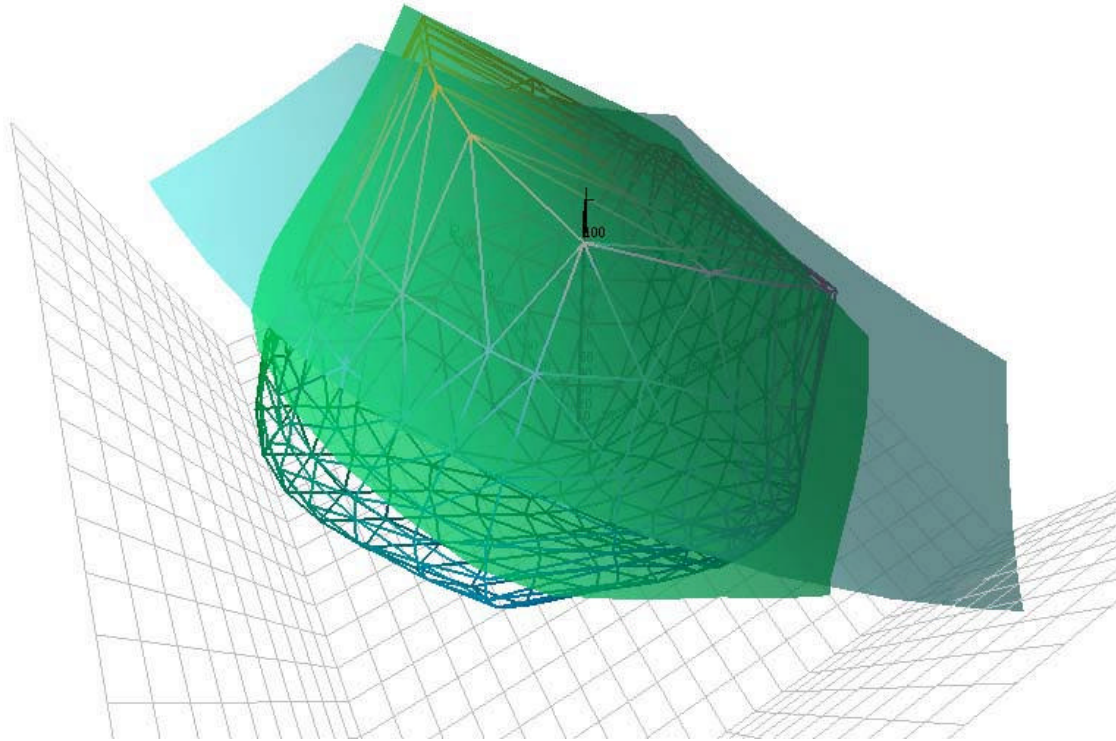
- Is defined to be the superset of 
 - gamuts of 20 representative ink jet printers
 - gamuts of a set of AgX media
- Considers
 - Pantone Colors

HP Perceptual Intent Reference Medium Gamut (yellow)



sRGB gamut after color re-rendering by the perceptual rendering intent of the new v4 ICC profile (colored wire frame)

More Gamut Comparisons (in CIELAB space)

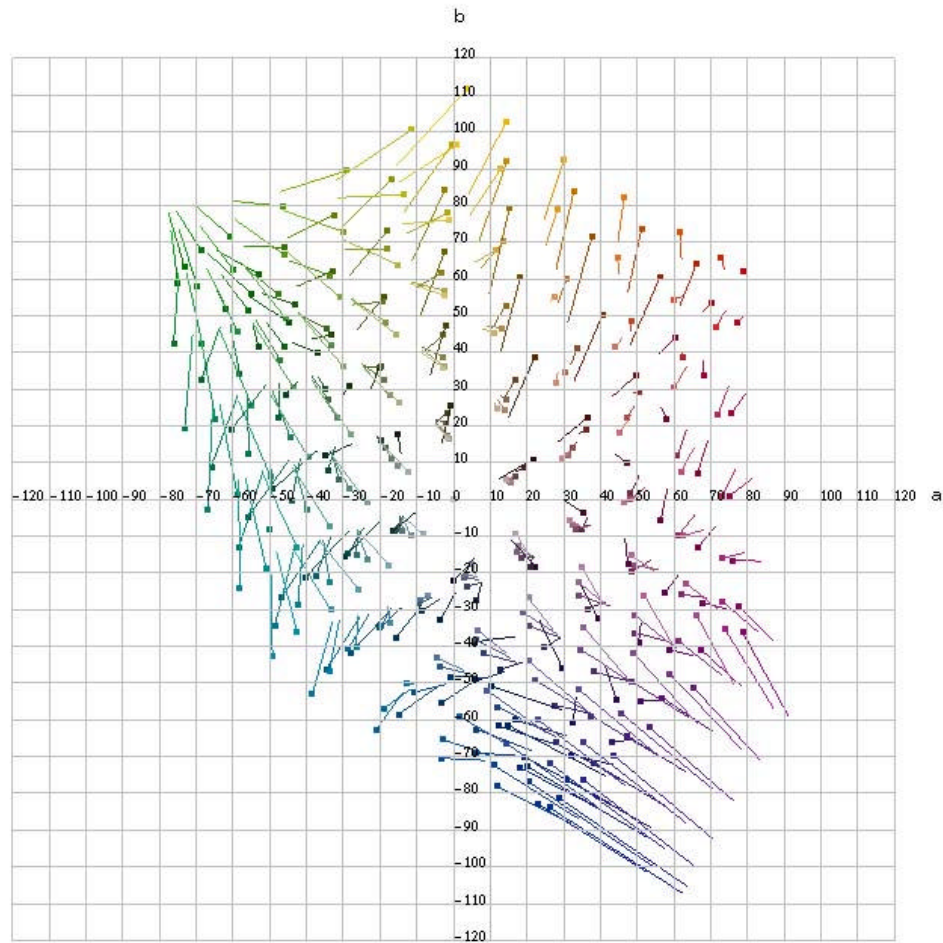


native sRGB color gamut (transparent cyan)

sRGB gamut after color re-rendering by the new v4 ICC profile (transparent green)

gamut of an HP ink jet printer (colored wire frame)

Colorimetric vs. Perceptual



Result of colorimetric rendering (starting points of lines) compared to the results of the perceptual rendering of the profile (ending squares) applied to regularly spaced RGB samples.

v4 sRGB Perceptual Rendering Intent



- Implementation
 - 33x33x33 3DLUT from sRGB to PCS (Lab)
 - 33x33x33 3DLUT from PCS (Lab) to sRGB
 - smooth
 - invertible
- Includes color re-rendering to HP proposed reference medium gamut.

v4 sRGB Relative Colorimetric Rendering Intent



- required to be measurement based, therefore
 - black point scaling is not incorporated into the data, but can be performed by the CMM if necessary
- Lab is used as the PCS instead of XYZ, which makes the transformations slightly more complicated
 - lutAtoBType and lutBtoAType tags were used with parametric curves (new structures defined in v4 of the ICC Specification)

Colorimetric Rendering Intent (Details)



- Implementation using lutAtoBType with parametric curves (sRGB -> Lab)

A curves -> 3D CLUT -> M curves -> M3x3+offset -> B curves

- A curves = invert sRGB non-linearity
- 3D CLUT = RGB linear to XYZ(D50) with Bradford chromatic adaptation
- M curves = non linear part of XYZ to Lab
- Matrix + offset = linear part of XYZ to Lab
- B curves = identity

Colorimetric Rendering Intent (Details)



- Implementation using lutBtoAType with parametric curves (Lab -> sRGB)

B curves -> M3x3+offset -> M curves -> 3D CLUT -> A curves

- B curves = linear scaling
- Matrix + offset = conversion to $X'Y'Z'$ (linear parts)
- M curves = non linear part of conversion to XYZ
- 3D CLUT = 3x3 matrix XYZ(D50) to RGB linear
- A curves = non-linearity to go to sRGB

Using the perceptual versus the colorimetric rendering intent of the sRGB v4 profile



- Applying the **perceptual rendering intent** to an sRGB image means that:
 - the image is re-rendered to the HP-proposed reference medium gamut
 - the PCS data is then in a print-referred state and as a consequence:
 - the output profile for a printer can be quite simple
 - in the case of a large gamut printer, the relative colorimetric intent may be sufficient
 - more consistency among different devices

Using the perceptual versus the colorimetric rendering intent of the sRGB v4 profile



- Applying the **colorimetric rendering intent** of the sRGB v4 profile means that:
 - the colorimetry of the original or reproduction are represented in the PCS
- This is useful for:
 - applications where a colorimetric reproduction is the goal
 - for proofing purposes
 - smart CMM
 - where color rendering from source to destination is performed by the CMM

Testing the Quality of the v4 sRGB Profile



- Print a large number of images using the perceptual intent of the v4 sRGB profile in combination with profiles of various output printing devices
 - skin tones, blue skies and green grass (memory colors)
 - sample images can be found in the proceedings
- Test the invertability of the profile by sending target patches and images forwards and backwards and comparing the final values with the original values
- Test smoothness of the tables by sending images with ramps/gradients through the profile

8-bit Accuracy Issues



- an sRGB gradient image containing the surfaces of an RGB cube was transformed into Lab using the PI v4 sRGB profile and then back to sRGB using the same profile
- if the operations were performed in 8-bit mode, blocking artifacts were found in certain regions
- the artifacts occurred with both Photoshop's CMM and our own Matlab CMM implementation
- in the 16-bit mode, the artifacts were gone

Future Steps



- The ISO and ICC need to agree on a particular reference medium gamut in order to insure true interoperability with input-side color re-rendering (in progress)
- Test the profile on a larger set of images, using different CMMs, and with different output printer profiles
- Generate true v4 perceptual rendering intent output profiles in order to test the full potential of v4 ICC color management

Conclusion



- Compared v2 and v4 ICC Specification
 - Enables Improved Interoperability
- HP Perceptual Intent Reference Medium Gamut Target
 - PI of the v4 sRGB ICC Profile
- Colorimetric Rendering Intent of the v4 sRGB profile
- Using the Perceptual vs. Colorimetric Rendering Intents
- Testing the Performance of the Profile
- Future Steps



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