

## W1.1 Image Quality of Printers

W1.1 2001 – 025

Color Rendition

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March 28, 2001

### Color Rendition Ad Hoc Group Teleconference Notes for 3/28/01

Present: Bob Cookingham, Eddy Dalal, Susan Farnand, Jason Gibson,  
and Karin Topfer

Next Teleconference: Wednesday April 11, 2001 @ 1:00 PM EST

#### Agenda for 3/28/01 Teleconference

1. Review of notes from 3/14/01 teleconference
2. Further discussion of color rendition sub-attributes including color fidelity and the issues concerning color preference
3. Thoughts by Karin and Bob on the comparison of classical and 3 integral and orthogonal color sub-attributes set
4. Eddy's thoughts on how pictorial and vector graphics differ in their color rendition aspects.

#### Proposed Agenda for 4/11/01 Teleconference

1. Review of notes from 3/28/01 teleconference
2. Further discussion of color rendition sub-attributes including color fidelity and the issues concerning color preference
3. Discussion of process for comparing classical and 3 integral and orthogonal color sub-attributes set
4. Discussion of items for discussion and/or presentation at meetings IS&T PICS-2001 meeting in Montreal

The majority of our discussion focused on the issues of color fidelity or color accuracy. We still have not arrived at a name that we are comfortable with that describes the attribute. We tried to pull the problem apart by considering how we might begin to quantify or measure color accuracy accounting for the impact of preference. Topics we touched on included weighting the importance of various colors and the impact of coordinated versus uncoordinated color errors on an overall accuracy metric.

We did agree that our test image/images would initially consist of **images** considered to have generally **pleasing** or **agreeable** color rendition. An example would be sRGB calibrated images in a standard space.

Jason suggested we all review the CIE Technical report entitled "Methods to Derive Colour Differences for Images" under consideration by CIE TC-8-02 prior to our next

teleconference. This report may provide some inspiration on ways to quantify color accuracy.

Bob and Karin shared their review of the “Correlation with classical color sub-attributes” for the three sub-attributes under consideration based on their experience. The table below includes shows that comparison.

<b>Classical Attribute</b>	<b>Color Fidelity</b>	<b>Color Scale</b>	<b>Color Quantization</b>
Tone scale		X	
Color balance	X		
Print lightness	X		
Colorfulness	X	X	
Loss of detail or blocking up of areas		X	
Memory colors	X		
Tonal clipping		X	
Color contouring			X
gamut	X	X	X

In this comparison an X indicates that the identified classical color attribute would be perceived in an evaluation of the identified rendition sub-attributes. We all agreed gamut should not be a sub-attribute and should not be considered. It was only included as an “what if” exercise to see what an often discussed characteristic of printers that would not make a good sub-attribute would look like.

## Proposal for three integral and orthogonal Color Rendition sub-attributes

Color Fidelity	Definition	<ul style="list-style-type: none"> <li>• The ability to match colors where needed</li> <li>• Colors look correct</li> <li>• Does not necessarily imply matching to an original or target print but can include matching to target colors.</li> </ul>
	Correlation with classical color sub-attributes	<ul style="list-style-type: none"> <li>• This attribute would include hue accuracy (really, lightness and chroma accuracy as well), color balance, and memory color reproduction</li> </ul>
	Examples (Appearance of sub-attribute in images)	<ul style="list-style-type: none"> <li>• Skintones, grass, sky look realistic</li> <li>• Image is not too saturated or too washed out or too dark, etc.</li> <li>• Image looks natural, color rendition meets expectations</li> <li>• Are there enough colors and are they reproduced to give a natural looking image</li> <li>• Color match a target image</li> </ul>
	Physical measurement, test target	<ul style="list-style-type: none"> <li>• Patch target for color fidelity measurement.</li> <li>• Colorimetry of a selection of neutral and color patches including memory and other important colors</li> <li>• Combine something like <math>[\sum (w_i \cdot \Delta E_i)^2]^{-1/2}</math></li> <li>• Skin, sky and foliage are measured against the digital image colorimetric values</li> </ul>
Color Scale	Definition	<ul style="list-style-type: none"> <li>• The ability to distinguish colors where needed</li> <li>• Colors that should be perceived as separate are distinguishable.</li> </ul>
	Correlation with classical color sub-attributes	<ul style="list-style-type: none"> <li>• This attribute would include tone scale (lightness), hue "scale", and color saturation (chroma)</li> <li>• The equivalent of "tone scale", but extended to cover C* and h in addition to L*.</li> </ul>
	Examples (Appearance of sub-attribute in images)	<ul style="list-style-type: none"> <li>• Distinguish between dark colors to avoid blocked shadows</li> <li>• Distinguish between light or pale colors to avoid blown highlights</li> <li>• Adequate separation of colors to provide contrast, etc.</li> <li>• Are there enough colors and are they distinct where they should be</li> <li>• Contrast, color saturation, tone scale detail in light and dark colors, detail in saturated colors, ability to distinguish hues</li> </ul>
	Physical measurement, test target	<ul style="list-style-type: none"> <li>• RGBCMYK printed, also maybe skin tone sweeps, and the delta E calculated from a digital scan of the sweep. Minimum steps would have to be defined such that anything less would result colors that are blocked, etc.</li> </ul>
Color Quantization	Definition	<ul style="list-style-type: none"> <li>• The ability to merge colors where needed</li> <li>• Colors that should be perceived as smoothly varying are free of contouring</li> </ul>
	Correlation with classical color sub-attributes	<ul style="list-style-type: none"> <li>• This attribute would include contouring</li> </ul>
	Examples (Appearance of sub-attribute in images)	<ul style="list-style-type: none"> <li>• Shading in faces or sky is free of contours</li> <li>• Adjacent steps in smooth sweeps are not perceptually distinguishable</li> <li>• Contours on smooth gradients (human faces, sky, differentially lit backgrounds, walls etc.</li> </ul>
	Physical measurement, test target	<ul style="list-style-type: none"> <li>• RGBCMYK printed, also maybe skin tone sweeps, and the delta E calculated from a digital scan of the sweep. Maximum steps would have to be defined such that anything greater would result in contouring.</li> <li>• Lightness and chroma gradients at different hues, could be 2D sheets or simulated 3D objects.</li> </ul>