

W1.1 Image Quality of Printers

W1.1 2001 – 052

Color Rendition

R. E. Cookingham

October 10, 2001

Color Rendition Ad Hoc Group Teleconference Notes 10/10/01

Present: Bob Cookingham, Eddy Dalal, Susan Farnand, Bill Kress, and Karin Topfer

Next Teleconference: Wednesday October 24 @ 1:00 PM EST

Agenda for 10/10/01 Teleconference

1. Continued discussion of "Color Rendition Perceptual Attributes and Definitions"
2. Discussion of test target considerations
3. Subsequent teleconferences (proposed 2nd and 4th Wednesdays 1 to 2 PM EST in

Notes of Teleconference

1. Continued discussion of "Color Rendition Perceptual Attributes and Definitions"

After brief consideration, there was general agreement that we were comfortable for the moment with the sub-attribute definitions and examples of how attributes would manifest themselves in images

2. Discussion of test target considerations

As a way to move into the discussion of test targets, the color quantization sub-attribute was chosen for consideration first. See the red text in the document below for agreed upon concepts and items for consideration, "thinkng about", for the 10/24 meeting.

3. Subsequent teleconferences (proposed 2nd and 4th Wednesdays 1 to 2 PM EST in Oct and Nov (10/24, 11/14, and 11/28)

Working draft below of
“Color Rendition Perceptual Attributes and Definitions”

Color sub-attributes and definitions:

1. Color Fidelity
 - Colors look correct
 - Does not necessarily imply matching to an original or target print
2. Color Scale
 - Colors that should be perceived as separate are distinguishable
3. Color Quantization
 - Colors that should be perceived as smoothly varying are free of contouring

Examples of attribute appearance in images:

1. Color Fidelity
 - Image looks real, natural, or reasonable
 - Skintones, grass, sky look real and natural (pictorial images only)
 - Image is not too saturated or too washed out or too dark, etc.
 - This attribute would include hue, lightness, and chroma accuracy, color balance, and memory color reproduction
 - Logos are accurate (text and graphical images only)
2. Color Scale
 - Distinguish between dark colors to avoid blocked shadows (pictorial images only)
 - Distinguish between light or pale colors to avoid blown highlights (pictorial images only)
 - Adequate separation of colors to provide contrast in pictorial images and distinguishability in graphics.
 - Are there enough colors and are they distinct where they should be
 - The equivalent of "tone scale", but extended to cover C^* and h in addition to L^*
3. Color Quantization
 - Freedom from contouring in smooth sweeps (human faces, sky, differentially lit backgrounds, walls, etc. in pictorial images or vignettes, fades, or gradated backgrounds, etc. in graphical images)

Test target considerations:

1. Color Fidelity

- Patch target for color fidelity measurement.
- Colorimetry of a selection of neutral and color patches including memory and other important colors
- Combine something like $[\sum (w_i \cdot \Delta E_i)^2]^{-1/2}$
- Skin, sky and foliage are measured against the digital image colorimetric values
This section needs significant work

2. Color Scale

- 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.
(Concern that this would actually work)

3. Color Quantization

- Target to consist of obliquely oriented neutral, magenta, cyan, skin, and sky sweeps. Yellow is not included as a sweep because of the low sensitivity of the human visual system (HVS) to yellow. Sweeps of sky and skin will incorporate combinations of primary colors in sweeps.

Think about the slope of the sweeps – and possible interaction with the human visual system (HVS) – should the sweep be longer or shorter depending on whether the HVS is more or less sensitive for a sweep in lightness, hue, or chroma as a function of frequency? Also consider hue variation sweeps as well – e.g., R to G through neutral. This could also include out of gamut colors

Think about whether sweeps should sweep in lightness or chroma or a combination of lightness and chroma?

Think about how we handle out of gamut colors. There was general agreement that how well a printer handles out of gamut color is a function of printer capability and is an item on which printers will perform differently and will produce images of higher or lower quality. This is something we would want to capture as a difference among printers.

- Target evaluation would consist of
 - = a digital scan along the sweep
 - ◆ Measurements will be made in reflectance not in L^* or density.
 - = apply a “virtual slit” perpendicular to the sweep direction and one pixel wide
 - = frequency filter (e.g. cut off low frequency) — TBD
 - = apply HVS based criteria — TBD
 - = frequency filter (e.g. cut off low frequency) — TBD

- Metrics (or predictors of objectionability) are TBD; however, they are expected to be determined in:
 - = frequency adjusted space domain
 - or
 - = frequency domain