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ISO-CIE trend for Color Output of equally spaced Color Series and Elementary Hues *RJGB* on Displays for Eight Ambient Reflections of ISO 9241-306:2008

The report CIE R1-47:2009 ”Hue Angles of Elementary Colours” recommends the CIELAB hue angles h_{ab} = 26, 92, 162, and 272 degrees for the elementary colors Red *R*, Yellow *J*, Green *G*, and Blue *B*. These hue angles are identical to the CIELAB hue angles of the CIE test colours no. 9 to 12 which are defined in CIE 13.3 to specify colour rendering properties of light sources.

Based on a request of ISO TC 159/SC4/WG2 ”Ergonomic - Visual Display Requirements”, CIE Division 1 ”Vision and Colour” decided in 2008 a reportership by *Thorstein Seim (Norway)* to produce the report CIE R1-47. For the *rgb*-input data 100, 110, 010, and 001 this report allows to produce the four elementary hues *RJGB* and any intermediate hue on any colour device.

The device independent hue output of the four elementary colours *RJGB* compared to the six device colours *OLYLCVM* (colour names according to ISO/IEC 15775) is shown for a standard offset process *(ORS18a)*, a standard *CRT* monitor *(TLS00)*, a photo printer *(PRS06a)* and the Swedish *NCS* system *(NRS11a)* for CIE standard illuminant D65 in the *PDF* file
http://www.ps.bam.de/De43/10L/L43e00NP.PDF

For example for the standard offset process *(ORS18a)* the device color Violet blue *V* with the *rgb*-input value 001 has the CIELAB hue angle 305 degree. The color of this hue angle appears very reddish compared to the elementary colour with the hue angle of 272 degree. The elementary hue *B* can be mixed approximately by equal amounts of the neighboring colours *V* and *C* or by the basic offset colours *C* and *M* of the ratio 3:1. ISO TC 159/SC4/WG2 requests to produce the elementary hue *B* instead of the device hue *V* on any colour device.

There are large changes of the scaling of achromatic colours by ambient light reflections on any display. ISO 9241-306 defines eight reflections 0, 1.25, 2.5, 5, 10, 20, and 40% compared to the white display surround. The 40% reflection appears for example if a data projector is used in a daylight office and the luminance of the projector and the daylight are equal on the display screen. In this case about 4 dark grey steps of a visually equally spaced 16-step grey scale appear equal and black. In application instead of the gamma value of about 2,4 a value of approximately 1,1 shall be used to make the 16 steps visible and to make a visually equally spaced 16 step grey scale. Similar changes appear for colour scales. For the changes of many 9-step colour scales for both 0% and 40% reflection, see the pages 1 and 2 of the PDF file
http://web.me.com/klaus.richter/JE08/JE08L0NP.PDF

The CIELAB gamut of the output colors is reduced by about a factor 0,3 in any of the three directions *L*, a*,* and *b**. According to CIE 165, Table 2 the *sRGB* colour spaces fills only 20% of the fixed CIELAB color coding space with the range 0 to 255 for *L** and -128 to 127 for *a** and *b**. For the above worse condition the output colors fill only 0.06% (=20x0.3x0.3x0.3%) of the CIELAB coding space. Colour management according to ISO 15076-1 (and ICC) is therefore not useful for the 8 ISO cases of display output. In other words the quantization error may be equal or larger as the CIELAB differences to be produced in the output. A proposed Technical Report of ISO TC 159/SC4/WG2 avoids this problem by using the *relative* elementary *RGB** color space in the fixed coding range between 0 and 1 for any display. This output increases the efficiency by a factor up to 150. Therefore for display output an improved color management is necessary which may use the coordinates of the device independent human *Profile Connection Space RGB** instead of *LAB** (CIELAB). Within the framework of ICC colour management an *RGB Profile Connection Space* is already defined but not used up to now.
A new German standard series DIN 33872-1 to -6 (in print) specifies the output properties of printers and displays. Equally spaced visual output for equally spaced *rgb*-input color data and elementary hue output according to CIE R1-47 is recommended, see many DIN-test charts at
http://www.ps.bam.de/33872E