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There are only a few topics that give raise to so much debate as the choice of the right illuminant. Contrary to the TV-, paper or textile industry, which are using D65 as the reference illuminant, the printing industry is seeming to go its own way. This article explains the background for that decision and discusses the consequence of a thinkable change toward D65.

Why the printing industry is not using D65?

The importance of the correct viewing conditions

The illumination plays a vital part when assessing colours between an original and a reproduction. Here both the spectral power distribution of the pertinent light source [over the visual wavelength ranging typically from 380 nm to 730 nm] and the state of visual adaptation determine the resulting colour appearance. The latter is basically governed by the entire field of view and most strongly by the immediate surround extending the objects to be appraised. Based on the principle transmission or reflection properties of the samples to be evaluated there are basically two different types of viewing conditions: Viewing transmissive media and viewing reflective media.

Typical transmissive objects are photographic transparencies while colour reflection artwork as well as reproductions such as proofs or production prints [press sheets] are typical candidates for hardcopy material. In the light of internationally agreed upon [standardized] way of colour appraisal, e.g. for image and colour quality evaluation or critical comparison of prints and transparencies, a common set of defined viewing condition parameters is strongly required. One of them is the reference spectral power distribution which plays also a vital part in other important processes such as data preparation [e. g. via ICC Colour Management] or colour measurement.

Fig. 1: Identical hardcopy prints under three different light sources [left: office illumination – „ Cool white fluorescent", middle: daylight simulator D50 according ISO 3664 [1], right: tungsten source].

Note: It should be noted that the current means of reproduction are metameric. That means they are restricted [adjusted] to achieve a visual match under one illuminant and one set of viewing conditions. Only modern multispectral methods and workflows aim for an illuminant and observer independent reproduction [2]. With nowadays [metameric] workflows any departures from the stringent use of one illuminant might cause visual differences and therefore customer complains. A distinct example is given in Fig. 1.

The quest for the right colour temperature

The current practice of colour appraisal is marked by a significant decline of transmissive media to be used as typical originals. The direct comparison of such transmissive media [e.g. slides] against the printed reproductions was the main reason for internationally agreeing on the warm white CIE D50 daylight illuminant in 1974 [ISO 3664:1974] [3]. That consensus was the result of important compromised which will be explained in the following section.

Photographic transparencies are mostly balanced in a way to exhibit a neutral colour appearance when illuminated by a tungsten projection lamp. Those kind of light source usually having a correlated colour temperature [CCT] ranging from 2800 K to 4000 K. The correlated colour temperature is the temperature of the Planckian radiator whose perceived colour most closely resembles that of a given stimulus at the same brightness and under specified viewing conditions. For that reason such a "CCT-range" was a reasonable choice for typical viewing application. Contrary to transmissive media a viewing apparatus was not necessary for judging press sheets or proofs. Therefore it was common to assess the prints at the north side of the building which resembles a natural daylight phase to some extend. Anyhow it is known that phase of natural daylight are far from being constant; they vary dramatically with local and temporal changes. Typical daylight phases have been defined by the CIE [CIE - Commission Internationale de l'Eclairage], see Fig. 2. They are characterized by their correlated colour temperature such as D50, D65 or D75.

It should be noted here that a light source refers to the physical photon emitter while the illuminant refers to tabulated data. Because it is very difficult to produce artificial light sources of illumination, which closely match the spectral power distribution of CIE daylight phases, it is important that the light sources used in the pertinent viewing cabinets [daylight simulators] show conformance to the criteria stipulated in ISO 3664 [1].

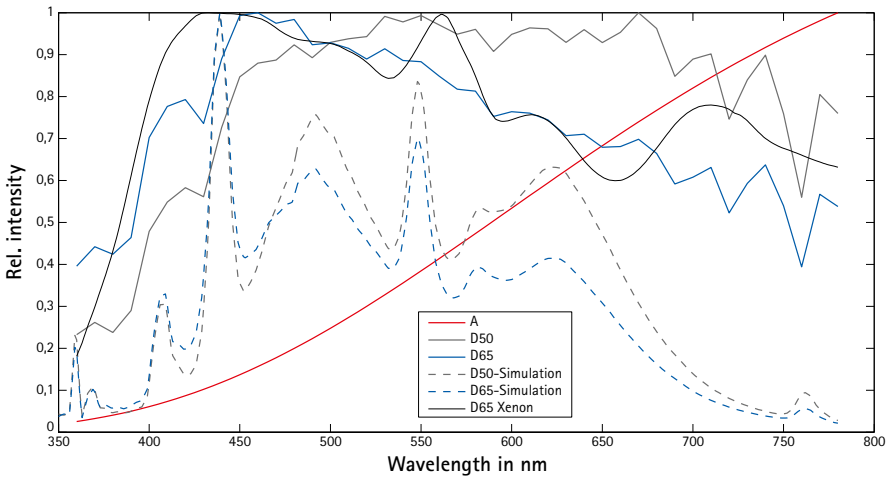

Fig. 2: CIE-daylight phases [solid line], simulators using discharge lamps [dashed line] and simulator using a xenon lamp.

The paramount reason for using daylight is, that it is usually perceived to be more neutral compared to objects illuminated by tungsten light sources. In addition a higher contrast is perceived using daylight illumination especially for colours absorbing in the blue spectral region such as yellows. A direct comparison between D50 and D65 with respect to the maximum colour differences between the adjacent tone values shows slight advantages using D50 for cyan and magenta colours. The differences for other colours have been found to be not significantly different from each other. In that experiment spectral reflectance curves of the primary and secondary offset colours have been facilitated by means of the CIE1976 and CIEDE2000 colour difference between tone values that differ about 1 %.

Having this scenario of two different correlated colour temperatures [approx. 3000 K [4] for transparencies and aprox. 6500 K for prints [5]] the compromise was reached by agreeing on an average colour temperature of 5000 K. This was necessary since the visual adaptation of the eye needs a stable reference [6]; a direct comparison [short term memory matching] of two images with different "white points" causes significantly different perceptions [7][8].

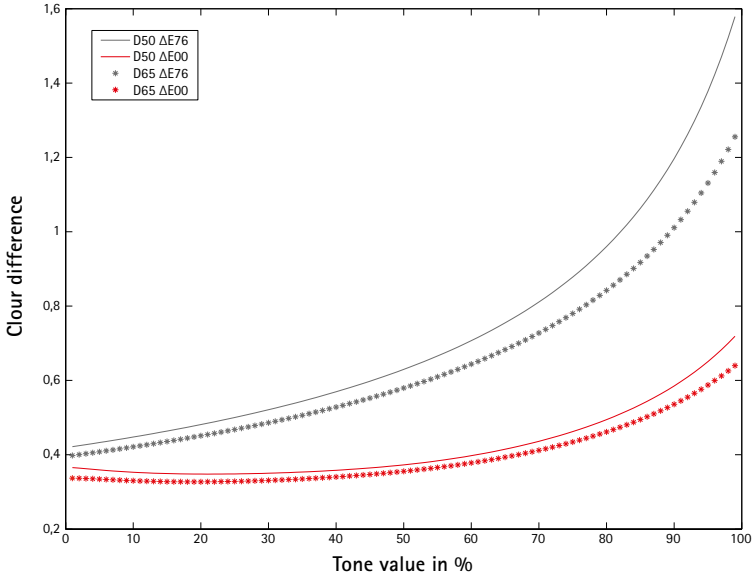

Fig. 3: Higher differentiation with D50 compared to D65 for a cyan-ramp [visualized as colour differences between adjacent tone values].

Though print shops weren't forced to install two different types of lamps in their prepress and press rooms. The already mentioned industry branches such as the textile or automotive industry weren't faced with those compromises and have been working with D65 for years.

So why not change to D65 when there are no transmissive media anymore?

In the light of the decline of transmissive media in prepress work the before mentioned compromised looses it's justification. A potential change toward D65 as the reference illuminant for the printing industry must be seen with caution. This is due to a plethora of consequences that will be outlined exemplary here:

- Extensive investments will be required for the established viewing apparatuses
- Revisions will be necessary for ISO standards with respect to aim values
- Modification of established documentation base [best practices, quality management documents, guidelines, characterization data, spec sheets etc]
- Enormous effort for communication and seminars needed
- More problems when matching samples with less [e.g. proof] and high amount of optical brighteners agents since the higher amount of UV leads to a higher excitation.

Giving those reasons a hasty change toward D65 can't be recommend. Interestingly a current study [9] shows, that the average colour temperature for indoor lighting is about 4700 K, and therefore even below of D50. Anyhow, in order to evaluate potential advantages of using D65 in the graphic arts, e.g. for softproofing applications, Fogra will study necessary experiments within a coming research project concerning the quality of viewing apparatuses.

Literature

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Please note:

Fogra Colour Management Symposium

Munich, 25/26 February 2010

The symposium will address the following topics:

- Preflight and [variable] data preparation in hybrid workflows
- [Soft] Proofing beyond Paper and CMYK
- Automatic Color Transformations
- Colour Management for [digital] packaging applications
- Future applications [multispectral imaging]

Keynote: Leonard Rosenthol [Adobe]

Discussion: Template and Platform Provider [TPP] - the future of prepress?

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FograCert Softproofing System

More and more prepess and printing houses use high-quality softproofing systems to either complement their hard copy proofing systems or to introduce its early creative work. In some cases the softproof already supersedes hard-copy-proofs. Therefore the demand for objective and vendor neutral assessment of those high-end softproofing systems is steadily increasing. Fogra has introduced the new FograCert Softproofing Creation to meet these demands. The FograCert Softproofing System allows the manufacturers to prove the high quality of their solutions, while giving guidance and certainty to the end user when choosing a system.

The FograCert Softproofing System specifies requirements for a complete Softproofing System which is intended to achieve a high quality visual match between a display and a reference [typically defined by a printing condition]. Visual characteristics further includes provisions for testing uniformity, profile accuracy, gamut and colorimetric accuracy. This metrology is the result of a research project [Fogra no. 10.047 "Setup and evaluation of a softproof working station"] that will be published at the end of 2009.

Tests

Pretest [once per construction type]:

Monitor
- ¬ Gamut
- ¬ Uniformity
- ¬ Viewing Cone

Viewing cabinet

We check your softproofing system with respect too:

Display Driving
- ¬ Uniformity
- ¬ Target Gradation [Gamma]
- ¬ Smoothness
- ¬ Profile Accuracy
- ¬ max. Contrast ratio
- ¬ Gamut

Simulation
- ¬ Contrast ratio
- ¬ Correlated Colour Temperature [CCT]
- ¬ Luminance
- ¬ Gray balance
- ¬ Colorimetric accuracy

Visual assesment [informative only]
- ¬ Smoothness
- ¬ White point
- ¬ Comparison of softproof to reference print

Duration of the test:
1 day at the vendors premise, written report after 3 weeks [Pre-Test of viewing cabinet and monitors separate]

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Ideen eine Zukunft geben