Aktuelle Forschungsthemen in der CIE
PD Dr.-Ing. habil. Peter Bodrogi

DIN-Workshop Farbnormung
Würzburg, 6. Oktober 2015

TECHNISCHE UNIVERSITÄT DARMSTADT

FACHGEBIET LICHTTECHNIK

Technical Committes and Reporterships

CIE Division 8: Imaging Technology

CIE Division 1: Vision and Colour

FGLT

Arbeiten in der Division 8: Imaging Technology

Year Established: 2004   **Chair:** Masahiro Yamaguchi (JP)

Terms of Reference:
To study, develop and recommend encoding techniques and data formats for the exchange of multispectral images, and to provide test procedures for the evaluation of multispectral imaging systems.

The technical report describes the basic model of multispectral imaging technology followed by the requirements and the examples of multispectral image formats suitable for colour imaging applications. Four example formats: JPEG2000, Spectral Binary File Format, Natural Vision, and Multispectral image file format AIX, are introduced and compared in typical use cases. The specifications of those formats except for JPEG2000 are provided in the Appendix.

CIE TC 8-09: Archival Colour Imaging
Bildgebende Verfahren für die Archivierung

- TC 8-09: Archival Colour Imaging, Robert Buckley (US)
- Terms of reference:

 "To recommend a set of techniques for the accurate capture, encoding and long-term preservation of colour descriptions of digital images that are either born digital or the result of digitizing 2D static physical objects, including documents, maps, photographic materials and paintings."

CIE TC 8-10: Office Lighting for Imaging
Bürobeleuchtung für die bildgebenden Technologien

- TC 8-10: Office Lighting for Imaging, Yasuki Yamauchi (JP), 2005
- It was proposed to close CIE TC 8-10, moving this activity into a new reportership. The main activity of collecting the data has been completed. So Yasuki Yamauchi proposed a reporship, R8-13, about Office Lighting for Imaging, with this terms of reference: To publish a Technical Note on the spectral power distribution and illumination levels used to view images in office lighting conditions, collected through the activity of TC8-10.

CIE TC 8-11: CIECAM02 Mathematics

- TC 8-11: CIECAM02 Mathematics, Changjun Li (CN), 2007

CIE TC 8-12: Image and Video Compression Assessment (Bewertung der Bild- bzw. Videokompression)

- TC8-12: Image and Video Compression Assessment, Christine Fernandez-Maloigne (FR), 2007

- A draft Technical Report has been submitted. It was proposed to finalize the Technical Report in 2016.

- In this report we give a state of the art of the most used quality metrics with some comments regarding their advantages and disadvantages and their suitability for a particular type of application. We differentiate quality metric with or without reference and with reduced reference. We will give some ideas for video quality assessment, generally based upon the evaluation of static scenes. But we begin by the description of the different databases that can be helpful to test all these metrics.

CIE TC 8-14 Specification of Spatio-Chromatic Complexity (Beschreibung der räumlichen und farbigen Komplexität von farbigen Texturen)

- TC8-14 Specification of Spatio-Chromatic Complexity, Noël Richard (FR), 2015

- Terms of reference: "To produce a state-of-the-art report on the existing definitions of the complexity notion related to the aspect of non-uniform surfaces, generally defined as textured. To combine these definitions in order to produce a single definition embedding both spatial and chromatic variations in a generic and vector form."

CIE R 8-09: Output Linearization Methods for Display and Printers

- R 8-09: Output Linearization Methods for Display and Printers
  - Vortrag: Prof. Klaus Richter

CIE R 8-10: Full-Reference Image Quality Metrics: Classification and Evaluation (Qualität von Farbbildern)

- R 8-10: Full-Reference Image Quality Metrics: Classification and Evaluation, Marius Pedersen (NO), 2012

CIE R 8-11: Colour Image Reproduction for 3D Reproduktion von Farbbildern in 3D

- R 8-11: Colour Image Reproduction for 3D, Kaida Xiao (GB), 2013
- Kaido Xiao presented the work of R 8-11 Printing, the outline, the technology limits and the plans for the future.

CIE R 8-12: Multi-view Image/Video Colour Data Format Conversion and Quality

- R 8-12: Multi-view Image/Video Colour Data Format Conversion and Quality, Hezerul Abdul Karim (MY), 2013

CIE R 8-13: Common colour appearance Unveränderte Farberscheinung

- R8-13: Common colour appearance, Craig Revie (GB), 2015

- A new CIE TC, TC 8-15 Common colour appearance was proposed in order to investigate the concept of common colour appearance (psychophysical and quantitative assessment; identify key elements underlying the concept ; define a metric or set of metrics to quantify). Many questions were asked by the attendees.

- "Common colour appearance" is defined as follows: images and pages should look the same across any media; print, web, mobile, broadcast etc. (Source: Paul Sherfield).

- In printing, there are the many different processes: offset litho, gravure, screen process, flexographic, and the myriad digital printing technologies

- They need their images, pages, brand colours and logos to look the same across all of these printing processes .

New Reportership: CIE R 8-15, A survey on Quality Metrics on Stereoscopic Imaging
Qualitätsmetriken für die stereoskopische Bildgebung

- New Reportership: R8-15, A survey on Quality Metrics on Stereoscopic Imaging, by Christine Fernandez-Maloigne (FR), Jesus Jaime Moreno (MX) and Alessandro Rizzi (IT)

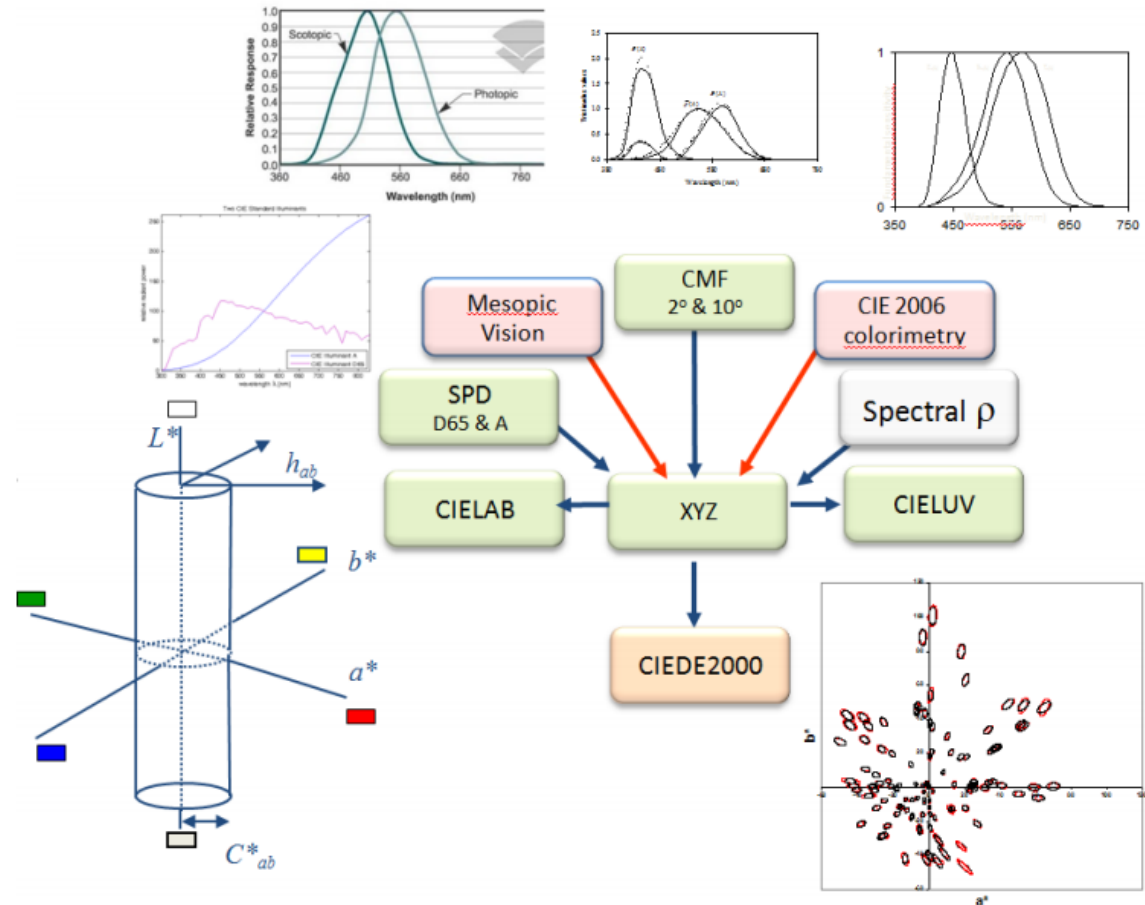# Arbeiten in der Division 1: Vision and Colour

CIE Division 1's Strategy

Source: Minutes of the 8th Meeting of the Luo Term in Manchester, 30 June 2015

1. CIE Colorimetry
- CIE Publication 15 revision
- ISO/CIE colorimetry series
- SPD, Observers, XYZ, CIELAB, CIELUV, CIEDE2000
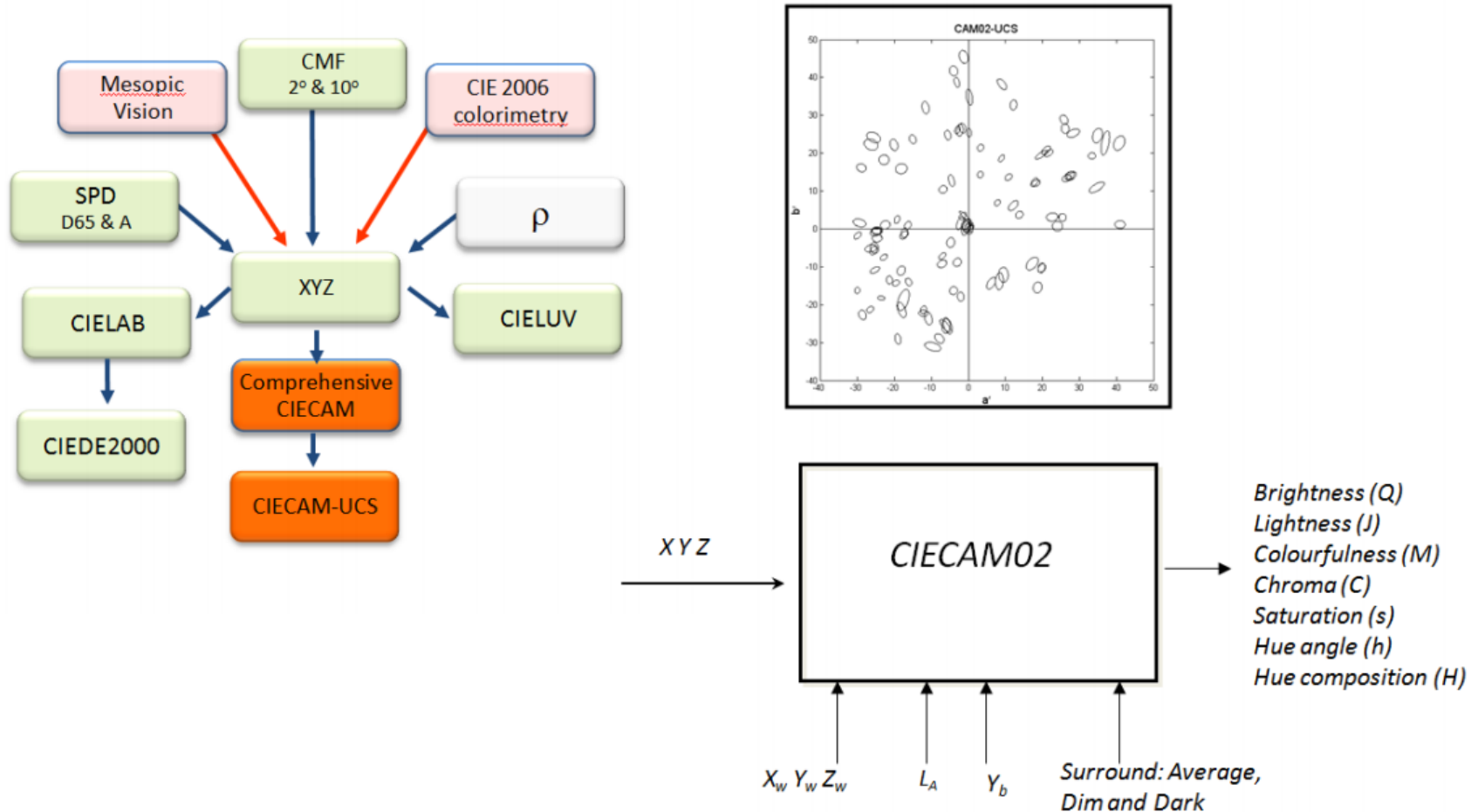- CIE 2006 Colorimetry
- CIE Mesopic Vision

Allumfassendes Farberscheinungsmodell

2. Comprehensive Colour Appearance Model
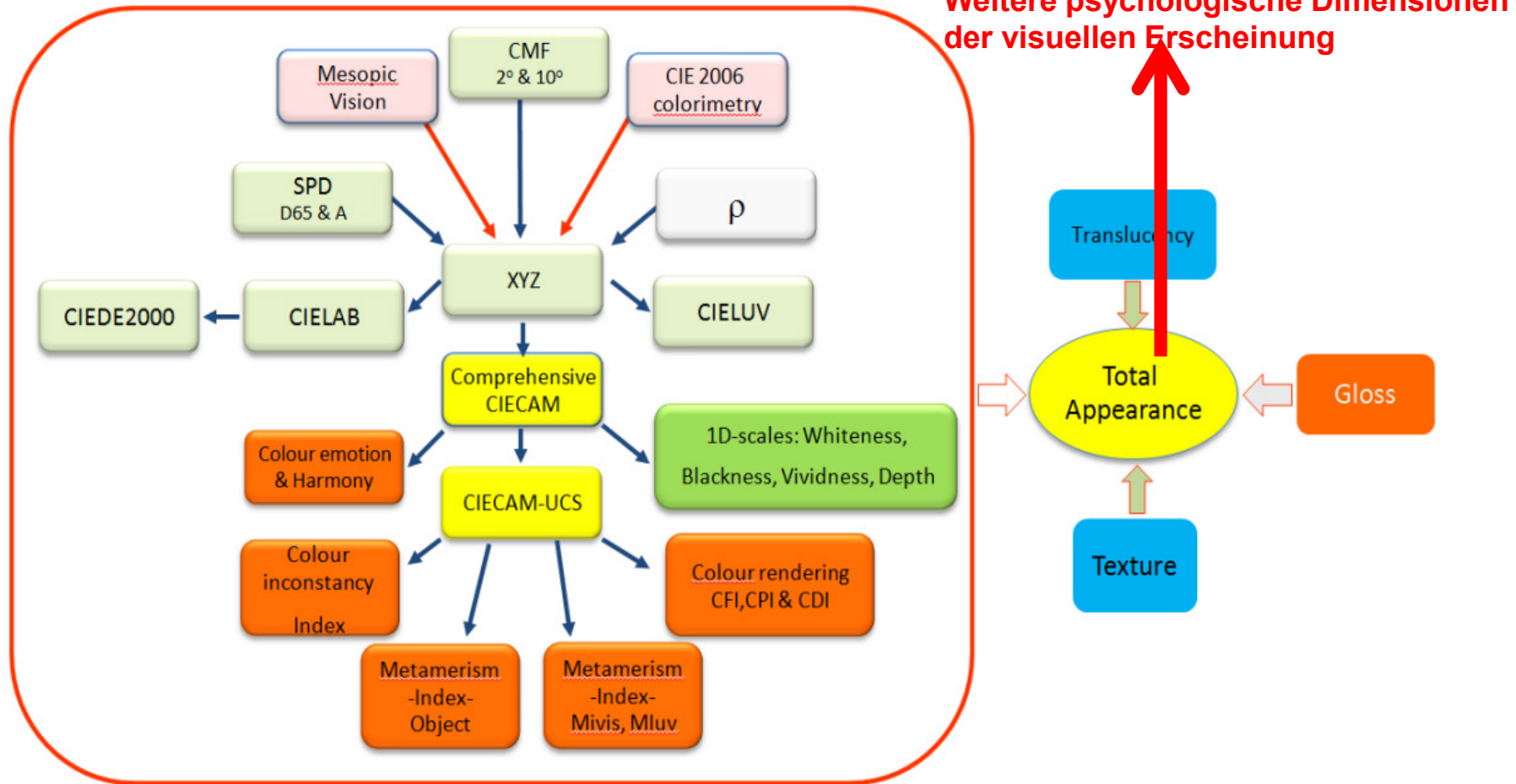
Source: Minutes of the 8th Meeting of the Luo Term in Manchester, 30 June 2015

Vision der Division 1 für die Zukunft

3. D1 Roadmap – The Future

Weitere psychologische Dimensionen der visuellen Erscheinung

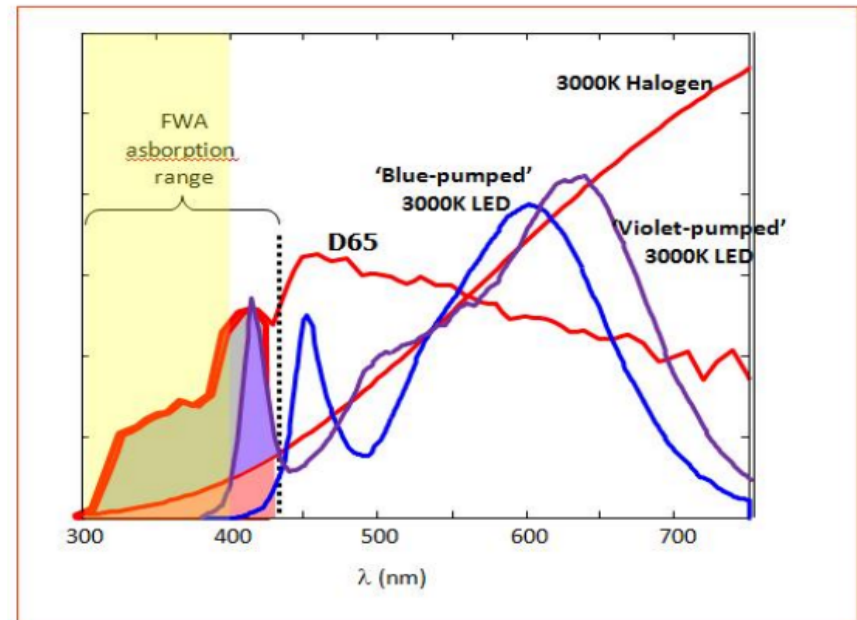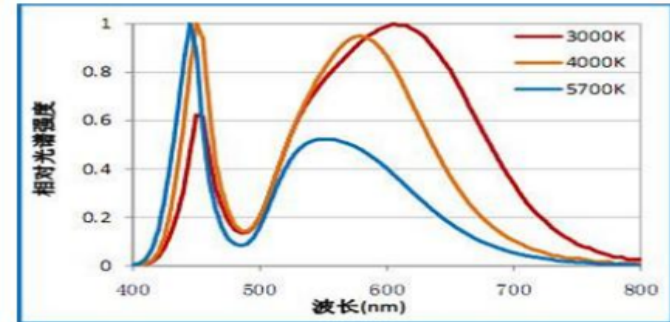Source: Minutes of the 8th Meeting of the Luo Term in Manchester, 30 June 2015

4. **Important Tasks**

Ongoing:

- CIE 2006 colorimetry
- Mesopic vision
- Comprehensive CIECAM
- Colour rendering (CRI + CPI)

New:

- Standard LED illuminant
- White perception locus
- Whiteness index for LED lights
- Whiteness for object colours
- LED daylight simulator

FGLT

Arbeit in den TCs der Division 1:
TCs 1-36, 1-82, 1-83

TC1-36 Fundamental Chromaticity Diagram with Physiologically Significant Axes:

Françoise Viénot FR   **Neue, netzhaut-orientierte Farbtafel**

Part II of the Technical Report is now with the Central Bureau for production and publication.

TC1-82 The Calculation of Colour Matching Functions as a Function of Age and Field Size:

Jan Henrik Wold NO   **Farbwertfunktionen als Funktion des Alters und der Sehfeldgröße**

A TC meeting was held in Manchester.

TC1-83 Visual Aspects of Time-Modulated Lighting Systems: Dragan Sekulovski NL

A TC meeting was held in Manchester.   **Visuelle Aspekte zeitmodulierter Beleuchtungssysteme**

Why do we exist?
- Influence of time modulated light on perception, LED.
- Definitions, basic quantification procedures.

CIE TCs 1-84 (Visual Field for Conspicuity), 1-88: Scene Brightness; 1-89: Enhancement of Images for Colour Defective Observers

TC1-84 Definition of the Visual Field for Conspicuity: Nana Itoh JP

Activity from last year **Auffälligkeit von Objekten in verschiedenen Sehfeldbereichen**

1. The contents of the
    "Guideline of how to consider visual fields function to increase the visibility of visual information"
2. First draft of TR was sent to TC members on 26 June 2015.
3. A TC meeting was held in Manchester.

TC1-88 Scene Brightness Estimation: Yoshiki Nakamura JP

No report received. A **Visuelle Bewertung der Helligkeitswahrnehmung von ganzen Szenen**

TC1-89 Enhancement of Images for Colour Defective Observers : Po-Chieh Hung JP

5. Enhancement technique
    5.1. Classification
    5.2. Re-col **Bildverarbeitung für farbfehlsichtige Beobachter**
        5.2.1. Optimization-based and projection-based techniques
        5.2.2. Exact compensation of color-weakness with discrimination threshold matching
        5.2.3. Image enhancement based on Hue-Rotation (HR) / Hue-Blending (HB) methods
        5.2.4. An efficient naturalness-preserving image-re-coloring method for dichromats
        5.2.5. Image enhancement methods based on the p/d-safe colour palette
        5.2.6. Real-time temporal-coherent color contrast enhancement for dichromats
    5.3. Edge enhancement
        5.3.1. Border enhancement

CIE TC1-93: Self-Luminous Neutral Scale

TC1-93 Calculation of Self-luminous Neutral Scale: Robert Carter US

Grauskala für Selbstleuchter

The TC has three sub-tasks:

1. Recommend a formula or computational method…e.g., based on the following Table.
2. Show that the formula works for self-luminous color difference calculation.
3. Clarify (and perhaps standardize) the meaning of "neutral" in the self-luminous context of this TC.

CIE JTC-1: Implementation of CIE 191: Mesopic Photometry in Outdoor Lighting

JOINT TECHNICAL COMMITTEES – VISION: Miyoshi Ayama

JTC-1   Implementation of CIE 191: Mesopic Photometry in Outdoor Lighting: Stuart Mucklejohn GB

Terms of Reference

Working Group 1: To investigate adaptation and viewing conditions and define visual adaptation fields in outdoor lighting.
Chair Tatsukiyo Uchida JP

Working Group 2: To define lighting applications where mesopic photometry could be used. To provide guidelines for implementing mesopic photometry in outdoor lighting.
Chair Stuart Mucklejohn GB

Umsetzung der mesopischen Photometrie für die Außenbeleuchtung

CIE JTC-7: Discomfort Glare from Luminaires…

JTC-7   Discomfort Caused by Glare from Luminaires with a Non-Unif0rm Source Illuminance:

Co-chairmen: Naoya Hara JP (D3), Miyoshi Ayama JP (D1)

Terms of Reference:

1. To review the literature on glare from non-uniform light sources to identify the parameters that influence the discomfort prediction (UGR) and define limits to the applicability of the UGR formula.
2. To propose a correction to the UGR formula that takes into account the non-uniformity of glare sources.

Psychologische Blendung von räumlich inhomogenen Leuchten bzw. Lichtquellen

CIE TC 1-55 (Uniform Colour Space for Industrial Colour-Difference Evaluation)

TC1-55 Uniform Colour Space for Industrial Colour-Difference Evaluation: Manuel Melgosa ES

A Technical Report has been approved by the TC members and will be submitted to the Central Bureau immediately following the CIE Session meeting.

Title: ... ...ae.

Summ... ...n visually-perceived colour differences in a given set of colour pairs and their corresponding predictions made by a colour-difference formula. This method is based on the Standardized Residual Sum of Squares (STRESS) index used in multidimensional scaling, and tests if two colour-difference formulae are or are not statistically significantly different. The same index can be also used to compute intra- and inter-observer variability in visual experiments. Beside important advances made in the field of colour-difference evaluation using reliable visual datasets currently available, the results achieved from the STRESS index indicate that it is not possible to recommend a more uniform colour space with a Euclidean colour-difference formula that is statistically significantly better than CIEDE2000.

Wahrnehmungsgemäß gleichabständiger Farbraum für die Bewertung von Farbdifferenzen in der Industrie

CIE TC 1-63 (Validity of the Range of CIEDE2000); 1-64: Terminology

TC1-63 Validity of the Range of CIEDE2000: Klaus Richter DE

Gültigkeitsbereich von CIEDE2000

The TC chairman requested that the Terms of Reference be changed to read:

> To investigate the application of the CIEDE2000 equation ~~at threshold, and to~~ <u>for</u> CIELAB color differences greater than 5 units.

This change of Terms of Reference was approved unanimously.

TC1-64 Terminology for Vision, Colour and Appearance: Sharon McFadden CA

The fourth draft of the Technical Note (TN) has been reviewed by members and, based on the

Terminologie für Sehen, Farbe und Erscheinung

to the

be

Submitted for final approval and publication.

The work of this TC will now be covered by a new JTC Terminology in Light and Lighting.

CIE TC 1-71 (tristimulus integration), 1-73 (real colour gamut)

TC1-71 Tristimulus Integration: Changjun Li CN

What we have done:

Yea **Integrationsmethoden für die Berechnung der Farbwerte** values

n methods

TC1-73: Real Colour Gamut: Changjun Li CN

What we have done:

Realer Farbgamut

- Made a comprehensive literature survey

Year 3-Year 4 (2010-2012)

- Accumulated a database of calculation methods and suitable 1 nm spectral data.

TC1-75 A Comprehensive Model of Colour Appearance: M. Ronnier Luo GB

Work Plan:

Year 1, 2: Conduct a literature survey and collect available components and data

Year ~~...~~ **Allumfassendes Modell für die Beschreibung** ~~...~~odel

Year ~~...~~ **der Farberscheinung** ~~...~~nge of

~~...~~viewing conditions~~...~~

Year 7, 8: Publish the proposed comprehensive model for general testing using new experimental data – this might lead to refinements of the model

Year 9, 10: Agree on a comprehensive colour appearance model and write as CIE Technical Report presenting a recommendation

TC1-77 Improvement of the CIE Whiteness and Tint Equations: Robert Hirschler HU

Publications and Research:

1. **Verbesserung der Voraussage des** ~~...~~ the TC

   Weißheitsgrades

Aurelien David, Michael R. Krames and Kevin W. Houser: Whiteness metric for light sources of arbitrary color temperatures: proposal and application to light-emitting-diodes. OPTICS EXPRESS 21, No. 14, 2013

CIE TCs 1-81 (small colour differences), 1-85 (Update CIE Publ. Colorimetry)

TC1-81 Validity of Formulae for Predicting Small Colour Differences: Klaus Richter DE

A TC meeting was held in Manchester.

Agreement on the content of the TC1-81 Report was reached during monthly WebEx meetings in 20... ...cludes the foll...

Gültigkeit der Formeln für die Voraussage von kleinen Farbunterschieden

For small CIELAB colour differences <=2 the performance is calculated between the visual evaluations and the colour differences for the five colour difference formulae CIELAB, CMC, CIE94, CIEDE2000, and LABJND. These formulae are also used in the report of TC1-63 for large CIELAB colour differences >5. Both reports use the STRESS values (recommended in the report of CIE TC1-55) without and with a Power Function (PF) correction of the calculated colour differences of these formulae.

TC1-85 Update CIE Publication 15:2004 Colorimetry: Janos Schanda HU

In early 2015 the Chairman, Janos Schanda asked Mike Pointer for help with the editing of this report; it w... ...r 2015 fron... ...addition

Die CIE-Publikation Farbmetrik aktualisieren

some decisions need to be made, for example about the inclusion of typical LED spectral power distributions, and also on the status of the many comments in the text. Mike Pointer felt that a new TC Chairman should be found who was a member of the TC – he was not – so that the decisions could be made with the benefit of the knowledge of previous discussions within the TC. Ellen Carter has agreed to take on this role with Mike Pointer's editorial support. Draft 11 should be ready during the summer of 2015 and it is to be hoped that this version will receive committee approval.

CIE TC 1-86: Models of Colour Emotion and Harmony

TC1-86 Models of Colour Emotion and Harmony: Li-Chen Ou TW

A TC meeting was held in Manchester.

Current Progress:

- **Modelle für die durch Farben hervorgerufene** om 10 countries,
- **Gefühle bzw. Farbharmonie-Modelle** n and the UK.

ountries,

including Argentina, China, Hungary, Iran, Spain, Taiwan and Thailand.

New models of color emotion:

Warm/cool:

$$WC = -0.89 + 0.052\, C_{ab}^*[\cos(h_{ab} - 50°) + 0.16\cos(2h_{ab} - 350°)]$$

Heavy/light:

$$HL = 3.8 - 0.07L^*$$

Active/passive:

$$AP = -3.4 + 0.067\{(L^* - 50)^2 + 1.93(a^* + 1)^2 + 1.05(b^* - 9)^2\}^{\frac{1}{2}}$$

CIE TC 1-90 Colour Fidelity Index

TC1-90 Colour Fidelity Index: Hirohisa Yaguchi JP

Meetings:

Farbtreue-Index   C1-90

April 2013, Paris:	1st meeting
July 2013, Leeds:	2nd meeting
March 2014, Kuala Lumpur:	3rd meeting
June 2014, Gaithersburg:	4th meeting
July 2015, Manchester:	5th meeting
March 2016, Melbourne:	6th meeting (tentative)

Work Plan:
- To gather reliable experimental data assessing color fidelity.
- To analyze the data by proposed color fidelity indices.
- To write a report to propose the new CIE CFI.
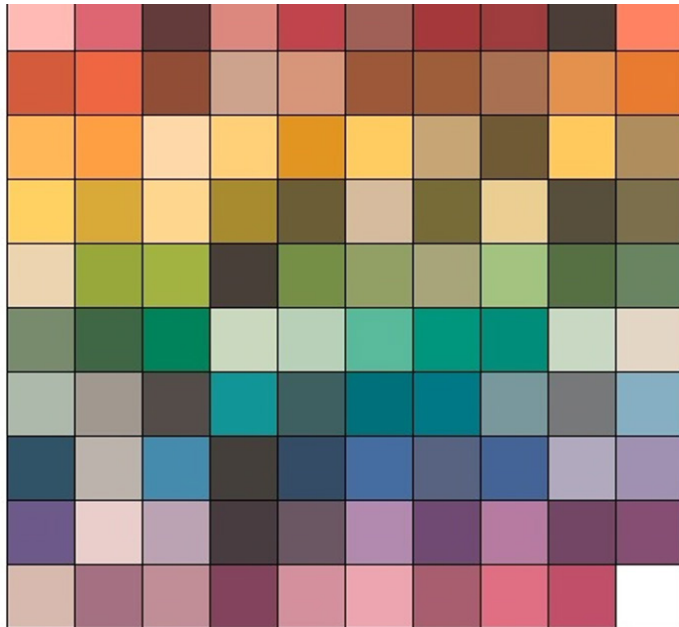
CIE TC 1-90 Colour Fidelity Index

Figure 1. The proposed 99 test samples plus white

Eigenschaften:

1. CAM02UCS-Farbraum
2. 99 neue Farbmuster
3. keine negativen Werte von R_a und R_i
4. Kontinuierlicher, linearer Übergang von der Planck-Strahler-Referenz zur Tageslichtreferenz zw. 4500 K - 5500K
5. Vereinbarkeit der neuen Indexwerte mit den früheren CRI-Werten

CIE TC1-91: New Methods for Evaluating the Colour Quality of White-Light Sources

- TC1-91 New Methods for Evaluating the Colour Quality of White-Light Sources: Yandan Lin CN

- A draft technical report has been written and updated to include 5 indices: CQS, FCI, MCRI, HRI.

Danke für Ihre Aufmerksamkeit