



COMMISSION INTERNATIONALE DE L'ECLAIRAGE
INTERNATIONAL COMMISSION ON ILLUMINATION
INTERNATIONALE BELEUCHTUNGSKOMMISSION

ACTIVITY REPORT

DIVISION 1

VISION AND COLOR

January 2008

Director: Prof. Ronnier Luo (GB)

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This report presents an overview of the status of CIE Division 1 - Vision and Color since the last Activity Report that was issued in January 2007.

The annual meeting of Division 1 was held as part of the CIE Quadrennial Meeting, on Tuesday, 10 June 2007 in Beijing, China. The meeting was attended by 5 Division officers, representatives of 19 of the 37 member countries, 20 TC chairs and reporters, and about 30 guests.

The following Technical Committees met in Beijing:

TC1-42 Colour Appearance in Peripheral Vision

TC1-44 Practical Sources for Daylight Colorimetry

TC1-56 Improved Colour Matching functions

TC1-58 Visual Performance in the Mesopic range

TC1-61 Categorical Colour Identification

TC1-63 Validity of the Range of CIEDE2000

TC1-65 Visual Appearance Measurement

TC1-68 Effect of Stimulus Size on Colour Appearance

TC1-69 Colour Rendering of White Light Sources

A summary of the status of each of the committees in Division 1 - Vision and Color is included in this report. The Reporterships and Liaison activities of Division 1 are also included. The order is first all the technical committees and reporterships of the Vision Section are presented. Then the technical committees and reporterships of the Color Section are presented. Next the Liaison reports are included. Finally, the recent publications are listed.

VISION SECTION

Active Technical Committees

TC1-30 (V) Luminous Efficiency Functions

Year Established: 1990

Terms of Reference:

To prepare a Technical Report on luminous efficiency functions which classifies and specifies the existing functions $V_{b,\text{point}}(\lambda)$, $V(\lambda)$, $V_{b,2}(\lambda)$, $V_M(\lambda)$ and $V_{b,10}(\lambda)$, and the color matching function $\bar{y}_{10}(\lambda)$ if appropriate, in their photometric use.

Chairman: Y Nakano JP

Members: M Ikeda JP, P K Kaiser CA, JA Kinney US, S Kokoschka DE, P Trezona GB, K Sagawa JP, H Yaguchi JP, F Viénot FR

Report:

This committee was closed at the Beijing meeting of 2007 with the work being transferred to a new reportership, R1-45.

TC1-36 (V) Fundamental Chromaticity Diagram with Physiologically Significant Axes

Year Established: 1991

Terms of Reference:

To establish a chromaticity diagram of which the coordinates correspond to physiologically significant axes.

Chairman: F Viénot FR

Members: D MacLeod US, JD Mollon GB, JD Moreland GB, Y Nakano JP, J Pokorny US, LT Sharpe DE, A Stockman US, A Valberg NO, PL Walraven NL, J Wold NO

Consultants: H Scheibner DE, P Trezona GB, and H Yaguchi JP

Working Program:

Write a report with a clear statement on the choice of a set of color-matching functions and estimates of cone fundamentals for the normal observer. The committee will take into account the variability among normal and dichromatic observers.

1. Agreement should be reached on the following points:
 - a. Choice of a set of color-matching functions and evaluation of the consequence of this choice, compared to other possibilities.
 - b. Accordance with the 1988 $V_M(\lambda)$ luminous efficiency function.

- c. Data on ocular media and macular pigment.
 - d. Use of Konig fundamentals. (Identity of the copunctal points with the fundamentals.)
 - e. None or little participation of S cones to luminance. If any, evaluation of the luminance discrepancy between a constant (L+M) diagram and a constant-luminance diagram.
2. Establish a chromaticity diagram.
 3. Prospect the construction of a color space with significant axes. Basic stimuli and scaling of the axes should be discussed. Reference the literature where such color spaces are used in order to list the topics relevant to this color space.

Report:

Following the publication of part 1 of the report in 2006, TC 1-36 is preparing a draft for part 2 that includes

Chapter 6: Photometric aspects; the choice of the $V_{2,F}(\lambda)$ and the $V_{10,F}(\lambda)$ -sensitivity curves

Chapter 7: Development of 3-dimensional colour space/2-dimensional chromaticity diagram

The TC is facing some difficulty in the choice of the appropriate $V(\lambda)$ function which should be a linear combination of the L-cone fundamental and the M-cone fundamental sensitivity functions. The weights of the functions are not obvious. Mail is being exchanged between members of the TC.

TC1-37 (V) Supplementary System of Photometry

Year Established: 1992

Terms of Reference:

To recommend a system of photometry to assess lights in terms of their comparative brightness relationships at any level.

Chairman: K Sagawa JP

Members: S Ashizawa JP, WB Cowan CA, CM Howard US, M Ikeda JP, JAS Kinney US, S Kokoschka DE, Y Nakano JP, T Takeuchi JP, PW Trezona GB, F Viénot FR, H Yaguchi JP, and A Yujiri JP. Also, HJ Schmidt-Clausen DE (Observer).

Working Program:

1. To list items on which photometric systems based on brightness matching are evaluated, such as the reference stimulus, linkage to the current CIE photometric and colorimetric systems, practical simplicity and the physiological basis of the system structure, etc. The numerical testing results from TC1-21 are to be included.
2. To evaluate the proposed systems according the items listed above.
3. To find a system for recommendation by selection from the proposed systems, or by some combination of them.
4. To prepare a report on the recommendation of a supplementary system of photometry.

Report:

A technical report is currently under preparation. The report will be submitted to Division 1 by the next D1 meeting in Sweden.

TC1-41 (V) Extension of $V_M(\lambda)$ Beyond 830 nm

Year Established: 1993

Terms of Reference:

To write a report on the feasibility of the extension of $V_M(\lambda)$ beyond 830 nm, including modification of $V_M(\lambda)$ in the 660-780 nm region of the spectrum.

Chairman: PL Walraven NL

Members: DH Sliney US and JJ Vos NL

Report:

No progress has been made since the last report.

TC 1-42 (V) Color Appearance in Peripheral Vision

Year Established: 1993

Terms of Reference:

To prepare a technical report on color appearance zones for colored lights in terms of unique hues in peripheral vision.

Chairman: M Ayama JP

Members: I Abramov US, M Ayama JP, H Chan US, G Derefeldt SE, L Eriksson SE, L MacDonald GB, K Okajima JP, A Yujiri JP

Report:

The committee had a meeting at the CIE Meeting on July 9, 2007, held in Beijing, China. In the meeting, Ayama presented the contents of a Technical Report and the writer(s) for each chapter were confirmed. The first draft of the report will be submitted to Division 1 by the next D1 meeting in Sweden.

TC1-54 (V) Age-Related Change of Visual Responses

Year Established: 1999

Terms of Reference:

To establish luminous efficiency, visual acuity, and contrast sensitivity as a function of age.

Chairman: K Sagawa JP

Members: H Bouma (NL), L Halonen (FI), W Iwai(JP), J Werner (UA), Donald Kline (CA), Anna Szucs (HU)

Working Program:

1. To survey relevant data in the literature and ongoing studies as well for establishing data bases for the age-related change in spectral luminous efficiency, visual acuity, and contrast sensitivity functions.
2. To establish fundamental data bases for those functions as a function of age.
3. Write a report with those databases.

Report:

A report entitled “Lighting and Visibility Guidelines for Older Persons and Persons with Disabilities – CIE Guidelines for Accessibility” was drafted as a result of collaborative work between a CIE BA Ad-hoc Group and TC1-54. The data collected in the TC were included in the draft version of the guidelines. The draft has been distributed to the members for review. Division 3 established TC3-44 “Lighting for the Elderly” and has been collaborating with this work and also reviewing the draft. The final draft of the guidelines will be completed during 2008.

TC1- 58 (V) Visual Performance in the Mesopic Range

Year Established: 2000

Terms of Reference:

To define mesopic visual performance and related terms.

To investigate performance based photometry in the luminance region below approximately 10 cd/m².

To propose a model for the basis of performance based mesopic photometry.

Chairman: L Halonen FI

Members: M Eloholma FI (Secretary). W Aiqun CN, M Ayama JP, P Bodrogi HU, EC Burini Jr BR, DL Crawford US, O da Pos IT, C Dahua CN, G Derefeldt SE, T Goodman GB, N Itoh JP, CS Kim KR, C Knight, L Leetzow, US, I Lewin US, M Nicholson GB, J Richards US, K Sagawa JP, J Schanda HU, F Viénot FR, S Völker DE, L Yandan CN, E Yandek GB

Report:

A meeting of this TC took place in the Netherlands on November 2007 to consider a working draft of the technical report.

TC1-60 (V) Contrast Sensitivity Function (CSF) for Detection and Discrimination

Year Established: 2001

Terms of Reference:

1. To specify a baseline achromatic CSF with its reference conditions and reference observer
2. To specify CSF extensions based on discrimination thresholds, as well as chromatic CSFs for both detection and discrimination.

Chairman: E. Martinez-Uriegas ES

Members: D Alleyson FR, M. Artigas Verdes ES, C-C Chen US, M Fairchild US, RV Klassen US, L MacDonald GB, S McFadden CA, Chaker Larabi FR, E Peli US, AB Watson, S Wuerger HU, H Yaguchi JP.

Observers: L Beke, MH Brill US, D Couzin US, P Hanselaer BE, N Itoh JP, O da Pos IT, K Richter DE, K Sagawa JP

Report:

Updated tasks, assignments, and status are as follows:

- Introduction/philosophy of the approach of the technical report.
Beau Watson (s), Mark Fairchild (s), Eli Peli (s), Eugenio Martinez-Uriegas
Status: Under discussion
- Search for data and conditions: Sharon McFadden, Chaker Larabi, David Alleysson (s), Jose M. Artigas (s), Chein-Chung Chen (s)
Status: Ongoing
- Preparing tables of data and conditions: Sharon McFadden, Lindsay McDonald (s), Hirohisa Yaguchi (s), Sophie Wuerger (s)
Status: Ongoing
- Combining data sets – analysis and review of data: Victor Klassen, Beau Watson (s), Eli Peli (s), Thom Carney (s)
Status: Ongoing
- Set up new Web tool for TC1-60 workspace (eRoom was dismantled for spending cuts policies). Eugenio Martinez-Uriegas
Status: Ongoing
- Combine all inputs to update and circulate our technical report draft: Eugenio Martinez-Uriegas
Status: Ongoing

This year we have received reviews and data updates from Victor Klassen, Chen Chien-Chung, Sophie Werger, and Lindsay MacDonald.

We are currently working on integration of contributions in the 3rd (hopefully final) Draft of TC1-60 Technical Report.

TC1-67 (V) The Effects of Dynamic and Stereo Visual Images on Human Health

Year Established: 2005

Terms of Reference:

To write a technical report on the physiological and psychophysical effects of dynamic and stereo visual images in terms of photosensitive seizures, visually induced motion sickness and eyestrain.

Chairman: H Ujike JP

Members: Members are being sought.

Report:

A presentation was given at the Beijing meeting in July 2007.

Vision Reporters

R1-19 (V) Specification on Individual Variation in Heterochromatic Brightness Matching: H Yaguchi JP

Year Established: 1997

Terms of Reference:

To report on the possibility to develop a simple test of individual characteristics for heterochromatic brightness matching.

Report:

The reporter has surveyed papers on heterochromatic brightness matching in terms of individual difference and examined the possibility to develop a simple test of individual characteristics for heterochromatic brightness matching. A report has been sent to the Division Director. Various factors of individual differences in brightness sensation are discussed including the optical density of the ocular media in eye, the physiological mechanism of brightness and the psychological attitudes of the observers. Experimental data of the spectral luminous efficiency functions for brightness from 18 papers are surveyed and reviewed in terms of the individual difference. The possibility to develop a simple test of individual characteristics for heterochromatic brightness matching is discussed. The chapters of the report are as follows:

Ch.1. Introduction

Ch.2. Datasets of heterochromatic brightness matching for photopic luminance level

2.1 Spectral color

2.2 Non-spectral color

Ch.3. Analysis of datasets

Ch.4. Models for heterochromatic brightness matching

Ch.5. Specification on individual variation in heterochromatic brightness matching

It was suggested that this report might be published in the CIE Collection, in which case two independent reviewers are required.

R1-23 (V) Guidelines on Planning a Mesopic Photometry Investigation:

P Trezona GB

Year Established: 1999

Terms of Reference:

With several new mesopic photometry investigations being contemplated, the impact of theory of other considerations on the experimental design will be reported.

Report:

No update.

R1-35 (V) Irregularities in $\bar{y}_{10}(\lambda)$: P Walraven NL

Year Established: 2004

Terms of Reference:

To document the irregularities in $\bar{y}_{10}(\lambda)$ and, if necessary, to recommend the formation of a Technical Committee to consider possible modifications.

Report:

No progress has been made since the last report.

R1-36 (V) Action Spectra for Glare: J Fekete HU

Year Established: 2004

Terms of Reference:

To summarize the literature on the subject and make recommendation for terms of reference for a technical committee.

Report:**Introduction**

One of the special feats of human vision is the ability to see well in lighting that ranges from moonlight to bright sunlight: almost a thousand-million-fold change in light level. It is no wonder that the eye remains past compare by any physical detector of light in yielding appropriate vision over a range that bridges about nine units on a logarithmic scale.

As humans obtain approximately 90% of information by means of visual perception, good visibility is particularly important when driving a motor vehicle. Poor visibility conditions result in a lack of information for drivers.

Night-time driving is a situation that takes place under changing mesopic conditions. Vehicle headlamps illuminate a small part of the visual field, and the headlamps of approaching vehicles modulate the state of adaptation of the driver continuously in a very unpredictable way, as well as causing glare for the driver.

The present report summarizes literature data (in 2007) on interrelationship between visibility and produced glare.

Papers presented during the past year

During the last ten years gas discharge (HID) lamps became popular. These HID headlamps provide visual benefits, chiefly due to their increased light output. Recently, spectrally-tuned high intensity discharge (HID) sources were introduced for use in vehicle forward lighting systems. One study dealt with this subject and has shown that spectrally-tuned HID sources can result in a decreased proportion of short-wavelength content toward oncoming drivers that can reduce discomfort, but will not impact disability glare equal illuminance at the eye. This study has also shown that spectrally-tuned HID sources can result in increased illumination and increased short-wavelength content that can reliably improve peripheral visibility measured through target detection.

Comfort and visibility characteristics of spectrally-tuned high intensity discharge lighting system

J. V. Derlofske^{*}, J. D. Bullough^{**}, Ch. Gribbin^{**}

^{*}3M Optical System Division Building, USA, ^{**}Lighting Research Center, Rensselaer Polytechnic Institute, USA

Some authors put a question: Are there any correlations between individual brightness efficiency and glare? In their attempt they found that chromatic type observers are likely to be more sensitive to glare than the others.

Study on glare of LED lamp and individual variations of brightness perception

Takako Kimura-Minoda^{*}, Yudai Fujita^{**}, Shinichi Kojima^{*}, Miyoshi Ayama^{**}

^{*}Stanley Electric Co. Ltd., ^{**}Utsunomiya University

7th International Symposium on Automotive Lighting, Darmstadt, Germany, September 25-26, 2007.

There are very few investigations on best spectrum for mesopic visibility and even less data on the spectrum of discomfort glare. Some authors have studied these two perceptions and came to the conclusion, that it is not enough to optimise for the combined photopic and scotopic luminosity functions but the chromatic components have to be taken into consideration too. They tried to determine optimum SPD for providing good visibility and low glare in mesopic conditions.

Optimizing spectral power distribution of car headlamp lighting

J. Fekete^{*}, G. Várady^{**}, C. Sik-Lányi^{***}, J. Schanda^{***}

^{*}University of Pécs Faculty of Health Sciences, Hungary, ^{**}University of Pécs, Pollack Mihály Faculty of Engineering, Hungary, ^{***}University of Pannonia, Hungary
CIE 26th Session, Beijing 4-9 July 2007. 56-59. p.

Visibility and glare at mesopic light levels

J. Fekete^{*}, G. Várady^{**}, C. Sik-Lányi^{***}, J. Schanda^{***}

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Conf. Iluminat 2007, Cluj-Napoca-Kolozsvár, 31 May – 1 June 2007.

Spectral power distribution optimization of headlights

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Lux et Color Vespremiensis, Veszprém, 2007. október 19.

Some articles have given a short overview about actual results on mesopic vision and the consequences for new installation of road lighting. These articles have shown it is indisputable that white light has psychological and physiological benefits and they therefore recommend it. On the other hand one has to realize that a decrease of light level leads to an increase in threshold contrast for foveal objects. Therefore it is necessary to consider a concrete situation and with the help of luminance pictures to decide whether the street illumination should be changed or not.

With this knowledge and the recommended measurement techniques a reply can be given to the question of whether all sodium lamps should be replaced by lamps with white light in the public lighting.

Mesopic vision – Should we replace all sodium lamps by lamps with white light in our public lighting?

S. Völker

In Proceedings CIE Congress 2007 Beijing

Do light sources with a high part of shorter wavelength promote safety?

S. Völker

In Proceedings ISAL 2007, 24-26. September, Darmstadt

R1-37 (V) Definition of the Visual Field for Conspicuity: N Itoh JP

Year Established: 2004

Terms of Reference: To summarize the literature on the Visual Field for conspicuity and make a recommendation for terms of reference for a Technical Committee.

Report:

The previous studies of various functions of visual field now have been investigated. Those visual fields were analyzed and classified into several functional fields such as: (1) Detection and Perception, (2) Discrimination, (3) Recognition, (4) Performance/Behavior. A part of the revised report was presented at the Division 1 meeting in Beijing, China. The work is ongoing for a full report now.

R1-38 (V) Concept and Application of Equivalent Luminance: Y. Nakano JP

Year Established: 2005

Terms of Reference:

The reporter is to prepare a report addressing this topic.

Report:

This reportship was formed when TC 1-46 was closed during the meeting of Division 1 in León Spain in May 2005, however, there has been no update since that time.

R1-40 (V) Scene Dynamic Range: J. Holm US

Year Established: 2006

To investigate the concept of scene dynamic range, the appearance of colors brighter than the adapted white, and adaptation to the dynamic range when viewing, and make recommendations regarding work to be done by the CIE.

Report:

Having spent some time looking into this issue, it seems clear that there has been little research performed in this area and not much is known. Speculating, the causes for this may be the need for difficult psychophysical experiments and the difficulty of generating or characterizing appropriate test scenes. It is fairly clear that for experiments to be meaningful natural test scenes must be used, as the adapted white may vary locally and adaptation to it and dynamic range could be affected by cognitive effects.

I do not have recommendations at this time for specific work, but I have been continuing to investigate the characteristics of natural scenes captured using digital cameras. While these cameras do not employ color matching function sensitivities it is possible to get reasonably accurate colorimetry estimates for most objects. Arguably the biggest issue is flare correction, which can have a significant effect on the measured dynamic range. Not only is flare locally varying, but in some cases digital cameras and raw processing applications appear to include some flare subtraction with the dark current subtraction, so even if flare correction is not explicitly performed when creating colorimetry estimates it may be included to some extent. This makes the determination of how much additional flare correction to apply scene, camera and software specific.

It seems to me that if it is possible to use digital camera captures of natural scenes to measure the scene colorimetry with sufficient accuracy, then subjective experiments could be performed where observers viewing from the camera location estimate the adapted white (possibly at various places in a scene) and then scale above-white colors.

It would also be useful to have a better understanding of scene dynamic range distributions, adapted white estimation and above-white color statistics, although that work would be more relevant to Division 8.

My current plan is to continue to acquire scene-referred images and collect scene statistics, possibly including comparisons of dynamic range estimates made using different cameras and software. There are also other notable efforts in this area, including work in ICC to support scene-referred images using ICC profiles, the new ISO 12640-5 (standard scene-referred images) work in ISO TC130, and the collection of HDR scene-referred images created by Mark Fairchild (<http://www.cis.rit.edu/fairchild/HDR.html>). I hope to have more to report for the Division 1 meeting this summer.

R1-43 (V) Standard Deviate Observer: B. Oicherman GB

Year Established: 2007

Report:

A literature survey is in progress.

R1-44 (V) Limits of Normal Colour Vision: S. McFadden US

Year Established: 2007

Terms of Reference:

To review the literature to see what information is available to establish the limits of normal colour vision.

Report:

I have collected a substantive number of papers on colour deficiency. In addition, I have also made contact with some people working in the area of colour vision standards. I anticipate that I will be able to have a report prepared by the 2008 meeting of Division 1.

R1-45 (V) Luminous Efficiency Functions: Y. Nakano JP

Year Established: 2007

Report:

No report.

COLOR SECTION

Active Technical Committees

TC1-27 (C) Specification of Color Appearance for Reflective Media and Self-Luminous Display Comparison

Year Established: 1990

Terms of Reference:

To study and make recommendations for the specification of a color appearance match between a reflective image and a self-luminous display image.

Chairman: PJ Alessi US

Members: TF Chong HK, G Derefeldt SE, MD Fairchild US, T Fuchida JP, AR Hanson GB, M Ikeda JP, E Khoury FR, V Kojtcheva BU, MR Luo GB, D Rich US, K Richter DE, AR Robertson CA, T Suzuki JP, J Walraven NL.

Consultants: RWG Hunt GB, Y Nayatani JP, MR Pointer GB.

Working Program:

1. Investigate whether the CIELUV and CIELAB color spaces adequately specify a color appearance match between a reflective image and a self-luminous display image.
2. Investigate whether modifications to the CIELUV and CIELAB equations (such as white point color stimulus specification) would be adequate to specify a color appearance match between a reflective image and a self-luminous display image.
3. Investigate the use of the Hunt and Nayatani color appearance models to specify a color appearance between a reflective image and a self-luminous display image.

Report:

The Chairman is working on the Technical Report and hopes to have it completed by the June 2008 meeting.

TC1-44 (C) Practical Daylight Sources for Colorimetry

Year Established: 1995

Terms of Reference:

1. To compare existing daylight simulators for color measuring instruments and colour matching booths.
2. On the basis of this intercomparison, to recommend practical methods for simulating daylight sources.

Chairman: R. Hirschler HU

Members: A Bristow SE, P Chong US, W Czepluch DE, H Fairman US, R Harold US, D Hinks US, R Hunt GB, T Ichijo JP, T Kehlibarov BG, MR Luo GB, Y Ohno US, B Powell AU, C Puebla DE, M L Rastello IT, A Rodrigues US, J Schanda HU, J van Kemenade NL, K Witt DE, R Young US, J Zwinkels CA

Consultants: P Bradfield US, G Dakin GB, R Harold US, C Hughes US, K Imura JP, C Lam HK, N Lena US, G Lorditch US, D Rich US

Report:

The first draft of the Technical Report for this TC was distributed for TC members and consultants in January 2007, the second draft in June 2007. The TC had its 4th meeting in Beijing in July 2007, with the participation of 6 members, one adviser and 16 guests. Taking the remarks and recommendations received on the second draft the Chair is preparing the third and final draft of the Technical Report, due to be ready for approval by the TC in the first half of 2008.

TC1-55 (C) Uniform Color Space for Industrial Color Difference Evaluation

Year Established: 1999

Terms of Reference:

To devise a new uniform color space for industrial color-difference evaluation using existing experimental data.

Chairman: M Melgosa ES

Members: D Alman US, R Berns US, E Carter US, G Cui GB, M D Fairchild US, R Kuehni US, M R Luo GB, J Nobbs GB, C Oleari IT, M R Pointer GB, D Rich US, K Richter DE, B Rigg (GB), A R Robertson CA, J Romero ES, G Rösler DE, M Vik CZ, K Witt DE, J H Xin CN, and H Yaguchi JP

Advisor: R Huertas ES

Report:

CIE TC 1-55 met in June 2006 at the University of Leeds (UK). A total of 11 people (members/advisor of this TC) participated in this meeting. Following four short individual presentations, Dr. Luo (UK), Dr. Oleari (IT), Dr. Vik (CZ) and Dr. Melgosa (ES), discussions focused on available experimental datasets to be used by our TC, and the concept of 'uniform color space' within the goal of our TC. A chairman's request for existing experimental datasets on color differences has been published in *Color Research and Application* **32**, 159 (2007). Recently different members of CIE TC 1-55 have published useful papers related to our terms of reference in *Color Research and Application* and the *Journal Optical Society of America*. We plan that Dr. Melgosa's team website (<http://www.ugr.es/~basapplcolor/>) will be ready to be used for future exchange of information (available experimental datasets, recent bibliography, etc.) amongst members. Now we are considering the possibility of another meeting of our TC to coincide with the Fourth European Conference on Colour in Graphics Image and Vision, CGIV 2008, Barcelona (Spain), June 10-13, 2008. We hope that at the time of this next meeting the available experimental data to be used by CIE TC 1-55 will be agreed upon, and first analyses of the results achieved by different color difference formulas can be presented.

TC1-56 (C) Improved Color Matching Functions

Year Established: 1999

Terms of Reference:

1. To compare results based on the current CIE color matching functions, color matching functions proposed by Dr. W. Thornton's laboratory, and those of CIE TC1-36.
2. To initiate experiments to obtain data for such comparison in different laboratories.
3. To report to CIE Division 1 on the results of the above investigation and make an eventual recommendation for future CIE color matching functions.

4. To report to CIE Division 1 an eventual recommendation for the use of the new color matching functions in specifying color spaces and color-difference formulas.

Chairman: M Brill US

Members: M Fairchild US, H Fairman US, K Houser US, R Kuehni US, MR Luo GB, Y Nakano JP, B Oicherman GB, C. Oleari IT, D Oulton GB, D Rich US, A R Robertson CA, J Schanda HU, A Stockman US, A Tarrant GB, *W A Thornton US, K Wenzel HU
* deceased

Report:

CIE TC1-56 conducted a meeting on 9 July at the Beijing CIE meeting (attended by M. Brill, R. Luo, A. Robertson, B. Oicherman, and 21 guests). At that meeting, Boris Oicherman gave a special presentation summarizing his PhD thesis work at the University of Leeds on color-matching. Based on the three experiments undertaken on behalf of the objectives of TC 1-56 (By Drs. Oleari, Oicherman, and Nakano), M. Brill set the objective to complete the final report of the committee by the CIE Mid-Term Meeting of 2009. That report would summarize the data and provide a recommendation. Tentatively, that recommendation was to continue to use Grassman additivity throughout colorimetry, except at low luminance levels for which mesopic color mechanisms must be considered.

After the Beijing meeting, the committee engaged in a brief but vigorous email discussion concerning the tentative recommendation. There are still some substantive issues to resolve.

Except at low luminance, recent publications provide evidence that averaging of intra-observer trials restores additivity and transformability of primaries. However, in the Second Edition of Wyszecki and Stiles, Maxwell matches are grossly inequivalent to maximum-saturation matches as revealed by the chromaticity plots in Section 5.6.6. Intra-observer data seem to have been averaged there, and the luminances were not low. Understanding these results is necessary for TC1-56 to finish its work.

TC 1-57 (C) Standards in Colorimetry

Year Established: 2000

Terms of Reference:

To prepare a series of CIE/ISO/IEC Standards that describe:

1. The method of calculating CIE tristimulus values and chromaticity co-ordinates
2. A uniform colour space and its associated metrics
3. A formula for industrial colour difference evaluation

Chairman: AR Robertson CA

Members: P Alessi US, JA Bristow SE, J Campos Acosta ES, R Connelly US, JF Decarreau FR, R Harold US, R Hirschler HU, H Ikeda JP, B Jordan CA, C Kim KR, D McDowell US, P McGinley AU, M Melgosa ES, Y Ohno US, MR Pointer GB, K Richter DE, G Rösler DE, JD Schanda HU, R Sève FR, K Witt DE, H Yaguchi JP, J Zwinkels CA

Liaisons: IEC TC100/TA2, H Ikeda; ISO TC 6, B Jordan; ISO TC35/SC9/WG22, G Roesler; ISO TC38/SC1/WG7(GB), M R Pointer; ISO TC38/SC1/WG7(US), R Harold; ISO TC42, D. McDowell; ISO TC130, D. McDowell; ISO/IEC/JTC1/SC28, K Richter

Report:

TC 1-57 is preparing four CIE Standards, as follows:

S 014-3 Colorimetry – Part 3: Calculation of CIE tristimulus values

*S 014-4 Colorimetry – Part 4: CIE 1976 L*a*b* colour space*

*S 014-5 Colorimetry – Part 5: CIE 1976 L*u*v* colour space*

S 014-6 Colorimetry – Part 6: CIEDE2000 colour-difference formula

Part 4 has been approved and was published in September 2007 as CIE Standard S 014-4/E:2007.

The third draft of Part 5 has been approved by the TC and was passed to the Division Secretariat and the Central Bureau for Division and Board of Administration ballots in June 2007. The results of the ballots have not yet been received by the TC.

A second draft of Part 3 is under preparation and should be complete early in 2008. The related work of TC 2-60 (Effect of Instrumental Bandpass Function and Measurement Interval on Spectral Quantities) is being monitored to be sure that the Standard does not conflict with potential recommendations of that TC.

A first draft of Part 6 will be prepared during 2008.

TC1- 61 (C) Categorical Color Identification

Year Established: 2001

Terms of Reference:

To prepare a report describing a color categorization map for the photopic and mesopic illumination levels.

Chairman: T Ishida JP

Members: N Johnson US, MR Luo GB, K Okajima JP, O da Pos IT, J Schanda HU, H Shinoda JP, H Yaguchi JP

Report:

This TC met in Beijing on July 9, 2007 where data were presented using the CIECAM02 colour appearance model. It was agreed that we would prepare a technical report describing the colour categorization map for surface colours, at different levels of illumination (1000 lx, 10 lx, and 1 lx), using both Munsell and CIECAM02 to present the data.

TC1- 62 (C) Color Rendering of LED Light Sources

Year Established: 2002

Terms of Reference:

To investigate by visual experiments color rendering properties of white LED light sources and to test the applicability of the CIE color rendering index to white LEDs.

Chairman: P Bodrogi, HU

Members: P Alessi US, I Ashdown CA, P Csuti HU, W Davis US, L Halonen FIN, G Heide DE, R Hirschler HU, F-C Hwang TW, A D Jackson US, C S Kim KR, K Kohmoto JP, B Kráncz HU, Y Kwak KR, C Li CN, M R Luo GB, K Muray US, Y Nakano JP, Y Ohno US, K Oshima JP, M R Pointer GB, E Radkov US, D Rich US, N Sándor HU, J Schanda HU, R Stolyarevskaya RU, J van Kemenade NL, R Stolyarevskaya RU, F Viénot FR, S Weintraub US, H Yaguchi JP, T Yano JP, and R Young US.

Advisors: O da Pos IT, A de Visser NL and F Viénot FR

Report:

A report has been published and this TC was disbanded in Beijing 2007.

TC1- 63 (C) Validity of the Range of CIEDE2000

Year Established: 2003

Terms of Reference:

To investigate the application of the CIEDE2000 equation at threshold, and to CIELAB colour differences greater than 5 units.

Chairman: K Richter, DE

Members: P Alessi US, EC Carter US, KR Gegenfurtner DE, T Holtsmark NO, MR Luo GB, M Melgosa ES, Y Nakano JP, J. Nobbs GB, C Oleari IT, D. Rich US, M Vik CZ, P Walraven NL, H Yaguchi JP

Report:

The research project for large colour differences between both white and black and the three primary and three secondary colours of offset printing has been finished until the end of 2007 by four countries (CZ, GE, GB, ES).

A visual representation of the three test charts can be found under the three URL's

<http://www.ps.bam.de/ME25/10L/L25E00NP.PDF>

<http://www.ps.bam.de/ME26/10L/L26E00NP.PDF>

<http://www.ps.bam.de/ME27/10L/L27E00NP.PDF>

The questionnaire to fill out is in on page 2 of each file output.

K. Richter chaired a meeting of TC1-63 members and about 20 guests during the CIE session in Beijing. Paula Alessi US was welcomed as a member and M. Pointer resigned from

membership. H. Yaguchi JP and Nakano JP agreed at the meeting to make additional visual experiments with the test samples.

There was a working meeting of several TC1-63 members after the BAM- DIN-Workshop on Image Technology in December 2007 in Berlin. At this meeting the preliminary results of four countries with the test chart samples were discussed. There were experimental reports of P. Vik Cz, P. Kittelmann GE, M. Melgosa ES and R. Luo GB who sent a written report. In all reports the test chart samples with large colour differences have been used. There were some differences in the viewing and presentation conditions compared to the first results of P. Kittelmann. Additionally threshold data and data of the industrial range (1 to 5 CIELAB) were included in three reports. J. Schanda was present and became interested to do additional experiments with the samples. T. Seim NO who works on colour vision models became a new TC member.

The preliminary results of the four research reports may be interpreted as follows:

Four large CIELAB colour differences greater than 10 the CIELAB formula seems to be better or equivalent to CIEDE2000. In the range near 3 to 5 CIEDE2000 is better compared to CIELAB. M. Melgosa showed that for thresholds there is a large difference between both formulas and experimental results. A description is unknown. Klaus Witt who made many experiments for the CIE report on industrial colour differences (CIE Report 142, Improvement to industrial colour difference evaluation) mentioned that near threshold about 20% of the observers evaluate a colour difference if the samples are identical. The small (hairline) separation or gloss effects and other reasons may lead to these strange results. It is not really known how to identify and eliminate the incorrect data from the evaluation.

A production of small colour differences of adjacent samples by image technology instead of making two physical samples which are presented side by side may avoid this problem. P. Kittelmann had produced the threshold differences of two adjacent samples by lighting technology. He puts some additional light on one half of a rectangular uniform sample and measures the threshold (50% detection probability of the difference).

The preliminary and further results will be discussed during the next TC1-63 meeting in Stockholm in June 2008. During this meeting there will be a demonstration of small and medium colour differences produced by image technology, see for example 5 and 16 step colour scales at the URL: <http://www.ps.bam.de/ZE95/10L/L95E00NP.PDF>

TC1- 64 (C) Terminology for Vision, Color, and Appearance

Year Established: 2003

Terms of Reference:

To monitor the terminology requirements of Division 1 including the revision of the present ILV terms and the addition of new terms.

Chairman: S. McFadden, CA

Members: P Bodrogi HU, EC Carter US, O da Pos IT, J Gardner, AU, Y Nakano JP, MR Pointer GB, J Schanda (HU), R. Seve (FR)

Report:

Currently, the CIE is preparing an electronic version of the updated ILV. It was anticipated that it would be available by the end of 2007. However, that is not the case. In anticipation of the publication of the ILV, the Chair of TC1-64 is compiling a list of terms that have appeared in recent Division 1 technical reports, but are not in the ILV. This list will be distributed to Committee members shortly for comment.

TC1-65 (C) Visual Appearance Measurement

Year Established: 2003

Terms of Reference:

To study, develop, and recommend a soft-metrology framework for measuring visual appearance. This should include potential measurement areas, psychophysical procedures and real applications.

Chairman: M R Pointer, GB

Members: There are three levels of membership: full, corresponding, and liaison members.

Full members: P Bodrogi HU, E Burini BR, J Campos ES, A Chalmers NZ, S Kim KR, P Clarke GB, O da Pos IT, G Derefeldt SE, P Hanselaer BE, R Harold US, J Hutchings GB, T Kolas NO, S Lindberg SE, D Lozano AR, M R Luo GB, L MacDonald GB, S McFadden CA, T Newman US, J Nobbs GB, C Oleari IT, G Rossi IT, K Sagawa JP, J Schanda HU, D Simmons GB, and F Viénot FR

Corresponding members: M Brill US, J Veitch CA, C Williamson GB

Report:

With the publication of CIE 175:2006 this committee was disbanded at the meeting in Beijing 2007. The work continues as TC1-72 Measurement of Appearance Network: MAnet.

TC1-66 (C) Indoor Daylight Illuminant

Year Established: 2004

Terms of Reference: To prepare a CIE recommendation on an Indoor Daylight Illuminant and a corresponding Indoor Daylight Source, considering the needs of the partner international standards organizations.

Chairman: J. Schanda, HU

Members: A Bristow SE, C Chain FR, F Clarke (advisor) GB, M K Gunde SI, R Hirschler HU, B Jordan CA, J T C van Kemenade NL, CS Kim KR, E Pierson FR, K Richter DE, G. Rösler DE, J Schanda HU, T Tarzali HU, J Zwinkels CA

Report:

A CIE Technical Report “Indoor Daylight Illuminants” is in the hands of the Division 1 Editor.

TC1-68 (C) Effect of Stimulus Size on Color Appearance

Year Established: 2005

Terms of Reference: To compare the appearance of small ($<2^\circ$) and large ($>20^\circ$) uniform stimuli on a neutral background.

Chairman: Peter Bodrogi (HU)

Members: P Alessi US, KF Anter SE, EC Carter US, I-P Chen TW, O da Pos IT, CS Kim KR, G Kutas HU, MR Luo GB, M Nicholson GB, T Nilsson CA, K Sagawa JP, J Schanda HU, R Sponner TR, F Viénot FR, K Xiao KR

Advisor: G Derefeldt SE

Report:

This TC met in Beijing. A comprehensive literature review has been carried out and some experimental work completed.

The colour appearance of a large (85° horizontal) homogeneous self-luminous visual stimulus has been studied. Large stimuli were displayed on a plasma panel display monitor and viewed for both 2 s and 8 s. These stimuli were compared with 2° (and 10°) standard-size stimuli presented on a grey background on a CRT monitor. The near-immersive colour stimulus was perceived to be lighter compared to the standard situation. Chromatic changes were also detected but they were not systematic.

In another study, the conspicuity of a coloured pattern was varied as a complex function of the size (area) and the hue and the apparent saturation and lightness of a surface colour found to increase with size (area).

In a third study comparing the “inherent” and the perceived colour of building facades, viewed in their existing surroundings, a consistent pattern of variation was found. The perceived facade colour was always less blackish than the “inherent” colour, and whitish colours tended to show increased whiteness, whereas more chromatic colours tended to become even more chromatic.

In a fourth study applying the colour perception of two-dimensional colour stimuli, e.g. computer screen images, it was shown that there were unexpected perceptual changes after application for real three-dimensional scenes (interiors and facades). In the real world, facades are generally not flat and they have textures and shadows as well. In this context, the perceived facade colours are subject to change.

Further studies are planned.

TC 1-69 (C) Colour Rendition by White Light Sources

Year Established: 2006

Terms of Reference:

To investigate new methods for assessing the colour rendition properties of white-light sources used for illumination, including solid-state light sources, with the goal of recommending new assessment procedures.

Chairman: Wendy Davis (US)

Members: P Alessi US, I Ashdown CA, R Bergman US, U Binder DE, Bodrogi HU, S Boissard FR, P van der Burgt NL, EC Carter US, R Daubach US, L Halonen FL, P Hanselaer BE, K Hashimoto JP, G Heidel DE, Hirschler HU, A Jackson US, W Jordan DE, CS Kim KR, C Li GB, MR Luo GB, M Mayrhofer DE, Y Ohno US, Ferreira de Oliveira BR, O da Pos IT, E Radkov US, D Rich US, K Richter DE, J Schanda HU, B Shugaev RU, F Szabó HU, M Thompson US, F Viénot FR, D Work US, H Yaguchi JP, T Yano JP, R Young US

Working Plan:

1. Agree on some basic criteria for a new metric (or system of metrics) such that it (or they) could be developed to be scientifically sound, acceptable to lighting industry, and useful.
2. Solicit, share, and discuss proposals for new assessment procedures for colour rendition properties of white light sources.
3. Evaluate proposed assessment procedures with visual experiments and compatibility with basic criteria (in #1).
4. Recommend a new metric (or system of metrics) based on evaluation (in #3).
5. Prepare a CIE Technical Report on recommended new metric (or system of metrics), including calculation procedures and justification for recommendation.

Report:

Members were recruited for this committee, discussion began via e-mail, and a web site was launched to enable sharing of papers, spreadsheets, and other documents. A working plan was proposed and agreed upon. The Committee also agreed to heed the recommendations of TC 1-62 “Colour Rendering of White LED Light Sources.”

A Technical Committee meeting was held at the 26th Session of the CIE in Beijing, China. At the meeting, attended by 47 people, several issues concerning the nature of the new metric were voted on. A subgroup was formed to develop experiment guidelines. A timeline was also established and agreed upon, with the ultimate goal of completing the work of the Committee by March, 2010.

Per the timeline, Members intending to conduct vision experiments relevant to the work of the Committee completed experiment questionnaires, detailing their plans. These were submitted to the Chair and distributed to the entire Committee. Fifteen experiments are planned, by six different research groups.

These experimental plans are currently being reviewed by the Experiment Guidelines Subgroup. The goal of this group is to make recommendations for ways to incorporate consistent elements in experiments conducted by different groups.

TC 1-70 (C) Metameric samples for indoor daylight evaluation

Year Established: 2007

Terms of Reference: To investigate the derivation of a set of metameric samples to enable the evaluation of indoor daylight simulators.

Chairman: B Kranicz (HU)

Members: Robert Hirschler HU, Danny Rich US, Alexander Rosemann CA, Péter Bodrogi HU.

Report:

The Committee is open for any experts interested in our topic.

TC 1-71 (C) Tristimulus Integration

Year Established: 2007

Terms of Reference:

To investigate methods for computing weighting tables for the calculation of tristimulus values from abridged data.

Chairman: C Li (CN)

Members: M Brill US, J Campos Acosta ES, M Fairchild US, H Fairman US, B Jordan CA, Y Ohno US, AR Robertson CA, J Schanda HU, R Seve FR, G Wang CN

Observers: MR Luo GB, E Carter US, MR Pointer GB

Report:

The TC 1-71 was formed in July last year in Beijing. After that the Chair, Changjun Li, started to invite experts in this area to become members of this TC and now the TC has members and observers as listed above.

At the moment, the chair of the TC is preparing contents for initiating the discussion work of the TC. Hopefully, the discussions will start in the next month.

TC 1-72 Measurement of Appearance Network: MApNet

Chair: MR Pointer GB

Formed: Beijing, 2007

Terms of Reference:

1. To establish a network of those interested in the measurement of visual appearance.

2. The network shall be under the direction and guidance of a group of at least four Technical Leaders each responsible for a particular aspect of the subject.
3. Each Technical Leader shall provide substantial periodic reports in a form that might be published.
4. A second Expert Symposium on Appearance shall be organised at an appropriate time within the next 4 years.
5. A database of relevant published work shall be maintained.
6. Consideration shall be given to the establishment of separate Technical Committees when appropriate.

Report

MApNet is now active, currently with 58 members! There are 8 Subject Groups:

- | | |
|-------------------------------------|--|
| 1. Physical aspects of appearance | To understand what happens to light incident on a surface, and to include interference, diffraction, absorption and scattering at surfaces and in the bulk, leading to effects that are responsible for colour, gloss, translucency and texture. |
| 2. Non-imaging appearance metrology | To measure light, including BSDF (including BRDF and BTDF), gloss, geometry, reflection, translucency, physical texture, distinctness-of-image, etc. |
| 3. Imaging appearance metrology | To measure spatial information, including images, focussing on the object, the illuminant, visual rendering, the reproduction of appearance, etc. |
| 4. Gloss | To investigate visual correlates that interpret the physical stimulus in terms of gloss. |
| 5. Colour | To investigate visual correlates that interpret the physical stimulus in terms of colour. |
| 6. Translucency | To define the relevant measurements and the contextual conditions which determine specific impressions of transparent/translucent objects. |
| 7. Texture | To investigate visual correlates that interpret the physical stimulus in terms of texture. |
| 8. Total appearance | To consider the interpretation of visual aspects of objects and scenes. |

The Technical Leaders are:

- | | |
|---------------------------|---|
| 1. Joanne Zwinkels | National Research Council Canada, Ottawa, Canada |
| 2. Frederic Leloup | KaHo Sint-Lieven University College, Gent, Belgium |
| 3. Marina Bloj | Division of Optometry, Bradford Optometry, Colour and Lighting Laboratory, University of Bradford, GB |

4. **Gaël Obein** LNE-INM/Cnam - Institut National de Métrologie
5. **Changjun Li** Dept of Colour Science, University of Leeds, GB
6. **Osvaldo da Pos** Dipartimento di Psicologia Generale, University of Padua
7. **Mike Chantler** Texture Laboratory, School of Mathematical and Computer Sciences, Heriot Watt University, GB

Changjun Li is only contributing to Group 5 within the remit that he has as Reporter R1-42 on extensions of the CIECAM02 colour appearance model.

Contributions have been encouraged from Network Members; we are actively pursuing ideas as to the location and form of the next CIE Expert Symposium on Appearance; we are going to advertise the existence of the Network to other Divisions and beyond CIE.

Color Reporters

R1-32(C) Emotional Aspects of Color: G Derefeldt SE

Year Established: 2003

Terms of Reference:

To review the literature on various non-image related effects of color and light.

Report:

No report.

R1-39 (C) Alternative Forms of the CIEDE2000 Color-Difference Equation:

MR Pointer GB

Year Established: 2006

Terms of Reference:

To investigate alternative formulations of the CIEDE2000 equation and to make a recommendation to the Division on any necessary action.

Report:

A Technical Report has been prepared and is in the hands of the Editor. This report recommends that a reformulation from four terms to three terms should form an addendum to the present CIE publication 142:2001. The CIE Central Bureau has indicated that this is an acceptable way to deal with this matter. Publication 142 would be re-issued with a revised date. It is not thought necessary to establish a Technical Committee to carry out this work, provided that this report is accepted by Division, National Committee and Board of Administration Ballot.

R1-41 (C) Adaptation Transforms: B. Oicherman GB

Year Established: 2007

Terms of Reference:

Report:

A literature survey is being carried out.

R1-42 (C) Extensions of CIECAM02: C Li CN

Year Established: 2007

Terms of Reference:

To evaluate potential additions to CIECAM02 in liaison with Division 8 and to include:

Those published in the literature;

Extension to include unrelated colours;

Extension of the range down to scotopic levels

This reportship was appointed in July last year. At the same time, Division 8 also formed a new TC 8-11 on CIECAM02-Mathematics. The Terms of reference of this TC are: to improve CIECAM02 model to avoid the mathematical inconsistencies; to enable CIECAM02 to work in colour management applications.

In fifteenth Colour Imaging Conference, November 5-9, 2007, Albuquerque, New Mexico, USA, the TC8-11 had an open meeting to discuss the problems with CIECAM02. The following points have been made in the meeting:

1. The colours that are causing the issue are near the spectral locus. Some consider these colours to have little practical importance. The correction needed is to clarify the mathematics.
2. Perhaps these colours are important for next generation displays.
3. Part of the discussion in this TC will be to define the applicability of the CIECAM02 model (e.g., PCS, colour difference, spectral colours).
4. The McCann data set was discarded in making the current CIECAM02. It does not fit well to the overall model. Perhaps that data set should be an indicator of the correction that is needed.
5. There is debate regarding whether narrow band imaging is intended to be included in CIECAM02. This TC would appreciate contributions of data sets of narrow band colours.
6. What is needed is canonical closed form method to handle all PCS CIELAB and CIEXYZ colours in colour management systems.
7. Will the CIECAM02 correction be a mathematical modification within the current structure, or will behaviour need to be changed to address narrow band colour.
8. Perhaps the approach should be for a short term fix (tweak the mathematics) but also to look at future needs for spectral imaging.
9. Tweaking the mathematics (CAT) will not address the issues of dealing with the full range of PCS colours.

10. The major problem with CIECAM02 (02) is that its domain is smaller than the ICC PCS. So what is absolutely needed is guidance for what the engineer using the system should do when encoding data. Perhaps there are two opposite solutions: First is to acknowledge the smaller domain and tell what to encode when you are outside it. Second is to enlarge the CIECAM02 domain to fill the entire ICC PCS. He would prefer the second option. Then there was some discussion about the current domain being illuminant dependent, but the HPE triangle ...
11. If CIECAM02 were improved to cover the full domain of the PCS would that be enough? No, because of the issues of change of illuminant. The first thing to do is to check for which illuminants CIECAM02 works.

Consensus Items that we agree on in the meeting:

1. We should expand the domain.
2. We shouldn't break (or change) anything that is currently working well.
3. First we should check for which illuminants CIECAM02 works, and at what illuminance levels it works.
4. We should make an action item to specify the domain that is desired.

In CIC15, there was one paper, which considered the colour appearance for the unrelated colours under the photopic and mesopic vision. The paper reference details are: Chengyang Fu, Changjun Li, M R Luo, RWG Hunt, and MR Pointer, Quantifying colour appearance for unrelated colour under photopic and mesopic vision, 15th Colour Imaging Conference, November 5-9, 2007, Albuquerque, New Mexico, USA, pages: 319-324.

This study investigates the colour appearance for unrelated colours with two sizes (0.5 ° and 10°) under photopic and mesopic vision. The same test colours with different field sizes were assessed under different luminance levels with reference white ranging from 60 to 0.1 cd/m². Eight phases of psychophysical experiments were conducted to obtain visual data assessed by a panel of 9 observers. The results showed that brightness and colourfulness increase with luminance level. For photopic vision, brightness and colourfulness were relatively increased for large stimuli size. For mesopic level (0.1 cd/m²), the results were about 50% brighter and 60% more colourful for 10° stimuli than for 0.5° stimuli. The experimental results were used to test two colour appearance models: CAM97u and CIECAM02. The CIECAM02 model was revised for predicting unrelated colours. It was found that CAM97u predicted brightness visual results more accurately than the CIECAM02 and the opposite was found for predicting colourfulness visual results. For predicting hue, both CAM97u and CIECAM02 gave satisfactory predictions.

Basically, this paper provides a starting point for extending CIECAM02 to the mesopic vision and to predict colour appearance for unrelated colours. However, there is a long way for deriving satisfactory extension.

Liaisons

L1-1 Association International de la Couleur: P J Alessi

The AIC is proud to announce that Mexico has joined as a regular member. The Mexican Association of Color Researchers has been incorporated into the AIC as a regular member, representing Mexico. More information can be learned about the Mexican color group by visiting their website at www.amexinc.org.mx

The AIC 2008 Interim Meeting will be hosted by the Swedish Colour Center Foundation. It will be held in Stockholm, Sweden from June 15-18, 2008. The theme of the conference is "Colour- Effects and Affects". Over 165 abstracts for papers and posters have been received for review. The specific topics that will be discussed are:

- a. Environmental colour design; colour in architecture and design; colour design for everybody; light and colour; colour, texture and surface material
- b. Aspects of colour perception; colour appearance; visual illusions and effects; colour memory
- c. Colour psychology and communication; colour symbolism and associations; colour semantics and emotions; colour harmony and aesthetics; colour linguistics
- d. Colour in art and culture
- e. Colour and education

For more information, please visit the website at www.aic2008.org. For direct email correspondence, please email info@aic2008.org.

The 11th AIC Congress will be hosted by the Colour Society of Australia from September 27-October 2, 2009. The venue is the University of South Wales in Sydney, Australia. The Congress will cover every aspect of the study of colour, including architecture, art, design, biology and botany, chemistry, physics, psychology, and physiology, engineering, vision, and textiles. The program will also include symposia of the AIC study groups; Environmental Colour, Colour Vision and Aging, Colour Education and Illusions. Sponsorship for the Congress is currently being sought. Please visit the website for more information: www.aic2009.org.

L1-2 CCPR (Comite Consultatif de Photometrie et Radiometrie), BIPM: M. Stock

Report:

No report.

L1-3 ISO/TC6/W3: Paper, Board and Pulp - Optical Properties: J C Zwinkels

The following recent activities may be of interest to the CIE:

In the past six months, voting has been completed for the following standards:

- DIS 2470-2 Paper, board and pulps – Measurement of diffuse blue reflectance factor – Part 2: Outdoor daylight conditions (D65 brightness).
- ISO/DIS 5631-2 Paper and board – Determination of colour by diffuse reflectance – Part 2: Outdoor daylight conditions (D65/10°)
- DIS 5631-3 Paper and board – Determination of colour by diffuse reflectance – Part 3: Indoor daylight conditions (D50/2°)
- DIS 9416 Paper – Determination of light scattering and absorption coefficients (using Kubelka-Munk theory).

The next meeting of ISO TC6 is planned for June 2008 in Seoul, Korea.

L1-4 ISO/TC38/SC1: Textiles: Colour Fastness & Measurement: M R Luo GB

Report:

- A method for predicting colour inconstancy based on CMCCON02 was proposed which includes the CAT02 chromatic adaptation transform used in CIECAM02. The final DIS document was completed and is in the process of national ballot voting.
- A method for assessing colour fastness grades by digital imaging technique was proposed. The method includes an illumination cabinet for capturing images of objects and two formulae for converting colour measurement data to colour fastness grades for colour change and staining respectively. A ring test including labs in 5 countries has just been completed. Two more countries are carrying out the work. The data will be used to further verify the methods.

L1-5 ISO/TC42: Photography: J Holm US

Report on ISO TC42 Activities of Possible Interest to the CIE (Including TC42 hosted joint work with ISO TC130)

WG18

Edition 2 of ISO 12234-1, the digital camera standard that specifies metadata and digital camera removable memory, directory, and file formats (pointing to Exif and TIFF/EP) has been published. Edition 2 is only slightly revised from Edition 1 (primarily a pointer to DCF was added), but work has begun on Edition 3. It was previously agreed that the Edition 3 revision could begin when Edition 2 was published. Edition 3 is planned to include a significant updating of the common metadata including metadata persistence rules, and the addition of a pointer to JPEG 2000. Work is ongoing and a draft is scheduled for circulation prior to the next WG18 meeting in Cologne (October 2008).

The ISO 12234-2 (TIFF/EP format) revision has begun. TIFF/EP is the base format for most camera raw images. Many users request more standardization in this area, but there are concerns from digital camera makers about how to proceed while protecting vendor differentiation opportunities. There were extended discussions at the Lausanne TC42 meeting (June 2007) and the San Jose WG18 meeting (January 2008), and it was agreed that somewhat processed (e.g. defect and noise removal, aberration correction, dark current and flat field correction) camera raw and/or scene-referred TIFF/EP format profiles could be

developed. The method of supporting demosaiced camera RGB and scene-referred images using ICC profiles was presented in Lausanne. In San Jose, additional metadata items for color processing were proposed, and it was agreed to work on creating optional pre-processing metadata for defect removal, etc. Liaison communications are ongoing with JTC1 SC29 concerning JPEG XR, which also uses a TIFF type file format. The ad-hoc group for this work was expanded and more discussions are planned for Cologne.

Revision and maintenance work continues on ISO 12231 (Vocabulary), ISO 12233 (Camera resolution), ISO 14524 (Camera OECF), ISO 15739 (Camera noise & dynamic range), ISO 15740 (Picture transfer protocol), ISO 16067 (Scanner OECF & noise), ISO 21550 (Scanner dynamic range), ISO 20462 (Subjective image quality evaluation).

ISO 12232 (Digital camera ISO speed and exposure index) Edition 2 was published recently; it includes significant technical changes and additions from Edition 1.

JWG21

Due to a lack of progress in the ISO 5 (Density measurement) revision work, and the fact that they are normative references for over 50 other standards, the current editions were reconfirmed at the TC42 Lausanne plenary. However, NP for CD new editions have now been circulated for voting (ballot closes in February). The primary objective of the revision is to better specify the calculation of density from spectral measurements, and add some graphic arts features like polarization.

JWG23

ISO 22028-1:2004 was reconfirmed (for five more years) at Lausanne plenary with a technical corrigendum to correct two typos. There are ongoing discussions about extending Annex B tables to include new standard color encodings as they are developed.

The ICC has requested a revision of ISO 22028-2 (ROMM RGB) addressing the ICC Perceptual Intent Reference Medium (PRMG) gamut. “The PRMG should be explicitly mentioned; a diagram of the encoding range, legal encoding range, and fuzzy reference medium gamut should be provided along with explanatory material. Describe the difference between an available encoding range, a legal encoding range and encoded values within a reference medium gamut.”

At the JWG23 meeting in San Jose, there was discussion of the need for a new scene-referred color encoding standard for digital camera captured images. Existing scene-referred encodings include RIMM and ERIMM RGB in ISO 22028-3 and scRGB and scRGB-nl in IEC 61966-2-2. It was suggested that the RIMM encoding has too little above adopted white headroom and the ERIMM encoding too much. The scRGB headroom is about right but the use of the 709 primaries requires the use of negative values or offsets that are not well supported by many popular imaging software applications. An ad-hoc has been formed to study the issues and make a recommendation.

A NP has been approved to standardize ECI RGB as ISO 22028-4. The NP draft appears to be in good shape and this standard is likely to proceed quickly.

JWG24

The comments on the ISO 3664 (Viewing Conditions) Edition 3 CD ballot have all been resolved and the DIS is being prepared. Significant changes include tighter UV tolerances for print viewing and display viewing tolerances that are linked to display brightness.

L1-6 ISO/TC130: Graphic Technology: D C Rich

ISO TC 130 has been very active in the past year.

Working Group 1 has been documenting terms used in the graphic arts industry, including terms relating to the use of color in graphic reproduction. These terms are being standardized in a series of standards, numbered as *ISO 12637 Graphic Technology — Terminology*. There are five parts to this series of standards. Part 1: General Terms, Part 2: Prepress Terms, Part 3: Printing Terms, Part 4: Postpress Terms, and Part 5: Screen Printing Terms.

Working Group 2 is responsible for a number of standards related to electronic files used to communicate colored images. But it has also been working on and releasing as FDIS the standard, ISO 12646, *Graphic technology — Displays for colour proofing — Characteristics and viewing conditions* which documents the methodologies for creating colored images on a visual display unit. It references CIE Publication 15 as normative and the following CIE Publications as informative, CIE Publication 116, CIE Publication 122 and CIE Publication 159.

Working Group 3 is responsible for process control in the production of graphic images. Here there has been a great deal of activity together with ISO TC 42. There are three joint working groups and they are busy revising standards on densitometry (ISO 5 series), on the measurement of color (ISO 13655) and on the viewing conditions for graphic technology and photography. The main concern in the latter two standards is the move in the graphic reproduction industry to substrates that contain significant amounts of fluorescent additives that make the substrate brighter and whiter. Current CIE standards on visually assessing the color and brightness of prints and inks on these substrates are considered inadequate. The use of CIE standard illuminants, like D50, is proving to be problematic as practical realizations do not include enough ultraviolet content to evoke the correct visual appearance. Commercial implementation of CIE recommendations on assessing the quality of a viewing source approximating D50 are not consistent from vendor to vendor or from prediction to experience. The introduction of new light sources, such as white LED sources, is impacting the graphic arts in much the same way as it is the commercial retailing and lighting industries. Better methods for describing the effect of a given lamp light on the perceived color of an image or a distribution of colors is being sought. The paper industry is also rallying to make changes to the ways in which they characterize their products so that high accuracy brightness values can be assessed and communicated between supplier and user without the need for very specific and unique instrumentation. There are general anecdotal reports that the CIE recommended scale of whiteness, derived in the late 1970s, does not correlate well with visual experiences on modern photo papers.

Working Group 4 is responsible for a number of standards on the materials used in graphic reproduction, including the colors of process printing inks used with various print technologies (offset, gravure, screen, flexo, digital). The primary interest in the work of CIE Division 1 by this Group is in the area of color differences and color tolerances. Revisions of several

standards are moving the embedded tolerances away from CIELAB into CIEDE2000 which is being seen as a significant move forward for the graphics industry. One area of concern, however, is the continuing stream of reports describing the problems with these formulas that apply local distortions of CIELAB space near the neutral axis. Neutral colors are a very important part of the visual assessment of image quality and the difficulty in computing the visual impact of a given stimulus difference can be quite troublesome.

L1-7 ISO/IEC JTC1/SC28 Office Equipment: K Richter

Report:

The ISO/IEC JTC1 SC 28 Business Plan presented by the chairman at the 2007 JTC 1 Plenary shows a lot of activities in the field of printers.

There are the following market trends:

The market of Inkjet Multifunctional Printers (MFP) strongly increased (40% per year) from 30 Million to 60 Million units within the two years 2005 to 2007. During the same time the inkjet printer market (not multifunctional) decreased but both the laser printer market and the laser MFP market increased by about 25% per year.

The market wants to compare:

- Cost per page of printers
- Productivity of digital copiers and printers
- Quality of hardcopy images
- Printer resolution

For each of these topics the main progress is given in the following:

Cost per page of printers

New standards have been published on test methods and on test pages for measurement of cartridge yield (toner and ink). The following list includes the different devices, the test methods and the test charts which are freely available from the SC28 ISO server.

- Laser Toner-mono: Test method and test pages ISO/IEC 19752

- Laser Toner-color: Test method ISO/IEC 19798, Test pages ISO/IEC 24712
- Ink (document printing): Test method ISO/IEC 24711, Test pages ISO/IEC 24712
- Ink (photo printing): Test method WD 29102, Test pages WD 29103

Productivity of digital copiers and printers

Two committee drafts CD 24734 and CD 24735 are available.

Quality of hardcopy images

ISO/IEC 19799 "Method of measuring gloss uniformity on printed pages" has been published.

Printer resolution

Project 29112 "Test chart and method for measuring printer resolutions of monochrome laser printers" is ongoing.

There is a new NP under ballot with the title "Printer cartridge characterization standard for inkjet and laser printers"

There is another new standard ISO/IEC 28360:2007 "Determination of chemical emission rates from Electronic Equipment" which includes possible emissions of the paper, and the ink or the toner of printers.

ISO/IEC DIS 10779 "Office equipment accessibility for elderly persons and persons with disability" has been approved. This proposed standard includes ergonomic aspects, for example the ergonomics of displays used in the printer devices.

Based on studies in Japan and Korea the market needs and user wishes are listed. Colour input and output is a key issue according to these studies. Therefore an "Office Colour Working Group" has been proposed by the SC28 Advisory Working Group (AWG). The formal creation is expected at the next plenary of SC28 during June 2008. Additionally the creation of a "Office Application Working Group" is expected which will deal with problems of different file formats (PDF/X, PDF/A and others) used in the office.

The present scope of the "Office Colour Working Group (OWG5)" reads as follows:

OWG5 will develop standards to enhance the interoperability of color data for exchange among office color equipment and will develop standards that evaluate device color properties for office color equipment. OWG5 will work jointly with the appropriate standards organizations to address these issues in both new standards and revisions of existing standards as necessary.

The proposed chairman is Fumio Nakaya from Japan. A list of 10 New Work Items in the field of colour has been discussed at the last AWG meeting.

Germany has proposed at the last AWG meeting to consider the following SC28 standard documents as one basis for the next developments in the field of colour.

- ISO/IEC 15775:1999 and Amd1:2005 "Method for specifying image reproduction of colour copying machines by analog test charts ? Realization and application"
- ISO/IEC TR 24705:2005 "Method of specifying image reproduction of colour devices by digital and analog test charts"
- ISO/IEC TR 19797:2004 "Device output of 16-step colour scales, output linearization method (LM) and specification of the reproduction properties"

The German standard series DIN 33866-1 to -5:2000 corresponds to these international standard documents. All colour patches are defined by colorimetry. These standards are designed to solve a lot of user wishes which are not covered by other standards, for example the output of 16 visually equally spaced steps for 16 equally spaced input data.

A relative visual assessment and a colorimetric specification of for example the printer output is described. There are colour test charts freely available; see the test charts according to ISO/IEC TR 24705 with 16 step equally spaced colour series: <http://www.ps.bam.de/24705TE>

ISO FDIS 9241-306:2008 "Ergonomics of human-system interaction Part 306:

Field assessment methods for electronic visual displays" has been published.

This standard is designed for the office work place and uses the monochrome test chart of SC28 defined in ISO/IEC 15775 for the display output test, for example at the office work place. Two

test charts according to ISO FDIS 9241-306 are freely available in PDF format (0.2 and 1.7 Mbyte), see <http://www.ps.bam.de/ME16/10L/L16E00NP.PDF>
<http://www.ps.bam.de/ME15/10L/L15E00FP.PDF>

The first file output at the office work place is designed to answer the questions according to ISO FDIS 9241-306, for example if the 16 grey steps can be distinguished.

The second file output simulates 8 different reflections of the ambient office light on the office monitor or the data projector screen. Only one of these simulations may produce an appropriate recognition and an equal visual spacing of the 16 gray steps.

According to the colorimetric calculations the output gamma of about 2.4 in the dark office with no reflections on the display has to be changed to a gamma of nearly 1.0. Then for example the luminance of the data projector on the screen may be in a worst visual case equal to the luminance of the daylighted office (ambient light). The lightness range is in this worst case between $L^*=70$ and $L^*=95$ for black and white. Still the 16 steps can be clearly seen if the spacing in lightness is linear. In this case the CIE lightness L^* may be approximated by a linear function of the luminance L (Gamma = 1). This is possible because of the very limited CIE lightness range between $L^*=70$ and 95.

User wishes to output the elementary hues red, yellow, green and blue, which may be represented by the CIE test colours no. 9 to 12 of CIE 13.3 are a new topic. For D65 the CIELAB hue angles are 28, 92, 162 and 272 degrees. The user wishes to produce on any (!) office device the four elementary hues for the standard RGB input values 100, 010, 010 and 001. Germany has proposed this topic for SC28. This user wish has been discussed also in ISO TC 159. The following statement is addressed for action to CIE Division 1 and should be discussed at the next meeting of the CIE Division 1 in June 2008 in Stockholm.

Conclusion 28/2007 of the 3rd meeting of ISO/TC 159/SC 4/WG 2 "Visual Display Requirements" 2007-05-19 to 21 in Long Beach, CA, USA:

"ISO TC 159/SC 4/WG 2 "Visual Display Requirements" realizes that the colour spaces CIELAB and CIELUV of CIE Division 1 will soon become ISO/CIE standards. In applications we use these CIE colour spaces and device-dependent relative RGB colour spaces. For users of visual display systems a device-independent RGB colour space is useful. This produces via software the elementary hues Red, Green and Blue for the RGB data 100, 010 and 001 and equally spaced output in CIE colour spaces for equally spaced RGB input. We recommend that CIE Division 1 study the colorimetric definition of such a space, which can be used in visual display applications.

Remark: We have realized that an example colour space of this type is published in CIE X030:2006, pp. 139 - 144"

The paper of this remark defines a special RGB* colour space with a linear relation to CIELAB for any device. If for example the input data RGB = 100, 010, and 001 are NOT interpreted as device data OLV* (according to ISO/IEC 15775) but as data in this RGB* elementary colour space, then the elementary hues Red, Green and Blue are produced on any output device. Therefore the hue output is device independent and the coordinates are to a high degree device independent. This is different compared to the existing device dependent RGB data, for example the RGB data of the sRGB space defined in IEC 61966-2-1. For an example output of the 5 and 16 step colour scales in six device hue planes (OYLCVM) and four elementary hue planes (RJGB) see the file (5.3 Mbyte): <http://www.ps.bam.de/XE29/10L/L29E00NP.PDF>

Remark: If the PDF vector graphic output is magnified by for example 400% then the colorimetric data within the 10 different hue planes are readable and can be studied.

For more information about the use of colour in Information Technology and in many standard groups see the many papers presented at a BAM-DIN-Workshop on Image Technology in 2007.

L1-8 IALA: M. Nicholson and I. Tutt

No report.

L1-9 ISO/TC159: Ergonomics: K Sagawa

ISO/TC159/WG2 “Ergonomics for people with special requirements” has developed technical report TR22411 which is now in printing in ISO. The report contains data on a number of age-related visual functions and methods how to use them, a part of which are those collected by CIE TC1-54. After the completion of the report, TC159/WG2 has just started to work on the 2nd edition of the TR to increase more useful data in the areas that have not been covered by the first version of TR22411. Meanwhile, standards on accessible design are being developed in Sub-committees (SC4 and SC5) in TC159 the contents of which being stemmed from the TR22411. Some other actions are being taken to promote accessible design in ISO/TC159, for which a new strategic working group has just been developed.

Recent Publications

J. Schanda, ed., Colorimetry: Understanding the CIE System, Wiley, 2007

CIE S 014-4/E:2006: Colorimetry - Part 4: CIE 1976 L*a*b* Colour Spaces.

CIE 177:2007. Colour rendering of white LED light sources. (TC1-62)

x032:2007: Proceedings of the CIE Expert Symposium on Visual Appearance, 19-20 October 2006, Paris, France.

TC1-55 chairman’s request for existing experimental datasets on colour differences has been published in Color Research and Application 32, 159 (2007).