



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

ACTIVITY REPORT

DIVISION 1

VISION AND COLOUR

January 2009

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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 February 2008. The annual meeting of Division 1 was held in Stockholm, Sweden on Sunday 15 June 2008. The meeting was attended by 4 of the Division officers, representatives of 15 of the 34 member countries, 14 TC chairs and reporters, and approximately 8 guests.

The following Technical Committees met in Stockholm:
TC1-58 Visual performance in the mesopic range
TC1-61 Categorical colour identification
TC1-63 Validity of the range of CIEDE2000
TC1-68 Effect of stimulus size on colour appearance
TC1-69 Colour rendering of white light sources

The following activities were closed in Stockholm:
R1-23 Guidelines on planning a mesopic photometry experiments
R1-35 Irregularities in $V_{10}(\lambda)$
R1-41 Adaptation transforms
R1-45 Luminous efficiency functions

And the following activities were started in Stockholm:
TC1-73 Real colour gamuts Changjun Li CN
R1-46 Evaluation of whiteness Joanne Zwinkels CA
R1-47 Hue angles of elementary colours Thorstein Seim NO

In addition, since the Stockholm meeting a Division ballot has approved the establishment of another TC, on 'Methods for re-defining CIE D illuminants' under the chairmanship of Janos Schanda. This has now been approved as TC1-74.

A summary of the status of each of the Technical Committees in Division 1 is included in this report together with summaries from the Reporters and Liaisons. The reports are grouped such that the Vision Section is preceded by the Colour Section followed by the Liaison reports.

The following publications have appeared during the last year:

Joint ISO/CIE Standards

ISO 11664-1:2008(E)/CIE S 014-1/E:2006 CIE Standard Colorimetric Observers

This CIE Standard is a renumbering of ISO/CIE 10527:2007, which contained only minor changes in comparison to ISO 10527:1991. It has now been clarified that the values of the colour matching functions apply for standard air to make the Standard conform to other CIE photometric and colorimetric data.

ISO 11664-2:2008(E)/CIE S 014-2/E:2006 CIE Standard Illuminants for Colorimetry

This CIE Standard is a renumbering of ISO 10526/CIE S014-2:2006, which contained only minor changes in comparison to ISO 10526:1999, mainly concerning the wavelengths that are to be taken as being in standard air, to make the Standard conform to other CIE photometric and colorimetric data.

ISO 11664-4:2008(E)/CIE S 014-4/E:2007 Colorimetry - Part 4: CIE 1976 L*a*b* Colour Space

VISION SECTION: TECHNICAL COMMITTEES

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

Established: 1991
Terms of: To establish a chromaticity diagram of which the coordinates correspond to
Reference: 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

At the present time, the progress of work of TC 1-36 is awaiting new data. The goal is to complete part B of the report with:

- Chapter 6 "Photometric aspects; the choice of the spectral luminous efficiency functions $V_{F2}(\lambda)$ -and $V_{F10}(\lambda)$ "
- Chapter 7 "Development of 2-dimensional chromaticity diagrams".

In order to complete Chapter 6, we need the $L(\lambda):M(\lambda)$ weight to the luminous efficiency function. Let me recall that at our meeting in Lyon, we agreed on $L:M = 1.55$ (in quantal units) for a 2 degree field, and daylight adaptation, as published by Sharpe et al. (2005). Now, the authors themselves prepare a discussion on the 1.55 value as the best ratio.

We have been waiting for a proposal of correction which is now in press in a peer reviewed paper. The authors come with a new proposal for the $L(\lambda):M(\lambda)$ weight to the luminous efficiency function. This information, together with a draft of Chapter 6, will be circulated to the TC members for approval.

TC1-36 cannot complete Chapter 7 without approval of Chapter 6. Two members have published the procedure to derive a XYZ observer from the LMS fundamental observer. The technical committee should agree the procedure. Once TC members have approved the choice of the $L(\lambda):M(\lambda)$ weight, it will be possible to prepare a draft for Chapter 7.

Sharpe LT, Stockman A, Jagla W and Jägle, H (2005). A luminous efficiency function, $V^*(\lambda)$, for daylight adaptation. *Journal of Vision*, 5(11):3, Pages 948-968.

Stockman, A., Jägle, H., Pirzer, M., & Sharpe, L. (2007). $V^*(\lambda)$: a generalized luminous efficiency function for any condition of chromatic adaptation *Journal of Vision*, in press.

Wold JH & Valberg A (1999). General method for deriving an XYZ tristimulus space exemplified by use of the Stiles–Burch 1955 2° color matching data. *J. Opt. Soc. Am. A*, 16 2845-2858.

Wold Jan Henrik, Valberg Arne (2001). Derivation of XYZ Tristimulus Spaces: A Comparison of Two Alternative Methods, *COLOR research and application*, Supplement Volume 26: S222-S224.

TC1-37 (V) Supplementary System of Photometry

Established: 1992
Terms of: To recommend a system of photometry to assess lights in terms of their
Reference: 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).

No report.

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

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

No report.

TC1-42 (V) Color Appearance in Peripheral Vision

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 Derefeltd SE, L Eriksson SE, L MacDonald GB, K Okajima JP, A Yujiri JP

No report.

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

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)

No report.

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

Established: 2000

Terms of Reference: To define mesopic visual performance and related terms.

Reference: To investigate performance based photometry in the luminance region below approximately 10 cd m^{-2} .

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 Derefeltd 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

No report.

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

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

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

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 Ujiike JP
Members: Members are being sought.

No report.

VISION SECTION: REPORTERS

R1-19 (V) Specification on Individual Variation in Heterochromatic Brightness Matching

Established: 1997
Terms of Reference: To report on the possibility to develop a simple test of individual characteristics for heterochromatic brightness matching.
Reporter: H Yaguchi JP

The report is currently with the Editor.

R1-36 (V) Action Spectra for Glare

Established: 2004
Terms of Reference: To summarize the literature on the subject and make recommendation for terms of reference for a technical committee.
Reporter: J Fekete HU

No report.

R1-37 (V) Definition of the Visual Field for Conspicuity

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.
Reporter: N. Itoh JP

No report.

R1-38 (V) Concept and Application of Equivalent Luminance

Established: 2005
Terms of Reference:
Reporter: Y Nakano JP

No report.

R1-40 (V) Scene Dynamic Range

Established: 2006
Terms of Reference: 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.
Reporter: J Holm US

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 I hope to have more to report for the Division 1 meeting this summer. (<http://www.cis.rit.edu/fairchild/HDR.html>).

R1-43 (V) Standard Deviate Observer

Established: 2007
Terms of: To document available databases that could yield a definition of a new
Reference: standard deviate observer.
Reporter: B Oicherman GB

No report.

R1-44 (V) Limits of Normal Colour Vision

Established: 2007
Terms of: To review the literature to see what information is available to establish
Reference: the limits of normal colour vision.
Reporter: S McFadden US

A final report will be presented at the 2009 annual meeting of Division 1.

COLOR SECTION: TECHNICAL COMMITTEES

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

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

The final draft of the technical report is completed. It has been sent to all TC 1-27 members for comment with a due date of March 1, 2009. Member comments will be incorporated into the final report. Then the final report will go out for Division ballot, hopefully by the CIE Midterm meeting in May, 2009.

TC1-44 (C) Practical Daylight Sources for Colorimetry

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, D Hinks US, H Fairman US, R Hunt GB, T Kehlibarov BU, T Ichijo JP, J van Kemenade NL, M R Luo GB, C McCamy US, M Pointer GB, Y Ohno US, B Powell AU, C Puebla DE, M L Rastello IT, A Rodrigues US, J Schanda HU, K Witt DE, R Young US, and 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

The third draft of the Technical Report was distributed for TC members and consultants in September 2008, and at the same time it was sent to the Division 1 Editor for editorial review. In addition to the Editor's corrections several new remarks and observations have been received from TC members, thus the preparation of a fourth draft is necessary. It is being prepared by the TC Chair and is due to be sent out for TC ballot in January 2009.

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

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

In coincidence with the "Fourth European Conference on Colour in Graphics Image and Vision", CGIV 2008, Barcelona (Spain), a meeting of CIE TC 1-55 was held on June 12, 2008, with participation of Prof. Roy Berns (USA), Dr. Guihua Cui (UK), Dr. Rafael

Huertas (Spain), Dr. Manuel Melgosa (Spain), and Dr. Danny Rich (USA). At this meeting there was an oral presentation related to a recent research on color-threshold differences carried out at the University of Leeds (UK). Dr. Manuel Melgosa indicated that it was disappointing that the request for existing experimental datasets on color differences for use by CIE TC 1-55, which was published in Color Res. Appl. 32, 159 (2007), had not received any answer. The convenience of analyzing experimental datasets individually (that is avoiding combined datasets) was mentioned by different participants.

Colleagues from North Carolina State University (Dr. Renzo Shamey and Dr. David Hinks) are doing research related to the goals of the Committee. Specifically, Dr. Renzo Shamey presented at CGIV 2008 the paper entitled "Performance of recent color difference equations around a CIE blue color center" and have provided their experimental data. Dr Guihua Cui has also recently provided his experimental data on color differences measured using CRT for the use of CIE TC 1-55 members. Different members have reported research related to the goals of the Committee. For example, M. Melgosa, R. Huertas, and R.S. Berns published "Performance of recent advanced color-difference formulae using the Standardized Residual Sum of Squares index," J. Opt Soc. Am. A 25, 1828-1834 (2008), where STRESS and PF/3 values for the four individual datasets considered at CIEDE2000 development are reported for different formulas: CIEDE2000, DIN99d, CAM02-SCD, CAM02-UCS and GP. Very recently was published by C. Oleari, M. Melgosa, and R. Huertas "Performance of a Euclidean color-difference formula defined in log-compressed OSA-UCS space for small-medium color differences" J. Opt. Soc. Am. A 26, 121-134 (2009). The authors propose a new Euclidean formula based on OSA-UCS space.

TC1-56 (C) Improved Color Matching Functions

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

To describe the progress of CIE TC1-56 (Improved Color Matching Functions) during the year 2008, I first review the activities of 2007:

CIE TC1-56 met 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 color-matching PhD thesis work at the University of Leeds. Based on the three experiments undertaken on behalf of the objectives of TC 1-56 (By Drs. Oleari, Oicherman, and Nakano), I 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 Grassmann additivity throughout colorimetry, except at low luminance levels for which mesopic color mechanisms must be considered.

After the Beijing meeting, the committee had a brief but vigorous email discussion about the tentative recommendation. Except at low luminance, the recent publications provide evidence that averaging of intra-observer trials restores additivity and transformability of primaries. However, it remains for CIE TC1-56 to understand the apparent discrepancy of the spectrum locus as derived from Maxwell with maximum-saturation color matches, as reported by Wyszecki and Stiles (W&S) in Section 5.6.6 of *Color Science* (2nd edition, 1982). Intra-observer data seem to have been averaged there, and the luminances were not low. The only distinctions I see between the maximum saturation and Maxwell procedures are (a) only Maxwell matching keeps the comparison field constant, hence potentially “nulling out” certain visual variations; (b) Maxwell matching at each wavelength involves two matches to the comparison field, which might compound random error; and (c) Maxwell matching always occurs at the chromaticity of the (white) comparison stimulus, but maximum-saturation matching occurs (as the name would suggest) at maximum saturation. It appears that Grassmann additivity cannot be maintained in the face of the discrepancy. However, Alan Robertson noted that the data in W&S Section 5.6.6 basically came from a single observer (although a very good one), so confirmation might be in order.

[*Note:* To introduce the mechanics of Maxwell color matching, I have produced a tutorial deriving equations relating light measurements to Maxwell-match color-matching functions. Toward applicable theory, W&S’s Section 5.3 relaxes Grassmann’s laws via conditions I-III (p. 295) to accommodate Maxwell but not maximum-saturation matching. This was attached to the minutes of the Stockholm meeting.]

Further email discussion ensued in January-February 2008. Boris Oicherman said that cross-media matching data from his Ph.D. thesis confirm failures of Grassmann additivity. (http://www.oicherman.com/Boris_Oicherman_PhD_thesis.pdf) Danny Rich’s experience in cross-media color matching confirms that the match is asymmetric and therefore is not logically tied to symmetric-match additivity. Therefore, Boris’s data may suggest (but do not mandate) a conclusion about non-additivity, and we will examine them. Alan Robertson suggested that, to model additivity failures, it may be necessary to pursue the possibility that a color match may be broken by adaptation that uses more than the usual three inputs (e.g., from a remote part of the retina). We’re probably not going to arrive at a definitive model in TC1-56, but may do so in a later effort.

Rolf Kuehni emphasized that we must be about the task of writing a report so as to bring the activities of TC1-56 to a graceful conclusion---within a year, per encouragement by CIE Division I leaders. We must tell a story that places nonadditivity data in perspective, weighted by the relevance of that data to unambiguous interpretation in terms of Grassmann failure.

One open question is to relate the Maxwell-Maximum-Saturation incompatibility reported by Wyszecki & Stiles (Section 5.6.6) to Boris’s general statement that observers use more blue light than their CMFs predict when matching broadband light by a narrowband triplet. And we must not forget that two studies (by Nakano and Oleari) have confirmed additivity after all. How can we tell a consistent story with such disparate ingredients?

Another open question is to propose criteria for data and replication to be acceptable results for a recommendation by a CIE committee like TC1-56.

All of the above material (including the Appendices) was completed by May 2008 and reported in the Division 1 minutes at the Stockholm meeting. Since May, Oleari [1] and Oicherman [2] have published experimental results. As of December 2008, we are continuing to discuss these matters, and I have begun to draft a Final Report in which a consensus position will be represented. The plan is to have the draft ready for discussion at the 2009 Midterm Meeting of the CIE.

1. Oleari, C., and Pavesi, M., Grassmann's Laws and individual color-matching functions for non-spectral primaries evaluated by maximum saturation technique in foveal vision, *Color Res. Appl.* **33**, 271-281 (2008).
2. Oicherman, B., Luo, R., Rigg, B. and Robertson, A.R., Effect of observer metamerism on colour matching of display and surface colours, *Color Res. Appl.* **33**, 346-359 (2008).

TC1-57 (C) Standards in Colorimetry

Established: 2000

Terms of AR Robertson CA

Reference:

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

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

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, Y Ohno US, MR Pointer UK, K Richter DE, G Roesler 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(UK), M Pointer; ISO TC38/SC1/WG7(US), R Harold; ISO TC42, D. McDowell; ISO TC130, D. McDowell; ISO/IEC/JTC1/SC28, K Richter

TC 1-57 is responsible for 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. It has now also been approved by ISO and published as ISO 11664-4.

The third draft of Part 5 was approved by the TC and passed to the Division Secretariat and the Central Bureau for Division and Board of Administration ballots in June 2007. It was approved by the Division and the Board of Administration in January 2008. It was then sent by the Central Bureau to National Committees for comments as DS 014-5.2/E:2008 with a deadline of 5 August 2008. A new version, DS 014-5.3/E:2008 has now been sent for National Committee voting with a deadline of 2 January 2009.

A second draft of Part 3 (Tristimulus values) was sent to the TC in January 2008. Comments were generally favourable but a third draft was needed. Most of the changes related to abridged methods for 10- and 20-nm intervals where care must be taken to follow the recommendations of CIE Publication 15:2004 and not to pre-empt the work of TC 1-71 (Tristimulus integration). This third draft referred to the weighting-function method for 10- and 20-nm intervals but stated clearly that this method produces

results that may differ from the standard method (1-nm interval, 1-nm bandwidth) and that (for the time being), it is the user's responsibility to determine suitability for their purpose. The draft refers to published work (ASTM, Li, Ohno etc) but only as "informative" references, not as "normative" references. Hopefully, the work of TC 1-71 will pave the way for a second edition of the Standard in the future which will deal with "abridged" input data. The related work of TC 2-60 (Effect of Instrumental Bandpass Function and Measurement Interval on Spectral Quantities) is also being monitored to be sure that the Standard does not conflict with potential recommendations of that TC. Only a few comments were received so a fourth draft was prepared for liaison members to solicit comments from various ISO and IEC Committees and Working Groups.

The final work of the TC will be Part 6 (CIEDE2000). A first draft will be produced within a few months.

TC1-61 (C) Categorical Color Identification

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, K Okajima JP, M Pointer UK, L Ronchi IT, K Sagawa JP, J Schanda HU, H Shinoda JP, O Da Pos IT, MR Luo UK, H Yaguchi JP, F Viénot FR(observer)

This TC met in Stockholm on June 14, 2008 where contents of the technical report were discussed. It was suggested that the report should include data comparison among color categories in the photopic level obtained in related studies. The draft will be prepared and circulated to TC members.

TC1-63 (C) Validity of the Range of CIE DE2000

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, K.R. Gegenfurtner DE, T. Holtsmark NO, M.R. Luo GB, M. Melgosa ES, Y. Nakano JP, J. Nobbs GB, C. Oleari IT, D. Rich US, J. Schanda HU, T. Seim NI, M. Vik CZ, P. Walraven NL, H. Yaguchi JP

K. Richter chaired a TC1-63 meeting in Stockholm in June 2008. Five members and about 20 guests were present. According to the Terms of Reference there are now reports for large colour differences and first reports for small (threshold) colour differences.

1. Large colour differences

For large colour differences the mean of the four countries' data indicates that CIELAB is better than or equal to CIEDE2000. This result is based on a research project which was developed for large colour differences.

Colour differences larger than 10 and up to 25 CIELAB units between both white and black and the three primary and three secondary colours of offset printing have been produced and studied.

There are publications from P. Kittelmann (2005), M. Vik (2007), M. Melgosa (2007, 2008) and R. Luo (2007) with the experimental results from the four countries DE, CZ, ES, and GB.

A visual representation of one of the three colour test charts used in the experiments can be found at <http://www.ps.bam.de/ME25/10L/L25E00NP.PDF> A questionnaire to fill out is in on page 2 of the file output.

2. Large and threshold colour differences

In 2008 R. Luo and P. Kittelmann gave reports at the TC1-63 meeting about their recent results for large, medium and threshold data. According to R. Luo CIEDE2000 performs best for the overall region. According to Melgosa and Kittelmann the stress index indicates bad results for the colour threshold area compared to the other areas for both CIELAB and CIEDE2000.

Therefore this area needs further studies. P. Kittelmann has produced many experimental results at threshold as a function of many parameters, including field size and sample distance; these data will be available during 2009 when his PhD thesis is to be published. A special procedure of adding coloured light to one half of the sample allows P. Kittelmann to avoid the hairline effect at the border of adjacent colours. According to K. Witt, 20% of the observers report a colour differences even if the samples are identical. This produces problems for the evaluation of the experimental data and this effect is excluded by the Kittelmann procedure (no gloss differences and no hairline geometric difference). A table, given in the minutes of the CIE Division 1 Stockholm meeting and published at the CIE Division 1 website (Minutes of the 2008 meeting) shows some preliminary results with optimized weighting factors for many colour difference formulas. If both the weighting factors for the red-green and yellow-blue visual processes are reduced by a factor 2 and additionally by factor 3 for yellow-blue with no change in black-white direction, then the Stress values S100 (normalized to 100) increase to a large degree (from 60 to 80) for CIELAB. If an optimization is used, then at threshold CIELAB performs better than CIEDE2000.

3. Reasons for some of the problems

In the literature, an effect known as small-field (yellow-blue) tritanopia is described. At about 4 minutes (0.06) it is not possible to distinguish colours in the yellow-blue direction of equal luminance. The reason is that the (blue) S cones are rare in the retina, so the spatial discrimination in the yellow-blue direction is limited. One paper shows a reduction of the yellow-blue contribution to the colour difference by a factor 2 at 30 minutes (0.5 degree) compared to 2 degrees.

In a diploma work, S Lander (2008, TU Berlin) has studied visually a 9 step colour series between white and yellow and the complementary series between black and violet-blue. The colour difference between two adjacent steps was in the region of approximately $\Delta E^*_{ab} = 8$. All steps appear as a continuous series and the single steps disappear at about 1 degree viewing angle. This indicates that the change of the colour difference as a function of viewing angle is an important factor.

CIEDE2000 was developed for a viewing angle of 10 degrees. For image applications, the viewing angles are often less than 2 degrees. The experimental results of Lander indicate that the yellow-blue discrimination may be reduced by a factor 2 or more for 2 degrees compared to 10 degrees.

The next TC1-63 meeting is planned in Budapest in June 2009.

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

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

The committee members are reviewing new terms suggested by Division 1 members or introduced in recent Technical Reports. However, significant progress is not possible until the ILV has been published and the Board of Administration decides on the process for adding new terms to the ILV.

TC1-66 (C) Indoor Daylight Illuminant

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

The final report has been printed and is expected to be published in January 2009.

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

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 Bodrog 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 Inver TR, F Viénot FR, K Xiao KR

Advisor: G Derefeldt SE

1. Besides the spectral composition and the intensity of the stimulus, colour perception is also affected by the viewing situation: the surrounding colours, the gloss, translucency, and texture of the coloured object (MapNet, CIE TC 1-72), the mode of appearance (object, surface, or self-luminous), other cognitive factors, viewing time, and also, the size of the colour stimulus (colour size effect, CIE TC1-68). Latter factors depend on the application: building façades (outdoors), painted walls (indoor room colours), large (even immersive) self-luminant screens (home cinema or head mounted display) or colour selection tools on a computer monitor.

2. From recent literature [1-6] it is apparent that neither the standard observers nor CIECAM02 can predict the colour size effect i.e. the colour appearance of large ($>20^\circ$) uniform stimuli on a neutral background (or as unrelated colours). Authors agreed that for larger samples, the perceived colours generally exhibited more lightness than expected from the models but the tendencies of perceived chroma (or colourfulness) depended on the viewing condition. Generally, no systematic hue changes were found.

3. It has become obvious that the explanation of the colour size effect should go beyond eye anatomy and eye physiology. The concept of equivalent colour (a small (2°) size stimulus in a standard viewing condition that appears the same as the large stimulus) can be used to quantify the appearance of the large ($>20^\circ$, uniform or nearly uniform) stimulus because the currently endorsed colour appearance model (CIECAM02) is designed for small-size related colours (1° - 10°) and the large stimulus can be unrelated or the other stimuli are in the periphery of the field of view. A model of the colour size effect predicts e.g. the CIECAM02 J, C, H correlates of the equivalent colour as functions of similar correlates of the "inherent" colour [4] of the large stimulus. The inherent colour can be computed by CIECAM02 e.g. by replacing the

large uniform stimulus with a 2° stimulus of the same tristimulus values and using an appropriate adopted reference white.

4. CIE TC 1-68 is currently preparing a Technical Report on this issue.

1. Xiao K, Luo RM, Hong G, Taylor C. Modelling Colour Stimulus for Different Sizes. Proceedings of AIC Color 05, Granada, Spain; 2005. pp 1067–1070.
2. G. Kutas, P. Bodrogi, Color appearance of a large homogenous visual field, Color Res. Appl. 33/1, pp. 45-54, 2008.
3. Osvaldo da Pos, Annarita Rapanà, Alessandra Gliro, How size can affect colour perception, Proc. AIC 2008, Stockholm, 2008.
4. Karin Fridell Anter, What colour is the red house? Perceived Colour of Painted Facades. NCS Publication, 338p, 2000.
5. Gombos, K, Schanda, J. Interrelationship between size and brightness dimensions of appearance, CIE Expert Symposium on Visual Appearance, Paris, 19-20 October (2006).
6. Masato Sato, Kazumi Nakayama, Kazuyuki Natori, A study on the area effect for wall colours, J. Archit. Plann. Environ. Eng. , AIJ, No. 555, pp. 15-20, 2002.

TC1-69 (C) Colour Rendition by White Light Sources

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: Richard Young US, Ronnier Luo GB, Changsoon Kim KR, Peter Bodrogi HU, Danny Rich US, Yoshi Ohno US, Ferenc Szabó HU, János Schanda HU, Emil Radkov US, Hirohisa Yaguchi JP, Peter van der Burgt NL, Boris Shugaev RU, Kenjiro Hashimoto JP, Robert Hirschler HU, Danielle Ferreira de Oliveira BR, Ian Ashdown CA, Osvaldo da Pos IT, Cheng Li GB, Andrew Jackson US, Günther Heidel DE, Ronald Daubach US, Ulrich Binder DE, Werner Jordan DE, Rolf Bergman US, Peter Hanselaer BE, Klaus Richter DE, Maria Thompson US, Sophie Boissard FR, Françoise Viénot FR, Katalin Toth HU

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.

This committee has been maintaining its timeline. An experiment guidelines subgroup was formed, but low participation made it unable to issue guidelines. The remainder of this year was dedicated to conducting vision experiments.

A Technical Committee meeting was held at the CIE Division 1 meeting in Stockholm, Sweden in June. Twelve active Members were in attendance, as well as many observers. Those conducting experiments gave updates on their work. Updates were provided by those who previously submitted experimental plans including Ronnier Luo, Janos Schanda, Emil Radkov, Wendy Davis, Peter van der Burgt, and Sophie Boissard.

The committee also heard about relevant research from Françoise Viénot, Osvaldo da Pos, and Kevin Smet.

Next year should be quite exciting, as experiments will conclude and the committee will move toward a decision.

TC1-70 (C) Metameric Samples for Indoor Daylight Evaluation

Established: 2007

Terms of: To investigate the derivation of a set of metameric samples to enable

Reference: the evaluation of indoor daylight simulators

Chairman: B Kránicz HU

Members: Péter Bodrogi DE, Robert Hirschler HU, Danny Rich US, Alexander Rosemann CA, János Schanda HU

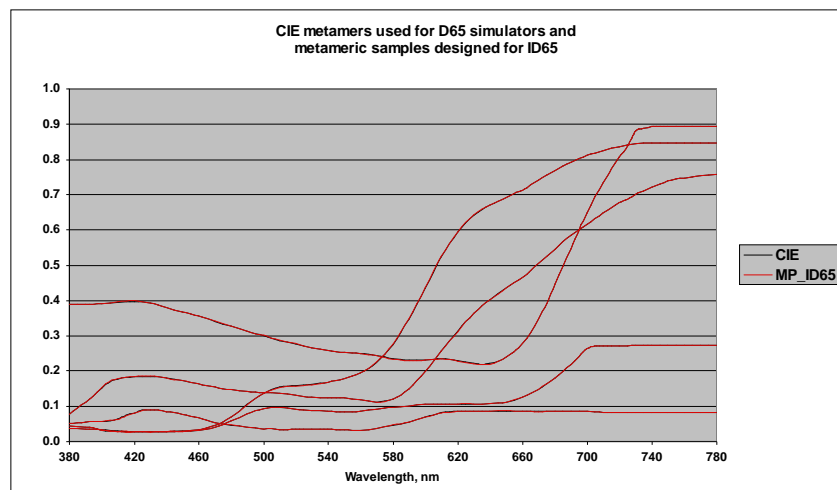
Based on the work *ISO - CIE: Standard method of assessing the spectral quality of daylight simulators for visual appraisal and measurement of colour, ISO 23603:2005 (E) - CIE S 012/E:2004*, five metameric samples have been derived for **ID65** and **ID50** as well, but at this time only for the evaluation of indoor daylight simulators in the visible range.

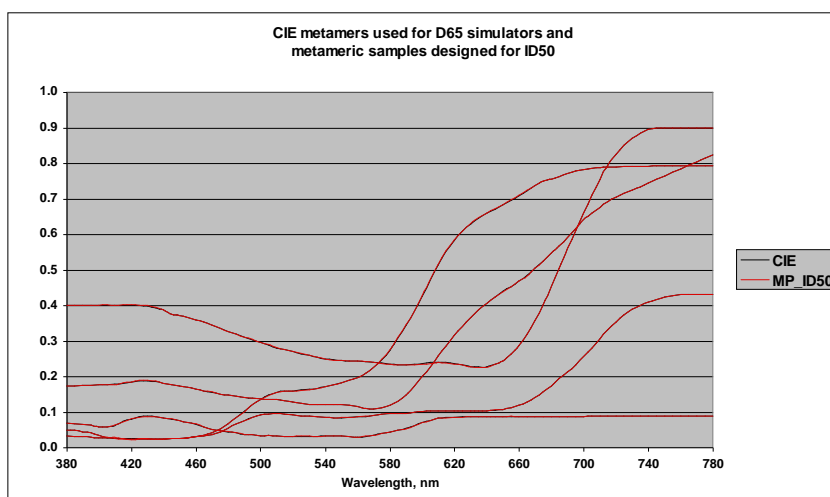
Committee members showed high interest in the results.

If the metameric pairs will be accepted they can be used as those given in the ISO-CIE standard detailed above.

Next working steps:

1. Investigation of fluorescent properties of indoor daylights (ID65 and ID50) and derivation of samples for the evaluation of indoor daylight simulators in the UV range.
2. Publication of the method how metameric samples with prescribed mathematical properties can be derived for colorimetric applications.





TC1-71 (C) Tristimulus Integration

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: J Campos Acosta ES, M Brill US, H Fairman US, B Jordan CA, Y Ohno US, C Oleari IT, M Pointer UK, AR Robertson CA, G Roessler DE, J Schanda HU, R Seve FR, G Wang CN

We have had very useful discussions amongst members. The progress up to now can be summarized as below:

For accurately computing the CIE tristimulus values and for the best agreement among the laboratories, we need a unified method. To fulfill the aim of this TC we should:

1. Study the effects of bandpass and scanning interval on object colour measurements;
2. Recommend a standard method for computing weighting factors for calculating CIE tristimulus values for reflectance measured at an interval larger than 1nm.

$$X = \sum_{j=0}^n W_{X,j}^{(\Delta\lambda)} R_j$$

3. Quantify the accuracy using the equations $Y = \sum_{j=0}^n W_{Y,j}^{(\Delta\lambda)} R_j$ with $\Delta\lambda = 5, 10, \text{ and } 20$

$$Z = \sum_{j=0}^n W_{Z,j}^{(\Delta\lambda)} R_j$$

nm;

4. Recommend sets of weighting factors under some specified illuminants such as A, C, D50, D65, D75, F2, F7 and F11, under two standard observers at 10 nm and 20 nm intervals;

Agreed Testing Procedure:

1. Interpolate the reflectance values from the available resolution to 1 nm using the Lagrange-cubic method.
2. Obtain 1-nm resolution \bar{x} , \bar{y} , \bar{z} color-matching functions, and also obtain 1-nm resolution data for the illuminant SPD (using Sprague interpolation if needed).
3. Compute ground-truth XYZ values by taking a wavelength-by-wavelength product of color-matching functions, illuminant SPD, and reflectance spectrum, and then summing the values (a 1-nm Riemann sum).
4. Subsample the reflectance values above to $\Delta\lambda$ nm, using an assumed triangular instrument waveform.

5. Using the candidate method develop a $\Delta\lambda$ -nm weight set for the given illuminant and the \bar{x} , \bar{y} , \bar{z} color-matching functions specified in (2) above. (**Note: Step 5 is the only place at which the weight-set method enters.**)
6. Compute XYZ values for the candidate method by multiplying the Step-4-subsampled reflectance with the weight set of Step 5, wavelength by wavelength at $\Delta\lambda$ -nm increments, and performing a $\Delta\lambda$ -nm-weighted sum to produce the integral.
7. Compare the XYZ values at Step 6 with the ground-truth XYZ values at Step 3.

Agreed Methods for testing:

ASTM Table 5, ASTM Table 6, Venable method, Optimum weights by Li, Luo and Rigg, Least Square Weights by Wang, Li and Luo, Direct Selection method, Oleari 's Local Power Expansion, 'CIE-R'.

Comprehensive comparisons are underway. Hopefully, the best method can then be recommended.

TC1-72 (C) Measurement of Appearance Network: MApNet

Established: 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.

Chairman: MR Pointer GB

The work of the Technical Committee is now established with work divided into eight areas:

- | | |
|-------------------------------------|---------------------|
| 1. Physical Aspects of Appearance | 5. Colour |
| 2. Non-Imaging Appearance Metrology | 6. Translucency |
| 3. Imaging Appearance Metrology | 7. Texture |
| 4. Gloss | 8. Total Appearance |

Each group except the last has a Technical Leader several of whom have submitted reports summarizing relevant activities during 2008. The total report is too long to include in this Activity Report: it can be obtained from the TC Chair, Mike Pointer at mrpointer@btinternet.com and will be available on the CIE D1 website.

Next CIE Expert Symposium on Appearance

Following the very successful symposium organized by Françoise Viénot and her team in Paris in October 2006, the TC is planning the next CIE Expert Symposium for September 2010.

Peter Hanselaer (CIE Division 1 member for Belgium) and Frédéric Leloup (CIE TC1-72 Technical Leader for non-imaging appearance metrology) have agreed to host the next symposium at the Catholic University College St.-Lieven, Gent, Belgium. Further details will be available later in 2009.

New Technical Committees

There are ongoing discussions on the feasibility of forming separate Technical Committees on Gloss, and Surface Texture.

COLOR SECTION: REPORTERS

R1-32 (C) Emotional Aspects of Color
Established: 2003
Terms of: To review the literature on various non-image related effects of color and light.
Reference: light.
Reporter: G Derefeldt SE

A volunteer is desired to carry on the objective of this reportership.

R1-39 (C) Alternative Forms of the CIEDE2000 Color-Difference Equation
Established: 2006
Terms of: To investigate alternative formulations of the CIEDE2000 equation and to make a recommendation to the Division on any necessary action.
Reference: and to make a recommendation to the Division on any necessary action.
Reporter: MR Pointer GB

A Technical Report has been prepared, was presented to the Beijing meeting in 2006 and has been reviewed by the Editor. Publication of this report awaits the publication of a relevant paper in the literature.

R1-42 (C) Extensions of CIECAM02
Established: 2007
Terms of: To evaluate potential additions to CIECAM02 in liaison with Division 8 and to include:
Reference: Those published in the literature;
Extension to include unrelated colours;
Extension of the range down to scotopic levels
Reporter: C Li CN

CIECAM02 now is widely used as a connection space for colour management in digital imaging systems; colour difference evaluation and, in addition, it can provide a uniform colour space: CIECAM02-UCS. However, work on further modifications and extensions to the basic model is underway.

Repairing the Mathematical Failure of CIECAM02

The Work of Michael H. Brill & Sabine Ssstrand

It was believed that if the chromatic adaptation transform (CAT02) failure could be corrected, it may be possible to correct the CIECAM02 colour failure problem and so much work has been carried out to improve the chromatic adaptation transform. It has been found that the red and green CAT02 primaries lie outside the HPE triangle and so this has been called the 'Yellow-Blue' problem. Brill and Ssstrand have suggested that the problem can be corrected by changing the last row of the CAT02 matrix to (0, 0, 1).

However, this repair seems neither to correct the failure of CAT02, nor the failure of CIECAM02. So Brill and Susstrand further suggested that a possible repair to the CIECAM02 failure might be made by modifying R' , G' , B' using:

$$R = \max(R', 0), G = \max(G', 0), \text{ and } B = \max(B', 0)$$

Thus, we always have for the achromatic signal:

$$A = [2 R'_a + G'_a + 0.05 B'_a - 0.305] \text{ for } M_{bb} \quad 0$$

Therefore, $J = 100 (A/A_w)^{0.2}$, is well defined since A_w is always a positive value [Li & Luo, 2005].

However, the above approach poses a problem with the inverse model because it cannot be conveniently inverted.

The Work of Li, Perales, Luo and Verdú

They tried to correct the CAT02 failure by a mathematical approach:

1. The CAT matrix M should be chosen so that:

$$g_c = M^{-1} \Lambda M g \geq 0$$

Here Λ is a diagonal matrix depending on the test and reference illuminants, g is the vector of the tristimulus values with its chromaticity coordinates located on or inside the CIE chromaticity locus, g_c is the tristimulus value of the corresponding colour.

2. Fitting the visual data sets (used for deriving CAT02).

1. and 2. result in a nonlinear optimization problem.

By solving the optimization problem, a new CAT matrix was derived:

$$M_{new} \begin{pmatrix} 1.007245 & 0.011136 & -0.018381 \\ -0.318061 & 1.314589 & 0.003471 \\ 0 & 0 & 1 \end{pmatrix}$$

It was found that i) the CAT02 failure problem is solved, i.e., for any colour g with its chromaticity coordinates located on or inside the CIE chromaticity locus, the corresponding colour g_c ≥ 0 ; ii) The accuracy for fitting the visual data sets is about 1.0 E_{ab} worse than before; It seems we have to sacrifice certain accuracy for the repairing the CAT02 failure; iii) This approach does not correct the failure of CIECAM02.

In an ideal case, the maximum domain for the CIECAM02 should include all the colours with their chromaticity coordinates located on or inside the CIE chromaticity locus. Toward this and motivated by their previous work, we need:

1. Choose CAT matrix M so that

$$g' = M_{HPE} M^{-1} \Lambda M g \geq 0$$

Here Λ is a diagonal matrix depending on the test and reference illuminants, g is the vector of the tristimulus values with its chromaticity coordinates located on or inside the CIE chromaticity locus, g' is the vector consisting of R , G and B ;

2. Fitting the visual data sets (used for deriving CIECAM02).

The above approach is underway.

The work of Graeme W. Gill

Graeme W. Gill has published a paper in the CIC16 (2008):

Graeme W. Gill, A solution to the CIECAM02 numerical and range issue, 16th IS&T Color and Imaging Conference, November 10-15, 2008, Portland, Oregon, USA, pages: 327-331.

This paper deals with the problem of CIECAM02 linking with ICC PCS. Suggestions have been given for dealing with colours outside the domain of CIECAM02. This work described in this paper will be further evaluated.

Extension of the CIECAM02 to Unrelated Colour Appearance Prediction

In Leeds, a PhD project has been set up for extending the CIECAM02 to predict unrelated colour appearance. The project has been completed and visual data has been accumulated. The CIECAM02 has been evaluated using the accumulated dataset. It was found that the CIECAM02 works very well for the hue and is better for the colourfulness prediction, but worse at predicting the brightness compared with the Hunt CAM97u model.

LIAISONS

L1-1 AIC (Association International de la Couleur)

Liaison: P J Alessi

AIC has been very busy with many activities. Brazil: Pro-cor has been accepted as a new AIC regular member. For more details on Brazil's national color association, visit www.procor.com.br.

The AIC 2008 Interim meeting was held on Stockholm, Sweden from June 15-18, 2008, hosted by the Swedish Colour Centre Foundation. The topic of the meeting was "Colour – Effects & Affects". This was a very interesting meeting. The effects of color that were discussed included color in interior and exterior design, like the change of color impressions depending on distance, lighting, color combinations and color interactions. The affects of color that were discussed included how color affects us as in color psychology, color meaning, color associations, and color emotions. The Proceedings of this meeting have been published in hardcopy and on DVD.

The AIC 11th Congress will be held in Sydney, Australia from September 27 to October 2, 2009. The Color Society of Australia is hosting the meeting. The deadline for paper submission is January 30, 2009. Congresses are very special events for AIC since they occur only every four years. Attendance is very rewarding as very high quality papers on state-of-the-art color information is always exchanged. This 11th Congress will feature papers on Color in Nature, Color Physics, Color Chemistry, Color Vision, Applications of Color Science, Color Imaging, Color Psychology, Color Communication, Color Theory, Color in Art, Design and the Built Environment, Color in Clothing Fashion, Appearance Measurement, and Color Education. A series of pre-congress Colour Skills workshops will be offered. These workshops will be sessions providing an overview of current issues in colour vision, colour technology and colour in art and design. Additionally there will be two symposia the themes of which will be approached from the perspective of the arts and the sciences. The symposia themes are 'Good' colours, 'bad' colours, humanity and the environment and Appearance: phenomena and measurement. Papers for oral or poster presentation will be subject to review, but they are also offering the opportunity to have author full papers sent to referees. The Congress proceedings will be published in separate volumes, one exclusively for fully refereed papers. The Colour Market is a new concept for this 11th Congress. This Colour Market will have books and examples of Australian design for sale as well as displays of instruments and other products for those who work professionally with colour. The social programme includes a welcome reception as well as a banquet. The choice of excursions will include an opportunity to climb to the top of the Sydney Harbour Bridge. The colours of Australia will be highlights of pre- and post-congress tours. Destinations will include the Great Barrier Reef and the 'Red Centre'. This 11th AIC Color Congress promises to be a very enriching one. For more information, visit the congress website at www.aic2009.org.

The AIC 2010 Interim Meeting will be held in Mar del Plata, Argentina. It will be hosted by the Argentine Color Group and the topic will be Color and Food: From Production to Consumption.

The AIC 2011 Mid-term Meeting will be held in Zurich, Switzerland. It will be hosted by Procolore and the topic will be Staging Color.

L1-2 CCPR (Comite Consultatif de Photometrie et Radiometrie), BIPM

Liaison: M. Stock

The CCPR did not meet during 2008, but its working groups met before and after the NewRad conference in Daejeon, Korea, in October 2008. The following gives a short summary of each meeting.

The key comparison working group (WG-KC) initiates key comparisons in the field of radiometry and photometry. These are the technical foundation for the mutual recognition of national measurement standards and of calibration and measurement certificates issued by national metrology institutes in the framework of the CIPM MRA (Mutual Recognition Arrangement, www.bipm.org/en/cipm-mra).

A standing agenda item of the meetings is an update on the status of the ongoing key comparisons, carried out by the CCPR and the Regional Metrology Organizations (RMOs). Most key comparisons of the first round are now finished and preparations for the second round have started. The second round will start with a comparison of regular spectral transmittance in 2010. The timeline foresees the start of one comparison per year, until 2017. The results of the key comparisons can be found in the key comparison data base kcdb.bipm.org.

The working group on calibration and measurement capabilities (WG-CMC) coordinates the international review of the declared calibration and measurement capabilities (CMCs) of national metrology institutes. The outcome of this review process is a list of internationally recognized CMCs, which are listed in the key comparison database of the BIPM (kcdb.bipm.org/AppendixC). For radiometry and photometry, calibrations of 36 countries are now covered, the total number of recognized calibrations in this field is larger than 950. At its last meeting the working group has discussed in which key comparisons a national metrology institute needs to participate to support its CMCs for a particular measurement service.

The working group on strategic planning (WG-SP) advises the CCPR on future directions and will monitor developments with respect to possible future modifications of the SI system of units. At the last meeting a first discussion on the future structure of the CCPR working groups was held.

The next meeting of the CCPR and its working groups will take place on 14-18 September 2008 at the BIPM. General information on the work of the CCPR can be found on www.bipm.org/en/committees/cc/ccpr.

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

Liaison: J C Zwinkels

There has been the following change in the membership of TC6/WG3: Mr. Petteri Maijanen is the new Finnish expert.

The following six FDIS standards have completed balloting and been prepared for final publication: FDIS 5631-3 *Paper and board - Determination of colour by diffuse reflectance method, - Part 3: Indoor illumination conditions (D50/2°)*, FDIS 5631-2 *Paper and board - - Determination of colour by diffuse reflectance method, - Part 2: outdoor illumination conditions (D65/10°)*, FDIS 2470-2 *Paper, board and pulps – Measurement of diffuse blue reflectance factor – Part 2: Outdoor daylight conditions (D65/10°)*, FDIS 2471 *Paper and board – Determination of opacity (paper backing) – Diffuse reflectance method*, FDIS 9416: *Paper – Determination of light scattering and absorption coefficients using Kubelka-Munk theory*, and FDIS 22754: *Pulp and paper: Determination of the effective residual ink concentration number (ERIC) by infrared reflectance measurements*. The following DIS standard: DIS 5631-1 *Paper and board: determination of colour by diffuse reflectance – Part 1: Indoor daylight conditions (C/2°)* has been approved (100%) for direct publication.

An important issue that will need to be resolved in the next revision of these Standards is ensuring that the terminology is consistent within the various related International Standards ((i.e. Parts 1, 2, etc.)

The following FDIS standard is being balloted: FDIS 8254-1 *Measurement of specular gloss – Part1: 75° gloss with a converging beam, TAPPI method*

The following ISO Standard has completed balloting at the DIS stage and is being prepared as an FDIS: ISO 2470-1 *Paper, board and pulps – Measurement of diffuse blue radiance: factor – Part1: Indoor daylight conditions (ISO brightness)*

The CD Standard: CD 11476 *Paper and board – Determination of whiteness, C/2° (Indoor illumination conditions)* has been registered as a DIS

The new work item for revision of ISO 2469 *Paper, board and pulps – Measurement of diffuse radiance factor* to incorporate a means to ensure that the UV intensity is negligible below 300 nm, has been adopted as a working draft (WD). .

At the June 2008 meeting of the ISO TC6/WG3 Optical Properties Authorized Laboratories (know as OPAL), a decision was made to further harmonize calibration procedures so that measurements traceable to different calibration laboratories would agree better. This recently-adopted harmonization procedure significantly affects the whiteness values of the fluorescent reference standards by an average of 1.7 CIE whiteness units. This change in whiteness level has been implemented by all five ISO authorized laboratories.

L1-4 ISO/TC38/SC1: Textiles: Colour Fastness & Measurement

Liaison: M R Luo GB

- The CMCCON02 colour inconsistency index is now officially accepted as an international standard. The full reference is ISO 105 J05:2007 Tests for Colour Fastness – Part J05: Method for instrumental assessment of colour inconsistency of a specimen with change in illuminant (CMCCON02).
- A method for assessing colour fastness grades by digital imaging technique is passed the working draft stage in the process of national ballot voting. 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 proposal on Dyer's terms for optimised colour difference equations is in the preparation stage.. The method allows to transform three conventional colour difference terms (lightness, chroma and hue) to the dyer's terms (depth, brightness and hue), for which each has a descriptor of brighter-duller, fuller-thinner and redder-greener-yellowier-bluer, respectively.

L1-5 ISO/TC42: Photography

Liaison: J Holm US

WG18 (Digital photography)

- Met in Köln 1-2 October 2008.
- ISO 12231 (Vocabulary) Edition 3 PWD completed; NP to be circulated for ballot.
- ISO 14524 (OECF) Edition 2 submitted for publication.
- ISO 12234-1 (Digital camera removable memory – metadata and file formats) Edition 3 revision work continues: metadata persistence clause to be updated and then submit for NP ballot.

- ISO 12234-2 (TIFF-EP) Edition 2 revision work continues. Preliminary agreement on defining two interoperability profiles with different file extensions (.tif & .dng). Detailed and significant technical discussions continue in the ad-hoc group.
- Next meeting 12-14 May 2009 in Fort Worth, TX (including color ad-hocs).

JWG20 (Digital camera colour characterisation)

- Met in Köln 30 September 2008
- ISO TC42 JWG20 resolves to form an ad-hoc group consisting of Mr. Wüller, Mr. Urabe, Dr. Hubel, Mr. Walowit and Mr. Holm with the charter to create a new PWD of ISO 17321-2, retaining the title "Graphic technology and photography – Colour characterisation of digital still cameras (DSCs) – Part 2: Methods for determining transforms from raw DSC to scene-referred image data" for consideration as a proposed NP.
- NOTE AMPAS ATPIIF Committee agreed to circulation of Digital Capture and Encoding draft in ISO and ICC (after minor edits).
- Next meeting 15 May 2009 in Fort Worth, TX.

JWG21 (Densitometry)

- Met in Amsterdam 26 September 2008.
- ISO 5 series (Densitometry) NP/CD comments resolved; DIS ballots in progress.
- Next meeting 15 May 2009 in Fort Worth, TX.

JWG22 (Joint colour work between ISO TC42, ISO TC130 and IEC TC100)

- Met in Köln 30 September 2008.
- Currently no joint work with IEC. Continue input to PT61966-12 (Gamut ID metadata) on liaison basis.
- Next meeting 15 May 2009 in Fort Worth, TX.

JWG23 (Extended colour encodings)

- Met in Köln 30 September 2008.
- ISO 22028-2 (ROMM RGB) - Prepare final PWD text, including figure and table. Propose NP for IS (elevating from TS).
- ISO 22028-3 (RIMM/ERIMM RGB) - Submit input on floating point RIMM idea.
- ISO 22028-4 (ECI RGB) - Submit final draft technical specification for ballot.
- Next meeting 15 May 2009 in Fort Worth, TX.

JWG24 (ISO 3664 – Viewing conditions)

- Met in Köln 29 September 2008.
- DIS of Edition 3 approved but negative vote from Germany. Informative annex with example calculations in preparation. FDIS to be circulated early 2009 (unless Germany withdraws negative vote in which case will go direct to publication).
- Next meeting 16 May 2009 in Fort Worth, TX, USA.

L1-6 ISO/TC130: Graphic Technology

Liaison: D C Rich

During the past year, this ISO technical committee has been very busy working on standards that reference CIE recommendations and standards. Of particular interest to Division 1 are the following activities.

TC130 Graphic Arts and TC42 Photography have three joint working groups, One is involved in revising all of the standards on the measurement of reflection and transmission density (ISO 5-1, 5-2, 5-3 and 5-4). The second is involved in revising ISO 3664, the standard for sources for viewing graphic arts materials for color and tone. The third is involved in revising 13655, the standard on the measurement of the color of printed images. The latter two are based on CIE D50 but have been wrestling

with the problem that CIE Division 1 has not yet issued a complete methodology for assessing the ultraviolet range of this illuminant. Publication 51 added visual range metamers for D50 and ISO 23603 extend the original work from D65 to D50 for UV (300nm to 400nm) spectral region and changed some procedures and tolerances from the 1964 (u,v) chromaticity diagram to the 1976 (u',v') diagram. This is becoming a critical issue as more substrates for printing, especially digital print, are being supplied with increasing amount of fluorescent whitening agents. In addition, the series of CIE / ISO standards continue to give inconsistent recommendations on the spectral ranges and sampling intervals for tristimulus integration.

There are two approaches to resolve this problem. In 3664 on viewing sources and in 13655 on instrumental measurements, three sources have been defined. Source 1 will be a close simulation of CIE D50 (category BB or better). Source 2 will be a source that is a category B or better simulation of D50 in the visible, using the methods of Publication 51 but includes an sharp-cut filter that blocks all radiations below 400nm. For spectral measurements this requirement is relaxed and any spectral source can be used as long as it has no UV radiance. International inter-comparisons of implementations have shown that the recommendations in CIE Publication 51 are difficult to follow, contain some misleading information and the standard ISO 23603 has no example computations or guidance at all.

ISO TC6/WG3 made a proposal to TC130 that they adopt a new illuminant for the graphic arts. In the past 2 years, TC6 has been active in developing new standards that use an illuminant which they have named, "Indoor Daylight". This illuminant was constructed by taking the historical CIE illuminant C and extrapolating the short wavelength end of the spectrum down to 300nm. Since the graphic arts has standardized on CIE D50 but has no definition of the UV portion, TC6/WG3 suggests that TC130 adopt D50 for wavelengths above 400nm and "Indoor Daylight" below 400nm. It is highly desirable to have a CIE prescription for simulation of D50 below 400nm. We are anxiously waiting for the recommendations of CIE TC 1-44.

In ISO standards that involve tolerances on the color of reproductions are beginning to either replace or supplement the traditional CIELAB differences with CIEDE2000 tolerances. Experience is showing that the newer equation is giving reliable results for visual correlation.

L1-7 ISO/IEC JTC1/SC28 Office Equipment

Liaison: K Richter

1. New standard documents in SC28

Recent International Standards in the field of colour and gloss are for example:

ISO/IEC 24712:2007

Colour test pages for measurement of office equipment consumable yield

ISO/IEC 19799:2007

Information technology—Method of measuring gloss uniformity on printed pages

The most recent International Standards to be published and less related to colour are

ISO/IEC FDIS 24734

Information technology—Office equipment—Method for measuring digital printer productivity

ISO/IEC FDIS 24735

Information technology—Office equipment—Method for measuring digital copying machine productivity

Projects related to colour are for example

ISO/IEC CD 24790

Information Technology—Office Equipment—Measurement of image quality attributes for hardcopy output—Binary monochrome text and graphic images

ISO/IEC WD 29102

Information technology—Method for the determination of ink cartridge yield for colour photo printing with inkjet printers and multi-function devices that contain inkjet printer components

2. Intended new “Office Colour Work Group” of SC28

After discussions during the last two years it is intended that a new “Office Colour Work Group” will be created at the next SC28 meeting in Korea in June 2009. A first New Work Item will be on “gamut mapping for printers”.

According to the user needs in many countries, “Colour” is an important area for office equipment which consists of, for example, colour copiers, printers, monitors and projectors.

ISO/IEC SC28 uses the CIELAB standard in many standard documents, for example in ISO/IEC 15775, ISO/IEC TR 19797, ISO/IEC TR 24705. The colour data rgb and cmyk used in these documents have a device dependent relation to CIELAB usually described by a lookup-table. If a device is linearized for example according to ISO/IEC TR 19797, then equations instead of lookup-tables describe the relation $rgb - L^*a^*b^*$ which simplifies colour management to a high degree.

For download addresses of some of the public documents of SC28 and new SC28- and DIN-colour test charts see the website: <http://www.ps.bam.de/33872E>

In SC28 there are at present 10 New Work Items listed by the intended Office Colour Work Group, for example Colour space standards for offices provide a device independent common colour space for office equipment.

An example for such a colour space with device independent hue output is described in the standard series DIN 33872-1 to -6 (in print, see the documents on the above website). Such a colour space is realized as Relative Elementary (unique hue) Colour System RECS, see

<http://www.ps.bam.de/RECS>

About 2000 colour samples in 16 hue planes have been printed with standard offset colours on standard (fluorescent free) offset paper. This colour atlas is available and serves as reference input and output for scanners, copiers, printers and monitors. The hue angles (26, 92, 162 and 272 degree in CIELAB) of the CIE-test colours no. 9 to 12 of CIE-Publ. 13.3 for D65 and the 2 degree observer are used as hue angles for the elementary colours. A special colorimetric colour management method has been developed to produce the equally spaced 16 step colour series, for example in elementary and three intermediate hue planes between elementary hues for any device.

Technically for the production of the RECS atlas the rgb device coordinates are interpreted as rgb^* elementary coordinates. The four elementary colours RJGB (J = French Jaune = Yellow) of maximum chroma of a device are produced for the rgb^* coordinates (1,0,0), (1,1,0), (0,1,0), and (0,0,1). 16 equally spaced steps in CIELAB between White and Black and between R, J, G, and B are realized in the RECS atlas. For the realisation of both intentions a transformation from rgb to rgb' is necessary. A new colorimetric method is available for the calculation of this transformation for any device. This transform needs for example a 9x9x9 grid of rgb input colours and the corresponding measured CIELAB data. For linearized devices, equations describe the relation between rgb^* and LAB^* (CIELAB) instead of Lookup-tables.

ICC colour management according to ISO 15076-1 is for example intended to produce colours of equal CIELAB data. This intention is important in the professional Graphics Arts area (ISO TC 130).

In the office area it is more important not to lose any information, for example the hue must be the same on any device and the 16 steps must be seen and remain on any device between Black and White, White and Red and Black and Red. The present framework of ICC colour management is not intended to realize equally spaced colour series or the elementary hues. The new intentions realized by the RECS atlas are highly device independent. There are DIN-test charts according to DIN 33872-1 to -6 that allow testing agreement with the intentions. For the first time there are now methods to test the colour management of the test chart output by visual criteria even without the RECS atlas using the criteria of DIN 33872-1 to -6.

3. Test charts of SC28 in new ISO 9241-306:2008

The Committee ISO/TC 159 "Ergonomics" has produced a new standard series 9241-30X (X=0 to 8) with the following part
Ergonomics of human-system interaction—Part 306: Field assessment methods for electronic visual displays

This International Standard is based on a test chart of SC28, the black and white test chart no. 3 of ISO/IEC 15775. For the test chart of ISO 9241-306 see the URL (1 page, 100 kByte)

<http://www.ps.bam.de/ME16/10L/L16E00NP.PDF>

ISO 9241-306 includes a form for the evaluation, for example of the computer or the projector display output. This form includes for example the question "Are the 16 steps distinguishable?"

In real applications the reflection of the ambient light changes this property for the test chart output on both the computer and the projected display. The standard defines eight standard ambient reflections with luminance contrast ratios between larger 255:1 and 2:1 (worst case) for white and black. The 16 steps are distinguishable if an appropriate output "gamma" between 1/2,4 and about 1/1,1 is used. The effect of the ambient light is simulated in the following ISO test chart (16 pages, 1,7 Mbyte)

<http://www.ps.bam.de/ME15/10L/L15E00NP.PDF>

For ISO 9241-306 eight simple ICC-profiles (only change of Gamma) are possible to make the 16 steps distinguishable for eight ambient light reflections that produce the different luminance contrast ratios. The standard describes a method to create the eight ICC profiles, for example on the Macintosh operating system. They then can be used also on Windows.

For the area of colour a solution is not given in the standard. At first a transformation rgb to rgb' is necessary to make the output of the 16 step series equally spaced in a dark room (without any display reflection of the ambient light). There is a colorimetric method to calculate the transfer for equal device colour output and additionally the device independent equal elementary colour output. A similar method seems not possible within the present ICC framework.

Many users wish to calculate the changes of the basic profile for the other seven ambient light conditions. Similar for printers the users wish for example to add the influence of a new paper, a new device colorant and of other factors to the basic profile of the printer. At present there seem to be no ICC framework to solve these wishes. Therefore the Office Colour Work Group may come with new solutions. Perhaps a complete new framework may be useful which is based on an alternate rgb^* instead of

the Lab* Colour Connection Space. This may solve the user wish for the equally spaced 16 steps and the elementary colour output.

More information is given in the following publications.

K. Richter, Ergonomic colour image technology with high visual and material efficiency based on elementary (unique) hues, 259-264, 16th **Colour imaging conference**, 2008, Portland.

K. Richter, Colour management reference circle: Scan - File - Print - Scan using a CIELAB camera and standard offset printing, 204-209, Expert symposium on advances in photometry and colorimetry, CIEEx033:2008

L1-8 IALA (International Association of Lighthouse Authorities)

Liaison: M. Nicholson and I. Tutt GB

IALA held a very successful IALABATT/IALALITES Workshop in Copenhagen in October 2008. Some 60 representatives from round the world attended the event which focused on power supplies and signal lights for marine Aids-to-Navigation.

IALA Industrial members provided an excellent display of equipment and presentations on the first day ranged from the use of super-capacitors and fuel cells to signal conspicuity and methods of determining effective intensity. The main work of the workshop was to update IALA recommendations and guidelines, and significant work was done in finalising some 23 documents.

Japan Coast Guard held an Expert Meeting in Tokyo during November 2008 on the topic of Standardization of New Lighting Methods for Marine Aids to Navigation. The meeting broached the subject of visual perception and the executive summary of the report concluded:

- 1. "That a flickering LED light is conspicuous and therefore has the possibility of becoming a new lighting method for marine aids to navigation however the flicker range is shorter than the nominal luminous range of the flickering light under certain conditions and thus the designing the flickering light should be done carefully. Further study and research are needed for its practical application;*
- 2. That Effective Intensity still is a useful tool for designing of marine visual aids to navigation. The Modified Allard Method developed by CIE TC2-49 has paved the way for calculating the effective intensity of all intensity profiles including a train of pulses used in marine aids to navigation;*
- 3. That Apparent Intensity - brightness at supra-threshold levels - is an important concept for designing marine visual aids to navigation and therefore the development of a robust and universal model is required;*
- 4. That Conspicuity is becoming a more important consideration when designing marine visual aids to navigation in built-up areas with many rival lights. However conspicuity is a complex matter and therefore further research on this matter is desired;"*

Recommendations were as follows:

- 5. "That research bodies as well as marine visual aids to navigation authorities are encouraged to conduct research on both apparent intensity and conspicuity. CIE and IALA should promote such research;*
- 6. That CIE and IALA should strengthen their relationship further through higher level liaison;*
- 7. That as the host nation of the meeting, the Japan Coast Guard should submit the report of the meeting including the copy of the presentations to the relevant committees of both IALA and CIE. "*

Accordingly, CIE should receive a copy of the full report of the meeting from Japan Coast Guard in due course.

New Publication

Of the recommendations approved by IALA Council in December, document E-200 was significant. It is a recommendation on Marine Aid-to-Navigation Signal Lights and is divided into six parts. The recommendation deals with colours of lights as well as measurement methods and determination of effective intensity. This and other IALA documents can be found on the IALA website under 'Publications'.
<http://site.ialathree.org/>

The Chairman of IALA EEP would like to express his sincere thanks for the invaluable assistance received from CIE members during the drafting of this important recommendation.

Committee Activity

The Aid-to-Navigation Management (ANM) and Engineering, Environment and Preservation (EEP) Committees of IALA are carrying out work in the area of visual conspicuity. Several working groups are looking at topics such as the effect of synchronising buoy lights, the effect of a flickering flash as well as trying to construct a conspicuity model. Several IALA members are carrying out their own research and the Research & Radionavigation Directorate is proposing to fund a PhD study into conspicuity related phenomena. If any CIE members would like to contribute or partner this study, please contact Ian Tutt in the first instance.

Other Topics of Interest

The use of LED products in marine signals is becoming more widespread with omnidirectional beacons of up to 50,000cd being available from some suppliers. The mariner's perception of such lights is often different to that predicted by photometric measurement, in particular white and red flashing lights. More knowledge is required as to why, in some instances, LEDs appear far more conspicuous than their filtered incandescent counterparts. Almost certainly the adaptation state of the observer plays a part. Preferential atmospheric absorption over the large distances used by mariners can also contribute. Atmospheric attenuation of shorter wavelengths can cause imbalance in the perception of red and green lights, it can also cause a colour shift in white lights making white LEDs appear yellow. As mentioned in the Japan Coast Guard report, conspicuity is a complex matter!

L1-9 **ISO/TC159: Ergonomics**
Liaison: K Sagawa JP

No report.