Color in Science, Art and Industry: The Inter-Society Color Council 75th Anniversary CD

Written and Compiled by
Ellen C. Carter and Cynthia Sturke

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Contents

Preface

In the year of 1931 New York City was a busy place. In May the Empire State Building opened as the tallest building in the world. In another part of the city, the Museum of Science and Industry, two meetings took place. These meetings culminated in the formation of a new North American organization the Inter-Society Color Council. In the same year the CIE made the first major recommendations regarding colorimetric standards in 1931 by approving the Standard Colorimetric Observer. These recommendations formed the basis of modern colorimetry and a new era was begun.

Thus we come together now in 2006 to celebrate an anniversary and have a birthday party. It is good to look at what has occurred over years and to assess where we are now. There are two items on the CD. The major part is a story *Color in Science, Art and Industry: The Inter-Society Color Council*. However, there is also a slide show entitled "Faces of the ISCC." We invite you to join us by viewing this CD.

We have divided the story into three main sections: The ISCC Through the Years, The ISCC Today, and The People of the ISCC. In Part 1 we have attempted to capture the tone of development of the ISCC and some of its significant activities over the years. This part includes six chapters: history, membership, leaders, meetings, project work, and awards. Our major resource for this section was the ISCC *News*. In Part 2, chapters 7 – 10, we provide important information, you might say, a handbook, for current members. We introduce a relatively new feature of the ISCC – the office, then include the Constitution and By Laws, and sources of communication (Chapters 7-9). Chapter 10 is detailed information about the Jubilee Week Activities of the 75th Anniversary. It includes schedules and abstracts for the ISCC Annual Meeting and the Symposium as well as the schedule for the Division 1 Meetings. In the final section we offer nearly 100 biographical sketches of members or former members of the ISCC. Again a major source was the ISCC *News* and also recent publicity announcements.

We want to acknowledge and thank those people who helped to make the CD possible. In particular, we thank Joanne Zwinkels, Alan Robertson, and Sharon McFadden for providing specific information on the Jubilee Week Festivities; Dave Wyble, the ISCC webmaster, who provided the screen capture of the ISCC website; Bob Marcus, Chair of the Publicity Committee, who provided approximately 40 publicity releases from his personal archives; and Terry Godlove, who provided a photo of the original Godlove award as well as a picture of I. H. Godlove. Joann Taylor researched Irwin Priest and wrote his biographical sketch as well as the one on Peter Goldmark. Jack Ladson and Bob Marcus proof read the nearly 100 biographical sketches. A special thank you goes to Hunter Associates Laboratory and in particular to Michael J. Casey who provided extensive help in the technology and reproduction of the CD. Without him you probably would not have had this CD in your hands today. We are grateful for the contributions and support of all these people and the many others that we failed to list individually.

Ellen C. Carter
Cynthia Sturke

The Inter-Society Color Council (ISCC)

An organization of societies and creative individuals working to further the understanding of color.

All about the Inter-Society Color Council

The Inter-Society Color Council was founded in 1931 to advance knowledge of color as it relates to art, science, and industry. Each of these fields enriches the others, furthering the general objective of color education. There are three classes of ISCC membership: Individual, Member-body, and Sustaining. Individual members enter the ISCC in much the same way they may enter other professional societies. Member bodies, represented by appointed delegates, are national and international organizations whose members have a professional interest in color. Any person or organization who desires to support the goals of the ISCC can become a Sustaining member."

The ISCC meets annually for project committee reports, seminars, workshops, and lectures. To promote general interest and knowledge in color, the Council established three Interest Groups to present round-table and papers programs, and a system of Project Committees to pursue specific topics and goals. In addition to the Annual Meetings, special topics are explored in depth at three-day conferences, referred to as Williamsburg Conferences.

The ISCC presents the prestigious Godlove and Macbeth Awards to individuals who have made outstanding contributions in the field of color. The Nickerson Service Award is presented to those who have performed exceptional services to the ISCC.

A newsletter is published six times a year. It features accounts of various meetings, activities, book reviews, and articles of interest about color. In 1976, the Council joined with the Color Group of Great Britain and the Canadian Society for Color to endorse the journal *COLOR Research and Application*. The journal is published by John Wiley & Sons and has added endorsements by several other national color groups. Issued bimonthly, it provides wide coverage throughout the field with articles, industrial notes, book reviews, meeting reports and other features. Members of the ISCC may subscribe to *COLOR Research and Application* at a substantial price reduction.

This CD prepared as part of the celebration of the 75th Anniversary of the ISCC contains much about the ISCC through the years since its inception, the ISCC today, the 75th Anniversary Festivities - including both program and abstracts, and an introduction to many of the people who have been an integral part of the ISCC.

Since its inception the Inter-Society Color Council is a forum for stimulation and cross pollination of ideas among its members, leading to an enlightened understanding of color and color science. If you are not already a member, go to our website for a membership application – **Join today!**
www.iscc.org/pdf/application.pdf

History

Conception

The Inter-Society Color Council had its beginnings in a "color conference" held in Washington, May 14, 1930. This color conference was called by Professor E. N. Gathercoal of the University of Illinois College of Pharmacy in connection with the decennial meeting of the National Formulary 1929 Revision Committee of the U. S. Pharmacopoeia. This committee needed help in the selection of color names for describing drugs and drug products in the U. S. Pharmocopoeia. This "color conference" aroused so much interest that the Executive Committee of the Optical Society of America adopted a resolution on October 30, 1930, that "the need for better organization of those interested in the description or specification of color which found expression at the color conference … can be met by the formation of a joint council consisting of officially designated representatives of the several national societies and associations interested in the description and specification of color." On February 26, 1931, at the Museum of Science and Industry in New York City, forty-seven persons – thirty-one of them of the representing fourteen national associations and sixteen of them interested individuals – met in a preliminary conference to discuss this resolution. Chairman of this first pre-organization committee was Royal Bailey Farnum. Lloyd [sic] A. Jones chaired the next sessions until the election of the first Inter-Society Color Council Chairman, Professor E. N. Gathercoal. The decision was made to form the Inter-Society Color Council at the first meeting held at the Museum of Science and Industry in New York City, September 21, 1931.

[taken from ISCC *News* #247, March/April 1977]

Early Organization

From ISCC *News* #12 dated January 13, 1936, we had an account of the early organization and reorganization of the ISCC.

"MESSAGE FROM THE CHAIRMAN

M. Rea Paul, National Lead Company, Brooklyn, N. Y.

As a result of a preliminary conference, held February 26, 1931, the Inter-Society Color Council came into being on September 21st of that year. Since then, the Council has closely adhered to its aims and purposes and has progressed despite conditions, adverse to its growth, that have existed since its formation.

It is the belief of your Chairman that the Council has rendered a real service to many inquirers and to certain of its member-bodies, notable the United States Pharmacopeia. This latter group submitted a problem that has been successfully solved through the efforts of the Council's Committee on Measurement and Specification.

The Inter-Society Color Council, shortly after its formation realized its plan of organization and procedure was inadequate. Through the efforts of Mr. L. A. Jones who was at that time Chairman, a new set of Articles of Organization and procedure were formulated. New activities could not be undertaken by the Council until this work had been concluded and the status of the member groups had been clearly defined. With the adoption of the new Articles, the opportunity has now been opened for the Council to progress along the lines for which it was originally intended – namely, "to stimulate and coordinate the work being done by various societies and associations leading to the standardization, description and specification of color, and to promote the practical application of these results to the color problems arising in science, art, and industry."

It is your Chairman's belief that the Council should not be thought of as a research group or standardizing body, but instead, an organization held together by a common interest in color, whose function is to disseminate information through publication of news letters and reports. Its second objective consists of an attempt to bring together those individuals having color problems with those who might be encouraged, through individual or cooperative researches, to provide the solution.

At the recent meeting of the Council's Executive Committee, it was decided to discontinue the Committee on Color Specifications, whose work consisted principally of the U. S. P. problem which they so satisfactorily concluded. It was also decided to discontinue the Committee on Color Names, owing to the resignation of the individual holding the primary interest in this subject. The Committee on Membership was continued and your Chairman, with the approval of the Executive Committee, appointed Dr. W. M. Scott as Chairman. It was also decided to continue the Committee on Color Problems and your Chairman with the approval of the Executive Committee, appointed Dr. D. B. Judd as Chairman.

It was the thought of the Executive Committee that individual subcommittees to handle special problems could be set up from time to time, under the Problems Committee, and in this way function most advantageously and to the best interests of the Council.

It was the decision of the Executive Committee to hold the annual meeting of the Council in New York City during the week in February, 1936, that the Optical Society of America and the American Physical Society hold their joint meeting.

Many problems have been presented to the Executive committee for consideration at their next meeting and it is probable that several of these will be referred as projects for study, to the Problems Committee. One, in particular that your Chairman believes would be of general interest to the various members of the Council would be the proposed attempt to assemble all the commercial standards relating to color that have been published, and issue this information to the members of the Council.

The Inter-Society Color council formulated at a time when depression was at its worst, and having successfully survived, leads your Chairman to believe that it will continue to progress through the combined efforts of its members, placing itself in even a better position to render a truly valuable service in the constantly broadening field of color.

Your Chairman takes this opportunity to seek your cooperation in developing the further growth of the Council, and to extend to you on his own behalf and on the behalf of the Executive Committee, best wishes for the coming year."

It was thus that the ISCC, formed in 1931, was reorganized to the form that continued with only minor changes until the present.

One milestone that should not be overlooked involved a legal change in structure. In the November 1953 ISCC *News* #109 there appeared a brief announcement that on October 14, 1953 the ISCC was incorporated. Details of this action will be discussed at the next annual meeting. However, the news letter and those following do not carry more information, except that we see that the title of Chair and Vice Chair were changed to President and Vice President for the elections of officers to begin their term in 1954. Also, what used to be Counsellors are now Directors.

Early Leaders

A Picture of the Early Leaders of the ISCC reproduced from ISCC New Letter #126 September 1956

The officers listed with their dates of office are: front row, left to right, F. L. Dimmick (1938-9); W. Faulkner (1956-); D. Nickerson (1954-5); D. B. Judd (1940-43). Back row, left to right, E. I. Stearns (1952-53); R. M. Evans (1946-7);; I. S. Balinkin (1950-51); M. J. Zigler (1944-45); and A. E. O. Munsell (1933).

Milestones

1931	Preliminary Conference	February 26
1931	ISCC came into being	September 21
1933	ISCC Accepts Individual Members	
1935	New Articles of Organization and Procedure	
1953	ISCC Incorporated	October 14th
1967	Long Range Planning Meeting #1	September
1977	ISCC hosts AIC Quadrennial Meeting in Troy NY	
1981	Long Range Planning Conference #2	July
1991	Long Range Planning Retreat #3	August
1994	First Student Chapter inaugurated from Rochester Institute of Technology	
1996	Opening of the Office	
1997	ISCC Unveils its Website	
1998	Long Range Planning Meeting #4	May
2001	ISCC hosts AIC Quadrennial Meeting in Rochester, NY	
2006	ISCC Reached 75 Years	

Additional Histories

Additional histories of the ISCC were prepared by W. J. Kiernan (ISCC *News #173*, 1964, and updated by F. W. Billmeyer (ISCC *News* #207, 1970); "Remarks in Observance of the ISCC's Annual Meeting" by Dorothy Nickerson (ISCC *News* #211, March-April 1971); "The Story of the Inter-Society Color Council" author unknown (ISCC *News* #247, March/April 1977); Dorothy Nickerson (presented at the 50th Anniversary Meeting in 1981, and published in *Color Research and Application* Vol. 7: 5-11, 1982 and distributed with ISCC *News* #277); and Gultekin Celikiz (ISCC *News* #361, May/June 1996).

Membership

The aims and purposes of the Inter-society Color Council are to stimulate and coordinate the work being done by various societies, organizations and associations leading to the standardization, description and specification of color, and to promote the practical application of these results to the color problems arising in science, art, and industry. With these aims in mind, the first form of membership was Member-Bodies. However, there are now three additional types of members – Individual Members, Sponsoring Members, and Honorary Members.

Member Bodies

A member body may be any non-profit society, association, organization of national scope interested in color and desirous of participating in the activities of the Council for the furtherance of its aims and purposes. Each may be represented by ten delegates. The chairman and two additional delegates are entitled to vote.

Over 50 organizations have been joined as member bodies at some time in the last 75 years. The following is a list of the member bodies. Those in bold are current members. An asterisk (*) indicates original founding members.

	American Artists' Professional League, Inc.	AAPL
*	**American Association of Textile Chemists and Colorists**	AATCC
	American Ceramic Society	AmCer Soc
	American Chemical Society	ACS
	American College of Prosthodontists	
	American Institute of Architects	AIA
	American Oil Chemists Society	AOCS
	American Philatelic Society	
*	**American Psychological Association**	APA
*	**ASTM International**	ASTM
	American Society for Photogrammetry & Remote Sensing	ASPRS
	American Society of Interior Designers	ASID
	Architectural Terra Cotta Institute	
	Artists Equity Association, Inc.	
	Association of Professional Color Laboratories	
*	**Color Association of the United States, Inc.**	CAUS
	Color Marketing Group	CMG
	Detroit Colour Council	DCC
	Dry Color Manufacturers' Association	DCMA
	Entomological Society of America	
	FPVPClubs (see FSCT)	
	Federation of Societies for Coatings Technology	FSCT
	Foundation for Analytical Research in the Arts, Inc.	
	Gemological Institute of America	GIA
	Graphic Arts Technical Foundation	GATF
	Gravure Technical Association	
	House and Garden Color Program	

	Human Factors and Ergonomics Society	HFS
*	**Illuminating Engineering Society**	IESNA
	Industrial Designers Society of America	IDSA
	Institute for Food Technologists	
	Manufacturers Council on Color and Appearance, Inc.	
	Mycological Society of America	
	National Association of Printing Ink Manufacturers	NAPIM
	National Paint and Coatings Association	
*	United States Pharmacopoeia and National Formulary	N.F. Am Ph A
*	**Optical Society of America**	OSA
	Package Designers' Council	
	Packaging Institute	
	Paperboard Packaging Council	
	Philatelic Foundation	
	Research and Engineering Council of the Graphic Arts Industries	
	Society for Information Display	SID
	Society for Imaging Science and Technology	IS&T
	Society of Motion Picture Engineers	SMPE
	Society of Plastics Engineers, Color & Appearance Division	SPE
	Tanners' Council of America, Inc.	
	Technical Association of the Graphic Arts	TAGA
	Technical Association of the Pulp and Paper Industries	TAPPI
	Technical Color Card Association	TCCA
*	United States Pharmacopoeial Convention	USP Conv.

Individual Members

The ISCC was from the first an organization of Societies or Member Bodies. However, there were always individuals who were active in the organization and committed to the aims of the Council. In 1933 they were recognized and accepted as individual members. One early activity was organizing the individual members. In News Letter #19, it is reported that Mrs. Elizabeth Burris-Meyer, Dr. Le Grand Hardy, and Miss Dorothy Nickerson were elected to serve as voting delegates to represent the Council's individual members. I believe that this was their first official representation by voting. It wasn't until much later in the 1990s that the bylaws were modified so that individual members could vote for officers and directors.

Individual Member Group. "Professor Hardy was also the speaker at the dinner meeting of the Individual [Member] Group of the I.S.C.C., held at the Hotel Dryden, New York City, on the evening of April 18 [1940]. His subject was "Color Photography." The talk dealt with the application of spectrophotometry and colorimetry to the problem of color reproduction, and was illustrated with a large collection of natural color photographs."

Local Color Groups. Throughout the early years the News Letter consistently reported on the activities of the Local Color Groups. Smaller groups of people interested in color met in various geographic regions. They included: 1) Washington and Baltimore Colorists, who held 3 - 4 dinner meetings a year and gave a contact person of Dorothy Nickerson; 2) Chicago Color Group with Walter Granville as contact; 3) Boston Color Group usually held about six dinner meetings per year, contact Arthur W. Cornell; 4) New York Color Associates – intermittent meetings, contact Elizabeth Burris-Meyer; 5) California Color Society – holds monthly meetings at the Art Center School in Los Angeles, contact A. H. King; and 6) Philadelphia-Wilmington Color Group – plans four meetings a year, contact S. C. Kelton, Jr.

Student Chapters. One of the recommendations resulting from the 1991 Long-Range Planning Retreat was to encourage local groups at universities to form student chapters. Prof. Bob Chung at Rochester Institute of Technology was first to take up the challenge, and in 1993 the RIT Student chapter was founded. In 1994 at the Annual Meeting, the Charter Student Chapter from Rochester Institute of Technology was officially recognized when the presented the Chapter with its Banner. The officers of the chapter reported on its formation and activities to the ISCC during the Education Committee meeting.

In the twelve years following this inaugural event, two other student chapters have been formed. The second chapter was located at the University of Chicago. ISCC *News #256* July/August 1996 carries a picture of the students and their advisors from University of Chicago receiving their Chapter banner. The students from the U. Chicago chapter came from diverse disciplines such as medicine, psychology, and ophthalmology.

The most recent chapter is at Fashion Institute of Technology. Recently, the students have provided exciting presentations on their projects during Interest Group and Education Committee sections of the Annual Meetings and during the 2004 Williamsburg Conference on Color and Design at the Fashion Institute of Technology.

Sustaining Members

The By-Laws of the Council provide that any person or corporation, or society, association, organization not of national scope is eligible to become a Sustaining Member of the Council. The ISCC *News* has carried descriptions of the Sustaining Members around the time that they joined the ISCC.

Current Sustaining Members include:

BYK-Gardner, USA
Ciba Specialty Chemicals
Color Communications, Inc.
Datacolor
Dupont Performance Coatings
Flex Products, Inc.
GretagMacbeth, LLC
Hewlett Packard Company
Hunter Associates Laboratory
Iso-Color, Inc.
Konica Minolta
Labsphere, Inc.
Pantone, Inc.
PPG Industries, Inc.

Honorary Members:

Honorary Membership is reserved for those ISCC members who have rendered signal service to the ISCC or to those fields served by the individual Member-Bodies of the ISCC, in such manner as to aid in accomplishing the objectives of the ISCC. An asterisk (*) indicates that the Honorary Member is deceased.

Eugene Allen*
William D. Appel*
Isay A. Balinkin*
Blanche Bellamy*
Fred W. Billmeyer, Jr.*
Charles Bittenger*
Elizabeth Burris-Meyer*
Therese Commerford
Edward T. Connor
Charles B. Conquergood*
Joyce Davenport
Hugh Davidson
S. Leonard Davidson*
Forrest L. Dimmick*
Carl C. Draves*
G. L. Erickson*
Ralph M. Evans*
Dean Farnsworth*
Waldron Faulkner*
Carl E. Foss*
George B. Gardner*
Louis A. Graham
Walter C. Granville*
E.N. Gathercoal*
Kasson S. Gibson*
I.H. Godlove*
Harry K. Hammond, III
Henry S. Hemmendinger*
Richard S. Hunter*
George W. Ingle
L. A. Jones*
Deane B. Judd*
Kenneth L. Kelly*
Joy Tuner Luke
David L. MacAdam*
Norman Macbeth, Sr.*
R. G. MacDonald*
Calvin McCamy
Alexander E. O. Munsell*
Elsie Murray*
Sidney M. Newhall*
Dorothy Nickerson*
M. Rea Paul*
Irwin G. Priest*
Frederick H. Rahr*
Margaret Hayden Rorke*
Max Saltzman*
Walter M. Scott*
Evelyn Stephens
Frederick T. Simon
Ralph Stanziola
Edwin I. Stearns*
Helen D. Taylor*
Vincent C. Vesce*
W. David Wright*
Michael J. Zigler*

Leaders

Table I – Executive Board

Year	Office	Name, Affiliation	Title	
1931	Chair	E. N. Gathercoal, USP	Counsellors:	M.H. Rorke, C. Bittinger
	Vice Chair	L. A. Jones		W. M. Scott
	Secretary	M. R. Paul		
	Treasurer	A. E. O. Munsell		
1933	Chair	A. E. O. Munsell, OSA*	Counsellors:	W. M. Scott, C. Bittinger
	Vice Chair	L. A. Jones**		E. N. Gathercoal
	Secretary	M. R. Paul		
	Treasurer	M. H. Rorke		
	** Resigned*			
	*** Acting Chair 1934-1935*			
1936	Chair	M. R. Paul, ASTM	Counsellors:	W. F. Little, F. L. Dimmick
	Vice Chair	D. B. Judd		W. M. Scott
	Secretary	R. G. MacDonald		
	Treasurer	M. H. Rorke		
1938	Chair	F. L. Dimmick, APA	Counsellors:	J. L. Parsons, R. G. Blauer
	Vice Chair	M. R. Paul		I. H. Godlove
	Secretary	D. Nickerson		
	Treasurer	M. H. Rorke		
1940	Chair	D. B. Judd, OSA	Counsellors:	H. P. Gage, S. M. Newhall
	Vice Chair	C. E. Foss		L. H. Hardy
	Secretary	D. Nickerson		
	Treasurer	N. Macbeth		
1942	Chair	D. B. Judd, OSA	Counsellors:	R. M. Evans, C. E. Foss
	Vice Chair	W. M. Scott		M. J. Zigler
	Secretary	D. Nickerson		
	Treasurer	N. Macbeth		
1944	Chair	M. J. Zigler	Counsellors:	W. S. Conrow, D. B. Judd
	Vice Chair	R. M. Evans		F. Scofield
	Secretary	D. Nickerson		
	Treasurer	N. Macbeth		
1946	Chair	R. M. Evans, SMPTE	Counsellors:	M. J. Zigler, I. A. Balinkin
	Vice Chair	I. H. Godlove		W. F. Little
	Secretary	D. Nickerson		
	Treasurer	N. Macbeth		

Table I – Executive Board continued

Year	Office	Name, Affiliation	Title	
1948	Chair	I. H. Godlove, ASTM	Counsellors:	A. H. Croup, R. M. Evans
	Vice Chair	I. A. Balinkin		W. C. Granville, E. I. Stearns
	Secretary	D. Nickerson		D. L. MacAdam
	Treasurer	N. Macbeth		
1950	Chair	I. A. Balinkin, ACS	Counsellors:	C. R. Conquergood, I. H. Godlove
	Vice Chair	A. H. Croup		D. L. MacAdam, E. I. Stearns
	Secretary	D. Nickerson		H. Helson
	Treasurer	N. Macbeth		
1952	Chair	E. I. Stearns, AATCC	Counsellors:	I. A. Balinkin, W. Faulkner
	Vice Chair	C. R. Conquergood		P. Thomson, F. O'Neil
	Secretary	R. M. Evans		G. Miller
	Treasurer	N. Macbeth		
1954	President	D. Nickerson	Directors:	W. C. Granville, H. D. Taylor
	Vice President	W. Faulkenr		E. I. Stearns, S. Wilson
	Secretary	R. M. Evans		D. Smith
	Treasurer	N. Macbeth		
1956	President	W. Faulkner, AIA	Directors:	G. L. Erikson, D. Nickerson
	Vice President	W. C. Granville		D. Taylor, S. Wilson
	Secretary	R. M. Evans		R. E. Pike
	Treasurer	N. Macbeth		
1958	President	W. C. Granville, OSA	Directors:	W. J. Kiernan, D. N. Obenshain
	Vice President	G. L. Erikson		F. L. Wurzburg
	Secretary	R. M. Evans		R. C. Stillman
	Treasurer	N. Macbeth		
1960	President	G. L. Erikson, NAPIM	Directors:	R. E. Derby, Jr., W. C. Granville
	Vice President	W. J. Kiernan		T. G. Pett, W. L. Rhodes
	Secretary	R. M. Evans		C. W. Jerome
	Treasurer	N. Macbeth		
1962	President	W. J. Kiernan, ASTM	Directors:	B. R. Bellamy, H. R. Davidson ,
	Vice President	R. E. Pike		R. M. Hanes, R. S. Hunter
	Secretary	R. M. Evans		G. L. Erikson
	Treasurer	N. Macbeth		
1964	President	R. E. Pike, FSPT	Directors:	F. W. Billmeyer, Jr., M. D. Foley
	Vice President	W. L. Rhodes		W. J. Kiernan, W. B. Reese
	Secretary	R. M. Evans		R. M. Hanes
	Treasurer	N. Macbeth		

Table I – Executive Board continued

Year	Office	Name, Affiliation	Title	
1964	President	R. E. Pike, FSPT	Directors:	F. W. Billmeyer, Jr., M. D. Foley
	Vice President	W. L. Rhodes		W. J. Kiernan, W. B. Reese
	Secretary	R. M. Evans		R. M. Hanes
	Treasurer	N. Macbeth		
1966	President	W. L. Rhodes, TAGA	Directors:	K. Fink, W. G. W. Ingle
	Vice President	F. W. Billmeyer, Jr.		M. Saltzman, M. Wilson
	Secretary	R. M. Evans		R. E. Pike
	Treasurer	N. Macbeth		
1968	President	F. W. Billmeyer, Jr.	Directors:	K. Fink, W. N. Hale, J. J. Hanlon
	Vice President	R. M. Hanes		W. L. Rhodes, G. Wyszecki
	Secretary	R. M. Evans		
	Treasurer	W. B. Reese		
1970	President	R. M. Hanes, APA	Directors:	S. L. Davidson, R. L. Feller
	Vice President	R. S. Hunter		R. Spillman,G. B. Gardner
	Secretary	F. W. Billmeyer, Jr.		
	Treasurer	W. B. Reese		
1972	President	R. S. Hunter, OSA,TAPPI	Directors:	R. M. Hanes, C. W. Jerome
	Vice President	R. E. Derby, Jr.		J. T. Smith, Jr., J. N. Yeatman
	Secretary	F. W. Billmeyer, Jr.		W. T. Wintringham
	Treasurer	W. B. Reese		
1974	President	R. E. Derby, Jr., AATCC, CAUS	Directors:	E. Allen, F. Grum
	Vice President	C. W. Jerome		R. W. Hunter, W. D. Schaeffer
	Secretary	F. W. Billmeyer, Jr.		H. K. Hammond, III
	Treasurer	S. L. Davidson		
1976	President	C. W. Jerome, IES	Directors:	S. Commanday, A. F. Styne
	President Elect	F. Grum	1976-1977	W. D.Schaeffer
	Secretary	F. W. Billmeyer, Jr.		
	Treasurer	S. L. Davidson	Directors:	F. M. Clydsdale**, R. Spillman
	Past President	R. E. Derby, Jr.*	1976-78	L. C. Noyes***
	** deceased 1977; replaced by R. S. Hunter*			
	*** resigned 1977; replaced by A. F. Styne*		Directors:	J. Davenport, C. S. McCamy
	**** resigned 1976; replaced by H.Hemmendinger*		1976-1979	F. T. Simon
			Directors:	T. Commerford, K. Fink
			1977-1980	A. R. Robertson

Table I – Executive Board continued

Year	Office	Name, Affiliation	Title	
1978	President	F. Grum, OSA	Directors:	B. Bender, S. F. Bergen
	President Elect	W. D. Shaeffer	1978-1981	E. L. Cairns
	Secretary	F. W. Billmeyer, Jr.		
	Treasurer	S. L. Davidson		
	Past President	C. W. Jerome		
	**resigned 1979; replaced by R. F. Hoban*		Directors:	F. Birren*, J. G. Davidson**
	***resigned 1980; replaced by A. B. J. Rodrigues*		1979-1982	B. K. Swenholt
1980	President	W. D. Shaeffer, GATF	Directors:	J. T. Luke, R. T. Marcus*
	President Elect	L. A. Graham	1980-1983	W. A. Thornton
	Secretary	F. W. Billmeyer, Jr.		
	Treasurer	E. T. Connor		
	Past President	F. Grum	Directors:	W. B. Reese, B. Schirmeister
	**resigned 1980; replaced by R. Stanziola*		1981-1984	T. G. Webber
1982	President	L. A. Graham, AATCC	Directors:	R. D. Ingalls, R. G. Kuehni
	President Elect	J. S. Davenport	1982-1985	F. W. Billmeyer, Jr.
	Secretary	T. R. Commerford		
	Treasurer	E. T. Connor	Directors:	R. Besnoy, A. C. Bliss
	Past President	W. D. Shaeffer	1983-1986	D. M. Zwick
1984	President	J. S. Davenport, FSCT	Directors:	N. J. Howard, P. K. Kaiser
	President Elect	A. B. J. Rodrigues	1984-1987	D. C. Rich
	Secretary	T. R. Commerford		
	Treasurer	E. T. Connor	Directors:	J. J. Hsia, J. J. Rennilson
	Past President	L. A. Graham	1985-1988	W. Walter
1986	President	A. B. J. Rodrigues, IMG	Directors:	P. J. Alessi, R. L. Connelly, Sr.
	President Elect	J. T. Luke	1986-1989	M. E. Zuyus
	Secretary	T. R. Commerford		
	Treasurer	E. T. Connor	Directors:	R. Berns, J. E. Frady
	Past President	J. S. Davenport	1987-1990	J. Welker
1988	President	J. T. Luke, AEA, ASTM	Directors:	J. A. Cave, H. E. Brown*
	President Elect	H. S. Fairman	1988-1991	W. N. Hale
	Secretary	T. R. Commerford		
	Treasurer	P. Hunter		
	Past President	A. B. J. Rodrigues, IMG	Directors:	N. Burningham, R. W. Harold
	**resigned 1989; replaced by J. DeGroff*		1989-1992	E. Stephens

Table I – Executive Board continued

Year	Office	Name, Affiliation	Title	
1990	President	H. S. Fairman, ASTM	Directors:	S. Graves*, N. J. Howard
	President Elect	P. J. Alessi	1990-1993	R. Kumar
	Secretary	D. C. Rich		
	Treasurer	P. Hunter	Directors:	E. C. Carter, J. M. Taylor
	Past President	J. T. Luke	1991-1994	M. Yglesias
	**resigned 1990; replaced by A. Laidlaw*			
1992	President	P. J. Alessi, ACS	Directors:	M. Brill, B. Chung, J. Pokorny
	President Elect	R. L. Connelly	1992-1995	
	Secretary	D. C. Rich		
	Treasurer	P. Hunter	Directors:	G. Beebe, J. Campbell
	Past President	H. S. Fairman	1993-1996	R. Marcus
1994	President	R. L. Connelly, AATCC	Directors:	M. Hammel, R. Riffel,
	President Elect	E. C. Carter	1994-1997	W. Vogel
	Secretary	D. C. Rich		
	Treasurer	D. Walton	Directors:	C. Brewer, M. Fairchild
	Past President	P. J. Alessi	1995-1998	W. Thompson
1996	President	E. C. Carter, OSA	Directors:	E. Hepps, J. Keiser,
	President Elect	M. H. Brill	1996-1999	J. Ladson
	Secretary	D. C. Rich		
	Treasurer	H. S. Fairman	Directors:	S. Caan*, D. Spooner
	Past President	R. L. Connelly	1997-2000	J. Zwinkels
	**resigned 1999; replaced by W. Gresho*			
1998	President	M. H. Brill, ASPRS	Directors:	C. Haley, C. Johnson, Y. Liu
	President Elect	J. Ladson	1998-2001	
	Secretary	R. Riffel		
	Treasurer	H. S. Fairman	Directors:	D. Phillips, R. Stanziola
	Past President	E. C. Carter	1999-2002	A. Springsteen
2000	President	J. Ladson, ASTM	Directors:	R. Buckley, A. Kravetz
	President Elect	D. C. Rich	2000-2003	M. McKnight
	Secretary	R. Riffel		
	Treasurer	H. S. Fairman	Directors:	J. King, E. Korenic, M. Miele
	Past President	M. H. Brill	2001-2004	
2002	President	D. C. Rich	Directors:	K. Braun, J. Suthers,
	President Elect	J. Zwinkels	2002-2005	L. Thieme
	Secretary	J. McCann		
	Treasurer	H. S. Fairman	Directors:	D. Battle, S. Commanday
	Past President	J. Ladson	2003-2006	M. Nadal

Table I – Executive Board continued

Year	Office	Name, Affiliation	Title	
2004	President	J. Zwinkels	Directors:	B. Nordby, F. O'Donnell
	President Elect	R. Buckley	2004-2007	M. Vrhel
	Secretary	J. McCann		
	Treasurer	H. S. Fairman	Directors:	N. Becidyan, J. A. Dimas
	Past President	D. C. Rich	2005-2008	S. Glasscock
2006	President	R. Buckley	Directors:	S. Austin, S. Fernandez
	President Elect	M. Nadal	2006-2009	J. Roberts
	Secretary	J. Ladson		
	Treasurer	H. S. Fairman		
	Past President	J. Zwinkels		

The chairs listed with their dates of office are: front row, left to right, F. L. Dimmick (1938-9); W. Faulkner (1956-); D. Nickerson (1954-5); D. B. Judd (1940-43). Back row, left to right, E. I. Stearns (1952-53); R. M. Evans (1946-7); I. S. Balinkin (1950-51); M. J. Zigler (1944-45); and A. E. O. Munsell (1933).

The presidents listed with their dates of office are: left to right, sitting, Robert Buckley (2006-), Joanne Zwinkels (2004-2006), Ellen Carter (1996-1998); standing, Danny Rich (2002-2004), Roland Connelly (1994-1996), Michael Brill (1998-2000), and Paula Alessi (1992-1994).

Meetings and Conferences

Meetings were always considered an important method of sharing ideas within the ISCC and with other people outside the ISCC. There have been four types of meetings that have played important roles in the ISCC. The first and foremost type is annual meeting of the group itself. The Inter-Society Color Council from the very first year has held an Annual Meeting. Special Conferences dedicated to a focused topic comprise an additional group of meetings sponsored by the ISCC. Most, but not all, of these were identified as Williamsburg Conferences. In this document all the specialized meetings come under the heading of Williamsburg Conferences. The third type sponsored by the ISCC is broad international meetings, namely for the AIC. The last type of meeting is the Long Range Planning Meeting.

Annual Meetings

The Inter-Society Color Council from the very first year has held an Annual Meeting. Table I includes a list of the annual meetings, the city where the meeting was held, the date(s) of the meeting, the co-sponsor if one was given, the chair, the topic and sometimes more detailed information about the location.

Table II. Annual Meetings

Year	#	Location	Date	Co-Sponsor	Chair(s)	Topic
1931	1	New York, NY	Dec. 29			(at the Museum of Science and Industry)
1932	2	New York, NY	Dec. 28		E. N. Gathercoal	(at Columbia University College of Pharmacy)
1933	3	New York, NY	Dec. 28		Loyd A. Jones	(at Columbia University College of Pharmacy)
1934	4	New York, NY	Feb. 21			(at Columbia University College of Pharmacy)
1935	5	New York, NY	Feb. 20	TAPPI		(at Waldorf Astoria)
1936	6	New York, NY			M. Rea Paul	(at Waldorf Astoria)
1937	7	New York, NY	Feb. 24	OSA		The Recording Spectrophotometer (at the Electrical Testing Laboratories)
1938	8	New York, NY		APA		Color Tolerances
1939	9	New York, NY		TAPPI		Spectrophotometry in the Pulp & Paper Industry
1940	10	Washington, DC		ASTM ACerS		Color..Its Specification and Use in Color Standards and Measurement
1941	11	New York, NY				Color in Art Education
1942	12	New York, NY		OSA		Color Blindness
1943	13	New York, NY		AATCC FPVPT		Small Color Differences
1944	14	New York, NY		AAPL		Color from the Standpoint of the Artist

Table II. Annual Meetings –continued

Year	#	Location	Date	Co-Sponsor	Chair(s)	Topic
1946	15	New York, NY		TCCA AATCC SMPTE		Color Measurement in Textiles
1947	16	New York, NY		TAPPI ACerS Design Div.	Ralph Evans	Symposium on Color
1948	17	New York, NY		SMPTE	Walter Granville	Symposium on Color Coordination in Industry
1949	18	New York, NY		IES		Symposium on Color
1950	19	New York, NY		ADI, AIA, AID, SDI		Color as Used in Architecture, Design and Decoration
1951	20	New York, NY				Color in Government
1952	21	New York, NY				Color in Science, Art and Industry
1953	22	New York, NY				Color Difference Specification: Technology and Insight
1954	23	New York, NY				Television in Color
1955	24	New York, NY		IES		
1956	25	New York, NY	April 5-6	GTA, IES, NAPIM, TAGA	Norman Macbeth	Color Problems in the Graphic Arts
1957	26	New York, NY		TCA		Recent History of Consumer Color Choice
1958	27	New York, NY		AIA		Color in the Building Industry
1959	28	New York, NY				Material Standards for Color
1960	29	New York, NY				Creative Color
1961	30	New York, NY		SPSE		Color in Photography and Television
1962	31	New York, NY		IES		Lighting for Color
1963	32	New York, NY				Color Measurement from Design to Production
1964	33	New York, NY		IES		Color Symposium: Color in Education
1965	34	New York, NY		FSPT		Fundamentals and Problems of Color II: Analytical Aspects Colorants for Industry and Design
1966	35	New York, NY		SPE		ISCC-SPE: A Combined Industry Approach to Coloring Problems

Table II. Annual Meetings –continued

Year	#	Location	Date	Co-Sponsor	Chair(s)	Topic
1967	36	New York, NY				Metamerism
1968	37	New York, NY				Creativity in Color
1969	38	New York, NY				Color Measuring Instruments
1970	39	New York, NY				Use of Color in Art and Science Factors Affecting the Pleasantness of Object Background Combinations
1971	40	New York, NY				Artists and Artisans Colorants: Today and Yesterday
1972	41	New York, NY		ASP		Color Aerial and Underwater Photography
1973	42	New York, NY				Professional Education in Color for Art and Technology
1974	43	New York, NY				The Development of a Color from Design to Execution
1975	44	New York, NY				The Heart of the ISCC: Problems Subcommittees
1976	45	New York, NY				Ralph M. Evans Memorial Symposium
1977	46	New York, NY	April 18-19			System of OSA Committee on Uniform Color Scales
1978	47	Washington, DC	April 17-18		Alex Styne	Human Response to Color on Objects Color In Illumination Color in Use
1979	48	New York, NY	April 22-24	SPE SMPTE	Richard Bauer	Color Rendering in Motion Pictures and Television Selecting Colors for Automobiles
1980	49	Rochester, NY	April 20-22		Frank Benham Bonnie Swenholt	Color in the Graphic Arts
1981	50	New York, NY	April 26-28		Allan Rodrigues Fred Billmeyer	50 Years of Progress in Use of Color Future Color Education
1982	51	Charlotte, NC	April 18-20	SID	Ralph Besnoy	Welcome to Textile Country Colorimetry of Self Luminous Displays
1983	52	Louisville, KY	April 10-12		Jim Cave Cecelia Riley	Color Coatings and Design
1984	53	Southfield, MI	April 4-6	DCC DSCT	Allan Rodrigues William Longley James Grady	Dynamics of Automotive Color
1985	54	Pittsburgh, PA	April 14-16	FSCT, MCCA		Color: the End User (SCAI Conference)

Table II. Annual Meetings –continued

Year	#	Location	Date	Co-Sponsor	Chair(s)	Topic
1986	55	Toronto, ON	June 16-18	CSC	Paula Alessi Peter Kaiser	Color Reproduction
1987	56	Philadelphia, PA				Industrial Appl. of Color Science
1988	57	Baltimore, MD		SID	Nick Hale	CRT to Hard Copy in Color
1989	58	Chicago, IL				Color In Architecture
1990	59	Cleveland, OH		FSCT		Color Appearance Instrumentation
1991	60	New York City, NY		CAUS	Evelyn Stevens	Trends in Color and Fashion
1992	61	Princeton, NJ		AIC	Ralph Stanziola Allan Rodrigues	AIC 25th Anniversary Color Matching
1993	62	Newport, RI		CPMA	Romesh Kumar	Color Regulations and Environment
1994	63	Detroit, MI		DCC	Jim Keiser	Auto Design Tech
1995	64	Greensboro, NC		AATCC	Ann Laidlaw	Textiles and Color
1996	65	Orlando, FL		ASTM	Hugh Fairman Danny Rich	Measurement of Appearance
1997	66	Baltimore, MD		SPE/CAD	Gary Beebe	
1998	67	Baltimore, MD		OSA	Mark Fairchild	
1999	68	Vancouver		TAGA	Bob Chung	
2000	69	Charlotte	April 16-18	CPMA	Romesh Kumar	Pigments and Color Industry
2001	70	Rochester	June 24-29	AIC	Paula Alessi	
2002	71	Pontiac, MI	April 20-23	DCC	Jim Keiser	Color and Appearance
2003	72	Chicago, IL	April 13-16	FSCT	Romesh Kumar	Color & Appearance Instrumentation
2004	73	Gaithersburg, MD	May 10-12	NIST		Advances in Measurement Science for Color and Appearance
2005	74	Cleveland, OH	April 24-26		Joanne Zwinkels Mike Henry	Automotive Color and Appearance
2006	75	Ottawa, Canada	May 14-17	CIE Div. 1	Joanne Zwinkels Alan Robertson	75 Anniversary of ISCC & 75th Birthday of the Standard Observer

Next we will highlight some activities, photographs or reports from selected annual meetings.

Annual Meeting #10. [the following was taken from ISCC News Letter #34]
"Each of you has received a copy of the recent annual meeting of the Council. But a business report of that kind cannot begin to tell you how successful were the meetings. At the Discussion Session there were 62 persons present, every member-body but one being represented. In addition to delegates, there were 17 individual members and 18 guests. The Business Session was also well attended as was the dinner meeting on Tuesday evening, when 58 persons sat down to spend a most informal few hours together. On Wednesday evening, the Popular Session attracted such a large group that the meeting had to be moved to the U. S. National Museum. And the guards there told us that more people attended the meeting that evening than had visited the Museum all day!"

The Annual Meeting that Never Happened. The ISCC News #57, January 1945 carried the following announcement:
"In accord with advice received from the War Committee on Conventions, plans for the ISCC 14th annual meeting have been cancelled. This advice reached us after copy for the News Letter had been made up, as will be evident by reference to two later items that refer to plans that were already well under way when this happened -- "

Later that year in ISCC News #62 we find "With transportation and hotel restrictions lifted, member bodies of the Council are beginning again to plan regular meetings." And also in the same issue "The Program Committee, appointed to plan the next annual meeting of the Council, consists of Ralph Evans, chairman, Margaret Hayden Rorke and John Scott Williams. The date and place will probably be late spring in New York City in order that we may hold a joint color session with the Society of Motion Picture Engineers at their 1946 Spring Meeting. As plans develop you will be kept informed."

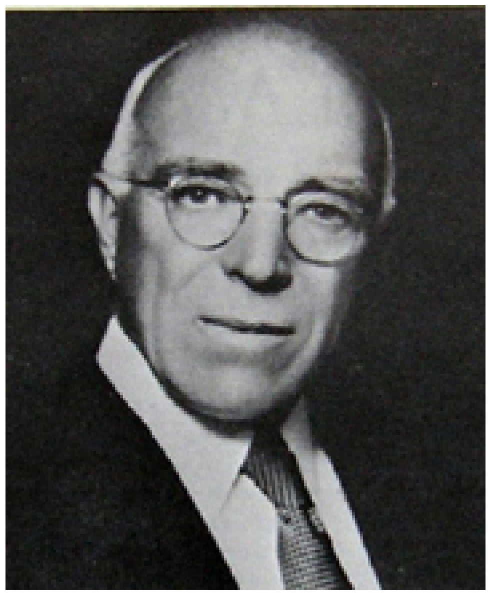
<u>19th Annual Meeting.</u> This picture was published in the ISCC *News* #321, September/October 1989. Although the annotation is not legible in this reproduction, in the *News* it is stated that this is a picture of the First Annual Dinner Meeting, the photo donated by Jaqui Welker. The inscription says:

INTER-SOCIETY COLOR COUNCIL
FIRST ANNUAL DINNER MEETING
HOTEL STATLER NEW YORK CITY
MARCH 8, 1950

The annotation seems to indicate that although this is not the first annual meeting, it is the first dinner meeting.

<u>25th Annual Meeting.</u> Here we include a photo from the 25th Annual Meeting. The photo is on file in the ISCC Office.

40th Annual Meeting. During the 40th Annual Meeting Dorothy Nickerson addressed the group at the dinner. She highlighted the founders of the ISCC whose dedication and foresight made it possible to reach 40 years. In particular she presented Edmund Norris Gathercoal, professor of Pharmacognosy, University of Illinois; Royal Bailey Farnum, Rhode Island School of Design; Alex. E. O. Munsell, son of Albert H. Munsell founder of the Munsell Color System; Chalres Bittinger, artist; M. Rea Paul, Research Laboratories, National Lead Company; Irwin G. Priest, chief of colorimetry at the National Bureau of Standards [now NIST], and Loyd A. Jones, chief physicist, Eastman Kodak Research Laboratories. Here we include the photos from her talk reprinted in ISCC *News* #211 March-April 1971.



Edmund Norris Gathercoal

Irwin G. Priest

Loyd A. Jones

<u>50th Annual Meeting.</u> Here are some scenes from the 59th Anniversary Meeting as published in ISCC *News* #252 May-June 1981.

For its 50th anniversary year, the history of the formation and early years of the Inter-Society Color Council, Dorothy Nickerson presented a lecture. It is reprinted here:

"**Fifty Years of the Inter-Society Color Council. 1. Formation and Early Years**

Introduction. As one of the very few present at the 50th annual meeting of the Inter-Society Color council who was "present at the creation," At the preorganizational meeting of 1930, and at one or more of the three organizational meetings of 1931, it seems fitting that I go back with you in memory to the early days, to events that led to the formation of the council, to the difficulties and accomplishments I it formative years. As secretary during 14 of its early years, 1937-1952, I was in a position to appreciate the remarkable nature of the cooperation and self-education among members of the working group of ISCC delegates and individual members in attacking an solving such problems a came to us. In this report I shall concentrate on the earliest years.

Background. The birth of the Inter-Society Color Council in 1931 was made possible by the existence in the 1920s of two major situations. On the one hand, there were problems such as that of Prof. E. N. Gathercoal, working with the Revision Committee of the U.S. Pharmacopoeia and National Formulary, who needed help in standardizing the color terms and color names in their publications. On the other hand, in scientific circles sufficient attention was now being paid to color science so that there seemed considerable possibility that solutions might be found to practical color problems. At the national Bureau of Standards, Irwin G. Priest already headed a potentially active Colorimetry Section. And in 1922 the Colorimetry Committee of the Optical Society of America had published a report that promptly became a color bible for those working on color problems, particularly those of psychophysical nature. Leonard T. Troland, a leading psychologist at Harvard, was chairman of the committee; members included Herbert E. Ives, Loyd A. Jones, Irwin G. Priest, and Eastman A. Weaver, all top scientists in the color field. All of this provided the background that made possible the successful formation of an inter-society color council in 1931.

Events Leading to the Formation of the ISCC. In 1932, in reviewing the history of the organization of the Inter-Society Color Council, Chairman Gathercoal wrote that it had been almost ten years since a study of color names in the U.S. Pharmacopoeia (USP) had been undertaken by a subcommittee of the U.S. Pharmacopoeial Revision Committee. One approach was to consult the National Bureau of Standards where Irwin G. Priest was chief of the Colorimetry Section. Much as he was interested in the problem faced by the Pharmacopoeial Committee, Priest had no immediate answer. If the problem were of interest to enough other groups, perhaps the possibilities could be explored further.

With this in mind the USP committee decided, in connection with their next decennial meetings, to call a general meeting in Washington of persons interested in the scientific study of color and lay the matter before them. This meeting, with an extensive color exhibit, was held at the Willard Hotel, May 14, 1930. It closed with appointment of a committee to organize a national body to correlate activities relating to the scientific naming of colors. Royal B. Farnum, Director of the Rhode Island School of Design, was its chairman.

By early September Dr. Farnum was ready to call a meeting of his committee to approve a constitution and a statement of aims and purposes. But the Optical Society representatives were not ready, they wished first to report the results of the May conference to the regular October meeting of the ISA Executive Council. This they did. Both Priest and Jones, members of that Council, were convinced from experience that something more than a general society of color interested persons was required if color problems such a those of the USP were to be solved. After considerable discussion two resolutions were adopted; first, that the need for better organization of those interested in the description and specification of color could best be met by the formation of a joint council consisting of officially designated representatives of national societies interested in the description and specification of color; and second that Dr. Gathercoal's attention be called to the OSA colorimetry program to be held on February 26, 1931, as offering a favorable opportunity for a further conference on the subject. When copies of the resolutions reached Dr. Farnum, meetings of his committee, already called were postponed.

On February 26, 1931, following regular sessions of the OSA, a Preliminary Conference on Organization of an Inter-Society Committee on Color Specification" was held at the Museum of Science and Industry, with L. A. Jones as Active Chairman. This meeting, attended by 31 delegates from 14 national associations, plus 16 individuals, was reported by M. Rea Paul. Priest explained the reasons for the conference, and presented the OSA resolutions. A lengthy discussion followed in which practically everyone present took part. At first a wide diversity of opinion was expressed regarding the best procedure for organizing an inter-society group. But as discussion progressed "ideas began to crystallize and finally almost complete unanimity was reached." Five resolutions were adopted. In essence they were to form an Inter-Society Color Council composed of delegates from national societies interested in the standardization, description, and specification of color.

On the previous evening the Farnum committee had met to discuss the situation and be brought up to date. They decided to wait until proposals developed at the February 16 meeting could be laid before them. When they were – a council-type organization with inter-society membership—they were received favorably. Members active in both groups, Paul and Alex. E. O. Munsell in particular, were most helpful in bringing the two groups together. After informing those who had attended the 1930 Washington meeting of the proposed new organization, and urging that all interested persons associate themselves with it, the Farnum committee was disbanded.

It was a considerable loss to the Council that Dr. Farnum, although personally interested, was not able to lead any national organization of art educations or other art-related group into membership in the ISCC. But the action on his part in accepting proposals made outside of his committee was a token and promise of the cooperation that has existed since the very beginning of this Council among colorists of widely different backgrounds and interest, cooperation that has led us forward a considerable way toward the accomplishment of the ISCC's aims and purposes.

In a report that I gave ten years ago commemorating the 40th annual meeting of the ISCC, I introduced – with portraits and sketches of each – the seven men that I consider most responsible for the founding an present form of the organization now celebrating its 50th annual mee4ting. They are Edmund Norris Gathercoal, Royal Bailey Farnum, Alex. E. O. Munsell, Charles Bittinger, M. Rea Paul; Irwin G. Priest, and Loyd A. Jones. Details about each and the apart he played in the establishment a development of this Council can be found in ISCC Newsletter No. 211, including portraits of Bathercoal, Priest, and Jones. The most recent general story of the IDCC appears in ISCC newsletters Nos. 211 and 247.

Organizational Meeting of the ISCC – 1931. On September 21, 1931, as reported by Paul, secretary, the first organizing committee of delegates was called to order at the Museum of Science and Industry. Jones was acting chairman and 16 delegates were present representing 13 interested societies. To serve until the adoption of a constitution, officers were elected: Gathercoal (not present), chair; Jones, vice-chairman; Paul, secretary; Munsell, treasurer. These officers, with delegates Margaret Hayden Rorke, Charles Bittinger, and Walter M. Scott, were appointed as an Executive Committee instructed to prepare a constitution and by-laws for action at the next meeting. Provision was to be made for membership by individuals; committees were to be established on Membership, Color Nomenclature, Measurement and Specification of Color, and the next meeting to be held before January 1, 1932.

First Annual Meeting – 1931. On December 29, 1931, "the first annual meeting of the Inter-Society Color Council" was called: Articles of Organization and Procedure were unanimously adopted, and Aims and Purposes approved. Officers and Councillors named in the September organizational meeting were officially elected, and committee chairmen appointed: Membership, Paul; Color Problems, Rorke; Color Names, Munsell; Color Measurement and Specification, I. H. Godlove. In bound copies of Minutes of the Annual Meeting* there is no record of this meeting, but a copy has been found in Dr. Gathercoal's file, attached to a letter of March 4, 1932, to Chairman Cook of the USP as part of a report for publication in their USP Circular. It includes the information that this "first annual meeting" was held at the Museum of Science and Industry in New York on December 29, 1931, with 17 national associations represented by one of more delegates. Mention was made that membership was restricted to national societies and associations interested in color and operating on a nonprofit basis, each member to be represented by delegates, with provision also made for cooperating associates.

The first bulletin of the Council, dated June 7, 1932 – a printed publication of 25 pages, including progress reports for three committees – indicates how swiftly members of the newly formed group set to work!

Second Annual Meeting – 1932. With Gathercoal as chairman, the second annual meeting was held December 28, 1932, at Columbia University College of Pharmacy in New York City. Present were nine delegates representing eight member associations, two co-operating associates, eight representatives from ten interested associations, and 16 interested individuals. The eight original member associations were the American Association of Textile Chemists and Colorists, the National Formulary of the American Pharmaceutical Association, the American Psychological Association, the American Society of Testing and Materials, the Illuminating Engineering Society, the Optical Society of America, the Textile Color Card Association of the United States, Inc. and the U.S. Pharmacopocial Convention. The Technical Association of the Pulp and Paper Industry, represented at this meeting but not yet a member, soon became one. The two original cooperating Associates were Norman Macbeth, Sr. and Dorothy Nickerson. (It is interesting to note that among the nonmember groups represented at this meeting were three that were art-oriented: National Academy of Design, National Federated Council on Art Education, and National Alliance of Art and Industry.)

Acceptance was reported of an invitation to hold a joint session with the OSA Colorimetry Committee in February. Also reported were the untimely deaths of two important delegates, Priest and Toland. Dr. Gathercoal, retiring chairman, reviewed the history of the organization and its first year. There were brief reports from committees on membership, color problems, and color names, and a more formal report from Dr. Godlove for the committee on measurement and specification. The Executive Committee reported, after hearing objections from Arthur S. Allen that the form of the Council would not enable it to meet industry's demands for color information that it would attempt to get further information regarding industrial color requirements and the part the Council should play in their solution. Officers elected for the coming year were Munsell, chairman; Jones, vice-chairman; Paul, secretary; and Rorke, treasurer. Scott, Bittinger, and Gathercoal were elected members of the Executive Committee for one year.

Joint Meeting with OSA Colorimetry Committee, February 25, 1933. At this meeting work of the4 several ISCC committees wads discussed in detail. A volumetric method for dividing the color solid was proposed for color names, the basis for what actually developed later as the solution for the color names problem. (9) The OSA Colorimetry Committee reported its plan to bring its 1922-1023 report up to date. (Twenty years later this report became a reality in book form.

Third Annual Meeting – 1933. The third annual meeting, restricted to members, was held December 28, 1933, at Columbia University College of Pharmacy. Vice-chairman Jones presided, and preset were 16 delegates representing 9 member associations, and 2 cooperating associates.

The secretary reported that after much discussion the Executive Committee had on December 27, 1933, formally accepted the resignation of Munsell as ISCC chairman; that the first issue of the Newsletter had been received so favorably that it would be issued regularly by the secretary; that a file of "Who's Who in Color" would be developed and that the formation of local color groups would be encouraged.

The chairman reported on the inadequacies of the present Articles of organization and Procedure. The Executive Committee was authorized to rewrite them, to define the duties of the problems committees and of official delegates and procedures for acting on reports, and (not record) to provide more adequately for individual memberships.

The Membership Committee reported production of a descriptive pamphlet about the ISCC. Munsell reported for the Color Names committee. Godlove proposed recommendations for the USP that all possible colors be described in terms of ten words and the suffix –ish; red, yellow, green, blue, purple, light, dark, strong, weak, and the adverb very, with the option that certain combinations be replaced by a single terms, as yellow-red by orange, dark orange by brown, and very strong by vivid. Other studies referred to by these committees make very interesting reading those many years later. Most of all, these reports indicate how quickly and directly the ISCC got down to basic ideas, for the final recommendations to the USP were based on ideas developed by the early Godlove and Munsell committees, the names themselves by the Godlove committee, but the method of defining limits for each name by the volumetric approach of Munsell.

At this meeting the ISCC went on record as urging that Munsell publish the trichromatic equivalents of all data available on Munsell colors (something that was done later I 1940 and 1943 reports in the *Journal* of the OSA).

Fourth Annual Meeting – 1935. Following joint meetings with the Optical Society of American and the American Physical Society, and an all-day color program during TAPPI's annual meeting, the ISCC held its fourth annual meeting on February 21, 1935, at Columbia University College of Pharmacy. Jones presided and present were 13 delegates representing 9 member bodies (no count of others present). The secretary reported that four *NewsLetters* had been issued since the last meeting, and that membership now consists of 9 national associations with 30 official delegates and 16 cooperating associates.

A letter from Godlove for the Committee on measurement and specification contained further thoughts on his plan of color standardization, and reported on the compilation of a color bibliography of some 2500 titles (published in 1957).

New Articles of Organization and Procedure, with revisions in accord with recommendations received with letter-ballot returns, were adopted unanimously, to become effective immediately. An early election was to be held to fill the offices for the remainder of 1935 and 1936.

In November, *NewsLetter* No. 11 reported election of officers and councilors; Paul, chairman; Deane B. Judd, vice-chairman; R. G. Macdonald, secretary; Rorke, treasurer; William F. Little, Forrest L. Dimmick, and Walter M. Scott, councilors.

A message from Chairman Paul discussed the recent changes in following the new plan of organization and emphasized that the Council is not a research or standardization body, but one whose functions are (1) to disseminate information through its *NewsLetters* and reports, and (2) to attempt to bring together individuals with color problems with those who might, through individual or cooperative research, provide the solution.

Fifth Annual Meeting – 1936. The fifth annual meeting, Paul presiding, was held February 20, 1936, at the Waldorf-Astoria, courtesy of TAPPI which was holding its annual meeting there; present were 16 delegates representing 7 member associations, and 4 associates.

Secretary Macdonald reported that the Newsletter continued to be popular; that membership consists of 8 member bodies with 44 accredited delegates and 12 individuals; that the Executive Committee had voted to limit committees to two, Membership and Problems, problems I the future to be handled by subgroups of the Problems Committee; that the USP Revision Committee had accepted the recommendations of the Committee on Measurement and Specification and was preparing to put them into effect; and that according to the new Articles the life of each committee terminated with the end of each Chairman's term of office.

Judd, chairman of the Problems Committee, submitted a detailed plan for assembly within each member body of (1) a list of color terms and definitions, (2) a file of color tests and specifications, and (3) a list of unsolved problems in order of importance.

This brief business session adjourned at 8 p.m. for an open meeting to which members of all member bodies were invited to hear three lectures on color (courtesy of the International Printing Ink Corporation); Color as Light, Chemistry of Color, and Color in Use. The lecture hall was filled; industry was indeed interested in color as Arthur Allen had earlier pointed out!

Sixth Annual meeting – 1937. In 1937 the sixth annual meeting was held at the Waldorf-Astoria with Paul president; present were 16 delegates from 8 member bodies, and 5 individual members. The secretary (Nickerson for Macdonald) reported a membership of 45 delegates from 8 member bodies, and 24 individual members. Expenses reported in 1935 at $121.55 had increased in 1936 to $523.85, chiefly for multigraphing of the NewsLetter, $222.72 and $137.55 for stationery and printing. (These figures I give mainly for shock purposes!)

The Executive Committee reported that in three meetings held during the year, it had (1) voted to encourage formation of local groups, (2) appointed Godlove editor of the NewsLetter, (3) recommended that the report on the USP problem be approved by vote at the annual meeting, subject to approval by letter ballot, and (4) approved a plan for organizing individual members into a group so that they might be represented by voting delegates.

Judd, chairman of the Problems Committee, reported that the Problem 2 report on color names for the USP was now approved, and that Problem 4, identifying chromatic filters for stage illumination, was also answered.

The general method for work on Problem 5, Who's who in Color, was reported and accepted. Problems 6, 7, and 8 – surveys of terms, tests and specifications, and problems-were being handled by subcommittees from each member body; reports already received indicated satisfactory progress.

For the OSA, Godlove reported that the OSA Colorimetry Committee was expected to provide answers for the committee work on terminology. He called attention to a study described by Judd and Nickerson in a six-page mimeographed statement of April 6, 1936, “Review of the Spacing of the Munsell Colors” (a summary attached to the Godlove report), with the suggestion that this project be handled by an ISCC Problems subcommittee, as a problem of the OSA, perhaps with Sidney M. Newhall a chairman. When this project was referred to the OSA, they decided that it was a project suitable for study by the OSA Colorimetry Committee. As a consequence, an OSA subcommittee was established, with Newhall as chairman. The work resulted in two important reports on the spacing of the Munsell colors, in 1940 and 1943 and to publication of two numbers of the OSA Journal devoted to papers relating to the measurement and definition of the Munsell system of color notation. Not only did the Godove proposal to the SICC in 1937 stimulate the OSA to study and publish this much more extensive scientific information on the Munsell system, but it led also to a later proposal that a similar study be made of the Ostwald system, by essentially the same people. This was done, and a symposium on Ostwald was arranged for an OSA program for March 1944. the papers were published in the July 1944 Journal of the OSA. Much of the credit for initiation of this work can be traced to the influence of the ISCC I bringing together the right people and encouraging their cooperative effort, either within a single member body, or by cooperative effort of the ISCC-one of the Council’s main purposes. It emphasizes also the long-established policy of the ISCC of accepting no problem that a suitable member body is willing to undertake.

Seventh Annual Meeting – 1938. In 1938 the seventh annual meeting was held February 24 at the Electrical Testing Laboratories, New York City, in the new building that was to house ETL’s expanding laboratories. Format for the meeting-an all-day, three session meeting – was one followed thereafter for many years; a morning business session, with reports from Problems Committee subcommittees and from the delegates from each member body; an afternoon technical session’; dinner, and an evening popular session. ETL was a generous host – they provided not only the meeting place, but luncheon and supper as well.

For the Business Session 20 delegates represented eight member bodies and the individual member group; there were 7 non-voting individual members and 5 visitors present. Officers for 1938-1939 were reported; Dimmick (APA), chairman; Paul (ATM), vice-chairman; Nickerson (IMG), secretary; Rorke (TCCA), treasurer. Membership was now 9 member bodies, 33 individual members.

The report of the retiring chairman (read in absentia) pointed out that much of the success in putting the Council in a stronger position was due to the clear definition of the various projects before the Council’s several committees. He also stressed that since Council member bodies constitute the fundamental basis upon which the Council is founded, it is essential to increase their number and to distribute Council activity as widely as possible among them.

There were reports from the several operating committees, but the greater part of the time was devoted to reports from seen subcommittees of the Problems Committee, each of which indicated substantial progress. Judd reported, with lantern slides, in some detail on Problem 2, the USP color names work. Dr. Gathercoal, in a report from the USP, wrote that they were pleased by the progress being made. He said that there was only one ISCC problem in which the USP was interested, and for this problem the Council had worked out the basis for a satisfactory system for use in the U.S. Pharmacopoeia and the general pharmaceutical literature. He reported that through the cooperation of the national Formulary a research associate, Kenneth L. Kelly, had been placed at the National Bureau of Standards and "is now engaged in the determination of the revised color names according to the system recommended by the Inter-Society Color Council." OSA delegates reported that a subcommittee of the OSA Colorimetry Committee had now been formed to study the spacing the Munsell system.

The afternoon session was attended by about 120 persons. Some idea of the interest may be gained from the fact that adjournment did not come until 6:25 p.m.! Papers centered around the history, operation, and use of the Hardy G.E. spectrophotometer, an instrument still new at that time to most colorists. The papers created so much interest that the Optical Society asked to publish them. (21)

Over 300 persons attended the evening session. After calling the meeting to order and making a few announcements, Chairman Dimmick turned the meeting over to Mr. Preston Millar, president of ETL. After a humorous introduction about his own "undistinguished color career" (see *NewsLetter* No. 270, January/February 1981, for a quotation from this introduction), Mr. Millar introduced the speakers for this popular session of the ISCC: Charles Bittinger, artist, to speak on the solar Corona and show his picture of it and movies of his trip with the U.S. Navy-National Geographic 1937 Eclipse Expedition; Forrest L. Dimmick to speak on The Psychology of Color; Ethel Lewis to speak on Color in Interior Design. Then Carl M. Lowry (for L. A. Jones) showed a Kodak film of growing crystals under polarized light (a film beautiful and interesting enough to have been awarded in 1935 a Medal of the Royal Photographic society of Great Britain).

ETL provided a record of the evening presentations. This, with the OSA's contribution of bound reprints of the afternoon papers, and the secretary's report of the annual meeting, provided ISCC members with a full record of this seventh annual meeting.

General Comments. With this 1938 meeting, the ISDC seemed fully on its way, headed in the right direction. In the years since there have been many accomplishments- in studies of color blindness and color aptitude, and of the illuminant in color matching – all so important in war years. Color symposia held o programs of our member bodies were important. In 1942 a symposium on art education was held at the metropolitan Museum of Art. We talked and wrote on color tolerances, color systems, on illumination, color blindness, small color differences. I remember meetings held in 1947 with TAPPI' one the same year with the Design Section of the American Ceramic Society; in May of 1948 a meeting on the program of the Society of Motion Picture Engineers in Santa Monica; and in 1949 a color seminar on the program of the American Institute of Architects. And who could forget those marvelous evenings of lectures on color by Ralph Evans, or the lecture-demonstration of Isay Balinkin!

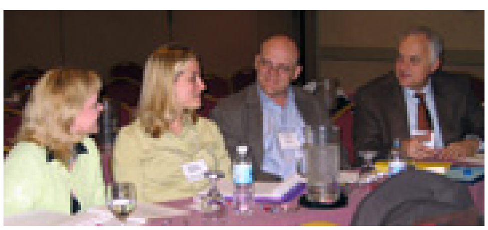
Today we have the Williamsburg Technical Conferences. And today the 1980 twin booklets – membership list and constitution and by-laws – and the newsletter provide a record of past meetings, reports, and publications. We have grown in member bodies from 8 in 1931 to 36 in 1980 and in individual members from 2 in 1932 to 589 in 1979. Table 1 provides a list of pat and present member bodies of the ISCC.

In closing, this report on the formation and early years of our Council, I point with pride to an organization that is a spirit of voluntary cooperation ahs accomplished much in these past 50 years in developing and disseminating color knowledge, and in making practical applications of that knowledge to problems in science, art, and industry. This has been done with a minimum of funds, but with a very real expenditure of contributed man-hours. As Judd said in 1952, the ISCC in these years has changed from 'a trembling confused organization to its present happy, powerful, and genuinely useful state.'"

Annual Meeting #74. Our most recent annual meeting took place in Cleveland, Ohio in 2005. Following the recent custom, the meeting was scheduled in April. However, the weather didn't cooperate entirely. The following are a few scenes from this most recent meeting.

After the Board of Directors Meeting, the official annual meeting opened Saturday evening with a welcome reception.

Sunday and Monday held Interest Group Sessions, project committee meetings and at noon time on Monday, the Business Meeting and Awards Banquet.



Tuesday and Wednesday were devoted to the two-day symposium and tabletop exhibits.

<u>75th Annual Meeting.</u> The 75th Annual Meeting schedule and abstracts are included under the section ISCC Today – Chapter 10 This Year's Festivities.

Williamsburg Conferences

In addition to the Annual Conferences which often have a symposium attached to the meeting, and to participating in meetings of the member bodies, the Council has sponsored a series of Technical Conferences, which have generally become known, because of their location, as the Williamsburg Conferences. These symposia have been limited-attendance meetings at which a single subject is discussed in detail by invited speakers and through audience participation. They are characterized by longer talks and more interchange between participants. These symposia are not scheduled on a regular basis, but are planned according to the timeliness of the subject matter. A couple of the conferences have been called Panchromatic Conferences because the have a specific focus on breaking barrier or crossing disciplines to allow discussions among participants who might not normally meet together. As far as this report, both Panchromatic Conferences and Williamsburg Conferences will be lumped into this one category.

Table III lists all the Williamsburg Conferences, their dates, location, organizers, and the topic on which each focused.

Table III - Williamsburg Conferences

Year	Date	Location	Chair	Topic
1966	Feb. 6-9	Williamsburg, VA	Max Saltzman D. B. Judd (Honorary Chair)	Instrumental Approaches to Colorant Formulation, First Williamsburg
1969	Feb. 9-12	Williamsburg, VA		Visual Perception
1971	Jan. 31-Feb. 2	Williamsburg, VA	John Yule Warren Rhodes	Optimum Reproduction of Color
1972	Feb. 6-9	Williamsburg, VA		Fluorescence and the Colorimetry of Fluorescent Materials
1976	Jan. 25-28	Williamsburg, VA		Instrumental Colorant Formulation 1976
1978	Feb. 5-8	Williamsburg, VA	Cal McCamy Ed Brenneman	Objectives of Pictorial Color Reproduction
1979	Feb 12-14	Williamsburg, VA	Rolf Kuehni	Judd Memorial Conference on Color Metrics
1980	Feb. 3-6	Williamsburg, VA	Fred W. Billmeyer, Jr.	Helson Memorial Symposium on Chromatic Adaptation
1981	Feb. 8-11	Williamsburg, VA	Ed Cairns Bonnie Bender Alan Robertson	Creativity the Common Denominator - Artist and Scientist Working Together
1983	Feb. 6-9	Williamsburg, VA	Charles W. Jerome William A. Thornton	Color and Illumination
1984	Feb. 12-15	Williamsburg, VA	Richard Ingalls	Color and Imaging

Table III - Williamsburg Conferences – continued

Year	Date	Location	Chair	Topic
1985	Feb. 10-13	Williamsburg, VA	Mark Gottsegen Rolf Kuehni	Color Then and Now
1986	Feb 9-12	Williamsburg, VA	Robert Feller Danny Rich	Colors of History: Identification, Re-creation, Preservation
1987		Williamsburg, VA	David H. Alman	Appearance
1989		Williamsburg, VA	Roy Berns Alan Robertson	Color Discrimination - Psychophysics
1991	Cancelled	Williamsburg, VA	Jacqui Welker	Colorfastness to Light
1992		Williamsburg, VA	Milton Pearson	Comparison of Colored Images Presented in Different Media that are Intended to Simulate Each Other or Another Image
1994	Feb. 20-23	Williamsburg, VA	Richard Harold	The Colorimetry of Fluorescent Materials
1995	Feb. 12-15	Williamsburg, VA	Michael Brill Steve Shafer	1st Panchromatic Conference
1998	Feb. 22-24	Williamsburg, VA	Wade Thompson	Color and Design: 21st Century Technology and Creativity
2000	Feb. 19-21	Savannah, GA	Cynthia Brewer	2nd Panchromatic Conference - Color In Its Surround
2001	March 19-20	Cleveland, OH	Roland Connelly	ISCC Color Course
2003	March 9-11	Philadelphia Univ, Philadelphia, PA	Ralph Stanziola John Locke	Solutions for Industrial Color Problems
2004	Oct. 22-24	FIT, NYC	Margaret Miele	Color and Design
2005	Nov. 4-5	Scottsdale, AZ	Danny Rich John McCann	Precision and Accuracy in the Determination of Color in Imaging

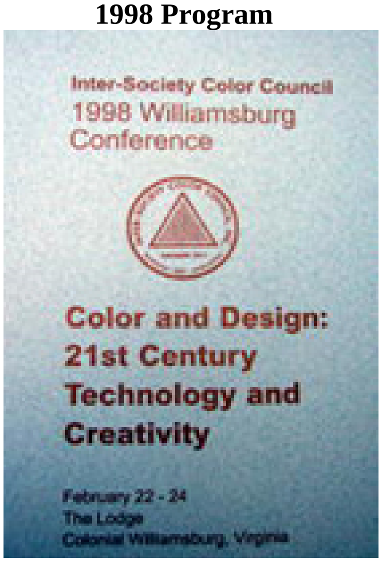
Williamsburg, Virginia

1972 Williamsbugh Conference on Fluorescence and the Colorimetry of Fluorescent Materials.

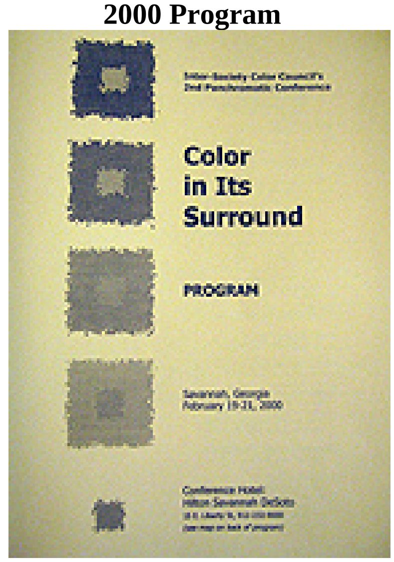
(from ISCC*News* #219 July-August 1972)

Speakers and Panelists. Standing from left to right: Fred W. Billmeyer, Jr., RPI; A. R. Robertson (Canada), NRC; E. Allen, Lehigh University; Ake Stenius (Sweden); J. Donnelly, Jr., Westvaco; H. Aach, Queens College; H. Terstiege (Germany); C. J. Bartleson, Macbeth; J. Schanda (Hungary). Sitting from left to right: F. Grum. Eastman Kodak Company; E. Ganz (Switzerland), Ciba-Geigy; H. Hemmendinger, HCL; A. Berger (Germany), Bayer; F. Simon, Clemson University; W. D. Wright (England), Imperial College. Missing in the picture are two speakers: G. Wyszecki and R. A. Ward.

1998 Program



2000 Program



International Conferences and Congresses

AIC International Colour Association

The International Colour Association (Internationale Vereinigung für die Farbe of Association Internationale de la Couleur) was founded on June 21, 1967 in Washington, D.C. It is best know by its French initials, the AIC.

The mission of the AIC is to encourage research in color in all its aspects, to disseminate the knowledge gained from this research, and to promote its application to the solution of problems in the fields of science, art, design and industry on an international basis.

In particular, the AIC arranges an international color congress to take place at convenient and appropriate intervals, initially every 4 years. The congresses shall be organized in turn by the national member associations. The AIC can also organize or promote special international or regional congresses or symposia. In practice it usually has 3 interim meetings with narrower themes and spaced in different geographic regions in the intervening years between Congresses.

Only one national organization from each country can become a regular member of the AIC. Each national organization can delegate any number of representatives from among its members to the meeting. Representatives of international member associations and observers shall also be entitled to take part. The Inter-Society Color Council is the organization representing the United States in the AIC. The ISCC was a charter member since the organization of the AIC in 1967. The current membership of the AIC is composed of Grupo Argentino del Color, Colour Society of Australia, Asociación Boliviana Del Color, Associação Brasileira da Cor, Colour Group – Bulgaria, Color Association of China, Centre Français de la Couleur, Deutscher Verband Farbe, The Colour Group (Great Britain), Hungarian National Colour Committee, Associazione Ottica Italiana, Color Science Association of Japan, Korean Society of Color Studies Nederlandse Ver. voor Kleurenstudie, Norsk Farveforum, Central Office of Measures (Poland), Slovenian Colorists Association, Colour Group of the South African Optical Society, Comité Español del Color, Stiftelsen Svenskt Färgcentrum (Sweden), Pro Colore (Switzerland), The Color Group of Thailand, and the Inter-Society Color Council (USA).

The ISCC has hosted two of the international congresses and one interim meeting. The first congress hosted by the ISCC was COLOUR 77, held at Rensselaer Polytechnic Institute in Troy, New York. The second one was held twenty-four years later. The 9th Congress of the International Colour Association was held in Rochester, New York in 2001. In 1992 on the 25th Anniversary of the AIC an interim meeting was hosted in Princeton, New Jersey in conjunction with that year's annual meeting.

Long Range Planning Conferences

There have been four Long-Range Planning Conferences, Retreats, or Meetings. The first was held in September of 1967. Although a summary of the meeting was appended to the Minutes of the Fall Board meeting of that year, the records show no mention of the planning meeting in the Newsletter or at the 1968 annual meeting.

The second was held in 1981 July 24 – 26, in Airlie, VA. It was organized by Joy Turner Luke. An ISCC Technical Report 81-1 entitled 1981 Long-Range Planning Conference was prepared by Fred W. Billmeyer, Jr. for the Board of Directors. It chronicled the meeting and presented the recommendations coming from the meeting to the Board of Directors. There were a total of 56 recommendations covering the general topics of 1) ISCC and its Membership, 2) Problems Committee and Projects, 3) Color Problems, Unresolved and Useful, 4) the Balance among ISCC Roles: Science, Art, and Industry, and 5) ISCC Roles in Government Regulatory Activities.

(photo supplied by Allan Rodrigues)

Left to right they are: Franc Grum (Past-President), Ed Connor (Treasurer), Bob Hoban, Bill Schaeffer (President), Fred Billmeyer (Secretary), Joy Luke, Bill Thornton, Therese Commerford, Alan Robertson, Lou Graham (President Elect), Joyce Davenport, Tom Webber, Steve Bergen, Ralph Stanziola, and Allan Rodrigues.

The third meeting was held ten years later in Fredricksburg, VA. It was opened to the ISCC at large and 16 members who were interested in the direction and structure of the ISCC attended. In preparation for this (retreat) meeting, an extensive survey was conducted by and for the individual members of the ISCC. The meeting not only discussed the results of the survey, but also assessed the implementation of recommendations from the second Long-Range Planning Conference. A Report about the Retreat was sent from Ann Laidlaw, Acting Secretary of the Long Range Planning

Committee to the President Hugh Fairman on December 9, 1991. Besides covering the retreat activities, it included a report from the executive committee which proposed numerous recommendations that the executive committee believed would have come out of the retreat if there had been an additional day to formulate them.

(from ISCC *News* 335 January/February 1991)

Front Row, left to right: Ellen Carter, Magenta Yglesias, Ann Laidlaw, Roland Connelly, Allan Rodrigues, Sy Commanday. Back row, left to right: Lou Graham, Evelyn Stephens, Ralph Stanziola, Mike Brill, Bill Thornton, Hugh Fairman

The most recent Long-Range Planning Meeting was held on May 16-17, 1998 in Reston, VA.

Problems and Interest Groups

Problems Committee

In a message from Chairman Paul to the Council he emphasized that an integral function of the organization was to attempt to bring together individuals with color problems with those who might, through individual or cooperative research, provide the solution. Thus it was decided to form the Problems Committee to establish and oversee the projects slated for study by ISCC Members. Deane Judd was the first chairman of the Problems Committee. Each project received a designation. The following is a list of the projects undertaken from 1931 to 2006.

1. CIE STANDARD OBSERVER (COMPLETED)

The Committee approved adoption of the CIE 1931 Standard Colorimetric Observer. For data on CIE 1931 Standard Colorimetric Observer see *J. Opt. Soc. Am.* 23, 359-374 (1934).

2. COLOR NAMES (COMPLETED)

The Committee developed the ISCC-NBS method for designating color. See report of Committee, Measurement and Specification (I. H. Godlove, Chair) Minutes 1932 Annual Meeting, ISCC Newsletter #4; Method of Designating Colors (with boundary charts) Deane B. Judd and Kenneth L. Kelly, *National Bureau of Standards J. Res.,* 23, 355, (1939);, Standardization of color names (with name charts), Dorothy Nickerson, (mimeo of War Food Administration, Washington, D.C.); Amer. Dyestuff Reporter 29, No. 16, Aug. 5, 1940; Instructions for determining color names for drugs and chemicals (with names of colors viewed with transmitted light), Kenneth L. Kelly, N.F.Bull, 8, 11, (1940); Systematic color designations for paper, Dean B. Judd, TAPPI Papers 23, 473-525 (1940), and Paper Trade Journal, Oct. 17, 1940. Central notations for ISCC-NBS color names, Nickerson-Newhall, *J. Opt. Soc. Am.* 31, 587-591 (1941); Preliminary color standards and color names for soil, Rice-Nickerson et al., USDA Misc. Publ. No. 425; Success of ISCC-NBS color names in the Chemical Monographs, Kenneth L. Kelly, N. R. Bull, 9, 302-311 (1941); Color designations for lights, Kenneth L. Kelly, *J. Opt. Soc. Am.* 33, 627-631 (1943); ISCC-NBS color names, Dorothy Nickerson, Bull. Am. Ceramic Soc. 22, 306-310, Sep. 15, 1943. Subcommittee was appointed in 1947 to consider boundary revision of 1939 report (RP 1239). New boundaries were approved June 1949. Description of the revised method and a dictionary of color names published as National Bureau of Standards Circular 553 (1955). This revision was used as a basis of defining color names in the 1961 edition of Merriam-Webster Dictionary. Subcommittee appointed in 1960 to arrange for publication of color samples to represent centroids of ISCC-NBS color designations. Color charts were published in May 1965 as a supplement to NBS Circular 553. In 1976, Circular 553 (then out of print) was incorporated in NBS Special Publication 440, Color: Universal Language and Dictionary of Names. The charts, providing a ready means of visualizing the centroid colors, may be ordered as Standard

Reference Material 2106 (with Publication 440, SRM 2107) from the National Bureau of Standards, Washington, D.C. 20234.

3. Color for Poison Label (Completed)

Suggestions summarized in Minutes of Seventh Annual Meeting, 1938.

4. Theatrical Filter Designations (Completed)

Designations of filters for theatrical lighting. Deane B. Judd, *J. Opt. Soc. Am.* 28 390-397, (1938); and amplification by I. H. Godlove, ISCC Newsletter 26, p. 5, December 1939.

5. Who's Who in Color. (Completed)

"*Who's Who in Color*" was published by the Council in 1938. (Supply exhausted).

6. Survey of Color Terms (Completed)

1939. A Comparative List of Color Terms, 42 pp.; preliminary report. (Supply exhausted).
1949. The ISCC Comparative List of Color Terms, a report of ISCC committee #6 under chaired by Sidney M. Newhall. Compiled by Sidney M. Newhall and Josephine G. Brennan, 94 pp. (Supply exhausted).
1972. Committee reactivated under the chair of C. J. Bartelson to revise and reissue the 1949 list. Member-bodies solicited for new terms and their lists collated.

7. Survey of Color Specifications (Completed)

1947. Committee appointed under the chair of Walter C. Granville. Report published 1956 by National Paint, Varnish and Lacquer Association, now the National Paint and Coatings Association.
1962. Committee appointed to revise and bring report up to date.
1973. Report issued as computer printout (Supply exhausted).

8. Survey of Color Problems (Completed)

The project assigned this number did not lead to an active committee.

9. CIE Chromaticity Diagram (Completed)

Made available in 18" x 20" size, in packages of 25. Available for many years through purchase from the Inter-Society Color Council. Now available from Munsell Color Company, 2441 North Calvert Street, Baltimore, MD 21218.

10. COLOR APTITUDE TEST (COMPLETED)

Committee completed its work in 1982. Progress reports in ISCC Newsletters and in annual reports. ISCC Color Aptitude Test, Forrest L. Dimmick, *J. Opt. Soc. Am.* 32, 75 (Abstract) (1942); Color Aptitude Test Developed for Textiles, Forrest L. Dimmick, Textile World, 94, 84, (1944). See ISCC Newsletter No. 56. A Color Aptitude Test, 1940 Experimental Edition; Forrest L. Dimmick, *J. Appl. Psych.* 30, 10-22 (1946). Report on 1944 edition, ISCC 1946 Annual Report, pp. 25-35. Test sold out. The Federation of Societies for Coatings Technology (then the Federation of Paint and Varnish Production Clubs) backed the publication of 1953, 1964, and 1978 editions. Renamed Color-Matching Aptitude Test in 1978. Test sold out.

11. COLOR BLINDNESS (COMPLETED)

The first work was done in connection with Project 10. See publication in *J. Opt. Soc. Am.* for Apr. 1943 and for Oct. 1943, containing papers resulting from a symposium on Color Blindness. Statement on corrective training issued 1974, see Sight-Saving Review, color perception endorsed 1947. Stimulated by the work of this committee Hardy, Rand, and Ritter developed the H-R-R Plates, once published by the American Optical Company. See Archives of Ophthalmology, 1954 for two papers on this test, also *J. Opt. Soc. Am.* (1954). The Farnsworth Lantern, developed by another member of this committee, was officially recommended (1954) by The Medical Policy Board of the Bureau of Medicine and Surgery for use in all Naval services and was adopted by the then Civil Aviation Authority, now Federal Aviation Agency.

12. STUDIES OF ILLUMINATION AND VIEWING CONDITIONS IN THE COLORIMETRY OF REFLECTING MATERIALS (COMPLETED)

Final report published in Color Engineering, May 1964, Vol. 2, No. 5, pp 14-23.

13. THE ILLUMINANT IN TEXTILE COLOR MATCHING (COMPLETED)

Report of the committee published in full following presentation at I.E.S. Annual Meeting, 1947. The Illuminant in Textile Color Matching - An Illuminant to Satisfy Preferred Conditions of Daylight Match, Dorothy Nickerson, Illum. Engin., 43, 416-464 (1948); The Illuminant in Textile Color Matching - Summary, Dorothy Nickerson, *J. Opt. Soc. Am.* 38, 458-466 (1948). Brief or partial reports by the committee members have appeared in journals of cooperating member-bodies.

14. THE COLORIMETRY OF TRANSPARENT MATERIALS (COMPLETED)

A committee under the chair of Robert H. Osborn was appointed in 1947 and reported to the 1953 annual meeting. The committee then continued under the chair of Ronald C. Stillman who prepared an interim report. After a period of inactivity the committee was reactivated under the chair of Wesley B. Reed and an interim report was approved for publication. A condensation of this interim report "Colorimetry of Transparent

Materials", Ruth M. Johnson, was published in the Journal of Paint Technology 3, 2-50 (1971).

15. Definitions of Color Terms (Completed)

The need for studying the color terms published in 1949 led to the appointment of an advisory committee to try to work out a practical way to obtain agreement among different member-bodies then utilizing a multiplicity of terms in ways which had little or no difference in meaning. It might then have been feasible to select preferred definitions for terms which have more than one meaning among different member-bodies. No progress was made and the effort was abandoned.

16. Standard Methods of Mounting Textile Samples for Colorimetric Measurement (Completed)

A report describing eight standard methods for mounting textile samples for colorimetric measurement was published in the American Dyestuff Reporter 57, 16-30 (1968).

17. Color in the Building Industry (Completed)

This committee was formed in 1951 with Waldron Faulkner as chair to produce a sound and practical program for providing a uniform set of material standards showing the color and appearance properties of all building materials. In 1965, it was suggested that, as a result of differences of opinion as to the effectiveness of its activities, consideration be given to the establishment of several other subject areas. In 1966, the committee's work was declared completed and the Committee for Project 30 was organized.

18. Colorimetry of Fluorescent Materials (Completed)

This committee was organized in 1952 with the objective of using spectroradiometric techniques to provide a colorimetric description of fluorescent materials. Chaired successively by Seymour Goldwasser, Eugene Allen, Franc Grum, Per S. Stensby, Frederick T. Simon, Thomas E. Cullen and David Alman various groups worked on projects investigating light sources and instrumentation relating to viewing and characterizing fluorescent materials. In recent years the direction changed as instruments became available to accomplish the original objectives of the committee. Preliminary work by Franc Grum and Cindy Ashton led to the creation of a set of diagnostic standards for the evaluation of instruments used to characterize the color of fluorescent materials. The results were turned over to Project #22: Materials for Instrument Calibration. Publications include *Color Res. App.* 3, 141-145 (1978) and ISCC Technical Report 78-1.

19. A Study of the Colorimetry of Near-White Surfaces (Completed)

This study was set up at the request of the American Ceramic Society delegates. A final report was published in the *J. Opt. Soc. Am.* 48, 597-605 (1958).

20. BASIC ELEMENTS OF COLOR EDUCATION (COMPLETED)

The final report of this committee was published as a book in 1963 with the title "Color: A Guide to Basic Facts and Concepts" by R. W. Burnham, R. M. Hanes and C. James Bartleson, John Wiley & Sons, New York. By special arrangement between the Council and the publishers it was possible to send a copy to all delegates and members of record at the time of publication. In 1977, the book was declared out of print by the publisher, and copies are no longer available.

21. STANDARD PRACTICE FOR VISUAL EXAMINATION OF SMALL COLOR DIFFERENCES (COMPLETED)

This study, initiated by the ASTM in 1957, has been actively worked on by a large committee. For progress see annual reports in the ISCC Newsletter. The final report of this committee was published by Sam J. Huey, Chair, in the *Journal of Color and Appearance,* 1 (4), 24-26 (1972)

22. MATERIALS FOR INSTRUMENT CALIBRATION (COMPLETED)

This project, initiated by the ASTM in 1957, was originally titled "Material Standards for the Colorimetry of Opaque, Translucent and Transparent Materials." The original scope and objectives were based on the premise, now largely discredited, that there was a need for stable, rugged standards. These standards should be readily available in a wide variety of colors, of a size suitable for use in present day instruments, and be sufficiently uniform and permanent to permit their use in standardization or comparison of instruments and durable enough to tolerate normal laboratory handling and cleaning. The committee's feelings were that improved techniques for color measurement must precede or accompany considerations of improved material standards. A progress report outlining the problems in this area were published as "Precision of Color Measurement with the G. E. Spectrophotometer I, Routine Industrial Performance," Fred W. Billmeyer, Jr., Chair, *J. Opt. Soc. Am.* 55, 707-717 (1965).

Subsequently chaired by Joseph T. Atkins, the committee turned its attention to the solution of specific measurement problems. For details, see annual reports in the Newsletter. Then, chaired by Ellen Carter, the committee undertook the preparation of a guide to available material standards and their use for color measurement, now published as ISCC Technical Report 78-2; a summary article based on the report is "Material standards and their use in color measurement," Ellen C. Carter and Fred W. Billmeyer, Jr., *Color Res. Appl.* 4, 96-100 (1979). Charles J. Sherman became co-chair in 1979, and chair in 1980. In 1981, Danny C. Rich took over the chair. The name of the committee was changed to *Materials for Instrument Calibration* to avoid any impression that either the committee or ISCC were trying to set standards.

In 1989 the committee published ISCC Technical Report 89-1, a revision to the earlier guide to material standards which is available from the office of the Secretary of the ISCC for a small fee.

23. EXPRESSION OF HISTORICAL COLOR USAGE (COMPLETED)

An interim report of this Committee, outlining a method for recording historical consumer color preferences for products in individual industries, was approved by the Board of Directors in 1960 and distributed to the members of the Council. Much work was subsequently done toward validation of the proposed method for data accumulation. See annual reports for progress. See also "A Universal Color Language", by Kenneth L. Kelly, *Color Engineering* Vol. 13, p16, Mar-Apr 1965; "Color -- Universal Language & Dictionary of Names", NBS *Special Publication SP440*, 1964; ISCC-NBS Centroid Color Charts, Std. Sample 2106; *Color Technology in the Textile Industry*, AATCC (ed. Celikiz and Kuehni), pp 135-152, 1983. With the formation of the Color Marketing Group, this Committee became inactive in 1964.

24. CATALOG OF COLOR MEASURING INSTRUMENTS (COMPLETED)

This committee was organized in 1966, chaired by Ruth M. Johnston, to provide the title catalog. An important addition to the sections presenting technical data on instruments, which were soon out of date, was an extensive preamble discussing instrument design features, definition of the user's measurement problem, and how to use the catalog as a guide to aid in selecting the best instrument. The catalog was approved for release, and the preamble was published by Ruth M. Johnston, *J. Color and Appearance* 1 (2), 27-38 (1971). The Committee, then chaired by Harry K. Hammond III, was discharged in 1974, with some of its function having been taken over by the Manufacturers' Council on Color and Appearance and the remainder assumed by the committee for Project 22.

25. DETERMINATION OF THE STRENGTH OF COLORANTS (COMPLETED)

This committee was organized in 1966 chaired by Charles G. Leete. Effort was soon divided into a Dyes Section, Rolf Kuehni, later Leonard A. Weiner, Chair, and a pigments section, Richard W. Harold, chair, later Joyce S. Davenport, and still later Jacqueline Welker, chair. In January, 1975, a new Section was formed to study the Strength of Pigments in Mass-Colored Fibers, chaired by Richard Bache and then by George Sonn. The Dyes Section has published the following reports: A General Procedure for the Determination of Relative Dye Strength by Spectrophotometric Transmittance Measurement, Textile Chem. Colorist 4, 134-142 (1972); A general Procedure for the Determination of Relative Dye Strength by Spectrophotometric Measurement of Reflectance Factor, Textile Chem. Colorist 6, 104-108 (1974); Reproducibility of Dye Strength Evaluation by Spectrophotometric Transmission Measurement, Textile Chem. Colorist 8, 36-39 (1976). The fibers section was active until recently.

26. DETERMINATION OF SETS OF MAXIMALLY DIFFERENT NON-FLUORESCENT COLORS (COMPLETED)

The committee was founded to determine and present a series of sets of colors having maximal difference within these sets. The sets were to consist of two, three, four, etc. up to 22 colors. It was desirable that as many sets as possible were not confused by color blind people. It was also desirable that all of the colors were taken from easily available standard sources such as the ISCC-NBS Centroid Colors. It was probably not necessary that each set have the maximum possible difference within the set, but this was desirable. This problem was solved in large part by work stemming from continuing activity on Project 2, culminating in publication of "Twenty-two Colors of Maximum Contrast", Kenneth L. Kelly, Chair, Color Engineering 3 (6), 26-27 (Nov-Dec, 1965).

27. INDICES OF METAMERISM (COMPLETED)

This committee was organized in 1967, chaired by Isadore Nimeroff, and reorganized in 1970 with Henry Hemmendinger as chair. Since similar studies were in progress in CIE Committee TC-1.3, Colorimetry, this committee assumed an observer role to some extent but was reorganized in 1975 with Ralph Besnoy and Allan B. J. Rodrigues as co-chairs. A paper "What is Metamerism?" authored by the co-chairs asking for comment on the scope and objectives of the committee, particularly as they related to nomenclature and the definition of problems, appeared in *Color Res. App.* 5, 220-221 (1980). The committee was chaired by Hugh S. Fairman from 1984 to 1990, and the publication "New Terminology for Metamerism Revisited" appeared in *Color Res. App.* 11, 80-81 (1986). A paper describing the results of the committee's questionnaire on metamerism terms and concepts written by Fred W. Billmeyer, Jr. appeared as "Results of ISCC Questionnaire on Metamerism", *Color Res. App.* 13, 376-384 (1988). The paper "Recommended Terminology for Matrix R" was published in *Color Research and Application* 16, 337-341 (1991).

28. AND 29. PROJECTS ASSIGNED THESE NUMBERS DID NOT LEAD TO ACTIVE COMMITTEES.

30. COLOR IN THE BUILDING INDUSTRIES (COMPLETED)

This project was reorganized from Project 17 of the same name and given a new scope in 1978. The original committee was organized in 1966 with Milo D. Folley as chair. The aim of the group was to coordinate and apply color science to color problems in the building industry, with particular concern for the application of the Munsell System notation to color specification problems in this industry.

This committee proposed to establish guidelines to improve the presentation of colored building products in manufacturer's literature so that they can be better selected and more accurately identified by architects and designers. Building materials and their colors are usually selected first by general category, then from producer's catalogs or printed illustrations. The final choices are made based on the visual appraisal of physical samples.

New methods of reproduction and presentation of color and texture in readily available form can lead to better decisions.

In 1976, a Task Force under Project 30 on "The Presentation of Colored Building Products" was established with the approval of the American Institute of Architects. It studied and evaluated a number of catalogs of building materials from Sweet's by means of score cards and tabulated the results. A report was presented at the annual meeting in 1978 for discussion.

31. Standard Methods of Measuring and Specifying the Color of Exposed and Processed Color Transparencies (Completed)

Sponsored by the ASP, this committee held its first meeting in 1971, with John T. Smith as chair. Little progress was made and in 1975 the committee was combined with the committee for Project 32.

32. Image Technology (Completed)

This committee was established in 1972 with the title "Colorimetry in the Graphic Arts," but was never active. In 1975, the committee for Projects 31 and 32 were combined, retaining the number 32, with C. S. McCamy as chair, under the title "Color Problems in Photography and Printing." The emphasis was at this time in three main areas; first, the organization of a Williamsburg 1978 symposium on color reproduction; second, the definition of "neutral" and how is it related to color densities, which lead to a Leroy DeMarsh publication; and finally, the availability of calibration standards by absolute methods. In 1978 the title was changed to "Image Technology," and the chair went to LeRoy E. DeMarsh. In his tenure, television and other video imaging systems were added to the scope of this committee. Mr. DeMarsh was replaced as chair by Ms. Paula J. Alessi in l982, and in 1989 Mr. Mark Gorzynski was added as co-chair.

Purpose: There is a need for an inter-disciplinary study of the problems common to photography, printing, video display, and television relating to the rendition, measurement, and specification of color.

Scope: To compile a color reproduction bibliography with an emphasis on emissive devices, photographic and graphic arts systems and combinations thereof.

Objective: To compile the color reproduction bibliography within the coming year and to disseminate the results in the form of an ISCC Technical Report.

33. Human Response to Color (Completed)

Several years ago Raymond Spilman, chair of The Industrial Designers Society of America delegation, suggested that the Inter-Society Color Council should begin to explore the use of color as far as people are concerned. An organizational meeting was held in 1973. The two main recommendations that were made by this group were that: 1. The name of the Committee be "Human Response to Color", with the realization that although it is a rather general title, it does indicate the wide interest of the several members of the committee with the possibility of working on different areas of interest in the future. 2. The specific initial study should be "Patients' Reaction to Color Environments in Hospitals."

The committee, chaired by Alexander F. Styne, was very active, presenting "mini-symposia" at many of its annual meetings. In 1978, the symposium, chaired by Mr. Spilman was titled "Human Response to Color of Objects" and included the following papers published in *Color Res. Appl.,* "Mass-Market Color Selections," by Carroll M. Gantz, 3, 137-140, (1978)., and "Color as a Marketing Tool," by Robert G. Smith, 4, 78-82, (1979).

In 1982 Mary Buckley and Walter C. Granville were appointed co-chairs. In January 1984 Walter Granville resigned his co-chair, and Mary Buckley served as chair until her resignation in March 1986. In June 1986 Walter Granville agreed to chair the committee again. In October 1987 the committee's activities were consolidated with Project #45, Physiological Response to Color.

34. COLOR DIFFERENCE PROBLEMS (COMPLETED)

The work of the committee on color difference problems involved a careful comparative study of the relative merits of the various color difference formulas then recommended (CIELAB and CIELUV). It undertook evaluation of the concepts of perceptibility and acceptability in industrial color difference problems, as well as the determination of whether acceptability rather than perceptibility is important in industrial color-matching. The committee was sponsored by the American Association of Textile Chemists and Colorists. The committee was formed in 1973 chaired by Rolf G. Kuehni, later Ruth Rich in 1978, and Sy Commanday in 1980. The committee has conducted active research and a paper "An experiment in visual scaling of small color differences," by Rolf G. Kuehni and Robert T. Marcus, was published in *Color Res. Appl.* 4, 83-91, (1979). Other progress is described in annual reports in the ISCC Newsletter.

35. COLOR OF LIVING TISSUE (COMPLETED)

The members of the American College of Prosthodontists were intimately concerned with the color-matching of natural teeth and of facial tissues. It was a matter of concern to the members of the College that past efforts in color-matching in dentistry had not taken advantage of modern color technology. Thus, this Committee was formed in 1973 chaired by Robert C. Sproull, and was later chaired by Stephen F. Bergen. The project was sponsored by the American College of Prosthodontists and dealt with color-matching in the dental and maxilla-facial prosthesis area. It was very active; for progress reports, see the annual report issues of the Newsletter.

36. EXAMPLES OF INDUSTRIAL COLOR DIFFERENCE ACCEPTABILITY (COMPLETED)

Many industries involved in buying and selling colored materials had no visual examples of acceptable color differences to serve as guides. The purpose of this project was to provide visual examples of color differences which were representative of industrial acceptability at two levels of tolerance, 'tight' and 'commercial', for a representative group of colors. This committee was formed in 1976 chaired by Anthony J. Pentz, and Rick Mathew became co-chair in 1982. The original title, Color Acceptability Standards, and the original scope was modified in 1978 to make it clear to all that neither the Committee nor the ISCC was attempting to set standards. A preliminary experiment using samples prepared for unrelated research demonstrated the feasibility of the proposed visual scaling, the but preparation of samples representing the results of this experiment proved to be too onerous a task to be performed by committee, and the work was abandoned in 1987.

37. Artists' Materials (Completed)

This committee was initially chaired by Joy Turner Luke. Early work was closely coordinated with the NBS Standing Committee on Artists' Paints. After the NBS ceased issuing voluntary standards, there has been close cooperation with ASTM. The committee researched color problems of these materials and made recommendations to ASTM Committee D-01.57, Artists' Paints and Related Materials. Mark Gottsegen replaced Mrs. Luke as chair in 1981, and Zora S. Pinney became co-chair in l982. In 1985 Hilton Brown became chair. In 1989, Joy Luke resumed as chair of this committee.

38. PHILATELIC COLOR DESIGNATION (COMPLETED)

This committee was formed in 1979 chaired by Donald L. MacPeek. It was sponsored by the American Philatelic Society, and the Committee also served as the APS Color Committee. Since the beginning of the hobby of stamp collecting, identifying and describing the colors of postage stamps has been a major unsolved problem for collectors at all levels of sophistication. Large differences in monetary value of some stamps depending on nuances of color have often compounded the difficulty. Most collectors have had no recourse other than to use names assigned to color varieties by the publishers of stamp catalogs as the means of assigning color names to various issues. Unfortunately, these names are all too often inconsistent and not descriptive. The objective of this Committee was to develop and arrange for the publication of a body of information identifying stamp colors in terms of the Universal Color Language (UCL).

The following publications based on the work of this committee has appeared: "APS Manual for Determining Color Designation of Stamp Colors," Kenneth L. Kelly and Fred W. Billmeyer, Jr., The American Philatelist 95, 709-717, (1981); "Universal Color Language Color Designations for Some Philatelic Color Aids," Fred W. Billmeyer, Jr., The American Philatelist 96, 506-516 (1982).

39. Color of Gems (Completed)

The purpose of this committee was to determine the suitability of instrumental methods for evaluating the color of gemstones, and to investigate color spaces which might be suitable for establishing grading scales for gems. Interest in this subject by several gemological groups led to the establishment of this committee in 1982, chaired by Therese F. Zook. Because individual interest on the part of members did not materialize, the committee was place on standby status in 1985.

40. Color Education (Completed)

This committee's purpose was to improve color education by organizing, coordinating, and maintaining current color education resources. The committee was organized in 1982 chaired by Dr. Nancy Jo Howard. The committee immediately undertook to compile a bibliography of color publications which might serve as a resource to color educators. This bibliography is available to interested parties from Dr. Howard. In 1984, Evelyn Stephens became chair of the committee. A questionnaire was sent to a large number of color educators at both college and secondary level to determine their needs for teaching resources. The committee was active in compiling a large number of slides dealing with color science for the purpose of eventually duplicating them for distribution.

41. Special Education (Completed)

The intent of the committee was to prepare special educational materials with information on color. This material was intended to represent the best understanding of color science and its practical application to art, science, and industry. Text and illustrations were to be prepared for publication. Methods for distribution of the printed materials to schools and educational outlets were considered by the committee. The committee was chaired by Richard Ingalls, but failed to attract enough membership interest to proceed.

42. Terminology (Completed)

The committee was initiated in 1987 chaired by Stephen Shafer with the purpose of defining color terminology to the interaction of light with matter, an area important to robot vision. It failed to attract enough interest to proceed, and was abandoned in 1988.

43. Color Vision Models (Completed)

Color vision models are used to tie together as much information as is known about color vision in a unified coherent story. It is expected that models will contain many features which will eventually be proven wrong, but the model will provide the best framework possible within which to pursue color vision research. A transformation via a color vision model is preferred to an empirical model which would apply only to the conditions under which the data were collected. Further, a good model would be one which is capable of modification as our knowledge about color vision develops.

The committee compiled a bibliography of the literature relevant to color vision models. This bibliography was completed in 1988, and is available from the chair, Peter Kaiser.

44. UNIFORM COLOR SOLID (COMPLETED)

Purpose: There is a need to develop a color order system whose spacing is improved in uniformity over presently existing systems.

Scope: Collect information on color order systems now in existence. Identify where improvements in spacing over such existing systems would be desirable. Define the anticipated requirements for such a solid such as visual uniformity, step size, orientation, handedness, gamut, sample size, material, and method of display. Develop a specification for such an improved solid so that it could be produced by others.

Objectives:

1. To produce and analyze a single lightness plane of such improved solid using a color solid model developed by the committee.
2. To produce and analyze such additional portions of the solid which the committee deems necessary.
3. To write the specification outlining the requirements of the system for potential producers of an atlas.

The committee was organized in 1987 chaired by Chuck Reilly. It began its work by measuring a copy of the OSA-UCS atlas and calculated the differences from the intended aim points both in terms of CIELAB color differences and in terms of OSA space color differences. The committee then performed an experiment to determine the applicability of the Semmelroth equation to the chromatic crispening effect. In 1988, Hugh Fairman became chair of the committee. Lately, the committee has been engaged in several visual experiments, scaling various equations describing a color solid, testing their relative uniformity.

45. PHYSIOLOGICAL RESPONSE TO COLOR (COMPLETED)

Purpose: There is a need to classify and define how color influences human physiology, psychology, and behavior in order to improve use of color in the human environment.

Scope:

1. To develop appropriate terminology and definitions for describing the effect of color on human physiology, psychology, and behavior.
2. To conduct experiments to generate data necessary to define human physiological response to color.
3. To conduct experiments to study the effects of color on human psychology and behavior.

Objective: To design and conduct an empirical study which will yield repeatable data on the biological response of normal humans to color.

The committee was convened at the Annual Meeting in 1988 co-chaired by Magenta Yglesias and George Brainard. It has worked on an exchange of published information in this field and on establishing an electronic network among members. In conjunction with Thomas Jefferson Medical College Department of Neurology and Desugnare, Ltd., the committee has conducted experiments on the effect of color on cardiovascular physiology in normal, healthy humans.

46. COLOR EDUCATION: SPEAKER'S BUREAU (COMPLETED)

This committee, under the chair of Stephen Bergen, established a speakers' bureau comprised of ISCC members willing to talk about their various area of expertise. This list was distributed to ISCC members, schools, colleges, community groups, and professional organizations as requested. The list will continue to be updated.

47. COLOR EDUCATION RESOURCES (COMPLETED)

This committee was established under the chair of Prof. Fred Simon to create a database of information on color educators, course, and resources. After discussion of a few educational demonstrations, it was decided to disband the committee and continue working through Interest Group IV, "Color Education", to draw together a wider group of educators to continue this work.

48. COLOR SLIDE COLLECTION FOR COLOR EDUCATION (COMPLETED)

This project committee worked under the chair of Dr. Nancy Jo Howard to develop a slide collection with accompanying script. The collection and script were to be based on accurate information and current educational needs. A detailed outline was prepared, and some slides collected. A closing report will be published shortly.

49. IMPROVED COLORIMETRY (DISBANDED)

This committee’s purpose was to further work on confirming and complementing recently published studies by Thornton and others relating to discrepancies between visual and computed characteristics of lights, identifying causes of the discrepancies, reducing them appreciably, and thereby producing a practical, improved colorimetry in the short term

The committee was convened at the Annual Meeting in 1992 and was chaired by Dr. William A. Thornton and co-chaired by Dr. Fred W. Billmeyer, Jr. during 1992 and 1993, and thereafter chaired by Dr. Thornton. This committee was disbanded due to the resignation of the Chair in 1996. The purpose of this committee was to deal with obtaining and publishing spectral power distributions of commercially available lamps.

50. COMMERCIAL LAMP LIGHT SPECTRAL POWER DISTRIBUTIONS (DISBANDED)

The purpose of this committee was to deal with obtaining and publishing spectral power distributions of commercially available lamps. There is a need in the computer aided color control industry to be able to predict the effects of many light sources other than those that are published by the CIE or ASTM. Lamp manufacturers continue to produce new lamps that have different spectral distributions. This causes considerable problem to industries producing colored products. Because individual interest on the part of members did not materialize, the committee was disbanded in 1996.

51. GUIDE TO MATERIAL STANDARDS (COMPLETED)

Purpose: There is a need for the revision of ISCC Technical Report 89-1.

Scope: To collect information on new material standards for color and appearance measurement, their suppliers, and their characteristics. To collect recent references to the literature of measurement, calibration, and standardization of color and appearance instrumentation for revision and modernization of the literature citations of TR 89-1. To collect new terms for the glossary, and to check accuracy of current terms by comparing with authoritative terminology sources such as ASTM E-284 and CIE Publication 17.4. To revise the current text of TR 89-1 to be complete and up-to-date with modern practice.

Objectives: To publish a revised version of ISCC Technical Report, TR 89-1, Guide to Material Standards, under a new publication number, ideally within one year. Much of the current publication TR 89-1 is still applicable and its integrity should be maintained. The new publication number may replace the old publication number on the list of current ISCC publications.

The purpose of this committee was to publish a revised version of ISCC Technical Report, TR 89-1, Guide to Material Standards. Initiated by the ASTM in 1957 and continued as ISCC Project Committee 22, the document has a history of more than four decades. It provides an introduction to material standards and their use for the standardization of color measuring instruments.

The revision involved the following tasks: To collect information on new material standards for color and appearance measurement, their suppliers, and their characteristics; to collect recent references to the literature of measurement, calibration, and standardization of color and appearance instrumentation for revision and modernization of the literature citations of TR 89-1; to collect new terms for the glossary; to check accuracy of current terms by comparing with authoritative terminology sources such as ASTM E-284 and CIE Publication 17.4; and to revise the text of TR 89-1 to be complete and up-to-date with modern practice.

The committee held its first general meeting at the May 1996 ISCC Annual Meeting with Jack Ladson as the Chair. Several chairs and editors guided the committee over the years, including Arthur W. Springsteen, Jeffery Sefl, Jack Ladson, Hugh S. Fairman, Michael H. Brill, and Joanne Zwinkels. In 2003, the revised ISCC Guide to

Material Standards and Their Use in Color Measurement (ISCC TR-2003-1) became available for purchase.

52. COMPARATIVE LIST OF COLOR TERMS II (ACTIVE)

Purpose: The ISCC Comparative List of Color Terms was first published in 1949, but the supply has been exhausted. While many terms are still useful and have not changed, the usage of others has evolved, and new terms have come into common appearance and should be added. Therefore, there is a need to update the original publication.

Scope:

1. To review the terms included in the original comparative list for current accuracy and appropriateness.
2. To solicit member bodies for new terms to be added.
3. To compare and contrast definitions and usage of terms in various disciplines and from other dictionaries or lists of color terms, identifying the source(s) of definitions(s) of each term.

Objective: To publish as an approved ISCC publication, the ISCC Comparative List of Color Terms II.

The project committee was approved by the ISCC Board of Directors in February 2000 and held its first public meeting at the Annual Meeting in April 2000 with Ellen Carter as chair. Although it wasn't in the original scope, a cross reference to terms in different languages will be included where possible. The project will be published on CD and updated periodically. Currently we are on hold waiting the publication of the updated ILV from the CIE

53. ANNOTATED "WEBLIOGRAPHY" OF COLOR (DISBANDED)

Purpose: To enhance the ISCC's website so as to promote the ISCC's role as a nexus for color information exchange. Other websites exist that are excellent sources of color information, and hence web linking resources to the ISCC. Such links would be separate from the current member links.

Scope:

1. To develop a list of criteria to select a website for annotation/citation.
2. To provide a first selection of websites for citation according to the criteria.
3. To organize the selection into an annotated list for incorporation on the ISCC website.
4. To provide rules for updating the resulting "Annotated Webliography".
5. To transition the effort to a standing committee that will review and update the webliography periodically.

Objective: To publish as an approved ISCC office document the list of criteria and the rules for updating the webliography, and to post an initial webliography.

The project committee was approved by the ISCC Board of Directors in February 2000 and held its first public meeting at the Annual Meeting in April 2000 with Michael H. Brill as chair. It was disbanded in 2002 due to the fast-changing Webscape and the insufficient personnel to keep the Webliography up-to-date.

54. COLORS OF MAXMUM CONTRAST (ACTIVE)

Purpose: There is a need to revise and republish the work of Project Committee #26. This work was completed in 1964 and was published in Color Engineering, November-December, 1965, page 26. This publication named twenty-two colors that were said to be maximally different from each other. In the light of modern developments in color measurement and specification as well as expansion of the producible surface color gamut, these colors are no longer thought to be the optimal set of colors of highest contrast to each other.

The Committee will:

1) Select an appropriate number of colors of maximum contrast to be published.
2) Select the colors to be published taking into account both surface color and applications where color is generated electronically.
3) Complete the project by fall of 2006.

The Co-Chairs of this committee are Hugh Fairman and Ralph Stanziola.

Interest Groups

Interest groups were first formed in 1988 to provide a mechanism through which members with similar interests and need could share ideas. These groups were to be a forum for discussion on current optics. When Interest Groups were first introduced there were four: Group I Measurement and Colorimetry; Group II on Appearance, Vision and Modeling, Group III on Art, Design and Psychology and IV on Education. It was planned that periodically the groups would be reviewed and possibly realigned to meet the needs of the membership of the Council in a changing world.

One of the changes resulting from the third planning retreat in 1991 was the realignment of the Interest Groups. Currently the Interest Groups are: Group I - Fundamental and Applied Color Research, Group II - Industrial Applications of Color, and Group III - Art, Design, and Psychology. Group IV on Education became the Standing Committee on Education.

Interest Group I	Milt Hardt, chair	Jim Roberts, vice chair
Interest Group II	Jerald Dimas, chair	
Interest Group III	Georgia Kalivas, co-chair	Marsha Cohen, co-chair

Education Committee Margaret Miele, chair

Awards

Godlove Award

The contributions of I. H. Godlove to the Council were extensive as has been indicated throughout this CD. While he was alive he spoke of establishing a fund with the Inter-Society Color Council to make possible a modest medal or award to members doing outstanding work in color over a designated period. After his death, the Board of Directors at their April 5, 1956 meeting votes to accept with gratitude the generous proposal for the establishment of the I. H. Godlove award made by Mrs. Margaret N. Godlove in memory of her husband Dr. I. H. Godlove (1892-1954). The award is now presented biennially to worthy persons for their lifetime contributions to the knowledge of color. The family continues to support the Award.

This photo is from the most recent annual meeting, during which Alan Robertson received the 25th Godlove Award on April 25, 2005. Left to right: Terry Godlove, Jr.; Hannah Godlove, daughter of Terry Godlove, Jr.; Benjamin Godlove, son of Terry Godlove, Jr.; Alan Robertson, Terry Godlove, son of I. H. Godlove; Gail Rubin, wife of Terry Godlove, Jr.; and Dorothy Godlove, wife of Terry Godlove. (Terry Godlove's daughter Karen, and her husband and two children could not attend that day.)

Recipients

Deane B. Judd	1957
Ralph M. Evans	1959
Dorothy Nickerson	1961
David L. MacAdam	1963
Isay A. Balinkin	1965
Edwin I. Stearns	1967
Harry Helson	1969
Norman Macbeth	1971
Dorothea Jameson and Leo Hurvich	1973
Vincent C. Vesce	1975
Hugh R. Davidson	1977
Gunter Wyszecki	1979
Robert M. Boynton	1981
Eugene Allen	1983
Franc Grum	1985
Charles D. Reilly	1987
W. David Wright	1989
Richard S. Hunter	1991
Fred W. Billmeyer, Jr.	1993
Joel Pokorny and Vivianne Smith	1995
Henry Hemmendinger	1997
Calvin S. McCamy	1999
Max Saltzman	2001
Rolf Kuehni	2003
Alan Robertson	2005

Godlove Award Design

The original (1957) design consisted of a suitably engraved acrylic plastic prism in which was imbedded a triangular gold-ruled diffraction grating. It is a triangular piece of glass on which gold is deposited and inscribed with thousands of lines to make a diffraction grating, all embedded in a triangular block of Lucite. The grating of course shows the rainbow colors when illuminated properly. Engraved in the Lucite are the words Science, Art and Industry. As Terry Godlove recalls these were developed at Johns Hopkins University. He believes that the final awards as actually given had additional wording. One trial model (without the gold grating) in his possession has the words "The Godlove Award for Contributions to the Knowledge of Color."

When in 1970 the supply was exhausted, a new design was prepared consisting of an acrylic plastic regular tetrahedron, six inches on a side, in which were imbedded three sheets of colored plastic representing the subtractive primary colors (magenta, yellow, and cyan).

(photo courtesy of Hunter Associates Laboratory)

When the supply of these awards ran low, Marjorie Ingalls volunteered to produce yet another physical embodiment for the Godlove award. Her design of a three-dimensional CIE chromaticity diagram in clear acrylic plastic was accepted in 1986 and first awarded the same year. When the supply of these awards ran out a new design was selected. 2005 was the first year that this most recent design was awarded. Also 2005 was the first year that a financial stipend was included as part of the award.

Macbeth Award

In 1970 the Board of Directors of the Council accepted with gratitude the offer of Norman Macbeth, Jr., to establish a Macbeth Award in memory of his father, Norman Macbeth (1873-1936). This award will be presented biennially on even years, alternating with the Godlove Award. The Macbeth Award shall be given in recognition of recent important contributions in the field of color, preferably within 5 to 10 years preceding the Award. The work may concern a specific project, application, service, or use of color, or other accomplishment relating to color in art, industry, education, merchandising, etc. The first award was to be given in 1972.

Recipients

Peter C. Goldmark	1972
Midge Wilson	1974
Richard S. Hunter	1976
Fred W. Billmeyer, Jr.	1978
W. David Wright	1980
Harry W. Levison	1982
Ruth Johnston-Feller	1984
Max Saltzman	1986
Joy Turner Luke	1988
Roy Berns	1990
Jozef Cohen	1992
Peter Kaiser	1994
Michael Brill	1996
David H. Alman	1998
Brian A. Wandell	2000
Mark Fairchild	2002
Louis Silverstein	2004
David Brainard	2006

Nickerson Service Award

The ISCC Service Award was established in 1980 to recognize members who have given outstanding service to the ISCC in the form of organizational, clerical, or technical contributions. In 1986, the “ISCC Service Award” was re-designated the “ISCC Dorothy Nickerson Service Award” in honor of the late Dorothy M. Nickerson (1900-1985), who provided outstanding service to the ISCC from its founding in 1931 until her death in 1985. She was its Secretary from 1938 to 1950, and its President from 1954 to 1956.

Recipients

Fred W. Billmeyer, Jr.	1983
Dorothy Nickerson and S. Leonard Davidson	1985
George B. Gardner	1986
Harry K. Hammond, III	1987
Ruth M. Johnston-Feller	1988
Walter Granville	1989
Joyce S. Davenport	1990
Bonnie Swenholt	1992
Terry Commerford	1994
Allan B. J. Rodrigues	1995
Ann Campbell Laidlaw	1997
Louis A. Graham	1998
Danny C. Rich	1999
Hugh S. Fairman	2000
Paula J. Alessi	2001
Romesh Kumar	2002
Ellen C. Carter	2003
Ralph Stanziola	2004
Gultekin Celikiz	2005
Mary McKnight	2006

The Office

For anyone who has joined the Inter-Society Color Council recently the person with whom the new member has most likely come to know best is Cynthia Sturke. She is the

new face and voice of the ISCC, our Administrator/Office Manager.

Although opening an office had been discussed in the Long Range Planning Retreats, in particular in 1991, it wasn't until Roland Connelly became President in 1994 that the office really became a priority. He and Ellen C. Carter, the President-Elect at that time worked with the guidance of the Board of Directors to locate and open an ISCC Office. Hunter Associates Laboratory, often known as Hunterlab, and especially the founder Richard Hunter had long been an ardent supporter of the Inter-Society Color Council. In 1995, Phillip Hunter, President and CEO of Hunterlab, offered to house the ISCC Office at their facilities in Reston, Virginia. By the time of the 1996 Annual Meeting when Ellen Carter became President, the Office was opened and Cynthia Sturke was installed in her position.

Having the office and having Cynthia in it has provided a continuity that had been missing in the recent years before the office's opening. With the opening, new members now have one person to call, one place to write, and one familiar face when they first arrived to register at Annual Meetings or other events. Before that time there were changes with each officer election.

Another change that has become integral to the ISCC is the use of internet. The ISCC website may produce a potential member's first introduction to our organization. Please see the chapter 9 on Communications to learn more about the website.

CONSTITUTION

Article I--*Name*
The name of the Corporation is the Inter-Society Color Council, Inc.
The Corporation shall hereafter in this Constitution be referred to as the "Council."

Article II--*Aims and Purposes*
The Council shall operate solely and exclusively as a non-profit organization with the following aims and purposes:

A. To stimulate and coordinate the work being carried out by the various members leading to the uniformity of description and specification of color by these members.
B. To promote the practical application of this work to color problems arising in science, art, and industry, for the benefit of the public at large.
C. To promote communication between technically oriented specialists in color and creative workers in art, design, and education, so as to facilitate more effective use of color by the public through dissemination of information about color in both scientific and artistic applications.
D. To promote educational activities and the interchange of ideas on the subjects of color and appearance among its members and the public generally.
E. To cooperate with other organizations, both public and private, to accomplish these objectives for the direct and indirect enjoyment and benefit of the public at large.

Article III--*Scope of and Limitations on Activities*
The Council is, and the same is hereby, authorized and empowered to receive by devise, bequest, donation, or otherwise either real or personal property and to hold the same absolutely in trust, and to invest, reinvest, and manage the same and to apply said property and the income arising therefrom to the objects of its creation.

No part of the net earnings of the Council shall inure to the benefit of, or be distributable to, its members, directors, officers, or other private persons, except that the Council shall be authorized to make payments and distributions in furtherance of the aims and purposes set forth in Article II hereof.

No substantial part of the activities of the Council shall be the carrying on of propaganda or otherwise influencing legislation, and the Council shall not participate in, or intervene in, including the publishing or distribution of statements, any political campaign on behalf of any candidate for political office. Notwithstanding any provision of these articles, the Council shall not carry on any activities not permitted to be carried on by an organization exempt from Federal income tax under section 501 (c) (6) of the Internal Revenue Code of 1954, or the corresponding section of any United States Internal Revenue Law.

Article IV--*Membership*
All conditions, qualifications, requirements, privileges, and regulations as to membership in the Council shall be fixed and governed by the By-Laws of the Council, to the extent that the By-Laws are not inconsistent with the objectives stated herein.

Article V--*Management*
The activities and affairs of the Council shall be managed as provided in the By-Laws of the Council, to the extent that the By-Laws are not inconsistent with the objectives stated herein.

Article VI--*Dissolution*

In the event of the partial or entire liquidation or dissolution of the Council, whether voluntary, involuntary, or by operation of law, the Board of Directors of the Council shall, after paying or making provision for the payment of all liabilities of the Council, distribute the assets of the Council to one or more organizations exempt from taxation under section 501 (c) (3) of the Internal Revenue Code, as they in their sole discretion may determine. Any of such assets not so distributed shall be distributed by the appropriate court of the county in which the office of the Secretary of the Council is located, exclusively to such exempt organization or organizations as said court shall determine.

Article VII--*Amendments*

This Constitution may be altered, amended, or repealed either on the recommendation of the Board of Directors or on recommendations signed by ten (10) voting delegates of the Council, provided that a two-thirds (2/3) affirmative vote of the entirety of the voting delegates shall approve said amendment, and provided that at least ninety (90) days notice of such a proposal shall have been given by publication in the ISCC News or by other distribution to the voting delegates before voting shall take place. The voting delegates may vote in person or by proxy at any regular or special meeting of the Council occurring after the ninety (90) days notice. The proxies for voting may be solicited by mail. The procedure for originating, processing, and considering amendments to this Constitution shall be identical in every respect to that prescribed in the By-Laws for amendment to the By-Laws.

By-Laws

Article I--Membership

Section 1. Classes of Membership

Membership in the Council shall be of six classes, namely:
A. Member-Bodies
B. Individual Members
C. Sustaining Members
D. Honorary Members
E. Student Members
F. Retired Members

Section 2. Eligibility

(a) Member-Bodies. Any non-profit society, association, or organization of national scope, interested in color and desirous of participating in the activities of the Council for the furtherance of its aims and purposes as set forth in Article II of the Constitution, shall be eligible for membership as a Member-Body.
(b) Individual Members. Any person interested in color and desirous of participating in the activities of the Council for the furtherance of its aims and purposes as set forth in Article II of the Constitution shall be eligible for individual membership.
Any society, organization, or corporation not eligible for membership as a Member-Body as set forth in subsection (a), but interested in color and desirous of participating in the activities of the Council as set forth in Article II of the Constitution, shall be eligible for individual membership by the designation of a named person who shall be an individual member.
(c) Sustaining Members. Any person, society, association, or organization, interested in color and desirous of participating in the activities of the Council for the furtherance of its aims and purposes as set forth in Article II of the Constitution, shall be eligible for membership as a sustaining member.
(d) Honorary Members. Any person who, as a Council member, has rendered signal service to the Council or to those fields served by the individual Member-Bodies of the Council, in such manner as to aid in accomplishing the objectives of the Council, is eligible for Honorary membership.
(e) Student Members. Any person who is a junior, senior, or graduate student registered in a college or university of recognized standing and is interested in color and desirous of participating in the activities of the Council for the furtherance of its aims and purposes as set forth in Article II of the Constitution shall be eligible for student membership. This eligibility shall cease when the student matriculates from or leaves the college or university, at which time the student member may be encouraged to apply for individual membership in the Council.
(f) Retired Members. Any individual member of the Council who retires from active employment related to color may, upon application to the Secretary, request change in membership status to that of retired member.

Section 3. Application for Membership

All applications for membership in the Council shall be made on forms supplied for the purpose and shall give the information required regarding the applicant's qualifications for membership in the class for which application is made.

Section 4. Election to Membership

(a) Member-Bodies. Applications for admission as a Member-Body shall be acted upon by the Board of Directors. A three-fourths (3/4) affirmative vote of the total membership of the Board shall be required for election of a Member-Body. Such elections may take place by mail between meetings of the Board or at regular or special meetings of the Board.

(b) Individual, Student, Sustaining, and Retired Members. Application for admission to individual, student, or sustaining membership, and for change of membership status to retired member, shall be acted upon by the Board of Directors. A vote shall be taken either by mail between meetings of the Board, or at regular or special meetings of the Board. A majority affirmative vote of a quorum of the Board shall be required for election to individual, student, sustaining, or retired membership.
(c) Honorary Members. Nominations for Honorary membership may be made by any member of the Council using forms provided for the purpose. Copies of such nominations shall be distributed to the Board of Directors. After a minimum of sixty (60) days, the application for Honorary membership shall be acted upon by the Board. A vote may be taken either by mail between meetings of the Board or at regular or special meetings of the Board. A three-fourths (3/4) affirmative vote of the total membership of the Board shall be required for election to Honorary membership.

Section 5. Duties

(a) Member-Bodies. Subject to the laws of the State of New York, the ultimate general authority and responsibility for the policies and affairs of the Council shall be vested in the Member-Bodies acting through their voting delegates and the Board of Directors.

Each Member-Body shall appoint at least three (3) but not more than ten (10) delegates who shall represent that Member-Body in the Council. Three of these delegates shall be designated by the Member-Body as voting delegates. In no case, however, shall the same person be designated, at a given time, a voting delegate of more than one Member-Body.

When a voting delegate of a Member-Body is elected or appointed to a position in the Council that includes voting privileges, as described in Section 6 (a), the Delegation Chair shall appoint another voting delegate from among the remaining delegates of the Member-Body. It shall be the responsibility of the President of the Council to notify the Delegation Chair of such election, and the duty of the Chair to notify the President of such an appointment, each within thirty (30) days.

It is expected that the three voting delegates representing the Member-Body shall cast their votes with the interests of the Member-Body in mind.

One (1) of the voting delegates of a Member-Body shall be designated by the Member-Body as the Chair of the Delegation. It shall be the duty of the Chair to report to the Member-Body all proceedings of the Council that in the Chair's opinion are of interest to the Member-Body, including reports of the Council that should appear in the publications of the Member-Body.

While it is expected that each Member-Body delegate will assist the Chair in these matters, it is the Chair's particular duty to see that the Delegation as a whole, functions efficiently in encouraging the closest possible relations between the Council and the Member-Body it represents. To do this at least one (1) meeting a year should be held by each Delegation, preferably at a meeting of its Member-Body. Reports of such meetings, as well as an annual report describing the activities and publications of the Member-Body of interest to the Council, shall be provided to the Council, which will publish them with the minutes of the Council's annual meeting.

A specific duty of the delegates is to bring to the attention of the Council any problems in the field of color that are of particular interest to their Member-Body.

Section 6. Rights and Privileges

(a) Voting Rights. The right to vote for officers and directors shall be granted to all individual members of the Council. The right to vote on all matters brought before the voting delegates of the Council for vote shall be granted to the following groups. These voting rights shall be ex officio, and shall expire when the person involved ceases to occupy the designated position. In no case, however, shall any person have the right to cast more than one vote upon any question.

1. Voting delegates representing Member-Bodies. It is expected that these delegates shall cast their votes with the interests of their respective Member-Bodies in mind.

2. Officers and Directors of the Council. It is expected that these persons shall cast their votes with the interests of the Council as a whole in mind.

3. Chairs of Standing Committees, Coordinators of the Problems Committee, Chairs of the Project Committees of the Problems Committee, and Chairs of Interest Groups. It is expected that these persons shall cast their votes with the interests of their chair and of the Council as a whole in mind.

(b) General Rights and Privileges. All delegates, individual members, retired members, and Honorary Members of the Council shall be entitled to serve as officers or directors, to receive all publications of the Council, and to attend all meetings of the Council and have the privilege of the floor. Student members and sustaining members or their representatives shall have all the above general rights and privileges, except that they shall not be eligible for election as officers or directors.

Section 7. Termination of Membership

(a) Voluntary Termination. Any member of any class may terminate membership by giving notice in writing to the Secretary, provided that the member's dues, if any are levied, including those of the current fiscal year, have been paid. Failure to pay dues for one (1) year without valid cause or failure to provide a valid postal address for the Secretary's records shall be considered a voluntary action terminating any class of membership.

(b) Expulsion. Should it be thought desirable to expel any member of any class, the matter shall be brought to the attention of the Board of Directors. If the Board decides that it should be considered, the Board shall appoint an ad-hoc committee to investigate, such investigation to include but not be limited to (1) a review of the charges, (2) discussion with the member involved, and (3) offer of a formal hearing before the ad-hoc committee to which both the member and those bringing the matter before the Board would be invited and at which documentary evidence would be presented and there would be opportunity for questioning on both sides.

If the matter is not resolved by the ad-hoc committee, for example by withdrawal of the charges or resignation, the Board, on receipt of the report of the ad-hoc committee, may consider expulsion of the member. A vote in favor of expulsion of three-fourths (3/4) of the total membership of the Board, affirmed by a vote of three-fourths (3/4) of the voting delegates, shall be required for the expulsion of a member.

Section 8. Dues

The membership dues shall be determined by the Board of Directors on the advice of the Finance Committee. As a general rule, the dues of sustaining members shall be greater than those of Member-Bodies, those of Member-Bodies shall be greater than those of individual members, and those of individual members shall be greater than those of student and retired members. Honorary members shall pay no dues.

All dues shall be paid annually, and in advance. The Council shall not have the power to levy any general assessment on its members or to enforce a payment of any amount beyond the annual membership dues.

Article II--Meetings

Section 1. Annual Meeting

During each year, at a time and place to be fixed by the Board of Directors, there shall be held the annual meeting of the Council, for the transaction of such business as may properly come before the Council.

The Secretary shall give notice of the annual meeting of the Council, specifying time and place, by mail not less than thirty (30) days and not more than ninety (90) days before the meeting. A copy of the notice shall be mailed to all members of and representatives to the Council.

Section 2. Special Meetings

Special meetings of the Council may be called at any time by the Board of Directors or the President. They shall be called by the President or the Secretary after receipt of a request in writing by five (5) members of the Board or by three (3) Member-Bodies. Such requests shall state the purpose or purposes of the proposed meeting.

The Secretary shall give notice by mail of each special meeting of the Council to all voting delegates not less than ten (10) days and not more than sixty (60) days before the meeting. The notice shall state the purpose or purposes of the meeting.

Section 3. Quorum

At any meeting of the Council, a quorum shall consist of at least one-third (1/3) of the total number of voting delegates or their proxies and, except as otherwise provided for by these By-Laws, the majority of such quorum shall decide any question that may come before the meeting.

Section 4. Voting

Upon any question with respect to which a vote shall be required or deemed advisable, except for the election of officers, the Board of Directors may ascertain the view of the Council by polling each individual entitled to vote pursuant to Article I, Section 6 (a), either directly or by means of proxies given to one or more persons designated by the Board, which person or persons shall vote as provided in said proxies at the next meeting of the Council.

Each individual entitled to vote shall be entitled to only one (1) vote unless the voter holds proxies from other persons eligible to vote.

Section 5. Parliamentary Rules

The latest edition of *Roberts Rules of Order* shall be the governing parliamentary authority of the Council in all cases not definitely provided for by its Constitution, By-Laws, or Standing Rules.

Article III--Officers

Section 1. Officers Enumerated

The officers of the Council shall be a President, a President-Elect, a Secretary, and a Treasurer.

Section 2. Eligibility, Time of Election, and Assumption of Office

The four officers shall be elected from among the eligible members of the Council as specified in Article I, Section 6 (b).

Election of officers shall be by mail ballot as provided in Section 3. Such election shall take place in January of each year in which election of officers is required. The officers shall assume their duties at the end of the annual meeting following their election.

Section 3. Mode of Election

The officers shall be elected by election by the membership at large, each member getting one vote. It shall be the duty of the Nominating Committee to obtain the consent of each nominee to stand for election and to submit its report to the Board of Directors prior to the fall meeting of the Board.

The report of the Nominating Committee shall be mailed to all voting delegates at least thirty (30) days before the date on which ballots are forwarded to the voting delegates. Additional nominations may be made at the request of five (5) voting delegates, provided they are forwarded to the Secretary within twenty (20) days after the report of the Nominating Committee is sent out. The Secretary shall give notice by mail of all additional nominations to all voting delegates at least ten (10) days before the ballot is sent to the membership at large.

Section 4. Terms of Office

The four officers shall be elected for a term of two (2) years or until their successors are elected.

The President-Elect shall succeed to the office of President at the expiration of the term of the President.

No officer except the Secretary and the Treasurer shall be eligible for re-election except when such eligibility is established by a three-fourths (3/4) vote of a quorum of the Board of Directors.

The term "re-election" as used in this instrument shall be construed to mean only the election of individuals to succeed themselves.

Section 5. Duties

The duties of the President, President-Elect, Secretary, and Treasurer shall be the usual ones performed by such officers, and are described in the Standing Rules of the Council. In addition, the officers shall be members of the Board of Directors with all of the rights and privileges of such membership.

The Secretary shall keep minutes of the business transacted by the Board of Directors, shall send copies of the minutes to each member of the Board, and shall file the original of the minutes, after approval by the President, in the permanent record book provided for that purpose. The Secretary shall keep all records of the Council other than the financial records, which shall be kept by the Treasurer.

The Treasurer shall be charged with the responsibility for the general funds of the Council and for such special funds as may from time to time be placed in his or her custody or control by order of the Board of Directors. The Treasurer shall pay the bills of the Council that have been approved by the Board, either through the adoption of an annual budget or by special action. The Treasurer shall be the chair of the Finance Committee.

Section 6. Vacancies

In the event of a vacancy in the office of President, the President-Elect shall succeed to that office. A vacancy in the office of the President-Elect shall be filled by special election of the voting delegates. In the event of a vacancy occurring in the other offices, the remaining members of the Board of Directors by an affirmative vote of a majority thereof shall fill such vacancy for the period of the unexpired term.

Article IV--Directors

Section 1. Composition and Eligibility

There shall be nine (9) directors, who shall be elected from among the eligible members of the Council as specified in Article I,
Section 6 (b).

Section 2. Terms of Office

The directors shall be elected for terms of three (3) years or until their successors are elected. The terms of three (3) directors shall expire each year. None of the directors shall be eligible for re-election except when such eligibility is established by an affirmative vote of three-fourths (3/4) of a quorum of the members of the Board of Directors.

Section 3. Time of Election and Assumption of Duties

The election of three (3) of the directors shall take place annually. The newly-elected directors shall assume their duties at the end of the annual meeting following their election.

Section 4. Mode of Election

The election of directors shall be carried out in the same manner as the election of officers, as set forth in Article III, Section 3.

Section 5. Duties

The directors shall be part of the Board of Directors and shall fulfill the duties of Board membership as set forth in Article V, Section 2.

Section 6. Vacancies

In the event of a vacancy occurring among the directors, the remaining members of the Board of Directors by an affirmative vote of the majority thereof may fill such a vacancy for the period of the unexpired term.

A director may be removed from office for just causes by a three-fourths (3/4) vote of the remaining members of the Board of Directors. Absence of a director from three meetings of the Board without prior written notice to the President or the Secretary may be considered just cause for removal of the director from office.

Article V. Board of Directors

Section 1. Composition

The Board of Directors shall consist of the four (4) officers, the immediate Past President, and the nine (9) directors.

Section 2. Duties

The duties of the Board of Directors shall be those pertaining to the executive, financial, or general administrative business of the Council. The Board shall conduct the business of the Council during the interim between the annual meetings, shall develop earnestly and carefully the aims and purposes of the Council, shall supervise the expenditures of all monies, and shall fix the time and place of the annual meeting of the Council.

The Executive Committee, defined in Article VI, Section 1 (a), shall be responsible for the conduct of the business of the Board of Directors between Board meetings. The vote of the Executive Committee upon any proposition, except as otherwise provided by these By-Laws, may be conducted by mail or telephone or at a meeting of the Committee, but any action shall be confirmed at the next meeting of the Board.

Section 3. Meetings

At least one meeting of the Board of Directors shall be held each year. Other meetings may be held at such other times and at such places as the President may direct or five (5) members of the Board shall propose in writing. The Board may adopt rules and regulations governing its procedures, the times and places of its meetings and the notices to be given concerning them, and other matters with respect to the conduct of its business.

Section 4. Quorum

At any meeting of the Board of Directors a majority of the Board members shall constitute a quorum and, except as otherwise provided by these By-Laws, a majority of such a quorum shall decide any question that may come before the meeting.

Section 5. Proxy

A member of the Board may delegate in writing, to the President, another member of the Board of Directors to serve as proxy, but no member may hold or exercise proxies for more than one member.

Article VI--Committees, Delegates, and Representatives

Section 1. Standing Committees

(a) Executive Committee. The Executive Committee shall consist of the President, President-Elect, Secretary, Treasurer, and immediate Past President. It shall meet when necessary and have all the powers of the Board of Directors, except that the Executive Committee cannot modify any action taken by the Board. All actions of the Executive Committee shall be submitted at the next meeting of the Board for its approval.

(b) Nominating Committee. The President shall appoint a Nominating Committee of five (5) members, namely the President-Elect, the immediate Past President, any other Past President, and two additional members who are voting delegates of Member-Bodies different from those of any of the aforementioned persons. The immediate Past President shall be the chair of the Nominating Committee.

(c) Other Standing Committees. The President shall appoint, with the approval of the Board of Directors, the following additional standing committees: By-Laws, Finance, Interest Groups, Problems, and Publications, and may appoint other standing committees that from time to time are deemed necessary for conducting the business of the Council.

Section 2. Ad-Hoc Committees

Ad-hoc committees may be appointed by the President, with the approval of the Board of Directors, when required to conduct the business of the Council. Ad-hoc committees shall be appointed for a limited objective and shall be discharged by the President when the objective has been achieved.

Section 3. Duties of Committees

The duties of standing and ad-hoc committees shall be those defined in the Standing Rules of the Council.

Section 4. Representatives and Delegates

The President shall submit to the Board of Directors nominations for representatives and delegates to other organizations. Such representatives and delegates shall be elected by the Board for such terms as their respective duties require.

Article VII--Official Publications

The Council shall publish the ISCC News and other publications that the Board of Directors deems necessary or desirable. Each member of all classes of membership in the Council shall receive an annual subscription to the ISCC News and shall receive such other publications as the Board may authorize for distribution to members.

Article VIII--Fiscal Year

The fiscal year of the Council shall last from January 1 to December 31, inclusive.

Article IX--Standing Rules

Section 1. Definition

Standing Rules are written statements of operating procedures and details of the organization of the Council.

Section 2. Adoption and Amendment

The Board of Directors shall adopt or amend Standing Rules, provided that two-thirds (2/3) of all members of the Board shall vote in favor of adoption or amendment, at any regular or special meeting of the Board. The text of the affected Standing Rules shall be published in the ISCC News as soon as possible after approval by the Board.

Article X--Amendments

These By-Laws may be altered, amended, or repealed either on the recommendation of the Board of Directors or on recommendations signed by ten (10) voting delegates of the Council, provided that a two-thirds (2/3) affirmative vote of the entirety of the voting delegates shall approve such amendment, and provided that at least ninety (90) days notice of such a proposal shall have been given by publication in the ISCC News or by other distribution to the voting delegates before voting shall take place. The voting delegates may vote in person or by proxy at any regular or special meeting of the Council. The proxies for voting may be solicited by mail.

Article XI--Suspension of Rules

The Board of Directors by a two-thirds (2/3) vote of the entire Board may suspend a By-Law or Standing Rule for a stated purpose and for a specific time not to exceed six (6) months.

STANDING RULES

Article I--General Provisions

Section 1.

If there is a conflict between the By-Laws and the Standing Rules, the By-Laws shall govern.

Section 2.

Appendices of the Standing Rules contain guidelines for the offices of President (Appendix AA), Secretary (Appendix A), Treasurer (Appendix B), Membership Secretary (Appendix M), Office Manager (Appendix N) and for the Nominating Committee (Appendix C), and other standing committees as indicated in the applicable paragraphs of Article II, Section 2.

Article II--Committees

Section 1. General Provisions

(a) The President, with the consent of the Board of Directors, shall appoint the chairs of all Council committees. Committee members unless otherwise stated, shall be recommended by the chair of the respective committee and appointed by the President. The chairs of Standing Committees are encouraged to attend Board of Directors meetings and are required to submit reports for those meetings.

Subcommittees and task groups may be established in committees by the committee chair. The membership of such subcommittees and task groups shall be appointed by the chair of the respective subcommittee or task group, unless otherwise specified in the Standing Rules.

At any meeting of a committee or its subcommittees or task groups, those members present shall constitute a quorum, and a majority of such quorum shall decide any question that may come before the meeting.

(b) All committees shall be subject to the direction and control of the Board of Directors.
(c) No committee shall commit the Council to the expenditure of funds not previously authorized for that committee by the Board of Directors or, in the case of sums of less than $100, by the President-Elect. Both requests and authorizations shall be in writing.
(d) The President and President-Elect, by right of their offices, are members of all committees (except that the President may not be a member of the Nominating Committee), and copies of all correspondence shall be sent to them. Copies of all appropriate correspondence shall be sent to the Secretary and to the Treasurer.
(e) The Chairperson of each Standing Committee shall report to the Board of Directors on the activities of that Committee at each of the regular meetings of the Board, normally three per year (winter, spring, and fall). The report may be in person at the meeting, or in written form. Written reports should be submitted sufficiently in advance of the meeting to allow for circulation to the Board members for review before the meeting date.

Section 2. Standing Committees.

(a) <u>Finance Committee</u>. The Finance Committee shall advise the Treasurer on the investment of Council funds. It shall also establish and maintain suitable procedures for collecting and disbursing monies. It shall guide the formulation of annual and special meeting budgets and shall make recommendations for dues. It shall render an annual accounting through the Treasurer. The Treasurer shall chair this committee.

(b) <u>Membership Committee</u>. The Membership Committee shall endeavor to contact societies, associations, organizations, and individuals with a professional interest in color and to see that they have information about the Council. The Membership Committee shall be responsible for recommending new

Member-Bodies to the Board of Directors after investigating the qualifications of the prospective Member-Bodies as set forth in Article I, Section 2 (a), of the By-Laws. Guidelines for the Membership Committee can be found in Appendix D.

(c) By-Laws Committee. The By-Laws Committee shall prepare and submit to the Board of Directors all proposals to amend the Constitution, By-Laws, and Standing Rules in accordance with Article VII of the Constitution, Article X of the By-Laws, or Article IV of the Standing Rules, whichever is appropriate.

This committee shall assist any member of the Council to interpret the Constitution, By-Laws, or Standing Rules whenever requested to do so. This may be done by the chair unless a report of the opinion of the full committee is requested.

(d) Problems Committee. The Problems Committee shall be responsible for activities on color problems that are brought to the attention of the Council. Such problems are considered by small groups known as Project Committees, working independently but responsible to the problems committee. It is intended that project committees shall address limited objectives so that significant progress can be made in a reasonable time. At the annual meetings of the Council, project committees shall either hold open meetings or shall report to the Council membership on their progress by oral or poster presentations.

If a new problem is appropriate to the activities of the problems committee, a new project committee may be proposed. Each proposed project committee shall develop, with the aid of the Chair of the Problems Committee, three statements to be submitted to the Board of Directors for approval:

(1) a Purpose, stating the reason for the project,
(2) a Scope, describing the project,
(3) and an Objective, identifying a short-term goal.

Upon approval of these statements, the new project committee shall be established.

Each project committee shall act autonomously within the written Purpose, Scope, and Objective that have been approved by the Board of Directors. Members of a project committee or its task groups may come from membership lists of the Member-Bodies concerned, or from the Council's individual membership list, or by enlisting any competent persons, and are appointed as outlined in Article II, Section 1(a).

The Chair of the Problems Committee shall review the progress of the project committees at least every other year to see that they function within their scopes to accomplish their approved objectives expeditiously.

Project committees are encouraged to issue written reports at the ends of important phases of their work, and are required to do so at the end of their project. These reports shall be submitted to the Board of Directors through the Chair of the Problems Committee with a recommendation as to possible publication. Draft reports may be circulated outside the project committee to solicit comments, but must carry the following or an equivalent statement: "Working document for ISCC project committee use only. Not for publication or attribution."

Reports that are to carry the endorsement of the Council shall be submitted by the Chair of the Problems Committee to the voting delegates for approval.

If, in the opinion of the Board of Directors, the endorsement of a report by the Council as a whole is not required, then the report in question may be published carrying the following or an equivalent disclaimer statement: "This (identified by origin) report has been authorized for publication and distribution by the Board of Directors of the Inter-Society Color Council, with the advice of the Problems Committee, but this authorization does not constitute direct or implied endorsement by the Inter-Society Color Council as a whole."

The Chair of the Problems Committee may select coordinators to assist and advise the project committees. Guidelines for the Problems Committee can be found in Appendix E.

(e) Interest Groups Committee. There shall be several interest groups within the Council, composed of individuals having similar interests in color. For administrative purposes, the chairs of the individual interest groups shall form a standing committee known as the Interest Group Committee. The Chair of the Interest Group Committee shall be appointed in the usual way.

The main functions of an interest group are to plan and present at the annual meetings of the Council programs of particular interest to their fields. An interest group may also recommend to the Problems Committee subjects for new project committees that may come to its attention.

Individuals who are or become Council members may affiliate with one or more interest groups, and may change this affiliation at any time. Affiliation insures that members receive information relevant to their fields and have the opportunity to meet other Council members with common interests.

The Chair of the Interest Group Committee shall be responsible for scheduling the interest group sessions at the annual meeting, in cooperation with the chair of the Arrangements Committee.

The chairs of the individual interest groups shall be appointed by the President with the consent of the Board of Directors. Guidelines for the interest groups can be found in Appendix F.

(f) Publications Committee. The Publications Committee shall give technical advice to the Board of Directors to guide it in the generation, editing, reproduction, and circulation of information.

The ISCC News shall be the official publication of the Council and shall be distributed without charge to all members. The Chair of the Publications Committee shall serve as Editor of the ISCC News and shall be responsible for its content. The Publications Committee shall have broad authority to determine both the content and the format of the ISCC News. It is expected, however, that decisions involving permanent changes in content, policy, or format of the News shall be referred to the Board of Directors for approval.

The ISCC News shall include information of interest to the membership of the Council. The News shall contain notices of meetings, minutes of the annual meetings and reports of the Board of Directors' meetings, news notes, reviews, letters, etc. This information may be generated either within or outside the Council. Its selection and publication shall be guided by the general principle of providing useful information without serving individual or commercial interests.

Reports and other substantive articles arising from Council activities that are not suitable for inclusion in the Newsletter for reasons such as length may be submitted elsewhere for publication. The Council endorses the international journal *Color Research and Application* and encourages the submission of such reports and articles to this journal for consideration for publication. Reprints of such publications and of others that may be of interest to Council members may from time to time be made available to all members as inserts with the News, generally without charge. The Publications Committee shall maintain a calendar of Member-Body events of interest to Council members, and publish it in the ISCC News. Guidelines for the Publications Committee can be found in Appendix G.

(g) Planning Committee. The Planning Committee, preferably chaired by an officer or a director, shall study, define, and recommend future goals of the Council so as to further the aims and purposes of the Council as stated in Article II of the Constitution.

(h) Publicity Committee. The Publicity Committee shall prepare and disseminate information about the Council's activities to members, Member-Bodies, and outside persons and organizations, in the form of news releases and similar documents, with the objective of publicizing and supporting such Council activities on a national and international basis. To aid in the dissemination the Committee should maintain mailing lists of individuals, organizations, and journals and other publications as required.

The types of Council activities to be considered for publicity shall include but not be limited to annual and special meetings, symposia, educational programs, elections of officers and directors, awards made by the Council, awards made to Council members by other groups, and other newsworthy activities.

The Publicity Committee shall monitor the inventory and timeliness of all Council publications, shall inform the President when new supplies or revisions are required, and shall implement any required action upon Board approval. Stocks of publications shall be maintained in and be available through the Secretary's office, gratis or for a modest fee. Guidelines for the Publicity Committee can be found in Appendix H.

(i) Arrangements Committee. The Arrangements Committee shall be responsible for the physical arrangements for annual and special meetings of the Council. This Committee must thus work closely with the General Chair and Program Chair of the meeting as well as with the Board of Directors to insure that meeting arrangements proceed smoothly and efficiently.

Specific aspects of this committee's duties include: selection of sites and dates, internal arrangements with the selected hotel, registration forms, pre-registration, registration on site, meeting support such as audio visual equipment and room arrangements, and financial arrangements including proposal of the meeting budget. The Chair of the Arrangements Committee shall be authorized to sign contractual arrangements with the hotel and other agencies as required on behalf of the Council. This committee will also arrange for Board of Directors meetings. Guidelines for the Arrangements Committee can be found in Appendix I.

(j) Member-Body Liaison Committee. The Member-Body Liaison Committee, composed of the Delegation Chairs from the Member-Bodies, shall be responsible for establishing and maintaining, through the Member-Body Delegations, good relationships between the Council and its Member-Bodies. It shall keep the Member-Bodies informed of Council activities, solicit Member-Body participation in those activities, attempt to stimulate the interest of the Member-Bodies in matters related to the aims and purposes of the Council, suggest matters of common interest among Member-Bodies that might otherwise be overlooked, and carry out such related activities as it may deem appropriate.

The Chair of the Member-Body Liaison Committee shall contact each Member-Body, through its delegation, at least once a year to obtain current information about the Member-Body address, telephone number, chief officer, publication title and editor; names of the members of the delegation and their addresses and telephone numbers; and the interests in color of the Member-Body. This information shall be forwarded to the President and Secretary, and shall be used to keep up to date the Member-Body listing in the Council's membership directory. The chair shall also urge the Member-Bodies to maintain a full list of delegates.

This Committee shall be responsible for soliciting and collecting annual reports from the Member-Bodies, as required by the By-Laws, for insuring that these reports emphasize the color-related activities of the reporting Member-Bodies, and for forwarding them to the Editor for publication in the ISCC News. Guidelines for the Member-Body Liaison Committee can be found in Appendix J.

(k) Awards Committee. The Awards Committee shall be responsible for storing the various ISCC awards, having them suitably engraved after recipients are chosen, and delivering them to the President at the meeting at which they are to be presented.

The Awards Committee shall have three subcommittees, whose chairs shall be appointed by the President with the approval of the Board of Directors. These are:

(1) the Macbeth Award Subcommittee,
(2) the Godlove Award Subcommittee, and
(3) the Nickerson Service Award Subcommittee.

Each of these subcommittees should have four members in addition to the Chair. The Chair of each subcommittee should preferably have served previously as a member of that subcommittee for at least two years. At least one member of each subcommittee should have previously received the award. At least two members of the subcommittee should be replaced every two years. Guidelines for the Awards Committee and Subcommittees can be found in Appendix K.

(l) Contributed Papers Committee. The Contributed Papers Committee shall solicit, review, and select contributed papers for presentation at special contributed papers sessions at the annual meetings of the Council. Such papers may be presented orally or in poster form. The intent of contributed papers sessions is to allow presentation to the Council of the results of current or ongoing studies on color that are not, because of subject matter, appropriate for presentation as parts of the main meeting program or the interest group programs.

Contributed papers should be reviewed by the committee for content. Those submissions that pertain directly to an Interest Group's subject matter should be forwarded to the appropriate Interest Group chair for consideration for inclusion in the Interest Group session. Guidelines for the Contributed Papers Committee can be found in Appendix L.

(m) Membership Secretary. This shall be a standing committee of one, charged with keeping the membership records of the Council. The Membership Secretary shall respond to individuals and organizations applying for membership and shall compile a list of these for periodic presentation to the Board of Directors for its approval. The duties of the Membership Secretary shall include providing the Secretary and the Treasurer with timely membership information, and keeping the membership list current by adding new members and adjusting the list based on information supplied by the Treasurer and the Membership and Member-Body Liaison chairs. Guidelines for the Membership Secretary's duties can be found in Appendix M.

(n) Meetings Committees. There shall be at least two Meetings Committees, designated respectively the Annual Meeting Committee and the Williamsburg Meeting Committee. Other Meetings Committees may be established as needed for other types or series of Council meetings, either permanently or on an ad hoc basis.

The Chairs of the Meetings Committees shall be the respective General Chairs of the next scheduled meeting of the type involved. These Chairs shall have full responsibility for their respective meetings. General Chairs of future meetings of the same type shall be members of these committees. At the close of each Annual Meeting or Williamsburg Conference, the position of Chair of the respective Meetings Committee shall pass to the General Chair of the next meeting of that type. Past Chairs should remain as members of the Meetings Committee they had chaired. These provisions are made to insure maximum continuity in the operations of the Meetings Committees, deemed to be essential to the successful organization and presentation of major Council meetings.

The duties of the Meetings Committees shall include but not be limited to selecting the theme or topic of the meeting or its component symposia, arranging for speakers and working closely with them, and establishing the format of the meeting, including social events. It is essential that the Meetings Committees maintain throughout their operation close liaison with the Board of Directors, the Office of the Treasurer, the Arrangements Committee, and the Publicity Committee. The chairs of the latter two committees shall be ex officio members of each of the Meetings Committees. Guidelines for the Annual Meetings and Williamsburg Conferences can be found in publications ISCC Technical Report 81-2: *Program Chair's ISCC Guide* and ISCC Technical Report 87-1: *Guidelines for Organizing an ISCC Williamsburg Conference,* respectively.

(o) Education Committee. The Education Committee shall preferably be chaired by a member of the Board of Directors. Its membership shall include, but not be limited to, the vice-chair of each ISCC Interest Group. The responsibilities of the Education Committee are to address the color education needs of the ISCC membership and to educate the general public, through the efforts of the ISCC membership, to help demystify various aspects of color. The following are specific duties of the Education Committee:

(1) Organize some event with emphasis on education for presentation at each annual meeting of the Council.

(2) Be responsible for the organization of, and oversee the operation of, ISCC Student Chapters formalizing the relationships between the Council and colleges and universities with color and color-related programs.

Guidelines for the Education Committee can be found in Appendix O.

(p) Additional Standing Committees. The President may appoint, with the approval of the Board of Directors, such additional standing committees as may further the aims and purposes of the Council. Such committees shall have the duties and responsibilities assigned to them. Each such committee shall have a written scope approved by the Board of Directors.

Section 3. Ad-hoc Committees.

Ad-hoc committees may be appointed by the President with the approval of the Board of Directors. The President shall designate the Chair of each ad-hoc committee. Each ad-hoc committee shall be disbanded by the President as soon as the purpose for which it was appointed is accomplished.

Section 4. Representatives and Delegates.

The President shall appoint, with the approval of the Board of Directors, representatives and delegates representing the Council in other organizations. Such representatives and delegates shall serve for such terms as their respective duties may require. Among such representatives and delegates shall be the following:

(a) Representative to the International Colour Association (AIC). Every other President shall serve as the Council representative to the AIC, with a term coinciding with the four-year terms of AIC officers.

(b) Associate Editor of *Color Research & Application.* The President, in consultation with the Editor-in-Chief of the journal Color Research and Application, shall appoint a representative to be an Associate Editor of the journal, representing the interests of the Council as an Endorsing Society of the journal. The duties of this representative shall include:

(1) keeping the journal informed of Council activities by arranging for the publication of meeting reports and of news releases prepared by the Publicity Committee;
(2) keeping the Council informed of journal policies, and of journal contents by arranging for publication of the journal's "In This Issue" pages in the ISCC News; and
(3) encouraging Council members to support the journal by subscription at the special rates accorded to members of Endorsing Societies and by submitting manuscripts for consideration for publication.

Article III--Dues

Section 1. Member-Bodies.

The dues for Member-Bodies shall be two hundred (200) dollars per year.

Section 2. Individual Members.

The dues for individual members shall be seventy-five (75) dollars per year for electronic version of the newsletter. The dues for individual members shall be ninety (90) dollars per year for hardcopy version of the newsletter. If an Individual Member is elected during the fiscal year, his dues shall be prorated by the Treasurer.

Section 3. Sustaining Members.

The dues for sustaining members shall be seven hundred fifty (750) dollars per year.

Section 4. Student Members and Retired Members.

The dues for student members and retired members shall be ten (10) dollars per year for electronic version of the newsletter. The dues for individual members shall be fifteen(15) dollars per year for hardcopy version of the newsletter.

Section 5. Library Subscriptions.

The price of a library subscription to the ISCC News shall be seventy-five (75) dollars per year.

Section 6. Overseas Members.

Members of the Council residing in countries other than the United States, Canada, or Mexico shall be assessed an extra mailing charge for the *ISCC News* based on current postal rates to their countries.

Article IV--Amendments

These Standing Rules may be altered, amended, or repealed by action of the Board of Directors by vote of a quorum of the entire Board, at any regular or special meeting of the Board, or by mail ballot between such meetings.

APPENDICES TO THE STANDING RULES

APPENDIX AA. GUIDELINES FOR THE PRESIDENT'S OFFICE

General

The duties of the President are difficult to delineate, partly because a list cannot be exhaustive. The President of the ISCC must oversee activities of the Society. He/she must motivate the volunteer membership without overworking them, communicate deadlines and expectations, and listen to members to address their concerns. It may be necessary to resolve problems personally. The President's attitude should be one of total responsibility for the success of the ISCC, its activities, and respect for each member.

The Presidency has a broad scope that cannot be defined precisely without compromising the benefits of individual style. Nonetheless, there are important duties to which all Presidents should attend.

Board of Directors and Executive Committee Meetings

The President (or his appointed proxy from the Executive Committee) shall chair all Board of Directors (BOD) and Executive Committee meetings. Prior to each BOD meeting, the President shall ensure that mailings are sent to the Board and other attendees;

1) Informing them of the meeting schedule and agenda, and
2) Reminding them of any action items that they need to complete.

A cover letter from the President has proven effective in this regard. Also, the President shall assure that there is a quorum of attendance, either through personal representation or through proxies. The President shall lead each such meeting, taking responsibility to complete the agenda in the allocated time, but facilitating discussion where appropriate. Also, at the beginning of each Board meeting, the President shall report administrative decisions made by the Executive Committee since the previous Board meeting. After the Board meeting, the President shall compile a list of action items including amendments to the previous list.
Robert's Rules of Order may help to complete an ambitious agenda.

Overseeing the ISCC Office

While remaining cognizant of the general need for BOD consensus, the President shall be responsible for the operations of the ISCC office, and for tasking of the office staff. The office staff reports to the President and works at the discretion of the President. Accordingly, the President decides whether to approve requests by others for significant labor by the office staff.

Joint Conferences

When the ISCC undertakes collaboration with another Society to conduct a conference, the ISCC President shall take responsibility for ensuring there is a written contract between the two societies that clarifies their activities and financial commitments.

Conference Arrangements

The President shall examine and approve all conference-related contracts into which the Society enters. The President may delegate that responsibility to the Executive Committee or their appointee. The President and Arrangements Chair shall reach consensus as to the advisability of entering into each such contract (especially hotel contracts). Contract problems should be resolved through consultation with the Executive Committee and with the Board of Directors.

Topical Meetings

The President shall oversee the evolution of each Topical Meeting for which a plan exists, and should encourage members to agree to chair new such Topical Meetings. Overseeing the evolution of a meeting involves keeping track of the timeline and reminding cognizant people (such as chair and Arrangements Chair) of imminent deadlines.

Annual Meetings

The President shall officiate the Awards Luncheon at each Annual Meeting. This activity involves introducing the head table, introducing the Secretary and Treasurer for their respective reports, presenting introducers of the awards, and presenting the awards. As in all events of the ISCC, the President should enact the principle that time and schedule are of the essence.

Publications

Customarily, the President writes a column for the ISCC Newsletter that summarizes past ISCC events and promotes upcoming events. The President may see fit to recognize outstanding efforts by members, and may choose to discuss relevant trends in technology or in society that have an impact on the ISCC. An optional guideline for the frequency of the presidential column is three times a year, corresponding to the three Board meetings, and summarizes significant decisions affecting the ISCC by the BOD.

Committees

The President is an ex officio member of all committees, and should track the chairmanship and membership of all committees. In some cases (as with the nominating committee) the President is responsible for appointing the committee. Even in such cases, the President may delegate the selection of each committee membership to the Chair of that committee, and simply ratify the decision of the Chair.

APPENDIX A. GUIDELINES FOR THE SECRETARY'S OFFICE

General

Because of the continuity of the Secretary's position, he or she is the official representative of the Council in most of its contacts with the outside world, and has the responsibility for responding, directly or by delegation to other Council officials, to all inquiries to the ISCC. The impression of the ISCC by those inquiring depends on these responses in no small way. Thus the Office of the Secretary carries with it a major responsibility that goes well beyond the duties outlined below.

As a consequence of the office, the Secretary is responsible for all written and telephone correspondence concerning the Council that comes to the attention of the office. The files of the Secretary's Office are a part of the official records of the ISCC and should be as complete as possible.

Board of Directors and Executive Committee Meetings

At the request of the President (unless he or she undertakes the task personally), the Secretary shall prepare and circulate agendas and notices of all meetings of the Board of Directors and the Executive Committee. For Board meetings, these shall be sent to all Officers and Standing Committee Chairs, and to any others expected to attend the meeting in question on invitation of the President. For Executive Committee meetings, only the Officers need be notified, by note or telephone. Notices should reach the recipients not later than 30 days before the meeting date.

For Board meetings, the agenda is customarily prepared with items in the following order:

1. Approval of the Minutes of the previous meeting.
2. Report and approval of actions of the Executive Committee, if any.
3. Status of action items from the previous Minutes.
4. Reports of the Officers and Standing Committee Chairs.
5. Planning for forthcoming Council meetings.
6. Other old and new business
7. Time and place of next Board meeting.
8. Review of new and continuing action items.

During the meeting, the Secretary should take notes of all significant discussions and actions. The use of a small tape recorder is encouraged as an aid in taking notes. As items requiring future action arise, special note of them should be made for inclusion in the list of new and continuing action items. The person(s) responsible for the required action should be identified. Any written reports submitted to the Board by Officers or Standing Committee Chairs (or others at the request of the President) should be attached to the Minutes as Appendixes.

Annual Meeting

At the annual meeting of the Council, the Secretary should present a brief oral report of any major actions involving the Secretary's Office during the previous year. A copy of this report should be sent to the editor of the ISCC News for inclusion in the Annual Report issue.

Also at the annual meeting, the Secretary should take minutes of the annual business meeting and any other official Council business functions and prepare Minutes of these events for the ISCC News. If requested, the Secretary should assist the Annual Meeting Chair on such matters as pre-registration, preparation of forms, name tags, etc.

Publications

The office of the Secretary shall be the official repository of all archival ISCC documents, including extra issues of the ISCC News, reports of Project Committees and other council groups, and Technical Reports and other items for sale. In many instances, such material may be reproduced on demand from master (archival) copies, thus limiting the inventory required. Requests for any of this material should be filled promptly, with invoices accompanying sales items, a copy being sent to the Treasurer in such cases.

Pertinent reports, such as final reports and Technical Reports of Project Committees and other groups, should be sent to Officers and Directors without charge. Correspondence from and, on occasion, to the Secretary should be copied to the President and to other Officers and Standing Committee Chairs as appropriate.

A particular item to be retained is six copies of each issue of the ISCC News to be used in preparing five bound and one unbound volumes when an appropriate number have been issued since the last binding. The sets of bound volumes are currently retained by the following:
Set 1, the Secretary; 2, Smithsonian Libraries, Washington, DC; 3, Library of Congress, Science & Technology Division; 4, reserved for the ISCC Historian; and 5, Editor of the ISCC News. The unbound copy, in 3-ring notebooks, is retained by the incumbent President and must be passed on to the successor at the change of the presidency. It shall be the duty of the Secretary to monitor the need for, and arrange for, the preparation and distribution of these copies.

Voting

The Secretary shall be in charge of elections of Officers and Board members and of ballots for the revision of the Constitution and By-Laws, and of any other matters requiring a vote, following the requirements for such votes outlined in the By-Laws.

For the election of Officers and Directors, the duties of the Secretary are:

To remind all members that an election is to be held. This may be by mailed written notice or by notice in the ISCC News, accompanied by the slate of candidates prepared by the Nominating Committee. In any case the notice must reach the voting delegates not less than 30 days before the ballots are sent out.

To prepare short biographical sketches of the candidates from information received from the Nominating Committee. These shall be enclosed with the notice of the election and with the ballot.

To prepare and issue ballots to all members, allowing a minimum of 30 days for voting plus a reasonable time for the return of the ballots to the Secretary's Office.

To keep an accurate record of ballots sent out and returned, so that a legal vote can be insured.

To arrange for counting the votes, usually by an ad-hoc Committee of Tellers. The ballots should be retained until it is clear that the election will not be contested; retention for one year is recommended.

To report the results of the election to the Board of Directors and arrange for their publication in the ISCC News. (It is usually the duty of the President to notify the winning and losing candidates of the results.)

The timing of these actions should be set to allow for the possibility of additional candidates being identified by the members after the announcement notice, as described in the By-Laws. This requires a second announcement mailing before the ballots are sent out. The final deadline to be kept in mind is usually the time of the winter Board meeting, when the results should be approved by the Board.

For voting on changes to the Constitution or By-Laws, the original and revised texts should be sent to the voters, together with a statement of the rationale for the change, usually prepared by the By-Laws Committee. It will be recalled that changes in the Standing Rules require only a vote of the Board of Directors.

Stationery

The provision of suitable stationery for the use of the officers shall be one of the duties of the Secretary's Office.

APPENDIX B. GUIDELINES FOR THE TREASURER'S OFFICE

General

The Treasurer is the chief financial officer of the Council, and as such holds ultimate responsibility for all Council income and expenditures. He or she shall act with the advice of the Finance Committee, which the Treasurer chairs, and shall be responsible to the Board of Directors.

Because of their importance, many of the duties of the Treasurer are described in the By-Laws, at the following locations: Article I, Section 8, regarding dues; Article III, Section 5, paragraph 3, regarding general duties including chairing the Finance Committee; Article V, Section 1, regarding membership on the Board of Directors; and Article VI, Section 1(a), regarding membership on the Executive Committee.

Budgets

The Treasurer manages the finances of the Council within the framework of an annual budget for each fiscal year (January 1 through December 31), which should be prepared and presented to the Board at its fall meeting. It should contain the approved budget figures for the fiscal year in progress, estimates of the actual income and expenses of the Council for the year in progress, and the proposed figures for the following fiscal year. Any unusual items should be accompanied by explanations. Upon Board approval, this budget provides the goals and targets of the Treasurer's Office for the fiscal year to come.

The overall budget just described should be supplemented by separate budgets for special events, such as the annual meeting and any Williamsburg Conference. These budgets shall be prepared by the Treasurer working with the Chair of the Standing Committee of the event, with additional input from the Arrangements and Publicity Committee Chairs. Each such budget shall be presented to the Board for approval well in advance of the event. The Treasurer shall review all contracts between the Council and conference facilities, hotels, etc., before they are signed, although the actual signing may be delegated to the Arrangements Committee Chair or another responsible Standing Committee Chair.

Income

The Treasurer shall be responsible for all Council income. Invoices for dues shall be prepared and sent out, usually by December 1 of the prior fiscal year, and shall be followed by second notices to those not responding by around February 1 and by drop notices to those still not responding by April 1. The Treasurer shall also receive from the Annual Meeting and Williamsburg Conference Committees all income from those events, and any miscellaneous income from other sources.

These incomes, in excess of those needed immediately to meet obligations, shall be added to the capital assets of the Council and invested in safe, interest-bearing vehicles, on the advice of the Finance Committee and with the approval of the Board of Directors.

The Treasurer shall prepare, or have prepared, and file in a timely fashion the Federal Tax Return for the Council, due May 15 of each year. To this end, and for the good of the Council in general, the Treasurer shall maintain the fiscal record books in a clear written form, suitable for audit as required.

Expenditures

The Treasurer shall dispense all monies in payment of bills and other obligations of the Council that have been approved by the Board, either by approval of the budget(s) or by special action.

The Treasurer shall reimburse Council Officers and Standing Committee Chairs for minor expenses incurred on behalf of the Council, as requested on a form prepared for the purpose and after approval by the President-Elect.

Other Duties

The Treasurer shall provide liaison with the Membership Secretary concerning membership status and changes of address of Council members, and liaison with the chairs of standing committees whenever matters of mutual concern regarding finances arise. The Treasurer shall also provide liaison between the membership and John Wiley & Sons regarding subscriptions at member rates to the journal Color Research and Application.

As Chair of the Finance Committee, the Treasurer shall bring to the attention of the Board all recommendations regarding Council finances arising in the Finance Committee.

Finally, as a member of the Board of Directors and the Executive Committee, the Treasurer should make every effort to attend meetings of these bodies. It is imperative that the Board and the Executive Committee have ready access to the advice of the Treasurer, and to the interpretation of budgets, financial reports, and other pertinent documents coming from the Treasurer's office, as required and without delay. Only by maintaining such close liaison can the Treasurer effectively fulfill the position of chief financial officer of the Council.

APPENDIX C. GUIDELINES FOR THE NOMINATING COMMITTEE

General

The Nominating Committee has responsibility for selecting individuals to be placed in nomination as follows: (a) candidates for President-Elect, Secretary, and Treasurer every two years; and (b) three candidates for Director every year. It is usual for the election of Directors to be contested, so five or six names of candidates should be selected each year. In choosing these candidates, the Nominating

Committee should select individuals who support the goals of the Council as stated in Article II of the Constitution, and can perform the duties of the offices for which they are candidates as stated in the By-Laws, Article III, Section 5, Article IV, Section 5, and Article V, Section 2. In addition, the following qualifications must be considered.

The candidate for President-Elect should have good administrative ability combined with excellent leadership characteristics.

The candidate for Secretary should have experience in the proper preparation of Minutes and have the resources necessary to oversee publishing, storing, and mailing ISCC publications, as outlined in Appendix A.

The candidate for Treasurer should have experience with keeping financial records, preparing tax forms, and making fiscal reports, as outlined in Appendix B.

Candidates for Director should show leadership qualities and a strong sense of responsibility. They should agree to attend all Board of Directors meetings unless there is a compelling reason why they cannot (see the By-Laws, Article IV, Section 6, the second paragraph). The president must be notified if a Director cannot attend a Board meeting. Candidates for Director should also be prepared to undertake specific duties and responsibilities for the benefit of the Council.

After satisfying the above qualifications, the Committee should give consideration to obtaining a well balanced Board of Directors, with members representing as much as possible all areas of interest in color. It is also desirable that Member-Bodies strongly supporting the Council's goals have a representative on the Board of Directors. However, it is not desirable to have more than one Director from a single Member-Body delegation or company. It is desirable, when practical, that one member of the Board come from Canada.

Membership
The Nominating Committee is chaired by the immediate Past President of the Council. Its members at large consist of the President-Elect, one other Past President, and two additional members, for a total membership of five as described in the By- Laws, Article VI, Section 1 (b). The President may not be a member of the Nominating Committee, as stated in the By-Laws and in the Standing Rules, Article II, Section 2 (d).

Operating Timetable
Annual Meeting. The President or the Chair of the Nominating Committee shall announce the names of the newly elected Officers and Directors.

Immediately after the Annual Meeting at which a new President takes office, the President and the Past President (as the Chair of the Nominating Committee) shall agree upon the list of appointees for Members at Large of the Nominating Committee.

June 1. The Chair of the Nominating Committee shall request a list of possible candidates from the members of the committee.

July. Names of candidates shall be selected from the lists received, by using one of the following procedures:

a. A combined list of names of candidates for each office to be filled shall be circulated by the Chair to the committee members. Each member shall rank ten of the competing candidates in order of preference, the highest ranking being given the number 10, the remainder of the ten smaller numbers in order of decreasing preference. The Chair shall then compile the number of points for each candidate to give a final ordered preference list from which potential candidates are to be contacted and invited to become nominees.

b. An alternative to the above is to reach agreement on the nominees at a meeting of the Nominating Committee or by telephone, but the above scheme has been found to work well.

The Chair should be sure that all members of the committee have been fully consulted in the selection process.

For the contested offices of the three Directors, it has been found usual to have to contact about twice as many candidates as there are to be nominees, since some may decline for lack of Company support or other reasons. All candidates selected are expected to confirm Company support of their candidacy, and it may be necessary for the committee to approach several candidates for each position.

The general time line for this process is recommended to be:

a. August. The Chair shall obtain the consent of each nominee to stand for election, and shall obtain biographical information and a photograph from each nominee for publicity purposes.

b. Fall Board meeting (usually October). The Chair shall report to the Board of Directors the names of all the nominees, with their biographical material and photographs appended. On approval of the list by the Board, this information shall be sent to the Editor of the ISCC News and to the Chair of the Publicity Committee for publication, and to the Secretary for the preparation of the election documents.

c. November 1. The Secretary shall mail the report of the Nominating Committee listing the nominees, together with their biographies and photographs, if received, to the Voting Delegates. The list of Voting Delegates is maintained by the Membership Secretary.

d. November 30. Following the procedures given in the By-Laws, Article III, Section 3, the Secretary shall add to the list of Nominees the names of any candidates nominated by five or more Voting Delegates.

e. December 24. The Secretary shall mail to all members, the ballot for the election of officers and directors.

f. Prior to the Winter Board meeting (usually February). The Secretary, with the assistance of an ad-hoc Committee of Tellers, shall count the ballots and report the results of the election to the Board of Directors. The Board of Directors will resolve ties by a vote at that meeting.

g. Following the Winter Board Meeting, the Past-President, as Committee Chair, shall notify all nominees, successful and unsuccessful, of election results as soon as possible. The President shall welcome new Directors and invite them to attend the next Board of Directors meeting as visitors.

APPENDIX D. GUIDELINES FOR THE MEMBERSHIP COMMITTEE

General

The Membership Committee has the responsibility of maintaining and increasing the membership of the Council with respect to both individual members and Member-Bodies. The committee seeks individuals having an interest in color, and invites them to become individual members. It also searches for non-profit organizations of national scope whose mission includes an interest in color, and invites them to become Member-Bodies of the ISCC.

Duties and Responsibilities

The Membership Committee shall:

1. Seek individuals having an interest in color, inform them about the Council and its aims and purposes, and invite them to become members. Some means of carrying this out are:

a. Insure that the publications of the Council include membership information whenever possible. Such publications include, but are not limited to, the ISCC News, technical reports, meeting advisory and registration information, membership rosters, and publications of Project Committees and Interest Groups.

b. Supply teachers of courses, seminars, lectures, etc., on color with application forms for individual membership, and encourage them to discuss the benefits of ISCC membership in their lectures.

c. Send applications to registered non-members following each ISCC meeting.

2. Review on a continuing basis the activities of the professional societies active in North America to identify those with an interest in color, and recruit them to become ISCC Member-Bodies. Existing membership of an ISCC member in such a society provides an excellent opportunity to recruit the society as a Member-Body.

3. Review the activities of the Council from the viewpoints of individual members and Member-Bodies, and make appropriate suggestions to the Officers and Directors for actions that will be of increased interest to the membership.

4. Report at each meeting of the Board of Directors, in person or by letter, on the activities of the committee, and make recommendations concerning new members and other actions pertinent to the committee's responsibilities.

APPENDIX E. GUIDELINES FOR PROBLEMS COMMITTEE

General

The Problems committee is responsible for coordinating all activities on color problems that need the special attention of a project committee.

The Problems Committee Chair shall perform the following duties:

1. Coordinate with the Arrangements Committee and the project committee Chairs to schedule project committee meetings during the time of the ISCC Annual Meeting, if the project committee Chair feels a meeting is necessary. Project committee meetings held during the ISCC Annual Meeting are not mandatory.
2. Insure that each project committee operates within its scope and objectives throughout the year and bring concerns to the Board, as necessary.
3. Recommend project committee Chairs for each new project.
4. Collect each project committee’s annual report from the Chairs and forward those reports to the Editor of ISCC News for inclusion in the Annual Report issue.
5. Seek Board approval of reports that project committees want to issue.
6. Report at each meeting of the Board of Directors, in person or by letter, on the activities of the projects committees.

The duties of each Project Committee Chair are as follows:

1. Conduct all activities of the project committee according to its approved scope and objectives.
2. Call project committee meetings as the need arises. Often times they are held during the Annual Meeting, although it is not mandatory to do so.
3. Assign a secretary to record attendance and the minutes of each project committee meeting. Distribute the minutes and attendance following each meeting.
4. Develop project committee meeting details, including format, speakers and titles or abstracts of their talks, etc., ideally three months prior to the Annual Meeting.

5. Work with the Problems Committee Chair on all business necessary to insure that project committee activities run smoothly.
6. Write a summary report on project committee activities at the close of each Annual Meeting and send the report to the Problems Committee Chair for inclusion in the ISCC Annual Meeting issue.

APPENDIX F. GUIDELINES FOR INTEREST GROUPS COMMITTEE

General
The Interest Groups Committee is responsible for coordinating all activities of each interest group, the most important of which are the meetings held during the time of the ISCC Annual Meeting.

The Interest Groups Committee Chair shall perform the following duties:

1. Coordinate with the Arrangements Committee and the Chairs of each interest group to schedule each interest group meeting during the time of the ISCC Annual Meeting.
2. Insure that all runs smoothly within each interest group throughout the year and bring concerns to the Board, as necessary.
3. Recommend new vice-chairs for each interest group when each position becomes vacated.
4. Collect each interest group's annual report from the chairs and forward those reports to the Editor of ISCC News for inclusion in the Annual Report issue.
5. Report at each meting of the Board of Directors, in person or by letter, on the activities of the committee.

The Chair and Vice-Chair of each interest group will have staggered terms. The Vice-Chair of each Interest Group is a member of the Education Committee. The Vice-Chair will assume the Chair upon departure of the current Chair. The Chair should rotate out after two years of service. The following duties are shared between the Chair and Vice-Chair:

1. Select the theme for each meeting to be held during the ISCC Annual Meeting. The theme should be chosen to meet the needs of the interest group constituency. Often times a theme whose subject matter is similar to the symposium topic of the Annual Meeting is preferred.
2. Select the format for each meeting to be held during the ISCC Annual Meeting. The meeting can take the form of a symposium, a contributed papers session, a panel discussion, a workshop, or any format that adequately addresses the selected theme.
3. Develop interest group meeting details, including format, speakers and titles or abstracts of their talks, etc., ideally three months prior to the Annual Meeting.
4. Issue Calls for Papers and/or information about interest group meetings in ISCC News at the appropriate time. It is important to start the publicity process one year in advance of each meeting. This means that at the close of each Annual Meeting, plans for the next year's meeting should begin.
5. Perform all necessary tasks to successfully run the interest group meeting, including introducing the program (i.e. speakers or discussion topic), insuring that all runs on time, and arranging for audio-visual equipment, if needed.
6. Provide detailed information about the interest group meeting, including speakers, biographies, titles and abstracts, to Annual Meeting Chair for inclusion in the main program booklet.
7. Work with the Interest Groups Committee Chair on all business necessary to insure that interest group activities run smoothly.
8. Work with the Interest Groups Committee Chair on adherence to the Interest Group speaker subsidization policy that follows.
9. Write a summary report on interest group activities at the close of each Annual Meeting and send the report to the Interest Groups Committee Chair for inclusion in the ISCC Annual Meeting issue.
10. Inform the Problems Committee Chair of color problems that are raised in the interest group sessions that may be better addressed by a project committee.

APPENDIX G. GUIDELINES FOR THE PUBLICATIONS COMMITTEE

General
The Standing Committee on Publications is responsible for the publication of the ISCC News and of Technical Reports produced by Council groups, as described in the Standing Rules, Article II, Section 2(f).

As stated therein, the ISCC News is the primary publication of the Council, and its production is the dominant activity of the Publications Committee. Because of the importance of the News and the effort necessary for its continuing timely content and publication, the Editor of the ISCC News is the Chair of the Publications Committee.

The duties of the Chair of the Publications Committee include:

1. Publishing the ISCC News.
2. Overseeing the publication of Technical Reports.
3. Appointing and coordinating the responsibilities of other members of the Publications Committee.
4. Attending meetings of the Board of Directors.
5. Reporting to the Board at its regular meetings.

The major responsibilities of the other members of the Publications Committee involve developing information for publication in the News, setting the format of the News, maintaining a Calendar of Events for publication in the News, and proofreading all publications.

ISCC News
Process of Publication. While there are many groups involved in the publication process, the major responsibility for this task falls on the Editor. The Editor receives and organizes all the material, sends it to the compositor to be set as camera-ready copy, receives that copy and approves it in final form, and sends it to the printer, who reproduces and mails it. The Membership Secretary maintains the mailing list and supplies current mailing labels to the printer (see Appendix M).

Content. It is the responsibility of the Publications Committee, with the approval of the Board of Directors, to establish what types of materials are appropriate for publication in the ISCC News. The Editor, working within this policy, makes the final decisions for acceptance or rejection of individual items. The News consists of the following sections, not all of which need appear in any given issue:

1. News of the ISCC: ISCC items of special interest, including short articles on color, book reviews, meeting reports, etc.
2. News from Member Bodies.
3. News of individual members.
4. News from other color-related organizations.
5. Calendar: a listing of coming events of Member Bodies and other organizations involved with color.
6. Calls for Papers for the ISCC Annual Meeting and ISCC Williamsburg Conferences.
7. The column "In This Issue" reprinted from Color Research and Application.

Archiving.
The ISCC Secretary is responsible for collecting copies of each issue of the News for permanent retention in bound volumes. See Appendix A.

Technical Reports
While the content of an ISCC Technical Report is the responsibility of the submitting committee with approval of the Board of Directors [see the Standing Rules, Article II, Sections 2 (d) and 2 (f)], the publication of such a report is the responsibility of the Publications Committee. The report is turned over to this committee after it receives Board approval for publication. The committee sees that the report is in standard form and then oversees its publication. The Secretary's Office maintains the supply of and distributes Technical Reports (see Appendix A).

APPENDIX H. GUIDELINES FOR THE PUBLICITY COMMITTEE

General

The Publicity Committee is composed of the Chair, a second permanent member, and one or more temporary members as needed. The work of the committee is outlined in the Standing Rules, Article II, Section 2 (g). The responsibilities of the Chair are:

1. Preparing publicity releases.
2. Maintaining the publicity mailing list.
3. Coordinating plans with the chairs of meetings and conferences.
4. Locating a local Publicity Chair for each such event.
5. Providing periodic activity reports to the Board of Directors.
6. The responsibilities of the second permanent member of the Publicity Committee are to aid the Chair in obtaining, writing, and proofreading publicity releases.

The temporary members of the committee are the local publicity chairs for such events as Annual Meetings and Williamsburg Conferences. They should be appointed at least one year in advance of the event, and serve until its completion. It is recommended that they be geographically local to either the Meeting Chair or the meeting location. Their duties are to develop the publicity releases for the event and assist the Meeting Chair with brochures, announcements, programs, and other items of information related to the event. They forward necessary publicity items to the Publicity Chair for distribution.

Publicity Releases

Timing. Because journals, newsletters, and other publications to which the releases are directed can have long lead times, it is essential that publicity releases be sent out early. Preliminary Annual Meeting or Williamsburg Conference information should be in the hands of the readers four to six months before the event. Journals such as Color Research and Application need to receive items four months before they appear; thus, preliminary announcements must be prepared ten to twelve months before the date of the event. Other publicity releases, such as announcements of awards, are less time sensitive, but should appear as soon as possible.

Contents. All publicity releases should include the following items:

1. **1.** The fact that the document is a news release, implying permission to copy, edit, and distribute it; use of a heading such as "FOR IMMEDIATE RELEASE" is a typical way of transmitting this information.
2. The date of issue of the document, and the date of its release if not immediate on receipt.
3. The name and address of a contact person for further information, often as the last paragraph of the release.
4. The main body of the release; see "Essential Information" below.
5. An indication on each page as to whether more pages follow; the words "MORE" or "END" in the center of the last line of the page are typically used for this purpose.

Essential Information. It is imperative that the first paragraph of a release contain, in concise form, the essential facts about the event described. For a meeting or conference, this information must include the date(s), location (hotel or conference center, city, state, country if not the United States), title and an indication of the content of the event, lodging, fees, and any other information that might influence the decision of a potential attendee.

Advantage should be taken when appropriate of the opportunity to tailor meeting or conference announcements to the interests of the recipients, either through the publication to which the release is directed, or to a group by direct mail. Thus, special releases might go to different organizations emphasizing different portions of the meeting program. Similarly, a release announcing an award could be tailored according to the affiliations of the award recipient.

Publicity Mailing Lists
Publications and Organizations. The current ISCC list of entries must be updated when organizations move, cease to exist, or are renamed. While the list is maintained on computer in the office of the Membership Secretary, that office does not automatically receive the information allowing it to be maintained. It is the responsibility of the Publicity Chair to ferret out such information. Periodic checks can be made by sending out notices with releases, and the reference section of a library can be helpful, but the task is difficult.

Direct Mail. In many instances, the use of direct mail lists is a highly effective means of distributing publicity in the form of a brochure for a meeting or conference, especially if the subject matter is of specific interest to those whose names are on an available list. The event Chair should be contacted and asked to give serious consideration to identifying groups and suggesting potential sources of lists. It is recommended, however, that contact with list owners be carried out by the Publicity Chair, for the following reasons. Lists may be offered for sale, necessitating a decision as to the benefits vs. the costs of their use. In some circumstances, it may be possible to send a batch of releases or brochures to the list owner for mailing at ISCC expense, so that further use of the actual list, not released to the ISCC, is prevented.

APPENDIX I. GUIDELINES FOR THE ARRANGEMENTS COMMITTEE

General
The Arrangements Committee is responsible for all physical arrangements for the Society meetings and shall be composed of a permanent Chair and one or more temporary members as needed to fulfill duties at specific meetings. The responsibilities include the Annual Meeting, Williamsburg Conferences, and Board of Directors meetings that may be scheduled at separate times from an Annual Meeting or a Williamsburg Conference.

In order to accomplish these duties, the committee shall be a part of the planning and program committees for the Annual Meeting and Williamsburg Conference and give detailed reports regularly. The committee must work closely with the Financial Committee in the budget planning phase, and with the ISCC Office concerning registration details, scheduling information, and facilities management.

The committee shall obtain prior Board approval to sell merchandise at meetings and conferences. No merchandise or other materials may be sold or otherwise distributed at meetings and conferences without Board approval.

Arrangements Duties
These shall include but not be limited to the following:

Site selection - Maintain communication with national hotel registries in order to recommend Annual Meeting locations. These data should be 2-3 years in the future for already scheduled meetings. The Chair will be responsible for examining hotels selected for Annual Meeting and making contractual arrangements.

A budget shall provide necessary financial information to the Meeting Chair and the Financial Committee to complete an overall meeting budget and registration fees.

Annual Meeting Publicity - Provide meeting Chair and ISCC Office with necessary information for compiling publicity and mailings. These should include but not be limited to:

1. Hotel location
2. Room cost
3. Air travel information
4. Local tourist information
5. Hotel meeting room locations

6. Handicapped accessibility
7. Additional costs related to receptions, audio-visual equipment, speaker breakfasts, and Business luncheon.

Williamsburg Conference Publicity-Provide conference Chair and ISCC Office with necessary information for compiling publicity and mailings. These should include but not be limited to:

1. Room cost
2. Meeting room locations
3. Specific information on events, restaurants, and other areas of interest.
4. Additional costs related to receptions, audio-visual equipment, speaker breakfasts, and luncheons.

General meeting needs-This list shall include but not be limited to:

1. Assist at the registration desk as needed.
2. Schedule appropriate meeting rooms.
3. Arrange for all audio-visual equipment.
4. Arrange for all meals and refreshments, on a timely basis.
5. Maintain coordination with the hotel through the final reckoning after the meeting.
6. Maintain accurate records for cost, registration numbers, etc. to assist the meeting Chair in preparing a final financial statement.

Annual meeting specific needs-List shall include but not be limited to:

1. Examine selected hotel facilities personally or by local designee 2 years prior to meeting schedule and schedule a Board Meeting 2 years prior to the meeting at that facility.
2. Schedule functions, tours, etc. of general historical interest and pertaining to color when the meeting chair requests.
3. Arrange informal "get-together" first night of the meeting.
4. Arrange for the official meal function for business meeting and awards presentations, etc.
5. Arrange for Board meeting to include room and meals.
6. Coordinate facilities for vendor exhibits with meeting Chair, if such exhibits are planned as part of the meeting.
7. Select menus for all appropriate functions.
8. Obtain list of audio-visual needs from meeting chair, and then arrange for the equipment.
9. Review and adjust hotel room quotas, size of meeting rooms, and head counts for meals as the meeting approaches.
10. The Arrangements Chair is responsible for negotiating and executing the contract on behalf of the ISCC with the explicit approval by the President or his designee.

Williamsburg conference specific needs- List shall include but not be limited to:

1. Arrange for Board meeting including room and meals.
2. Provide any specific information needed for the site; such as, dining, tours, etc.
3. Obtain list of audio-visual needs from meeting Chair, and then arrange for the equipment.
4. Review and adjust hotel room quotas, size of meeting rooms, and head counts for meals as the meeting date approaches.
5. The Arrangements Chair is responsible for negotiating and executing the contract on behalf of the ISCC with the explicit approval by the President or his designee.

Board meeting-make all necessary arrangements for meetings which are not part of Annual meeting or Williamsburg conference. This shall include but not limited to:

1. Book hotel rooms based on expected attendance.
2. Arrange necessary meeting room, meals, audio-visual equipment, etc.
3. The Arrangements Chair is responsible for negotiating and executing the contract on behalf of the ISCC with the explicit approval by the President or his designee.

Provide any specific information as appropriate.

APPENDIX J. GUIDELINES FOR THE MEMBER-BODY LIAISON COMMITTEE

General

The Member-Body Liaison Committee is responsible for establishing and maintaining, through the Member-Body Delegations, good relationships between the Council and its Member-Bodies. The Chair of the Committee shall have the duties outlined in the Standing Rules, Article II, Section 2 (j). In addition the duties of the Chair shall include those listed below.

For information regarding the eligibility, election, and duties of the Member-Bodies and their Delegations, see the By-Laws, Article I, Sections 2 (a), 4 (a), and 5 (a).

Duties of the Chair

1. Facilitate ongoing communication with the Member-Body Delegations and key personnel.
2. Meet with as many Member-Body Delegation Chairs as possible each year, generally during the ISCC Annual Meeting.
3. Encourage Delegation Chairs to maintain a full complement of ten Delegates who have an interest in the work of the Council and who attend its meetings.
4. Remind the Delegation Chairs of their responsibility to prepare an annual report for publication in the ISCC News detailing the color-related and other activities of the Member-Body during the year. See the By-Laws, Article I, Section 5 (a), sixth paragraph.
5. Periodically determine that each Member-Body has ISCC literature and is informed about Council activities.
6. Update the list of Member-Body Delegates annually, generally at the beginning of the calendar year, to facilitate the inclusion of current information in the annual ISCC Directory prepared by the Membership Secretary (see Appendix M).
7. Inform Delegates of current, relevant ISCC business and projects.
8. Periodically survey the Delegations to determine shifts of interest and ways that the Council can better serve each Member-Body.
9. Solicit input from the Delegations on color-related projects and areas of interest to the Member-Bodies.
10. Encourage Delegates to prepare reports on relevant ISCC activities for distribution to their Member-Bodies, for example, by publication in the Member-Body newsletter or journal.
11. Encourage Delegates to furnish newsworthy items on color-related topics to the Editor of the ISCC News.
12. Prepare a report of Member-Body Liaison Committee activities for presentation to the Board of Directors at its meetings. The report may be delivered in person or in writing.

APPENDIX K: GUIDELINES FOR THE AWARDS COMMITTEE AND SUBCOMMITTEES

General

The awards and their designs are described below. The design of the awards may be changed at the discretion of the Board of Directors. The extra awards are stored with the Chairman of the Awards Committee, or with the Secretary of the Inter-Society Color Council. He, or she, should be notified when an award is to be made to allow sufficient time to prepare the award for presentation. The Board of Directors shall authorize the Treasurer to procure additional awards as required.

Description of the Awards

1) Macbeth Award

The Macbeth Award was established by Mr. Norman Macbeth, Jr. in honor of the memory of his father, Mr. Norman Macbeth. The award is usually, but not necessarily, presented biennially in even-numbered years.

The Macbeth Award is given for one or more recent outstanding contributions in the field of color. It is to be presented to a member, or former member, of the Council. The contributions shall have advanced the field of color, interpreted broadly as in the objectives of the Council as defined in Article II of the Constitution. The merit of a candidate shall be judged by his or her contributions to any of the fields of interest related to color whether or not it is represented by a Member-Body. The contribution to color may be direct, it may be in the active practical stimulation of the application of color, or it may be an outstanding dissemination of knowledge of color by writing or lecturing. The candidates for the Macbeth Award need not have been active in the affairs of the Council.

2) Godlove Award

The Godlove Award was established by Mrs. Margaret N. Godlove in memory of her husband, Dr. I. H. Godlove. The fund was presented to and accepted by the ISCC during the 25th Anniversary Meeting of April 6, 1956. The award is usually, but not necessarily, presented biennially in odd-numbered years. The Godlove Award is the most prestigious award bestowed by the Inter-Society Color Council, and honors long term contributions in the field of color. Candidates will be judged by their contribution to any of the fields of interest related to color, whether or not it is represented by a Member-Body. A candidate's contribution is to be considered in the light of the objectives of the Council as defined in Article II of the Constitution. This contribution may be direct, it may be in the active practical stimulant of the applicant of color, or it may be an outstanding dissemination of knowledge of color by writing or lecturing, based upon original contributions of the nominee. The candidate need not have been active in the affairs of the Council, but they must be current or former members of the ISCC. Al candidates must have had at least five years experience in their particular field of color.

3) Nickerson Award

The Nickerson Service Award was established by the Board of Directors at a meeting held on February 3, 1980. This award is presented as the occasion arises but no more frequently than once a year. The Nickerson Service Award is presented for outstanding, long-term contributions towards the advancement of the Council and its aims and purposes. The contribution may be in the form of organizational, clerical, technical or other services that benefit the Council and its members. The candidates must be members of the Council and must have been active in the affairs of the Council.

Design of the Awards

1) Macbeth Award

The original Macbeth Award was designed by Professor Robert E. Redmann. It consisted of an electroplated engraving of the bust of Norman Macbeth, on a circular plaque bearing the words "Pioneer in Color and Illumination" above and "Norman Macbeth" below. On the front of the plaque were the words "ISCC Macbeth Award" and the name of the recipient and year.

2) Godlove Award

The original Godlove Award was an engraved acrylic prism in which was embedded a triangular gold diffraction grating. In 1970 the award was redesigned by Karl Fink to be an acrylic plastic regular tetrahedron in which were embedded three sheets of thin plastic in the primary colors cyan, magenta, and yellow. This award was given between 1971 and 1991. The current version of the award is based upon an interpretive design by Marjorie Ingalls; an edition of six awards was produced under her direction in 1986 by Ultra Plastics of Lancaster, PA. The design was a clear cast acrylic cylinder whose cross-sectional shape is based upon the CIE 1931 chromaticity diagram. The acrylic form was nine inches tall, horizontally measures 5.5 inches by 4.5 inches, and was mounted on a clear acrylic square base whose sides measured 8.5 inches. A metal plate was mounted on each of the four sides of the base. On the base, proceeding clockwise from above, were the following inscriptions: "GODLOVE AWARD", date (month, day, year), "INTER-SOCIETY COLOR COUNCIL", and the name of the recipient.

In 2003 the Godlove Award was redesigned by Jack Ladson and Danny Rich. The design, interpreted by the world-famous Venetian designer Maestro Orlando Zennaro, consists of a Venetian glass oval bowl on a wooden base. The bowl measures approximately 5 7/8 inches long by 3 7/16 inches wide and 2 ¼ inches high. The design uses colored striped that run longitudinally along the bowl. The colors on one half of the bowl represent those used in subtractive colorimetry; namely, cyan, magenta, yellow, and black. The colors on the other half of the bowl represent those used in additive colorimetry; namely, red, green and blue. The bowl is presented on a black-lacquered, wooden base slightly larger than the dimensions of the bowl. The wooden base contains an engraved brass plague with the following inscription: "ISCC Godlove Award", the name of the recipient, and the year of the award.

3) Nickerson Award

The Nickerson Service Award is a piece of Steuben glass in the form of a pyramid with truncated points. It is about five inches tall and sits on a round silver base about six inches in diameter. Around the base are the words "ISCC Nickerson Service Award" and the name of the recipient and the year of the award.

The Awards Committee and its Subcommittees

1) Duties of the Chair

The Award Committee Chair is responsible for obtaining the Macbeth, Godlove, and Nickerson Awards and their containers, and responsible for notifying the Board of Directors if the supply of any award is running low. He, or she, shall store or arrange for storing the awards, shall have one each engraved appropriately when a recipient has been chosen, and shall bring the appropriate awards to the meeting where they are to be presented.

2) Composition of the Subcommittees

The Macbeth, Godlove and Nickerson Service Award Subcommittees should each have a chair and four members appointed by the President with the approval of the Board of Directors. One of the members of each subcommittee should be a previous recipient of that award. The chair should be a person who has served on that subcommittee for the previous two years.

3) Duties of the Subcommittees

Each award subcommittee shall solicit nominations for the award under its jurisdiction, recommend a recipient, and prepare a report justifying its recommendation. It shall solicit nominations for its award from each of the Member-Bodies and from the individual membership of the Council. All nominations received must indicate the nominator. No more than one nomination may be submitted by any Member-Body or individual member.

Information Required for Nomination

The following information is required in support of the nominations. Subcommittees often find it appropriate to distribute a form questionnaire with the required information listed for Member Bodies and individual members to use to make their nominations.

1) Macbeth and Godlove Awards
- a) Name and address of nominee.
- b) Professional affiliation (company, institution, if any)
  - i) Present
  - ii) Most recent (past 10 years)
- c) Title (present or most recent) and duties.
- d) Other professional affiliations and positions held.
- e) Nature of interest and activities in color.

f) Evidence of the contribution made in encouraging education, scientific, industrial, or artistic use of color.
   i) In own organization
   ii) In own aspect of color, in own company, in own professional group.
   iii) In outside interest contributions to color (other industries, for example).
   iv) In national activities.
   v) In international activities.

g) Writing, speaking done in support of scientific, industrial, educational use of color. Attach representative, not necessarily exhaustive, list of publications, patents, etc.

h) Additional general background information.

i) Source of nomination.
   i) Member Body , and give name of person in Body preparing nomination.
   ii) Individual member, and give name.
   iii) Award Subcommittee.

2) Nickerson Award
   a) Each of a), b), c), d), and e) under Macbeth Award above.
   b) Evidence of service given towards the advancement of the ISCC and its aims and purposes in form of organizational, clerical, technical, or other services that benefited the Council.
   c) Each of h), and i) under Macbeth Award above.

Confidentiality of the nomination is of the utmost importance. The nominator or nominating group must insure that the nomination is not disclosed to the proposed nominee. If any of the above information cannot be obtained without risking such disclosure, the information should be omitted from the nominating letter. A statement to this effect should be included verbatim in any form questionnaire produced by the subcommittee.

Consideration of Nominations

The Awards Subcommittees shall consider the nominations that have been submitted using the appropriate criteria outlined above. The Awards Subcommittees shall not be limited to the nominations that have been submitted but should actively search for suitable candidates for the awards, and may submit one or more nominations resulting from its consideration. The information required for nominations indicated above shall be required for these subcommittee nominations as well.

Each Award Subcommittee should recognize that the nominations received from the Member Bodies and the individual members will to a certain extent represent special interests. It is the responsibility of the committee members to set aside any special interests they may have and to look at the entire field of color. Accordingly, it is the award committee's responsibility to make whatever additional nominations are appropriate and to consider each nomination on its merit, regardless of the origin of the nomination.

Citizenship, place of residence, age or other personal circumstances shall not be considered in the granting of these awards. It is not intended that the recipient of the Macbeth, Godlove, or ISCC Service Awards shall preclude the granting of other awards to the same recipient. It is, however, anticipated that no one person would receive more than one award for the same contribution. An individual might receive any one of them at one stage in his career and receive another one for work done subsequent to the first award. To clarify this rule it is noted that: 1) The Macbeth Award is based upon recent work which should concern one or more specific projects, accomplishments, or services in the field of color; 2) The Godlove Award is based upon cumulative contribution to the field of color; 3) The Nickerson Service Award is based upon outstanding long-term contributions toward the advancement of the Council, as opposed to the field of color itself.

In the deliberations of the subcommittee, it would be fortunate if the committee could agree unanimously on the most deserving candidate. If this cannot be done, it is not the responsibility of the committee to find a less deserving candidate on whom all can agree. Rather it is their responsibility to find the candidate whom the majority of the committee thinks is most deserving of the award.

The documentation for the unsuccessful nominees for an award shall be retained and made available to later award subcommittees for that award. However, nominees from previous years shall be given no special consideration. Since it is time consuming to document a nomination, it is desirable that this documentation not be lost at a time when the candidate is presumably becoming even more deserving of consideration.

If in the judgment of the subcommittee no suitable candidate emerges from their deliberations, the chair should so inform the Board of Directors, and the Board has the option to decide that no award will be presented at the following Annual Meeting of the ISCC.

Report of Subcommittee

Whether or not a suitable candidate has been selected a report of the decision for the Macbeth and the Godlove awards shall be made to the Board of Directors by the Fall Board Meeting usually held in October of the year before the award is to be presented. In the case of the Nickerson Service award, the recommendation shall be presented to the Board of Directors not later than their Winter Meeting usually held in January or February of the year in which the Award is to be presented. The report shall justify the recommendation. The Board of Directors reserves the right to disapprove any recommendation made by an awards subcommittee. If the recommendation is not approved, the Chair and individual members of the subcommittee shall be notified of the Board's action. The awards subcommittee shall reconsider other nominations made for the award and may recommend another candidate to the Board of Directors. If no agreement can be reached that award will not be presented at the following Annual Meeting of the Council.

Announcement of Recipient

After approval of the candidate by the Board of Directors, the President shall notify the recipient and verify that he or she will accept the award. The recipient shall be asked for a photograph to be used for publicity, and the names and addresses of any local or professional publications the recipient would like notified should be solicited.

If possible the chair of the subcommittee shall give notice of the award and the recipient to the ISCC News in time for publication in the newsletter well prior to the Annual Meeting. Usually the last issue received before the Annual Meeting is the January/February issue for which the deadline is December 15. Sometimes the March/April issue reaches the membership before the Annual Meeting.

Prior to January 1 of each year in which the Macbeth or Godlove awards are given, March 1 in the case of the Nickerson Award, the chair of that award subcommittee shall furnish the Publicity Committee with information as to the intent of the award, to whom its is being given, and the reasons for which it is being given to that individual. The chair of the Publicity Committee shall send an announcement containing this information to the public, trade, and professional press prior to the Annual Meeting.

The report of the Award Subcommittee or the citation shall be published in the ISCC News immediately following the Annual Meeting.

Presentation of Award

It is desirable that any award be presented at a meal function at the Annual Meeting of the ISCC, usually the Awards Luncheon. For sufficient reason, the Board of Directors may authorize the presentation at another appropriate occasion.

The presentation shall be preceded by laudatory remarks in the form of a citation, which may or may not differ in content, but shall not differ in intent, from the report of the Award Subcommittee. In the case of the Godlove or Macbeth Award, the recipient may choose the individual to give the citation, or the citation may be given by the individual who nominated the recipient, or by the Award Subcommittee chair. In the case of the Nickerson Service Award, the chair of the subcommittee usually gives the citation.

The Award shall be presented to the recipient by the President of the ISCC or his or her delegate. Following the presentation the recipient may, at his discretion, respond briefly, usually limited to ten minutes. Alternatively, a recipient needing or desiring more time to speak might be invited to be the after-dinner speaker at the Banquet. If the ISCC desires the latter arrangement, the invitation should be issued immediately after the nomination is approved by the Board of Directors.

Timetable for Subcommittee Activities of Macbeth and Godlove Awards

1. October Board Meeting two years prior to award: ISCC President appoints chair and members of subcommittee and obtains Board approval.
2. November two years prior: Chair furnishes Publicity Committee with notice of the award, and a solicitation of nominations for Member Body publications and CR&A.
3. April 15 prior year: Chair submits article and call for nominations for May/June issue of ISCC News.
4. August prior year: Chair reviews nominations received and solicits additional information if needed.
5. September prior year: Chair polls subcommittee to select nominee.
6. October Board Meeting prior year: Chair submits the nominee and his, or her, qualifications to the Board for approval.
7. November prior year: President notifies the nominee, verifies that he, or she, will accept the award, and determines who will make the citation.
8. December prior year: Chair files newsletter item announcing awardee and his qualifications.
9. February of year of award: Chair notifies Awards Committee Chair to have award engraved and brought to Annual Meeting.
10. April of year of award: Citation is given at Awards luncheon at Annual Meeting.
11. Immediately following Annual Meeting: Chair sends ISCC News both citation and recipients remarks for publication.

Timetable for Subcommittee Activities of Nickerson Award

1. Winter Board Meeting year prior to award: ISCC President appoints and gets approval of new chair and members of Nickerson Service Award Committee.
2. June 15 of prior year: Chair announces award and solicits nominations in July/August newsletter.
3. October year prior: Chair compiles list of nominees from membership and committee members. Requests additional supporting information if necessary.
4. December prior year: Chair polls committee to select nominee, if any.
5. Winter Board Meeting year of award: Chair reports nominee and his, or her, qualifications, or reports that there is no nominee this year.
6. February year of award: President notifies the nominee, verifies that he or she will accept the award, and determines who will make the citation.
7. February year of award: Chair files newsletter item announcing awardee and his qualifications. Chair notifies Awards Committee Chair to have award engraved and brought to Annual Meeting.
8. April of year of award: Citation is given at Awards luncheon at Annual Meeting.
9. Immediately following Annual Meeting: Chair sends ISCC News both citation and recipients remarks for publication.

APPENDIX M. GUIDELINES FOR THE MEMBERSHIP SECRETARY

General

The Membership Secretary is charged with developing and enhancing membership services, increasing membership among various categories, and maintaining a vital link between the membership and the ISCC Board of Directors.

Duties and Responsibilities

The Membership Secretary shall:

1. Be the official chair of the Membership Committee
2. Work with the Individual Member Group Liaison to do whatever is necessary to increase membership globally or in specific color-related categories, if the need is present.
3. Do whatever is necessary to increase the number of sustaining members.
4. Work with the Member-Body Liaison to do whatever is necessary to bring new Member-Bodies into ISCC membership.
5. Work with the Administrative Office Manager to keep current on membership status and to help with membership problems that may arise.
6. Work with the Editor of the ISCC News to incorporate important membership issues as they arise.
7. Report at each meeting of the Board of Directors, in person or by letter, on pertinent activities, making appropriate recommendations as required.

APPENDIX N. GUIDELINES FOR THE ADMINISTRATIVE OFFICE MANAGER

General

The Administrative Office Manager is charged with performing all duties necessary to keep the ISCC Office running smoothly. These include covering the phone and FAX, processing membership applications from individuals, sustaining members and Member-Bodies, maintaining the membership roster, assisting individuals or organizations needing to reach the ISCC membership through the mails, and updating the ISCC Directory on an annual basis.

Duties and Responsibilities

The Administrative Office Manager shall:

1. Answer all telephone messages coming into the ISCC Office.
2. Receive correspondence coming into and transmit correspondence out of the ISCC Office as needed.
3. Provide membership information to existing Council members and delegates, and to all others who request such information.
4. Process applications for membership, deposit all monies to the proper bank accounts as directed by the Treasurer, forwarding completed membership applications to the Board of Directors for its approval, and after such approval, providing information about new members to the Editor of the ISCC News.
5. Maintain the membership list on computer, by the use of data base software, adding data for new members, making required changes, and deleting data for resigning or lost members.
6. Incorporate membership information as well as all necessary additional information that appears in the published ISCC Directory in order to update it on an annual basis.
7. Forward updated ISCC Directory data to the printer for publication as required.
8. Bill the membership (retired, student, individual, but omitting honorary), member-bodies and sustaining.
9. Provide to the Treasurer, the mailer of the ISCC News, and other authorized persons, current rosters as hardcopy, magnetic media, or mailing labels covering the Council membership in whole or in part, so as to promote the best interest and smooth operation of the organization. An example of such use is: Labels for all voting members and delegates are provided to the Secretary for mailings related to balloting. Occasionally, with Board of Director authorization, labels are provided, sometimes for a fee, to organizations desiring to reach ISCC members.
   a. The ISCC Membership List is available to such organizations under the following guidelines:
      (1) Fee Schedule
      (2) Member Body-----------No fee as long as a reciprocal agreement to share mailing lists exists, otherwise $250.00
      (3) Sustaining Member-----$500.00
      (4) All Others----------------$1,000.00

b. The fee covers a one-time use.
c. Payment to the ISCC will be made in advance.
d. The ISCC will supply postal addresses only – No E-mail addresses will be released.
e. The ISCC will supply the Membership List as individual labels.
f. The ISCC makes no claim for the accuracy of the list.
g. The Executive Committee may make exceptions to this rule as it deems necessary.
h. This policy is in effect as of April 20, 2002.

10. Report at each meeting of the Board of Directors, in person or by letter, as to the operations of the Administrative Office and the membership status, making appropriate recommendations as required.
11. Assure that upon approval new members receive a welcome letter and directory.

APPENDIX O. GUIDELINES FOR THE EDUCATION COMMITTEE

General
The Education Committee has the responsibility of serving the needs of the ISCC color science educators as well as identifying and addressing the color education needs of the ISCC general membership. The Education Committee is led by a Chair appointed by the Board of Directors. The members include the Vice-Chairs of the ISCC Interest Groups.

Duties
The specific duties of the committee are
(1) Organization of a program at the annual meeting and
(2) Organization and review of the Student Chapters.

The Chair reports on the activities of the Committee to the Board before each Board meeting.

(1) Education program at the annual meeting: The Education Committee program is usually scheduled for a 3-hour time slot on the first morning of the annual meeting. The goal of this program is to present informative material that will reflect the interests of the membership. There is no set format. Previous programs have included brief presentations from the three Interest Groups followed by an open Round Table discussion, topic-based programs with expert speakers invited from outside the society, and inter-disciplinary programs that involve all three Interest Groups.

(2) Student Chapters: A student Chapter is formed by a group of ISCC student members at an institution. The students must first find a Faculty advisor, who is an active ISCC member. With guidance from the advisor, the proposed chapter should establish a formal structure with elected officers. The student president is the liaison to the home institution and to the ISCC Education Chair. The structure of the proposed student chapter should conform to institutional requirements for student activities. The student president should then petition the ISCC Education Chair for formal recognition. The petition should include the membership list and a description of activities. Once accepted as an official student Chapter of the ISCC, the ISCC provides the group with a student banner. An example of the ISCC/RIT Student Chapter Constitution and Bylaws is on file with the Education Committee. Information concerning the design of the banner is available from the Education Committee Chair. The student president provides annual reports on Chapter activities to the Education Chair.

Specific Duties for the Chair concerning the Education Program at the annual meeting

The Chair, with the advice of the vice-Chairs of the Interest Groups and other officers of the Society selects a program for the meeting.
(a) Speakers are identified and asked to participate.
(b) Following the "Guidelines for Annual Meeting Chairperson", the names and titles of the speakers are reported to the General Chair for the Annual meeting. Special audio-visual needs are reviewed at this time. Abstracts and biographical material are submitted to the General Chair according to appropriate deadlines.

(c) Information about the date, time and location of the meeting is given to the speakers, including information about hotel reservations and registration. If an invited speaker can attend only the Education Program, the Chair requests waiver of the registration fee from the General Chair.

(d) Limited funds are available for reimbursement of travel expenses for invited speakers who have insufficient funds to attend the meeting. The procedure to request reimbursement is described in "ISCC Interest Group Speaker Reimbursement".

Communications

ISCC *News*

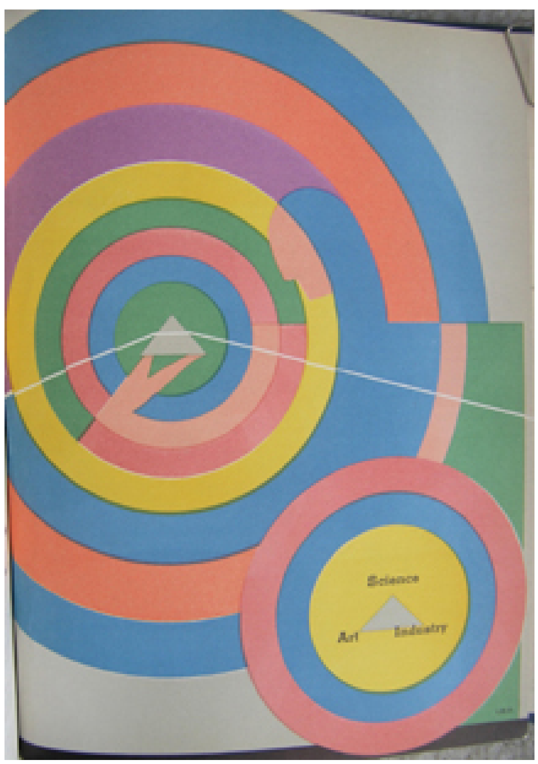
The ISCC Newsletter was first published in 1933. It is dated October 16, 1933 and was written by the then Secretary, M. Rea Paul. Paul produced the first ten issues until he became Chairman of the ISCC. Then R. G. Macdonald, the new Secretary began producing the newsletter beginning with #11 dated November 27, 1935. In Issue #16 Dated January 1937, there is an announcement that the Executive Committee recently appointed I. H. Godlove as Editor-in -Chief. With him was associated an Editor for Art - C. Bittinger and an Editor for Science – D. B. Judd. It was stated that later an Editor for Industry would be appointed. Dr. Godlove served as editor of the ISCC Newsletter from 1936-1954.

Editors	
I. H. Godlove	1936-1954 (#16 - #115)
Dorothy Nickerson (Acting Editor)	for 2 issues in 1955
Eugene Allen	May 1955 (#118) – Jan 1957 (#127)
Warren L. Rhodes	March 1957 (#128) – June 1966 (#182)
Randall M. Hanes	July 1966 (#183) – Dec 1969 (203)
Robert W. Burnham	Jan. 1970 (#204) – Feb. 1974 (#228)
William Benson	Mar. 1974 (#229)-October 1981 (#274)
Mary Ellen Zuyus	Nov. 1981 (#275) – Feb. 1986 (#299)
Harry K. Hammond III (Interim Editor)	Mar. 1986 (#300) – Dec. 1986 (#304)
Bonnie Swenholt	Jan. 1987 (#305) – Oct. 1990 (#327)
Michael A. Hammond	Nov. 1990 (#328) – Oct. 1995 (#357)
Gultekin Celikiz	Nov. 1995 (#258) – Present

Today. The major publication of the Council is still the ISCC *News*, published bi-monthly. Items submitted for publication must reach the Editor (Mr. Gultekin Celikiz, Editor, 1309 Paper Mill Road, Erdenheim, PA 19038-7025) not later than February 1, April 1, June 1, August 1, October 1, and December 1 for publication in the issue appearing one month later. News notes, meeting announcements, and reports, book reviews, and especially Member Body news items are welcomed, but lengthier articles are not accepted. The ISCC *News* is sent electronically to all delegates, Member Body liaison representatives, and individual members without charge or by mail for a fee.

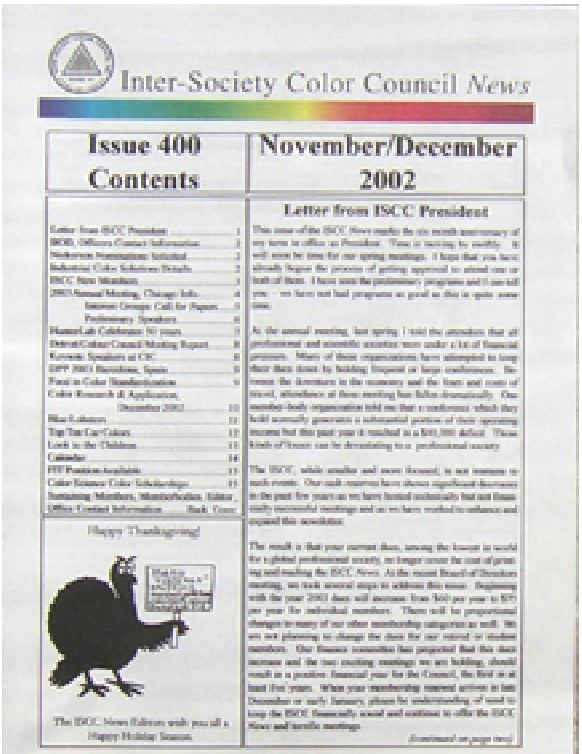
One issue each year is designated the Annual Report issue and contains reports of officers, committees (including the Problem Committee and its Project Committees), and Member Body delegations, as required by the By Laws. It is expected that the delegations will also report on ISCC activities to their membership, and that such reports will appear in the journal of that Member Body.

“At the time of his death Dr. Godlove was preparing a “Jubilee Issue” of the ISCC Newsletter to celebrate the 100th issue under his editorship. The issue was completed by his wife, Margaret Noss Godlove. The cover for the Jubilee Issue was designed and painted in spring of 1954 by I. H. Godlove to illustrate the coordination of color represented by the membership of the Inter-Society Color council in the fields of science, art and industry. Godlove invited about 30 persons to review the progress made during the 18 years of his tenure as Newsletter Editor. The list of contributors was outstanding, these were the individuals who inaugurated the modern science and technology of color. Included in the list were Norman Macbeth, Deane B. Judd, Richard S. Hunter, Sidney M. Newhall, Walter Granville, Kenneth L. Kelly, Farber Birren, Forrest L. Dimmick, Ralph M. Evans, and Commander Dean Farnsworth.”
[reprinted from the remarks on receiving the 1995 Godlove Award by Joel Pokorny and Vivianne C. Smith as reprinted in the ISCC News No. 356, July 1995, pp. 8-10]



ISCC *News #115 –*
(100th Edition under Godlove)

At other times the *News* took on different appearances.


Inter-Society Color Council *News*

Issue 400

Contents

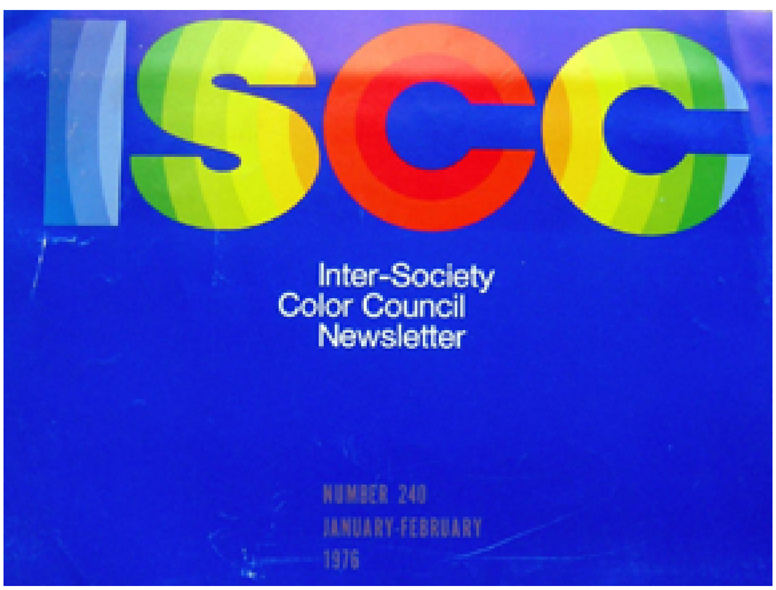
November/December 2002

Letter from ISCC President

Happy Thanksgiving!

The ISCC News Editors wish you all a Happy Holiday Season.

ISCC *News* #400 2002

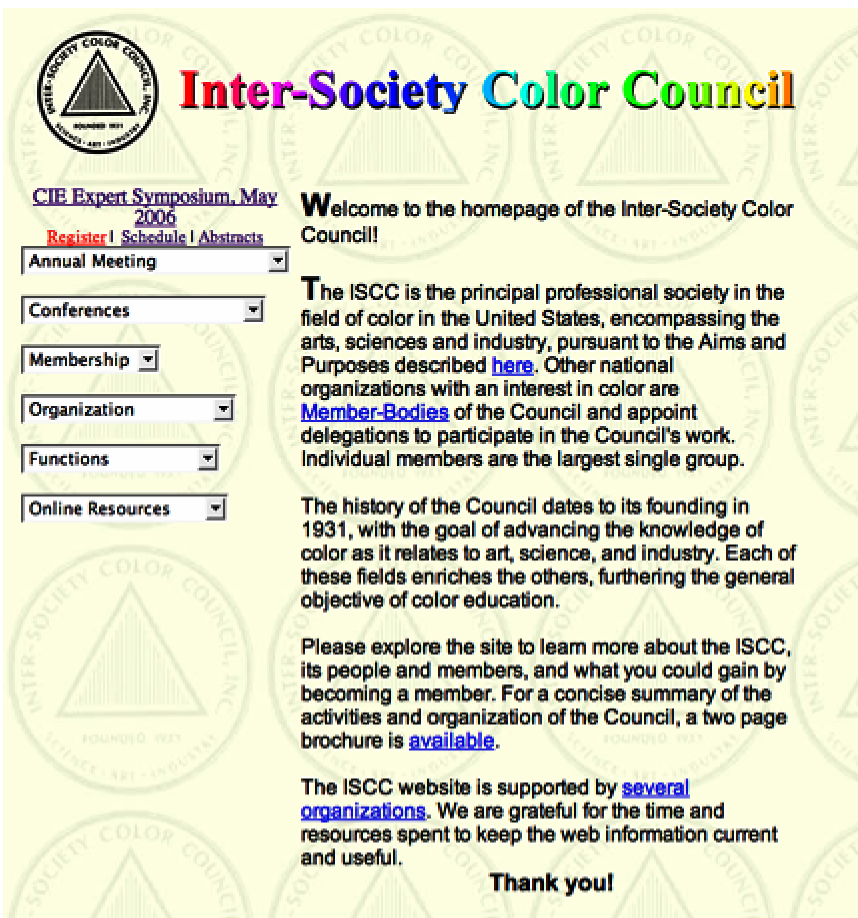


ISCC *News* # 240 January-February 1976

ISCC Website

By the 1990s the methods of communication were increasing. Although our newsletter was still going strong, more and more people were turning to the internet to get their information electronically. The January/February 1997 issue of the ISCC *News* #365 is the first one in which the ISCC website http://www.iscc.org is noted. Rich Riffel, who would become ISCC Secretary later that year, was the first webmaster. He was located at Hunterlab.

In 1998, the site moved to Rochester Institute of Technology and Dave Wyble, the current webmaster, took over the care of the site. The site provides a means of letting members and other interested people know about current and upcoming events. As it has grown and expanded over the years to include meeting announcements and registration information, historical information, pictures of recent events and much more.



ISCC Reports

Project reports, either carrying the endorsement of the Council with the approval of the voting delegates, or released for information without carrying either the direct or implied endorsement of the Council, are usually published in the journal of the appropriate Member Body or in the independent journal *Color Research and Application*.

Project reports which are not directly suitable for journal publication because of their length or nature are published by the ISCC in limited editions as ISCC Technical Reports. Availability of such reports is announced by ISCC NEWS articles and press releases.

The following material, originally made available by the Council in bibliofilm to the American Documentation Institute, may be obtained on microfilm from the Library of Congress, Photo Duplication Service, Auxiliary Publications Project, Washington, DC:

Godlove Bibliography on Color, 236 pages, Document No. 1162
Munsell Color Diary, 426 pages, Document No. 1307
COLOR NEWS, first issues, Document No. 1330.

The following publications may be ordered prepaid from the ISCC Office. Contact Cynthia Sturke at the ISCC Office, 11491 Sunset Hills Road, Reston, VA 20190; tel: 703-318-0263 fax: 703-318-0514 email: isccoffice@cs.com:. Prices shown are for individual members. Prices for libraries are twice the amounts shown.

Application form for individual membership — No charge

ISCC Technical Report 81 2: Program Chair's ISCC Guide
by Joyce S. Davenport and Allan B. J. Rodrigues(For Internal use only)

Proceedings of the 1987 Williamsburg Conference on Appearance. — $10.00

ISCC Technical Report 87 1: Guidelines for Organizing an ISCC Williamsburg
Conference by David H. Alman — (For internal use only)

ISCC Technical Report 89 1: Guide to Material Standards and their use in Color
Measurement by Ellen C. Carter, Fred W. Billmeyer, Jr.
and Danny C. Rich — $15.00

ISCC Technical Report 90 1: 1989 ISCC Williamsburg Conference on Color
Discrimination Psychophysics by Fred W. Billmeyer, Jr. $15.00

ISCC Technical Report 2000 1: Guidelines for Organizing ISCC Williamsburg
Conference and Panchromatic Conferences — by Cynthia Brewer
(For internal use only)

ISCC Technical Report 2003-1 Guide to Material Standards and Their Use in Color
Measurement — $50.00 plus Shpp/Handling

Technical Report: Demystifying Color by Prof. Bob Chung
Ten myths about color. — $5.00 each or 20 copies/$50.00

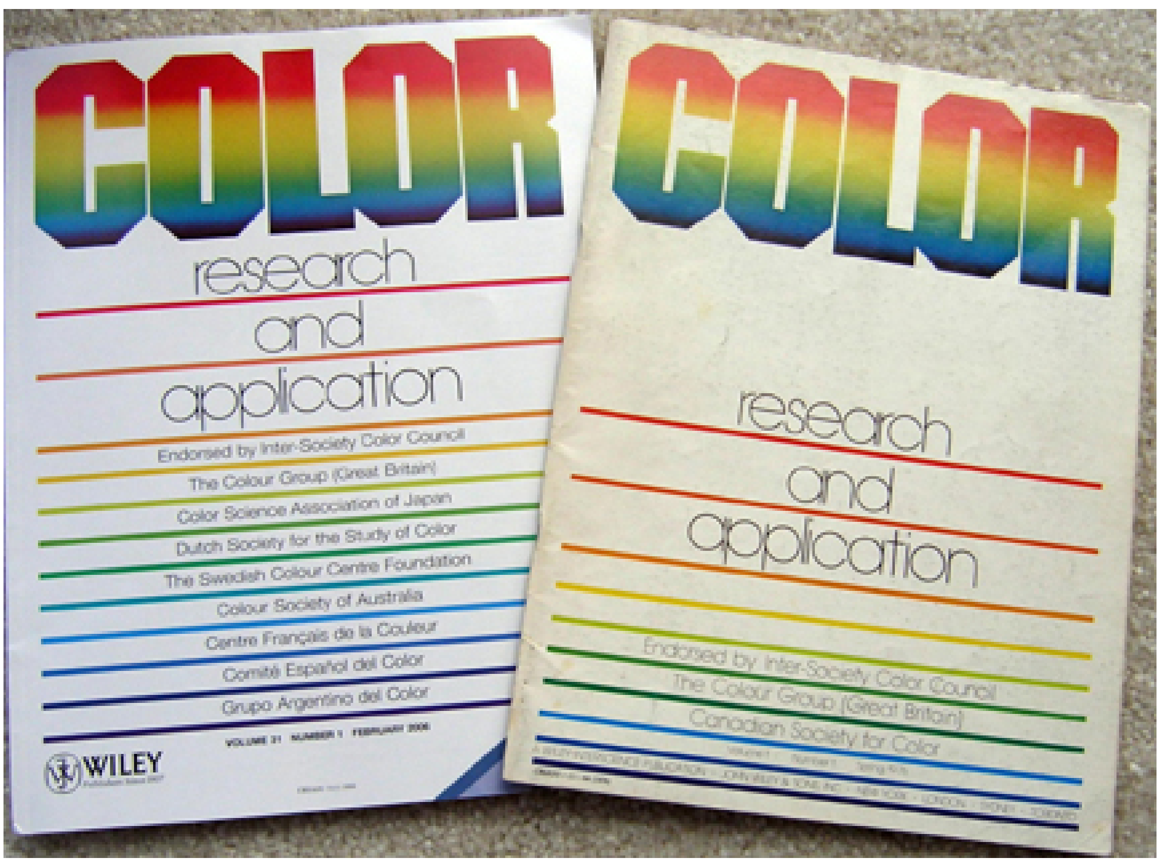
Reprints: Color and Light, by Fred W. Billmeyer, Jr., and Harry K. Hammond, III
Chapter 40 of ASTM Paint Manual, 23 pages. Authorized reprint from
ASTM Manual 17, Copyright 1996. — $5.00 each or 20 copies/$50.00

Mailing labels for ISCC members and delegates — $250.00
(Distribution must be approved by ISCC President.)

Color Research and Application

From its inception, one of the aims of the ISCC was communication of knowledge about color. The early ISCC News Letters carried fairly lengthy articles on numerous topics. However as time went on it was thought that a journal would be useful.

Color Research and Application is an international journal that reports on the science, technology, and applications of color in business, art, design, education, and industry. However it is intimately connected with the Inter-Society Color Council. Two earlier attempts at color journals were made before CR&A made its debut in 1976. In the 1960s it was thought that there should be a journal specifically addressing the issues of color. In 1966, in the First Edition of *Principles of Color Technology* Fred W. Billmeyer annotates "*Color Engineering* publication irregular…A new journal which tends to cover all aspects of the field of color from physics through aesthetics. Too new to tell, but off to a good start" By the 2nd Edition, not only wasn't *Color Engineering* listed, but neither was its successor, *Journal of Color and Appearance*, an excellent journal, which lasted only two years, from July 1971 through Sprint 1973.



Fred W. Billmeyer, Jr. became the first editor of CR&A. CR&A learned from its predecessor. Two innovations began with the first issue of the journal. This is taken from "The Editor's Pallette" in Issue #1 of CR&A, "But color is far more than a science, and it is our intent to make COLOR RESEARCH AND APPLICATIOM far more than a scientific or technological journal. Thus we solicit and provide space for articles on color in art, design, education, business and industry as well as in science, engineering, and technology. In doing so we hope to serve the widest possible audience to the very bust of our ability." The second innovation was the endorsement of the major color societies of the Engilsh-speaking world – The Canadian Society for Color, the Colour Group (Great Britain) and the Inter-Society Color Council.

Not only was the first editor in chief from the ISCC, but also to this date all the succeeding editors in chief are from the ISCC. Billmeyer remained Editor in Chief from 1976 until 1987. Rolf Kuehni served as editor-in-chief from 1987-1989 and Ellen Carter, the current editor-in-chief, took over with the first issue of 1990. The ISCC has also provided an Associate Editor since the journal's inception. These people are:

Rolf Kuehni	1976 – 1981
Harry K. Hammond III	1981 – 1984
David Alman	1985 – 2003
Robert Buckley	2004 – present

Today. The independent journal *Color Research and Application* is endorsed by the Inter Society Color Council, The Colour Group (Great Britain), Color Science Association of Japan, Dutch Society for the Study of Color, The Swedish Colour Centre Foundation, Colour Society of Australia, Centre Français de la Couleur, Comité Español del Color and Grupo Argentino del Color. It is published by John Wiley & Sons, New York with Dr. Ellen C. Carter as Editor and Dr. David H. Alman as Associate Editor for the ISCC. Reduced subscription rates are afforded to ISCC members by the Journal. ISCC members are invited to visit the journal website (Wiley InterScience: Journal Home - Color Research & Application) where they can view the contents of the most recent issue, search for specific topics, set up their Personal Home Page and sign up for contents alerts whether the subscribe to the journal or not. Also members are encouraged to submit manuscripts electronically by going to: http://mc.manuscriptcentral.com/col.

Jubilee Week 2000 Festivities

ISCC 2006 Annual Meeting
75th Anniversary
President's Welcome

On the occasion of the 75th Anniversary of the Inter-Society Color Council (ISCC), it is my great pleasure to welcome you to Ottawa for our 2006 Annual meeting.

The ISCC was founded in 1931 as a non-profit organization of societies and creative individuals – artists, designers, educators, industrialists, scientists, that are actively interested in the description and standardization of color and the practical application of color knowledge to problems in art, science and industry. These are the fundamental tenets of the ISCC logo – a pattern of individual lines forming a triangular shape representing the interchange of ideas on color and appearance between these three special-interest areas of art, science and industry, and fusing into a cohesive form for the benefit of all.

The year 2006 also marks a major milestone in the history of color science – the 75th Anniversary of CIE colorimetry so it is only fitting that the ISCC is co-sponsoring with the Canadian National Committee of the CIE a Special Symposium on 75 Years of the Standard Colorimetric Observer. It is wonderful that many of you are planning to stay in Ottawa to take part in both of these special jubilee events.

I would also like to take this opportunity to specially recognize those individuals that have worked so hard to make these meetings a tremendous success. These are my Co-Chair, Ms. Sharon McFadden, Symposium Chair and President-Elect, Dr. Rob Buckley, Symposium Technical Chair, Dr. Alan Robertson, Dr. Ellen Carter, who prepared the 75th Anniversary commemorative CD, Dave Wyble, who set-up and maintained the special jubilee web-site, Dr. Romesh Kumar who handled many of the local arrangements, and Ms. Cynthia Sturke who prepared the souvenir 75th Anniversary program book and attended to countless details.

If you are not currently a member of the ISCC, I strongly encourage you to join this growing family of individual members, Member-Body organizations, and Sustaining members, and to help shape the activities of the Council as it strives to meet the color challenges of the next 25 years. I also hope that some of you will have the pleasure of celebrating the 100th anniversary of the ISCC and its remarkable achievements in 2031!

Wishing you a memorable and enriching experience,

Joanne Zwinkels

Joanne Zwinkels
President, Inter-Society Color Council (2004-2006)

ISCC 2006 Annual Meeting

14 – 15 May 2006
NRC Sussex Laboratory
100 Sussex Drive
Ottawa, Ontario

Program Schedule

Saturday, 13 May 2006

18:00 – 20:00 *Wine & Cheese Reception,* Sheraton Ottawa Hotel

Sunday, 14 May 2006

09:30, 09:45 Bus transportation from hotel to NRC Sussex

09:45 - 10:30 *Continental breakfast and Registration,* NRC Council Chambers

10:30 - 11:00 Project Committee 54: Colors of Maximum Contrast, *Hugh Fairman*

EDUCATION COMMITTEE
Session Chair: Prof. Margaret Miele
Moderator: Dr. Michael H. Brill

11:00 - 12:30 The Color Curiosity Project
Dr. Mark Fairchild, R.I.T
Presentation and Discussion

12:30 – 13:30 *Lunch,* NRC Council Chambers

INTEREST GROUP III – ART, DESIGN & PSYCHOLOGY
Session Chair: Ms. Georgia Kalivas, F.I.T.

13:30 - 14:00 Applying Colour Science in Colour Design
Dr. M. Ronnier Luo, University of Leeds

14:00 - 14:30 Using Color to Transmit Information
Ms. Sharon McFadden, Defence R&D Canada

14:30 – 15:00 Brief History of Artists' Colors
Stephen Gritt, National Gallery of Canada

15:00 – 15:30 *Refreshment Break*

15:30 – 16:15 Bayesian Models of Color Appearance
Dr. David Brainard
University of Pennsylvania and Recipient of ISCC 2006 Macbeth Award

16:15 – 16:45 Getting Brighter: Coloring More Sustainably
Prof. Georgia Kalivas, Fashion Institute of Technology

17:05, 17:20 Bus transportation to hotel

18:00 - 19:00 *Social Hour,* Sheraton Hotel

19:00 - 21:00 *ISCC Awards and Business Banquet,* Sheraton Hotel
Presentation of Nickerson and Macbeth Awards

Monday, 15 May 2006

07:30, 07:45 Bus transportation from hotel

08:00 – 08:30 *Continental breakfast*

08:30 – 08:35 ISCC 2006 Announcements and Logistics: Dr. Joanne Zwinkels

INTEREST GROUP II
INDUSTRIAL APPLICATIONS OF COLOR
Session Chair: Jerald Dimas, Color Communications, Inc.
Moderator: Milt Hardt, Color Communications, Inc.

08:35 – 09:00 Improving inter-instrument agreement through profiling
Tim Mouw, X-Rite Inc.

09:00 – 09:25 Comparison of portable and bench top spectrocolorimeters using the RIT reproducibility data.
Dr. Danny Rich, Sun Chemical Corporation

09:25 – 09:50 In-line fiber optic color spectrophotometer for process control
Jaime Gómez, Equitech International

09:50 – 10:15 Reliable digital workflow
Dr. David Battle, GretagMacbeth

10:15 - 10:45 *Refreshment break,* NRC Council Chambers

10:45 – 11:10 To profile or not to profile: The User's question
Chuck McLellan, Datacolor

11:10 - 11:35 On-line, non-contact color measurement solutions
Frank Koger, X-Rite Inc.

11:35 – 12:00 The new realities of color measurement and visualization
Randy Snavely, Ciba Specialty Chemicals

12:00 – 13:00 *Lunch*, NRC Council Chambers

INTEREST GROUP I – COLOR RESEARCH
Session Chair: Milt Hardt, Color Communications Inc.
Session Vice-Chair: Jim Roberts, BYK-Gardner

13:00 – 13:30 Ten Commandments for Standardized Model Making
Dr. Michael H. Brill, Datacolor

13:30 – 14:00 Standardized Procedures for Improved Color Measurements
Dr. J. Zwinkels, National Research Council

14:00 – 14:30 Recent Developments of the NIST Colorimeter
*Dr. Maria Nadal, NI*ST

14:30 – 15:10 R*efreshment break and Poster Presentation*
CIELAB Definition and Application of Device Independent rgb* Color Coordinates for Output of Elementary Colors
Prof. Dr. Klaus Richter, BAM

15:10– 15:40 Comparison of Methods of Parameric Decomposition
Zhaojian Li, R.I.T

15:40– 16:10 Comparison of Methods for Verifying the Accuracy of Color Measuring Instruments
Dave Wyble, R.I.T

16:10 – 16:40 The Color of Retroreflective Pavement Marking Materials
Dr. Cameron Miller, NIST

16:40 – 16:45 Closing Remarks, Joanne Zwinkels

16:45, 17:00 Bus transportation to hotel

18:00 – 20:00 *Symposium Wine and Cheese Reception*, Sheraton Ottawa Hotel

Project Committee 54: Colors of Maximum Contrast
Hugh Fairman

Purpose: There is a need to revise and republish the work of Project Committee #26. This work was completed in 1964 and was published in Color Engineering, November-December, 1965, page 26. This publication named twenty-two colors that were said to be maximally different from each other. In the light of modern developments in color measurement and specification as well as expansion of the producible surface color gamut, these colors are no longer thought to be the optimal set of colors of highest contrast to each other.

The Committee will:

1) Select an appropriate number of colors of maximum contrast to be published.
2) Select the colors to be published taking into account both surface color and applications where color is generated electronically.
3) Complete the project by fall of 2006.

The Co-Chairs of this committee are Hugh Fairman and Ralph Stanziola

Sunday 11:00 - 12:30
Education Committee-Fairchild

Sunday 12:30 – 13:30 Lunch
NRC Council Chambers

The Color Curiosity Shop

Presentation and Discussion

Mark D. Fairchild

Xerox Professor of Color Science, Director, Munsell Color Science Laboratory, Chester F. Carlson Center for Imaging Science, Rochester Institute of Technology, Color Science Building, Bldg 18 - Room 1077, 54 Lomb Memorial Drive, Rochester, NY 14623-5604
mdf@cis.rit.edu *www.cis.rit.edu/fairchild* *www.whyiscolor.org*

Abstract

This ISCC Education Committee session will feature a brief presentation on The Color Curiosity Shop project followed by plenty of time for discussion, suggestions, questions, etc. The Color Curiosity Shop will be an interactive, multiple-medium, resource illuminating the relationships between scientific endeavors and everyday experiences. The project theme is color — a topic of near-universal experience and fascination. Descriptions of color in scientific terms will be made in a way that eliminates the potential intimidation of scientific and technical discourse. Once viewers work through an exploration series on color topics, they will discover they were learning about science without having to overcome any science anxiety. Innate curiosity is the driving force behind this mode of learning. The viewer will greatly increase knowledge about color, gain an appreciation of how science enriches everyday life, and perhaps be motivated to engage in additional exploration and education.

The main resource will be a public website <whyiscolor.org>with 64 modules addressing actual student questions about color at eight levels spanning eight traditional disciplines. As viewers navigate the modules they will discover that science is ultimately about satisfying our natural curiosity. Further dissemination will be through a downloadable, navigable, electronic book, a free printable book, and potential development of a museum or science-center installation.

Biographical Information

Mark D. Fairchild is the Xerox Professor of Color Science and Director of the Munsell Color Science Laboratory in the Chester F. Carlson Center for Imaging Science at the Rochester Institute of Technology. He received his B.S. and M.S. degrees in Imaging Science from R.I.T. and Ph.D. in Vision Science from the University of Rochester. He was chair of CIE Technical Committee 1-34 on color appearance models, is currently a member several other CIE technical committees dealing with color appearance and image technology issues. Mark was presented with the 1995 Bartleson Award by the Colour Group(Great Britain) and the 2002 Macbeth Award by the Inter-Society Color Council for his research work in color appearance and other areas of color science. He is author of over 150 technical publications in color and imaging sciences and the book, Color Appearance Models, 2nd Ed., which serves as a reference to the fundamentals of color appearance and the formulation of specific models. He served as Color Imaging Editor for IS&T's Journal of Imaging Science and Technology for 3 years and was named a Fellow of IS&T (the Society for Imaging Science and Technology) in 2003 for his contributions to digital color imaging. Mark is an active member of IS&T, ISCC, CORM, CIE-USNC, OSA, SID, and ACM-SIGGRAPH.

Applying Colour Science in Colour Design

Dr. M. Ronnier Luo
University of Leeds
Department of Colour and Polymer Chemistry
University of Leeds, United Kingdom
M.R.Luo@Leeds.ac.uk

Abstract

Although colour science has been widely used in a variety of industries over the years, it has not been fully explored in the field of product design. This paper reviews the recent development of the integration of the advanced colour technologies together with modern colour imaging devices to assist designers for colour design. These developments can be divided into two parts: 1) the computer controlled systems for colour communication, capturing high colour fidelity and high quality images, and measuring total appearance of a product, and 2) the tools for evaluating colour harmony schemes and colour emotion feelings.

Some examples will be given in the design of colour palettes through colour selection by means of a number of widely used colour order systems, the creation of the harmonised colour schemes via a colour harmony model, and the generation of emotion colours using various colour emotional scales.

Biographical Information

M. Ronnier Luo is a Professor of Colour and Imaging Science at the Department of Colour and Polymer Chemistry at the University of Leeds, UK. He was the former Director of the Colour & Imaging Institute at the University of Derby. He received a B.S. degree in fiber technology from the National Taiwan University of Science and Technology, and a Ph.D. degree in color physics from the University of Bradford, UK in 1986. He has numerous publications in the areas of color measurement, color difference, color appearance, and color reproduction. He chairs two Technical Committees of the International Commission on Illumination (CIE): TC1-52 Chromatic Adaptation Transforms and TC8-2 Color Difference Evaluation in Images. He is a Fellow of the Society of Dyers and Colourists and the Society for Imaging Science and Technology. He was also the recipient of the 2003 Royal Photographic Society's Davies Medal and 1994 Bartleson Award for his contribution in the field of color science.

Using Colour to Transmit Information on Electronic Displays

Sharon M. McFadden

Defence R&D Canada – Toronto

Abstract

Colour has always been an important method for coding different classes of information. With the development of products such as geographic information systems, electronic charts, and data mining systems, colour coding has become an even more important tool to aid the interpretation of information. Unlike the presentation of natural images or scenes on electronic media, there is no correct colour representation of the underlying information. Instead, the goal is to ensure that the user is able to quickly and accurately understand the information being presented.

Long before the existence of electronic media, colour was used to code information such as elevation and depth on maps and cartographer then as now went to great effort to ensure that the colour coding was consistent and that the colours were discriminable and easily interpretable by the mariner. The problems faced by early cartographers continue to plague the designers of information displays. In fact, they have become worse. The cartographer of old knew the medium that the map would be displayed on and the set of colours that appeared on the map were fixed at the time of printing. The modern designer of geographic information systems can only guess at the characteristics of the electronic media that will be used to display their maps. The combinations of information sources, maps, overlays, etc., that the user will present simultaneously is limited only by the time and effort available. Hence it is not sufficient to adjust the colours until they 'look right' on the designer's display. Instead, it is necessary to understand how colour appearance can change as a function of the media and the environment, the combination of colours displayed, and the size and shape of the coloured areas, and to choose colours and colour combinations that are resistant to unexpected changes in appearance and visibility.

The presentation will focus on some of the relevant information that must be considered by the designer of colour coding for electronic information displays. Colours must be clearly discriminable and easily identifiable. Use of CIE metrics can support this goal along with the results of recent research on colour naming, chromatic induction and linear separability. To insure consistency across different media, device independent specification of colours is essential. All of these issues will be discussed in the context of our efforts to specify colours for electronic chart displays.

Biographical Information

Mrs. McFadden is a Defence Scientist in the Human Factors Research and Engineering Section of Defence R&D Canada – Toronto. Her background is in experimental psychology and she holds a M.A. in that field as well as B.A. in Mathematics from York University, Toronto, Ontario. At DRDC Toronto, she has been involved in research on human visual and auditory capabilities as they relate to the presentation of information on complex displays. Her recent research has been concerned with the use and specification of colours and symbols on electronic charts and tactical displays, the development of interfaces for decision support systems, and human factors evaluations of new display technology. She is currently Director of Division 1 of the CIE, Vision and Colour.

Brief History of Artists' Colors

Stephen Gritt

National Gallery of Canada
Restoration and Conservation Laboratory
Ottawa, Ontario, Canada K1N 9N4

Abstract

This talk will look at the history of pigment use by painters and artists from the 14th to the late 19th centuries.

Biographical Information

Stephen Gritt is the Chief Conservator at the National Gallery of Canada. He received his BA (Honours) from the University College London, History of Art with Philosophy and studied at the Courtauld Institute of Art, London, DCons CIA, where his thesis was entitled "The Notion of Patina in Paintings". He worked as a Mellon Fellow, then Assistant Conservator at the Philadelphia Museum of Art and as a Lecturer in Conservation and Conservator to the Galleries, Courtauld Institute of Art, before joining the National Gallery of Canada.

Sunday 15:30 – 16:15
Interest Group III-Brainard

Bayesian Models of Color Appearance

Dr. David Brainard
University of Pennsylvania
Recipient of ISCC 2006 Macbeth Award

Abstract

Modeling the relation between the color stimulus and color appearance is challenging. One challenge arises because the relation depends on context – the same spectrum reaching the eye can appear dramatically different depending on what surrounds it. In this talk, I will review work from my lab that seeks to understand how context affects color appearance. The point of departure for the work is the idea that many color context effects are a consequence of the visual system's attempt to stabilize object color appearance across changes of illumination, a phenomenon generally referred to as color constancy. I will emphasize the basic principles of the approach, and show how a Bayesian computational algorithm designed to achieve color constancy can serve as a model for empirical data on how context affects color appearance.

Biographical Information

David H. Brainard is Professor and Chair of Psychology at the University of Pennsylvania. He received his A.B. (Physics) from Harvard University in 1982, and his M.S. (Electrical Engineering) and Ph.D. (Psychology) from Stanford University in 1989. His research interests include human color vision, particularly color constancy, and digital color image processing. Prof. Brainard is the recipient of the 2006 ISCC Macbeth Award for recent outstanding contributions in the field of color. The award recognizes his application of Bayesian methods to problems in color appearance and his role in developing the Psychophysics Toolbox, a free set of tools for vision research.

Getting Brighter: Coloring More Sustainably

Prof. Georgia Kalivas

Adjunct Associate Professor, Textile Development & Marketing
FIT Sustainability Group, Fashion Institute of Technology
georgia_kalivas@fitnyc.edu (work) colourlady@optonline.net (home)
Tel: (212)-217-7143

Abstract

We will look at the various ways we have colored textiles and other substrates in the past and how these methods and colorants have changed and affected us. We will also compare natural versus synthetic and present some of the more environmentally friendly procedures and materials that have been developed plus the effect they may have on future generations.

Biographical Information

Georgia Kalivas is an instructor at the Fashion Institute of Technology (FIT), where she teaches courses in Textile Science with an emphasis on color to students in various majors including fashion merchandising, textile development, art and design. She has worked for Fab Industries where she set up procedures to have lab dips made and evaluated lab dips and at Colortec as a support technician where she assisted in building databases and customer support, training and seminars. Before starting her teaching career, Georgia was a Color Studio Manager, Stylist and Dyer for Colibri Textile Dyeing Studio in Manhattan where she created lab dips.

Georgia's well-rounded color experience in color and lab dips gave her the opportunity to develop a color course, Color Studio: From Principles to Practice for FIT's Center for Professional Studies' Color Specialist certificate program. Previously Ms. Kalivas has served as chairperson and vice chair of ISCC's Interest Group III: Art, Design and Psychology.

Georgia is currently finishing up a Masters Degree program in Adult Education. While working on her thesis she cultivated her newest passion for sustainable development. In line with her presentation, *Getting Brighter: Coloring More Sustainably,* she is also deeply involved with others at FIT planning an upcoming international conference scheduled for April of 2007 to mark FIT's commitment to making sustainability the new cultural paradigm for the college.

Improving Inter-Instrument Agreement through Profiling

Timothy A. Mouw

3100 44th X-Rite Incorporated, Manager – Customer Success Industrial
Street SW, Grandville, MI 49418
616-257-2566 – FAX 616-257-2076 tmouw@xrite.com

Abstract

This paper discusses the need to improve inter-instrument agreement across a population of instruments. This can be achieved through the profiling of the instruments. Topics discussed will include:

- Corporate color programs
- Multi-plant / multi-supplier production
- Global / electronic color standards
- Color matching dis-similar products
- Inherent causes of poor inter-instrument agreement
- Definition of an instrument profile and how it differs from an ICC profile
- Expected improvement and sample data of profiled vs. unprofiled measurements

Biographical Information

Tim Mouw began working with color at the age of 16, as a part time employee of Diamond Vogel Paint. He continued to work there through his high school and college career. Upon finishing school, he was hired by BASF and was a group leader for flush color production for 3 years. He then worked for 10 years in an applications laboratory for pigments in the coatings industry. In 1994, Tim was hired by X-Rite, Incorporated and spent 12 years in the Applications and Training department. In that time, Tim taught over 300 classes in Color Theory, Quality Control, and Formulation to some 4000 students. Tim was recently promoted to the position of Customer Success Manager at X-Rite. His current duties include overseeing technical support to X-Rite's industrial customer base. Tim has had numerous articles published in trade magazines and presented technical papers for NPE, SPE, and FSCT.

A Comparison of Portable and Benchtop Spectrocolorimeters Using the RIT Reproducibility Data

Dr. Danny Rich, Sun Chemical Corporation

Sun Chemical Corporation, Color Research Laboratory
Daniel J. Carlick Technical Center
631 Central Avenue, Carlstadt, New Jersey 07072 USA

Abstract

At the 2005 Special Topics Conference in Scottsdale, AZ sponsored by the ISCC and the IS&T Dave Wyble presented the first results obtained from a new study on spectrocolorimeter performance. The study was carried out during the summer of 2004 as part of a special summer program held on the RIT campus. The details of the study are described in a paper that has been submitted to the journal Color Research & Application. The raw data from that study is being made available to the color community for further study.

In this paper, I compare the performance of the large, benchtop instruments with the performance of small, portable instruments. The results will show that larger instruments tend to perform better than smaller instruments, even when the optical system is similar. The data also provide some insight into the interaction of the instrument geometry with the specimen revealing one source of the lack of inter-instrument agreement in commercial spectrocolorimetry.

Biographical Information

Dr. Rich obtained his Bachelors degree in Physics from the University of Idaho in 1973. He received a Masters degree in Physics in 1977 from Virginia Polytechnic Institute and State University in Blacksburg, Virginia. His research involved laser optics and its application to light scattering experiments. During his studies at VPI&SU he met Dr. Fred W. Billmeyer, Jr. who convinced him to transfer to Rensselaer Polytechnic Institute and work toward a PhD in Color Science. In 1980, he completed his program of studies by defending his dissertation entitled, "The Perception of Moderate Color Differences in Surface-Color Space". He joined the Sherwin-Williams Company in the fall of 1980 where he directed work on optical properties of coatings, process control, computer modeling and statistical experiment design. In the fall of 1984 he became the Manager of Research for Applied Color Systems, Inc. in Princeton, New Jersey where he did research on color simulation, instrument design and optical metrology and calibration.

Monday 9:25-9:50
Interest Group II-Gómez

In-Line Fiber-Optic Color Spectrophotometer for Process Control

Dr. Jaime Gómez

Equitech International

Abstract

Equitech International has developed a robust spectrophotometer that acquires accurate and precise color information in real time directly in the process through the use of a variety of specialized fiber-optic probes. Use of this instrument affords the opportunity for immediate process adjustment to maintain product color, as well as greatly expands knowledge about the behavior of the process over time - something that cannot be done by occasional analysis of samples off-line in the laboratory. Examples of probes and applications in the paints, inks, and plastics industries will be shown.

Biographical Information

Dr. Gómez was appointed Executive Vice President of Equitech International with responsibility for marketing and sales in January 2004. Prior to coming to Equitech, Dr. Gómez was the Vice President of the Pigments Color Solutions Division of Datacolor, a manufacturer of spectrophotometers and software for the measurement of color. Dr. Gómez's education, experience and knowledge in color, plastics and electro-optical instrumentations provide him with the appropriate background to lead Equitech to the commercialization of its technology.

Prior to joining Datacolor, Dr. Gómez was the Director of Strategic Planning & Business Development at Corning OCA, a subsidiary of Corning in California dedicated to the manufacture of electro-optical components for laboratories, space and military applications.

Dr. Gómez initiated his professional life at the R&D laboratories of Union Carbide Corporation in Tarrytown, New York where he conducted research in Silane Coupling Agents and composite materials during several years. Upon completion of his MBA, Dr. Gómez transferred to FMC Corporation where he worked as an International Business Development Manager for the Agricultural Products Division before joining Corning.

Dr. Gómez, a native from Colombia, has a BS in Chemical Engineering from Universidad Pontificia Bolivariana in Medellín, Colombia, and MS in Organic Chemistry and a PhD in Polymer Science from the University of Connecticut. Dr. Gómez received an MBA from New York University in Marketing and International Business & Finance.

Monday 9:50-10:15
Interest Group II-Battle

10:15 - 10:45 Refreshment break
NRC Council Chambers

Reliable Digital Workflow

Dr. David Battle, GretagMacbeth

Abstract

This paper discusses some of the recent enhancements to NetProfiler and the technology of profiling instruments. It has now become the heart of a reliable digital workflow providing confidence in the reliability of color measurements throughout the global supply chain. This increase in confidence is achieved by ensuring that instruments meet established performance specifications as well as identifying data that has been successfully profiled.

Biographical Information

Dave Battle is Director of Hardware Engineering for GretagMacbeth. He has been with GretagMacbeth for 4 years leading a team of engineers developing Color Measurement Spectrophotometers from their Research Triangle Park facility in North Carolina. Dave has been working in the color measurement industry for 27 years starting with Instrumental Color Systems in England. In 1992 Dave relocated to the US to lead instrument development for Datacolor. He has a B.S. in Electronics from the University of Kent at Canterbury, an MBA from Temple University in Philadelphia and is a member of the board of directors of the ISCC.

To Profile or Not to Profile: The User's Question

Chuck McLellan, Datacolor

Chuck McLellan, Alan Ingleson, Dan Randall, and Michael H. Brill, Datacolor

Abstract

To profile a color-measuring or color-producing device means to quantify its input-output relationships. In spectrophotometry, profiling is used to effect instrument correction---whereby a spectrophotometer is characterized parametrically and corrected to measure like a reference instrument by software and a series of reflectance standards. Such profile-based correction (PBC) has been discussed for a long time (e.g., by R. Berns and K. Peterson, and by D. Rich and D. Martin). It is time to look at the question of when instruments *should* be profiled for correction.

Profile-based correction has limitations. It can compensate instrument malfunction due to changes in wavelength scale, bandwidth, or gain. However, it will not fix optical alignment or bad pixels. Also, it cannot correct, e.g., the numerical noise due to wavelength error (from mismatch between the sample and reference signals.) Also, PBC cannot fix the following typical symptoms of aging spectrophotometers: dirty/dusty optics; stained/hazy filters and lenses; degraded spheres and specular ports; light-source degradation; and imprecise sample mounting. Finally, a corrected spectrophotometer may lose traceability if its native data are unavailable, especially if the reference instrument is un-traceable. Despite the fact that all of color management is based on the philosophy implicit in PBC, the tolerances of industrial spectrophotometry are much tighter than in such worlds as ICC---too tight to permit digital vagaries.

Profiling a spectrophotometer may be useful in diagnosis, and such diagnosis entails a threefold decision: Do nothing (if the performance is good), service the instrument (if its performance is bad), or perform software correction using PBC. That decision should depend not only on the mean ΔE error, but also on the specimens for which the error occurs. Chromatic colors with $\Delta E > 0.5$ can still support PBC, but neutral colors that are off by as little as 0.1 ΔE in the presence of much lower error on the white tile indicate un-fixable errors (e.g. stray light, sample-to-reference cross-talk, gloss/sphere problems, sample-mounting/ aperture-size problems and translucency problems.) Because of the above risks, it is important not to perform PBC on instruments that are performing too well or too poorly. To inform customers of when PBC is appropriate, a test of the candidate algorithm (in conjunction with its implied reference instrument) is needed now that PBC has become more popular than ever.

The present paper will reveal a test plan for determining the native ΔE range within which a PBC can be effective for a particular industry. The plan includes the following:
(1) Select a set of specimens appropriate for an industry of concern (such as textiles).
(2) Select a set of spectrophotometers in various typical states of departure from the reference instrument (either due to drift or due to difference of manufacturer). Make sure some chromatic and achromatic ΔE values exceed respective thresholds so as to find the upper limits of PBC viability.
(3) Adhere to a uniform protocol for measuring the specimens (e.g., rotate a woven-textile specimen through four right angles, remounting it each time).
(4) Identify the reference instrument and document its traceability to a standard.
(5) For each measurement, save its native value and its PBC value, and compare the ΔE values from the reference instrument thereto appertaining.

Responsible use of profile-based correction depends on tests such as are described here.

Biographical Information of Presenting Author

Charles McLellan is the Manager of Hardware Engineering at Datacolor in Lawrenceville, NJ. After obtaining his BSEE in Rochester Institute of Technology, he joined Eastman Kodak, where he contributed to and led various efforts in film scanner technology until he joined Datacolor in 2005. Early in his Kodak career, as a research scientist, he created unique CCD processing circuitry and transferred the designs to production. While a group leader at Kodak, he transferred technology to photo CD and graphics film scanners, managed a software development team, obtained a US patent for an analog signal processor for electronic imaging systems, and received Kodak's C. E. K. Mees Award for Scientific Excellence. As the Chief Engineer for the Wholesale Scanner, he enabled development of the world's fastest high-resolution film scanner. As Chief Engineer for the Film Processor System, he integrated a technical development team acquired from ASF with Rochester based manufacturing and image-science teams. Throughout his career, Mr. McLellan has met color-science challenges in achieving engineering goals.

Monday 11:10-11:35

Interest Group II-Koger

On-line, Non-contact Color Measurement Solutions

Frank Koger, X-Rite Inc.

Lead applications Specialist, X-Rite, Inc. 44th Street SW, Grandville, MI 49418
Tel: 888-826-3042 Fax: 616-534-7722 E-mail: frkoger@xrite.com
Website: www.xrite.com Help Desk: CASupport@xrite.com
Customer Success, Industrial, 3100 *measureitrite.com*

Abstract

This paper will provide a basic overview and brief discussion of today's choices in the on-line instrumentation market, their use and field applications. This introduction will combine some color theory, color physics, instrumentation design and geometry into a workable and easy-to-understand document. I will start by putting the instruments into three technology categories: 1) Digital, 2) Colorimeters and 3) Spectrophotometers.

Biographical Information

Frank has been working in the color industry for over 20 years. He has 20 years experience working with the Paint, Plastic and Textile industries training and consulting in the field of color theory, spectrophotometery, and computerized color formulation. In addition, he has 12 years with X-Rite Inc. holding a position as a Senior/Lead Applications Specialist currently working with industrial and non-contact instrumentation. Frank holds a BS/BM Bachelor of Science degree in Business Management and is a current member of AATCC, DCC, ISCC, and SPE.

Monday 11:35-12:00
Interest Group II, Snavely

Monday 12:00 – 13:00 Lunch
NRC Council Chambers

The New Realities of Color Measurement and Visualization

Randy Snavely
Business Manager of Color Services
Ciba Specialty Chemicals

Abstract

This paper is designed to show the technical advances the newest tools available to the market to better capture Color from the feasibility, formulation, visual rendering and physical makeup. This includes software, spectros and Internet tools available to the market. The presentation will include real models and demonstration of the tools.

Biographical Information

Randy Snavely has over 25 years in the chemical and coatings industry and is currently the Business Manger of NAFTA for the Color Services Group within Ciba Specialty Chemicals. Prior to that he was the Vice President of Sales for BYK Gardner. Mr. Snavely holds a BS in Economics from SE Missouri Sate University and a MBA from Baldwin-Wallace College.

Ten Commandments for Standardized Model Making

Dr. Michael H. Brill
Principal Color Scientist at Datacolor/ColorVision
Lawrenceville, NJ

Abstract

With apologies to Cal McCamy (*Color Res. Appl.* Vol. **10** [1985], p. 23), this note presents modeling rules and violations of them in existing color-and-lighting standards.

BEFORE MAKING THE MODEL

1. Decide clearly what question you intend to answer. [Counter Case: The CIE Color Rendering Index is maximal for any blackbody radiator, but we wanted an index whose value can exceed that of a blackbody spectrum. Also, not all blackbody radiators should have the same CRI.]
2. Have in mind (and describe) tests of your model that would allow you to falsify it if it were wrong. [Counter Case: any of the CIE Color Appearance Models (CIECAMs), which have nine model outputs for each color, and no protocol to test or even consistently to describe these outputs. And how can a subject differentiate a CAT02 match from a CIECAM02 match?]
3. Never recommend more than one model at a time without differentiating their application domains, lest a user view differences among the model predictions as a precision intended for each. [Counter Case: CIELAB versus CIELUV, both advanced in 1976 at the same CIE meeting.]

WHEN MAKING THE MODEL

4. If the ordering of mechanisms underlying a model is known, do not invert the ordering, at least without a clearly stated reason. [Counter Case: The CIECAMs perform Von Kries chromatic adaptation (supposed to be the second stage of processing) in one tristimulus basis, and then transform back to the Hunt, Pointer, Estevez (HPE) basis---the space of the cone fundamentals, where the processing is supposed to *begin*.]
5. Make sure your model doesn't give nonsense predictions upon crossing an arbitrary threshold. [Counter Case: In CIECAM02, the coordinates of white caused by some illuminants can cause division by zero in any of the sharpened Von Kries responses as well as in lightness J. Also, intense blue adaptation drives asymmetric matches outside the HPE triangle, where the signs of the coordinates change and the subsequent nonlinearity has infinite slope. This last pathology is a symptom of having failed to follow (4) above!]
6. Take care not to introduce artificial and ineradicable discontinuities into your model, lest it hang up an optimizer. [Counter Case: In CIE DE2000, Gaurav Sharma found three ineradicable discontinuities. In contrast, CIELAB's L* discontinuity is eradicated by increasing precision.]
7. Verify the required mathematical properties of your constructs. [Counter Case: The Judd-MacAdam-Wyszecki principal-component eigenvectors of daylight spectra aren't

orthogonal to each other. All current CIE standard daylight spectra depend on these eigenvectors.]

8. Arrange your terminology so as not to mislead. [Counter Cases: In CIE94 and CMC, ΔH is not the delta of any coordinate H; also, in CMC(l:c), c must be unity to obtain sane results, but the user is misled into thinking c is an adjustable parameter.]

AFTER MAKING THE MODEL

9. When science advances, make your standard follow in a reasonable time. [Counter Case: CIE 1931 color-matching functions were corrected by Judd in 1951, whereupon a movement to change the CIE cmfs should have been underway. Here we are, 54 years later, with standard color-matching functions that are eschewed by the vision-research community. Shame on us.]
10. Be slow to tout the generality of your model. [Counter Case: CIECAMs have been touted as universally applicable, but they don't apply to a monochrome display in a dark surround---for which a white point is undefined by any CIECAM. The slack has been taken up by ATIS/CVO: "Human Factors Design Guidelines for Advanced Traveler Information Systems (ATIS) and Commercial Vehicle Operations (CVO)", FHWA-RD-98-057, Chapter 3. See also http://www.tongji.edu.cn/~yangdy/atis/ch03/ch03_11.html.]

Biographical Information

Michael H. Brill is the Principal Color Scientist at Datacolor/ColorVision in Lawrenceville, NJ. Since obtaining his Ph.D. in physics at Syracuse University, he has carried out extensive theoretical research in color in human and computer vision, in geometric/photometric invariance, and in physics-based vision. He is co-inventor of the Emmy-Award-Winning Sarnoff vision model. Dr. Brill is also a Past President of the Inter-Society Color Council, and author of more than 80 refereed technical publications, 10 U.S. patents, numerous national standards, and a SID test pattern. He has chaired or co-chaired four conferences on color technology, vision, and digital display. In addition, he obtained the 1996 Macbeth Award from the ISCC for his work on color constancy. Dr. Brill is a member of the Editorial Board of Color Research and Application, and chairs ASTM Subcommittee E12.04 (Color and Appearance Analysis) and also CIE Technical Committee TC1-56 (Improved Color Matching Functions).

Monday 13:30-14:00

Interest Group I - Zwinkels

Standardized Procedures for Improving Absolute Color Measurements

J.C. Zwinkels and M. Noël
National Research Council of Canada
Institute for National Measurement Standards, Ottawa, Ontario K1A 0R6

Abstract

The repeatability of instrumental color measurements has improved dramatically over the past decade where color difference errors of 0.003 ΔE CIELAB units are now achievable. However, the overall accuracy of these measurements has lagged far behind the best current measurement capabilities of 0.1 ΔE CIELAB units. The problem is that absolute measurements require the transfer of absolute color scales via transfer standards and transfer instruments. The uncertainty in the absolute color measurement is thus limited by several factors including differences in national scales of reflectance and transmittance, lack of proper traceability and quality assurance, non-ideal transfer standards and non-ideal transfer instruments. Standards and standard methods are well-known for many of the sources of instrumental error, such as wavelength shifts, detector nonlinearity and isochromatic stray light. However, there are several less well-understood sources of error that limit the overall accuracy of color measurements and their calibration has not been standardized. These error sources include sample recess, sphere efficiency, heterochromatic stray light, bandpass effects and even the methods that are used for data acquisition and colorimetric analysis. These errors are more difficult to diagnose and to rigorously specify since they are inter-dependent on other effects, such as instrument geometry, sample-instrument interaction, or operating conditions. This paper will discuss the standard calibration procedures and standards used at the National Research Council of Canada (NRC) to test and correct for these less well-known error sources that limit the accuracy of absolute color measurements.

Biographical Information of Presenting Author

Joanne Zwinkels is a Senior Research Officer with the Institute for National Measurement Standards, National Research Council of Canada (NRC). She obtained her PhD in Physical Chemistry from the University of Alberta (1983) and joined NRC in 1984, to work in the fields of spectrophotometry and gloss and. Since1991, she has also been the Head of the Photometry and Radiometry Group. Her principal research activities involve the development of new instrumentation, procedures, and reference standards for high-accuracy spectrophotometry, spectrofluorimetry and measurement of color and appearance attributes, such as gloss. She is active in standards organizations and committees, such as CCPR, CIE and ISO, and professional societies such as ISCC, CORM and OSA. She is the current President of the ISCC, Canadian delegate to the CCPR, the NRC liaison to CORM, the Vice President of the Canadian National Committee of the CIE, the Canadian member for CIE Division 2, and Chair of a CIE technical committee on fluorescence measurements.

Recent Developments of the NIST Five-Axis Goniospectrometer

Maria E. Nadal, Robert Bousquet, Gael Obein*, and Vyacheslav Podobedov

Optical Technology Division
National Institute of Standard and Technology
Gaithersburg, MD 20899-8442

Abstract

Recently, the reference colorimeter at the National Institute of Standards and Technology (NIST) has been modified to measure the spectral reflectance of non-fluorescent colored samples over all combinations of illumination and viewing angles, which is important for the colorimetric characterization of complex surfaces, such as gonio-apparent coatings or retroreflective surfaces. Presented is the new five-axis goniometer developed at NIST, which allows the measurement of the complete bi-directional reflectance distribution function (BRDF) for colored surfaces with the objective of differentiating between the scattering mechanisms in the coating. The basic setup of the instrument is a source-monochromator, a sample goniometer that rotates the sample about three different axes and one translation stage, allowing illumination of the sample from any direction within the hemisphere about the sample. A single-element diode is located on a rotation stage and is used to select the viewing angle. To validate the five-axis goniospectrometer, a comparison with the NIST Spectral Tri-function Reference Reflectometer (STARR) is been carried out. A white diffuser was measured on both instruments at a wavelength of 550 nm with unpolarized light for three different directions of illumination (0°, 30° and 60°) and viewing directions from -80° to 80° at 5° increments. The two instruments agree to within 0.5 %. In our current setup, we measure the BRDF at each wavelength for each measurement geometry. Such measurements are time consuming, creating higher cost for the calibration service, and decreasing the lifetime of the instrument. Recently, a fiber-coupled CCD with a white illumination source has been added to the five-axis goniometer. Unlike the scanning systems, the array spectrometer measures the entire spectrum simultaneously, dramatically decreasing the measurement time. Preliminary measurements to validate this system will be presented. This project will establish the foundation of a BRDF database containing a selected number of materials.

* CNAM – INM, 61 rue du Landy, 93210 La plaine saint Denis

Biographical Information of Presenting Author

Maria E. Nadal is currently involved with spectrophotometric measurements in the Optical Technology Division at NIST. Her primary areas of research are color and appearance. She is involved in developing new calibration services and standard reference materials for color and appearance attributes, including research in the goniochromatic attributes of special effect coatings. She received her Ph.D. in Physical Chemistry from the University of Colorado at Boulder in 1996. In 1997, she joined NIST's efforts in spectrophotometry. She is an active member of ASTM, ISCC, and CORM.

Monday 14:30-15:10
Refreshment Break
Poster Presentation-Richter

CIELAB Definition and Application of Device Independent *rgb** Colour Coordinates for Output of Elementary Colors

Prof. Dr. Klaus Richter, BAM
BAM and TU Berlin, Federal Institute for Materials Research and Testing (BAM), VIII.1
Unter den Eichen 87, D-12205 Berlin, Tel. +49 30 8104 1834; Fax +49 30 8104 1807
Version1.0E: 2006-04-06 klaus.richter@bam.de www.ps.bam.de
For a web version: www.ps.bam.de/ISCC06.PDF

Elementary Colours

The elementary colours Red (R) and Green (G) within a hue circle are both defined as neither yellowish nor bluish by visual assessment. Similar the elementary colours Blue (B) and Yellow (J= Jeane according to ISO/IEC 15775) are both defined by the criteria neither reddish nor greenish. For example the Swedish Natural Colour System (NCS) is based on the four elementary colours RJGB determined by many observers. The NCS hue circle shows the colours R – G and J – B on the horizontal and vertical axis. In the Munsell colour order system the four elementary hues RJGB correspond to the Munsell hue names 5R, 5Y, 5R and 5PB. The "strong" chromatic CIE-test colours no. 9 to 12 have been chosen from approximately these four elementary hues. The four CIE-test colours have the CIELAB hue angles $h_{ab,}$ 25, 92, 162 and 272.

User requirement for elementary colour coordinates and output

Up to now in image technology device specific or defined *rgb* colour data, for example interpreted as *sRGB* or *Adobe RGB* colour data, are used. The standard colour data are (1,0,0) for red, (0,1,0) for green, and (0,1,0) for blue. Instead of the elementary hues these standard data produce on devices usually very different hues and the colour hues appear usually yellowish red, yellowish green, and reddish blue. Therefore the hues of the output colour are called Orange-Red (O), Leaf-Green (L) and Violet-Blue (V), for example according to ISO/IEC 15775:1999 and ISO/IEC TR 24705:2005. The data called *olv* data for both the standard offset printing and the television process. However, most of the users require in application *olv* data interpreted as *rgb** data with the following properties: The equal or equally spaced *olv* data in the output file shall be interpreted as *rgb** data and shall produce

1. output of the same hue on different devices for standard input data (1,0,0), (1,1,0), (0,1,0).
2. output of the four elementary hues RJGB for standard input data (1,0,0), (1,1,0), (0,1,0) and (0,0,1).
3. output equally spaced in CIELAB for equally spaced *rgb* data.

CIELAB definition of *rgb colour coordinates for elementary hues.**

In image technology the four *olv* colour data (1,0,0), (1,1,0), (0,1,0), (0,0,1) interpreted as *sRGB* or Adobe RGB data produce the three colours OYLV (Orange-Red, Yellow, Leaf-Green and Violet-Blue) with CIELAB hue angles 35, 103, 137 and 304 on a standard screen. However the four elementary hues RJGB have approximately the different hue angles 25, 92, 162, 272 in CIELAB. The CIE-test colours no. 9 to 12 according to CIE-Publ. 13.3 are representatives of the four elementary hues. If additionally the device is linearized according to ISO/IEC 19797:2004 then the output is equally spaced in CIELAB, for example for the 16 step colour series between White and the elementary Red (R).

Application: *olv* data in the file and interpreted as *olv or rgb* data for device output**

Two PDF files with *olv* data and interpreted as *olv** data produce monitor or printer output in 10 hue planes for the three basic colours (OLV), the three mixed colours (CMY), and for the four elementary colours (RJGB). For a display with the standard television colours (see ISO/IEC TR 24705:2005) the output of the PDF-file (10 pages, 350 Kbytes) *www.ps.bam.de/NE09/10L/L09E00NP.PDF* produces the television device colours on pages numbers 1 to 6 and the four elementary colours of the four CIE-test colours on the page numbers 7 to 10 all equally spaced in CIELAB for the 3 step series for example between White and Cyan C on page number 4. In a similar PDF file the o*lv* data interpreted *rgb** data produce the colours R, J, G, G50B, B, and B50R of the NCS system on pages 1 to 6 and the hues of the four CIE-test colours on pages 7 to 10. *www.ps.bam.de/TE09/10L/L09E00NP.PDF* In all example files the *olv* data interpreted as *olv** or *rgb** data and the CIELAB data are on the output pages. For different layouts and up to 16 step colour series for example between White and Orange Red (O) or Red (R) see *www.ps.bam.de/NE.HTM* . Printer outputs with equally spaced colours in CIELAB for device and elementary hues will be shown at the poster.

Biographical Information

Klaus Richter earned a PhD in Physics and Colour metrics, University of Basel (Switzerland), 1969). He has published many papers in CIE documents since 1970, including Cube root color spaces and chromatic adaptation, CR&A, **5**: 25-43, 1980; *Computer graphics and colorimetry, Color systems, PostScript and device independent CIE colors,* VDE-Verlag, 1995, 288 pages (in German). He is chairman of CIE TC1-63 , Validity of CIEDE2000, and editor of standard documents in image technology: ISO/IEC 15775:1999 (Colour copiers), ISO/IEC 19752:2004 (Output linearization of devices), ISO/IEC 24705:2005 (Specification of image reproduction properties using ISO/IEC-test charts). Dr. Richter is the liaison officer in ISO/SCIT, CIE Division 1 and 8, ISO/IEC JTC1/SC28, ISO TC42. He has taught color metrics and computer graphics at the Technical University of Berlin, since 1972.

Comparison of Methods of Parameric Decomposition for Evaluating Metamerism

Zhaojian Li and Roy S. Berns
Munsell Color Science Laboratory
Chester F. Carlson Center for Imaging Science
Rochester Institute of Technology, Rochester, New York (USA)

Abstract

Based on Wyszecki's hypothesis and its application to quantifying metamerism as described by Fairman, parameric decomposition is a technique to adjust one spectrum of a parameric match in order to achieve a perfect (metameric) match under a specific illumination and observer condition [1]. This method can be viewed as batch correction using three "colorants" where the color-mixing model is linear in reflectance [2]. This paper will present these methods using the basis functions from the CIE color-matching functions as well as alterative basis functions derived from dimensionality reductions techniques such as principal component analysis and independent component analysis for a pre-defined spectral dataset. 1232 parameric pairs surrounding 25 color centers were synthesized using an automotive finish paint system and two-constant Kubelka-Munk turbid-media theory. Each parameric pair was corrected to a metameric pair using these various methods. The corrected spectra are compared with the formulated spectra using Kubelka-Munk theory to evaluate the parameric decomposition accuracy.

[1] H Fairman, Metameric correction using parameric decomposition, Color Res Appl 1987; 12:261-265.
[2] RS Berns, CJ Hawkyard. Synthetic reflectance curves. J Soc Dyers Colour 1994; 110:386-389.

Biographical Information of Presenting Author

Zhaojian Li received his B. S. degree in Physics from Central University for Nationalities, China in 2001 and his M. S. degree in Optical Engineering from Beijing Institute of Technology, China in 2004. Now he is a second year M. S. student in color science in the Munsell Color Science Laboratory at Rochester Institute of Technology.

Comparison of Methods for Verifying the Accuracy of Color-Measuring Instruments

David R. Wyble
Munsell Color Science Laboratory, Rochester Institute of Technology, Rochester, NY

Abstract

A recent ASTM specification, E2214-02 *Standard Practice for Specifying and Verifying the Performance of Color-Measuring Instruments* was created to standardize the terminology and procedures used to evaluate color measurement instruments. The paper will focus on methods for verifying the accuracy of such instruments. The analyses are based on a large scale measurement project conducted at the Munsell Color Science Laboratory in 2004. Measurements were made on eight commercially available spectrophotometers. These measurements included calibrated neutral tiles to evaluate photometric linearity, rare earth samples to evaluate the wavelength scale, and black traps to evaluate the black level. These samples were selected and the measurement techniques were conducted using E2214 as a guideline. The overall goal of the work is to analyze the *methods* recommended in E2214. The reporting of the accuracy performance of our specific set of instruments is secondary.

Experimental Details

The specific measurements included the following samples:

- Five neutral ceramic tiles (BCRA CCS-II™)
- One holmium and one erbium rare earth reflectance standards
- One black trap, either the instrument's own, or another suitable one

The set of devices included four benchtop hemispherical instruments and four hand held hemispherical instruments. The standards were calibrated at high-accuracy laboratories using hemispherical geometry, specular included mode.

Analysis Details

ASTM E2214 recommends separating the analyses of wavelength scale and radiometric scale. To analyze the radiometric scale, the spectral reflectance of each neutral tile is measured, and CIE Y values are calculated from that measured data and the calibration data. These data are plotted against one another and a series of linear fits are made. E2214 specifies that a linear fit be performed between each measurement point, yielding four fits for our five measured tiles. The percentage difference between the fit slope and ideal (unity slope) represents the photometric linearity analysis.

For wavelength scale analysis, E2214 recommends following ASTM E1164, *Standard Practice for Obtaining Spectrophotometric Data for Object-Color Evaluation*. E1164 in turn recommends several procedures. One of them: NBS Special Publication 260-66

Didymium Glass Filters for Calibrating the Wavelength Scale of Spectrophotometers, will be applied here. NBS 260-66 recommends the use of a series of inflection points found between the peaks and troughs in didymium transmittance. The rare earth erbium and holmium standards have similar reflectance properties. The steep inflection points should provide a bandpass-independent point to which the NBS analysis can be applied. That analysis is to perform a quadratic fit to correct the positions of the wavelengths of the inflection points in the measured data.

As a means of comparison, another technique will be presented that simultaneously evaluates bandpass shape and the wavelength scale. This technique relies on the location of the peaks and/or troughs and therefore may be bandpass dependent.

Conclusion

The application and explanation of E2214 accuracy methods will be shown. The techniques will be applied to a dataset from eight commercial spectrophotometers. The emphasis of this talk is on the utility of that specification, not on the actual accuracy performance of a particular set of instruments.

Biographical Information

Dave Wyble is a Color Scientist in the Munsell Color Science Laboratory, at Rochester Institute of Technology. His research interests center around color measurement instrumentation, its evaluation, and its application to device characterization. He is a member of IS&T, and active in CORM and ISCC. He received an MS degree in Color Science from RIT in 1998.

The Color of Retroreflective Pavement Markings

Cameron Miller
National Institute of Standards and Technology
Gaithersburg, MD
Fuat Atkan and Tom Schnell
University of Iowa
Iowa City, Iowa

Abstract

Pavement markings are by far the most widely used traffic control device on the roadways. They convey essential information to the motorists in a continuous fashion, without any need to look away from the roadway. Pavement markings may appear yellow during daytime but may not appear as yellow at night under automobile headlamp illumination. When lead was removed from yellow thermoplastic pavement marking pigments, it was found that some of the replacement materials appeared to be almost white at night. Since the color of the pavement markings conveys significant information related to the direction of traffic, it is important that they can be clearly distinguished both during day and night. The National Cooperative Highway Research Program developed Project 05-18, "Color Effectiveness of Yellow Pavement Marking Materials" to determine the characteristics of an effective yellow line and how to measure the properties of the material.

The University of Iowa team designed and conducted three experiments to address the human factors facet of the project. The first experiment investigated the color classification of young and older participants in a color booth furnished with a CIE standard D65 and an incandescent (near-Illuminant A) illuminant, through which the daytime and nighttime conditions were simulated, respectively. The second experiment was conducted in the laboratory with a large-size back-projection screen, where a straight and level two-way roadway with continuous yellow pavement markings with varying chromaticity was simulated. The third experiment was conducted in the field using four thermoplastic and one latex paint type pavement markings. Three of the four thermoplastic markings were tailored in their spectral reflectivity only by varying their respective titanium dioxide contents. The samples were viewed under tungsten-halogen and high-intensity gas discharge headlamp illumination. Participants were asked to classify each pavement marking stripe as either yellow or white. Each stimulus used in the experiments listed above was meticulously characterized at the Center for High Accuracy Retroreflection Measurements facility at the National Institute of Standards and Technology, in terms of its spectral and spatial retroreflectivity. Several experiment were performed to characterize the materials including testing how the chromaticity coordinates change over a range of viewing geometries and how the chromaticity coordinates change over a range of distances using the same viewing geometry.

This presentation will discuss the results of the human factor experiments, the quirky color characteristics of retroreflective marking material and the next step in understanding the appearance of color under different levels of illumination.

Biographical Information of Presenting Author

Cameron Miller received his Masters and Ph.D. in Physical Chemistry (1994) from Cornell University. He worked as a Post Doc at The NSF Center for Photo induced Charge Transfer at the University of Rochester and then as a NRC Post Doc at NIST. He has been a research chemist in the Optical Technology Division of NIST since 1998 and is the Photometry Project leader working on various projects from photometric calibrations and scale realizations, LED characterization and calibration and the NIST Center for High Accuracy Retroreflection Measurements.

16:40-16:45 Closing Remarks, Joanne Zwinkels, Meeting Chairman

The Inter-Society Color Council

wishes to thank you for

attending our Annual Meeting

and sharing in our celebration of

our 75th Anniversary!

ISCC/CIE Expert Symposium

75 Years of the
CIE Standard Colorimetric Observer

The year 2006 marks the 75th Anniversary of the CIE 1931 Standard Colorimetric Observer. It seems an opportune time to reflect on all that has been accomplished in the area of colorimetry, the current status of our understanding, and to provide guidance to CIE Division 1 on what work they should undertake in the future in the area of colorimetry. Thus, the Inter-Society Color Council (ISCC) and the Canadian National Committee of the Commission Internationale de l'Eclairage (CNC/CIE) are hosting a CIE Expert Symposium in celebration of this very important 75th Anniversary.

By general consent in all countries the specification of basic standards for use in colorimetry is the province of the CIE. The CIE made the first major recommendations regarding colorimetric standards in 1931 by approving the Standard Colorimetric Observer. These recommendations formed the basis of modern colorimetry.

The original recommendations of 1931 were reviewed from time to time by the CIE Colorimetry Committee and later by CIE Division 1, Vision and Colour. When necessary, changes were made. New recommendations were added to supplement the existing ones or to broaden the scope of colorimetry in accordance with developments in practice and science. The most recent summary of these recommendations can be found in the 3rd edition of CIE Publication 15, Colorimetry, published in 2004.

Currently, Division 1, through TC 1-57, is preparing standards on key aspects of the CIE recommendations on colorimetry. Recent years have seen tremendous strides in the development of colour appearance models. These go beyond the specification of colour in a three dimensional colour space to take account of the influence of factors such as ambient illumination and surround on perception of colour. The advent of a wide range of imaging technology and light sources has also given rise to many new issues.

Program Schedule

Monday, 15 May 2006

17:00 – 19:00 *Reception at the Sheraton Ottawa Hotel*

Tuesday, 16 May 2006

07:30 & 07:45 Bus transportation from hotel to NRC Sussex
08:00 - 09:00 *Registration & continental breakfast*
09:00 - 09:05 Welcoming address
09:05 - 09:10 Opening remarks

SESSION 1: Standard Observers
Chair: Michael Pointer
09:10 - 09:45 Origins and history of the Standard Observers, *Françoise Viénot*
09:45 - 10:20 Open problems on the validity of Grassmann's Laws, *Michael H. Brill*

10:20 - 10:45 *Refreshment break*

SESSION 2: Colour Matching Functions
Chair: János Schanda
10:45 - 11:20 Physiologically-based colour matching functions, *Andrew Stockman and Lindsay T. Sharpe*
11:20 - 11:40 Colour matching based on fundamental spectral sensitivity functions, *Péter Csuti*
11:40 – 12:00 Individual difference of color matching functions and its cause, *Y. Nakano, Y. Nakayasu, H. Morita, K. Suehara, J. Kohda and T. Yano*
12:00 - 12:20 Test of the transformation of primary space: forward- and inverse-matrix methods, *Boris Oicherman, Ronnier Luo and Alan Robertson*
12:20 - 12:40 Studies on colorimetry, the Stiles-Crawford Effects I & II, and fiber optics properties in the laboratory of W.S. Stiles at the NPL, Teddington, *Jay M. Enoch*

12:40 - 13:40 *Lunch*

SESSION 3: Instruments and Standards
Chair: Ronnier Luo
13:40 - 14:15 CIE recommendations and standards on colorimetry, what next, *János Schanda*
14:15 - 14:35 A new method for calibrating colorimeters, *Maria Luisa Rastello*
14:35 - 14:55 Development of the NIST detector-based color temperature scale, *George Eppeldauer and Yoshi Ohno*
14:55 - 15:15 Full 3D BSDF spectroradiometer, *F. Leloup, T. De Waele, P. Hansalaer and M. Pointer*

15:15 - 15:35 An active vision system for 3D surface colour measurements, *A. Balsamo, A. Chimienti, P. Grattoni, R. Nerino, G. Pettiti, M.L. Rastello and M. Spertino*

15:35 - 16:00 *Refreshment break*

SESSION 4: Temporal and Spatial Issues
Chair: Hirohisa Yaguchi

16:00 - 16:20 Spatial and chromatic properties of negative afterimages, *L. Beke, Györe, A. Lénár and P. Bodrogi*
16:20 - 16:40 Additive colour mixing model based on human color vision, *Takako Nonaka, Morimasa Matsuda and Tomohiro Hase*

SESSION 5: Miscellaneous
Chair: Robert Buckley

16:40 - 17:00 The colour of the Canadian flag, *Alan R. Robertson*

17:05 & 17:20 Bus transportation to hotel
18:00 & 18:20 Bus transportation from hotel to Canadian Museum of Civilization
18:15 - 19:00 *Cash bar*
19:00 - 21:00 *Banquet*
21:30 Bus transportation to hotel

Wednesday, 17 May 2006

07:30 & 07:45 Bus transportation from hotel
08:00 - 09:00 *Continental breakfast*

SESSION 6: Colour Appearance 1
Chair: Todd Newman

09:00 - 09:35 CIE colour appearance models: their past and future, *Robert W.G. Hunt*
09:35 - 10:10 Color appearance in image displays, *Mark D. Fairchild*
10:10 - 10:30 Color appearance of aged observers, *Gábor Kutas, Youngshin Kwak, Peter Bodrogi, Du-Sik Park, Seong-Deok Lee, Heui-Keun Choh and Chang-Yeong Kim*

10:30 - 11:00 *Refreshment break*

SESSION 7: Colour Appearance 2
Chair: Françoise Vienot

11:00 - 11:20 Standards for color legibility, *Thomy Nilsson*
11:20 - 11:40 Scaling of comfort for a colored scene and development of a colour comfort meter, *Ken Sagawa, Soichi Takazawa, Tatsuo Saito and Toshikazu Doi*
11:40 - 12:00 Span of colors similarities of the low vision, *Nana Itoh and Ken Sagawa*

12:00 - 13:30	**POSTER SESSION:**
	Pick up a Gourmet Lunch Box in the Library and Speak to the Presenters
	Conspicuity of blinking LED lights with various temporal frequency and duty ratio, *Miyoshi Ayama, Takanobu Fujama, Hitomi Fujii, Gennji Yanamoto, Norihiro Ikeda and Masanori Nagata*
	Local contrast for no-reference colour quality assessment, *B. Bringier, N. Richard and C. Fernandez-Maloigne*
	Mathematical properties of the RGB chromaticity diagram inconsistent with the three-cone theories of color vision, *Vitaly V. Gavrik*
	Trials on integrating spatial information in color appearance models, *Mohamed-Chaker Larabi, Olivier Tulet and Christine Fernandez-Maloigne*
	Intransitive colour matching and metamerism, *Alexander D. Logvinenko*
	Device dependent linear relative CIELAB data lab* and colorimetric data for corresponding colour input and output on monitors and printers, *Klaus Richter*
	The colorimetric capability developed at NIM-Romania, *Mihai Simionescu and Amadeu Seucan*
	About a method to predict M-cone and L-cone photopigments from colour-matching functions, *Françoise Viénot*
	SESSION 8: Colour differences
	Chair: Joanne Zwinkels
13:30 - 14:05	Colour difference formulae: past, present and future, *M. Ronnier Luo*
14:05 - 14:25	Evaluation of color difference formulae for color rendering metrics, *Wendy Davis and Yoshi Ohno*
14:25 - 14:45	Color matching functions for a perceptually uniform RGB space, *Joanna Marguier and Sabine Süsstrunk*
14:45 - 15:05	Looking for potential indicators of human tetrachromacy, *Zoltán Jakab and Klára Wenzel*
15:05 - 15:25	Establishing the statistical limits of "normal" chromatic sensitivity, *John L. Barbur, Marisa Rodriguez-Carmona and Alister Harlow*
15:25 - 15:50	*Refreshment break*
	SESSION 9: Colour Management
	Chair: Mark Fairchild
15:50 - 16:25	Color Management: Issues and Challenges – A Virtual Roundtable, *Robert Buckley, Geoffrey Woolfe, Jack Holm, and Craig Revie*
	SESSION 10: Conclusions
	Chair: Sharon McFadden
16:25 - 17:15	Roundtable discussion
17:15 - 17:30	Closing remarks
17:35 & 17:50	Bus transportation to hotel

Local contrast for no-reference colour quality assessment

B. Bringier, N. Richard and C. Fernandez-Maloigne
SIC Laboratory, CNRS FRE 2731, University of Poitiers
Bat. SP2MI, Bvd Marie et PierreCurie, PB 30179
86962 Futuroscope cedex, France

Abstract

Image quality assessment plays an important role in various image processing applications. In recent years, some objective image quality metrics correlated with perceived quality measurement have been developed. Two categories of metrics can be distinguished: full-reference and no-reference. Full-reference looks at decrease in image quality from some reference of ideal. No-reference approach attempts to model the judgment of image quality directly, independent of the reference. Unfortunately, the universal image quality model is not on the horizon and empirical models establish on psychophysical experimentation are generally used. In this paper, we present a new algorithm for colour reproduction quality assessment based on human visual system modeling. A local contrast definition [1] is used to assign quality scores. Finally, a good correlation is obtained between human evaluations and our method.

Introduction

Image quality models are known to be multivalued with some visual attributes. In image reproduction, image contrast is commonly defined in terms of tone reproduction curve. Unfortunately, two sets of images having very different white and black points may have very different perceptual contrasts. Image quality can't be established from the tone reproduction curve. Consequently, some empirical models based on psychophysical experimentation are developed to compute the quality perceived regarding the contrast in an image. The more succeeded model uses a simple definition of Lightness-Contrast, Chroma-Contrast and Sharpness-Contrast [2] in Lab colour space. However, the parameter weights in this type of models depend on the set of images used in the human quality assessment. To solve this problem, we proposed a new no-reference algorithm based on a modelisation of the human visual system. Initially, we compute the perceived information on a soft or hard reproduction image. Then, a local contrast definition is used to assign quality scores. Finally, we use a psychophysical experimentation to evaluate the performance of the proposed method.

Method

The first step of our method computes the perceived information from a displayed image by using colour contrast sensitivity function in an opponent colour space. The contrast sensitivity function is probably the most important stage in any HVS model. The output image is filtered by a set of band-pass filters and fan filters like cortex transform [3]. Five spatial frequency bands and five orientations compose the frequency decomposition. The effects of these filters are cascaded to describe the combined radial oriental selectivity of cortical neurons.

The next step computes the local band-limited contrast to assign quality scores. The frequency bands information is converted into some measure of contrast. Generally, Weber or Michelson contrasts are used to compute simple stimuli contrast. In our model, these definitions cannot be used because a real image is not symmetric and these definitions are global quantities depending on the average luminance of the whole image. We used a modified version of the Peli's definition:

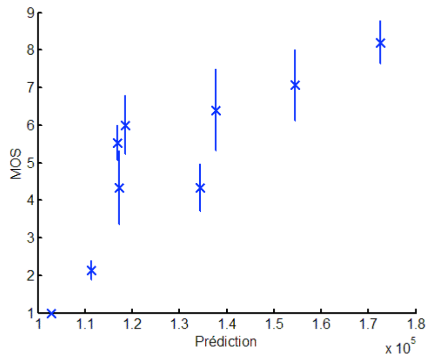
$$LBC_{k,l}(x,y)=\begin{cases}\dfrac{B_{k,l}(x,y)}{M_{k,l}(x,y)+\sum_{i=0}^{k-1}B_{i,l}} & \forall k=2\ldots K\ ,\ l=1\ldots L\\[2ex] \dfrac{B_{k,l}(x,y)}{M_{k,l}(x,y)+B_0} & \forall k=1\ ,\ l=1\end{cases}$$

where B_0 is the average of the image defined by the center of Daly frequency decomposition and $M_{k,l}$ depends of the average of the image and can be used to model the frequency and orientation sensitivity of the HVS.

Results and conclusion

To corroborate the perceptual relevance of our metric, we carried out one set of subjective experiments. We ask twenty viewers to evaluate the quality perceived in a set of twelve test images representing the typical images used in multimedia applications. With these images, our database was created by simulating nine tone reproduction curves that can be typically obtained in CRT and LCD screens. The nine simulated images were shown to each observer, on the same screen, for each original image. Observers were asked to provide their perception of quality by grading the nine reproduction curves from the best to the worst.

For our analysis, the grade was then converted linearly into scale 1-9 (1 for the worst and 9 for the best). We computed the mean opinion scores (MOS) and the corresponding 95% confidence intervals. Figure 1 shown the results for two images of the test, representing "*Athletes*" and "*Transports*". Same results can be computed for the whole database. Very good fitting is obtained between prediction and MOS (90% of correlation between MOS and prediction).



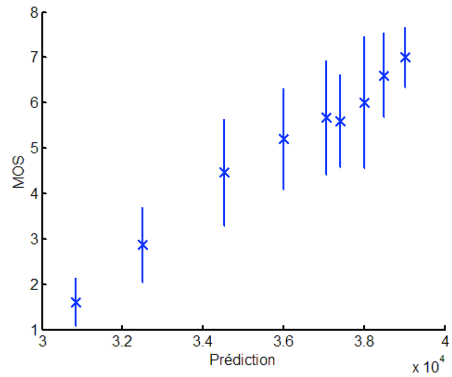


Figure 1. Quality predictions versus mean opinion scores, left: "Athletes", right: "Transports"

These results are encouraging and show a new way of work for image quality measurement without image reference. The use of human visual system modelisation solves the dependency problem of the model parameters from a learning database and allows a generic formulation.

1. E. Peli. Contrast in complex images. Journal of optical society of America, 7(10), October 1990
2. A.J. Calabria and M.D. Fairchild. Perceived image contrast and observer preference II: Empirical modeling of perceived image contrast and observer preference data. Journal of Imaging Science & Technology, 47:494-508, 2003.
3. A. Watson. The cortex transform : Rapid computation of simulated natural images. Computer vision, graphics, and image processing, vol. 39, no. 3:311-327, 1987

Open Problems on the Validity of Grassmann's Laws

Michael H. Brill
Datacolor
Lawrenceville, NJ, U.S.A.

Hermann Grassmann disclosed rules for assessing colour sameness more than a century ago, and all of basic colour theory (including the CIE standard observers) depends on these rules:

Symmetry: $$\textit{If }\ \mathbf{A}=\mathbf{B}\ \textit{ then }\ \mathbf{B}=\mathbf{A} \tag{1}$$

Transitivity: $$\textit{If }\ \mathbf{A}=\mathbf{B}\ \textit{ and }\ \mathbf{B}=\mathbf{C}\ \textit{ then }\ \mathbf{A}=\mathbf{C} \tag{2}$$

Proportionality: $$\textit{If }\ \mathbf{A}=\mathbf{B}\ \textit{ then }\ k\mathbf{A}=k\mathbf{B} \tag{3}$$

Additivity: $$\textit{If }\ \mathbf{A}=\mathbf{B}\ \textit{ and }\ \mathbf{C}=\mathbf{D}\ \textit{ then }\ \mathbf{A}+\mathbf{C}=\mathbf{B}+\mathbf{D} \tag{4}$$

$$\textit{If }\ \mathbf{A}=\mathbf{B}\ \textit{ and }\ \mathbf{A}+\mathbf{C}=\mathbf{B}+\mathbf{D}\ \textit{ then }\ \mathbf{C}=\mathbf{D} \tag{5}$$

Grassmann's laws are tested by what is called a *symmetric-matching* experiment: An observer compares two lights that are presented on identical backgrounds and with a visual system adapted the same for both sides of the match.

The laws are known not to be exactly true in human colour matching. Besides the three cone types that herald the trichromacy of vision at high (photopic) light intensities, a fourth photoreceptor type (rods) contributes to vision at low (mesopic and scotopic) light intensities and away from the centre of vision (fovea). At very high light intensities, unbleached photopigments deplete and, in aggregate, change their action spectrum. At still higher light intensities, a photopigment molecule can absorb multiple photons but respond as if it absorbed only one photon. These effects compromise Grassmann's laws, but the successful application of the laws, e.g., in photography and television, has led us to believe that the compromises are not serious.

In 1980, Wyszecki and Stiles published a detailed study of the pigment-bleaching hypothesis, comparing Maxwell-type matches at retinal illuminances of 1000 and 100 000 td. They found strong and predictable bleaching characteristics for the "red" and "green" fundamentals but the "blue" fundamental exhibited unexpected and unexplained behaviour. In 1982, the same authors published colour-matching functions for a single observer measured by the Maxwell and maximum-saturation methods. The deviations are considerable and the authors conclude that they represent failures of the additivity law.

Further cause for questioning the practical sufficiency of Grassmann's laws emerged in 1992, when Thornton conducted symmetric colour-matching experiments to test the transformability of primaries. Through these experiments, Thornton inferred colour-matching functions for six observers using three different sets of nearly monochromatic primary lights, and also for a virtual seventh observer whose colour-matching functions are averaged from the other six observers. His observers made many matches, but each observer made each match only once.

Thornton found, for each observer, that a colour match of a test light with a mixture of three primary lights becomes a substantial mismatch when each of the primaries in this set is replaced by a matching combination of a second set of primaries. Such *transformation of primaries* amounts to two applications of Grassmann's additivity law. (Find the Set-2 match of each primary in Set 1, replace each Set-1 primary with its Set-2 match, and thereby predict the matches made with Set 2 in a new experiment.) Hence Grassmann's laws fail if transformability fails.

The possibility of such failure leads one to ask what generalization could replace Grassmann's laws. Implicit in Grassmann's additivity rule is the interpretation that "+" means addition at each wavelength of light intensities (or quantum fluxes) per unit wavelength interval. Other additivity domains could be imagined. Brill[15,16] tried two theories, each of which contained a parameter whose value could optionally be set to retrieve conventional Grassmann additivity, but covered other alternatives for other parameter values. One such *covering theory* posited that photon counts in given-sized wavelength-time bins undergo a power-function transformation before being summed into three "tristimulus-like" numbers. The other theory posited a depleted optical density of photopigments under more intense lights.

Another question is to what extent statistical variations could account for Thornton's primary-transformation data. In the absence of replicate matches, a numerical simulation was performed about five years ago. The simulation transforms the CIE 1931 CMFs to Thornton's Prime-Color (PC) and Anti-Prime (AP) primaries, adds Gaussian noise to each set of CMFs, and transforms from each set to estimate the CMFs of the other. A Monte-Carlo approach was chosen, because the alternative partial-derivative approach fails if the relative errors are large—i.e., when the 2% of maximum is added to a small "true" value.

The basic finding of the study was that Thornton's observed failures of transformability are consistent with random intra-observer matching noise. This does not *prove* that Thornton's result is a statistical artefact. It merely opens that explanation as a possibility. *The replicate-match experiment is still needed to answer the fundamental question.*

Thornton's findings were discussed at a CIE Symposium on Improved Colorimetry in June 1993. However, the questions remained unresolved. Then, in Warsaw in 1999, CIE Division 1 sought to bring the matter to closure by forming a new technical committee, CIE TC 1-56, "Improved Colour Matching Functions."

The original plan of CIE TC 1-56 had several steps: The first step was to resolve the transformability problem by conducting an experiment with many replicate colour matches for individual observers. The next step was to look at differences between observers, and to weigh the statistical significance of the deviations of the average of these observers from the CIE functions. Finally, if improvements could be made, the committee was chartered to suggest improved colour-matching functions.

After this fairly stringent plan, no experiments were reported until 2005, when three groups indicated that they were doing relevant work: Ronnier Luo, Boris Oicherman, et al. (University of Leeds, UK) at about 3 cd/m^2, Claudio Oleari at about 30 cd/m^2, and Yasuhisa Nakano at about 300 cd/m^2. These expressions of interest solidified at the 2005 meeting of TC1-56 in León, Spain, and all three groups presented their preliminary results. At that point, TC1-56 down-scoped its goals: Henceforth, the main goal is not to find better colour-matching functions, but to test the transformability of primaries for many trials on a single observer.

Within the next four years, the three laboratories above should have gathered enough data so that CIE TC1-56 can assess the usability of Grassmann's laws in the ever-more-demanding environments of today's world.

Spatial and Chromatic Properties of Negative Afterimages

L. Beke, D. Györe, A. Lénárt, P. Bodrogi
University of Veszprém,
Department of Image Processing and Neurocomputing
Veszprém, Hungary

Introduction

Spatial, temporal and chromatic properties of retinal afterimages have serious influence on color perception. There is evidence that both photopigment bleaching and post-trichromatic processes contribute to afterimage effects[1]. However, measuring the aforementioned properties is a very delicate task, speaking of a dynamic effect, which is furthermore mostly superimposed on the inducing stimuli.

The present paper reports the first results of an experimental framework in which all three properties (spatial, temporal, and chromatic) can be investigated.

Method

Two experiments have been carried out regarding the spatial and chromatic properties of monochromatically induced negative afterimages. Monochromatic (or at least quasi-monochromatic) induction is a key concept because, beyond the obvious technical difficulties, it offers the possibility of investigating receptor-level mechanisms and action spectra.

The first experiment investigated the chromatic properties of negative afterimages with two methods. The first method was called "timed out matching" in which a monochromatic induction was followed by a limited-time interval-matching procedure. In this procedure, perceptual correlates (CIECAM02) were used to navigate to the matching color of an annular matching structure. The second method was a "blank rotation" method in which one of the multiple monochromatic inducers arranged on a circular path was cancelled – thus a "blank" inducer moved along a circular path – this way the afterimage was constantly present and could be matched with the aforementioned matching structure. In both cases, the task of the observer was to match the (CIECAM02) lightness, chroma and hue of the matching structure to the perceived sensation of the negative afterimage on white backgrounds. The apparatus consisted of a Xe arc lamp and a series of quasi-monochromatic metal interference filters of 10 nm bandwidth which provided the high-luminance monochromatic inducers; and a DLP projector which projected the matching structure. Three observers were included (one female, two males), between 23-26 years of age, all had good color vision tested by the F-M 100 Hue Test.

The second experiment investigated the spatial properties of monochromatically induced afterimages. Using the method of constant stimuli, the minimal contrast was determined at which exposing the retina with a Gabor-patch resulted in a perceivable negative afterimage, as a function of spatial frequency and conditioning wavelength. The task of the observer was to give positive or negative answer after the conditioning interval, if an afterimage had been seen. Observers were instructed to give a positive answer only in that case if a spatial structure of opposite phase had been seen. The apparatus consisted of a DLP projector filtered by quasi-monochromatic metal interference filters. The aforementioned two male observers were included.

Results and Discussion

Example results of the experiments are shown in Fig. 1. To the left, the result of the first method in the chromatic experiment is shown. Near the spectrum locus, the monochromatic inducers are shown, connected with the color coordinates of the samples matched with the afterimages. The closed black square shows the background white. In Fig. 1, to the right, an example of the spatial investigations is shown. Diamonds show the detection contrast sensitivity and squares show the afterimage contrast sensitivity (inverse of the minimal contrast that induced an afterimage), along with the 95 % confidence intervals. Detection contrast sensitivity was very roughly determined and thus it is depicted without confidence intervals.

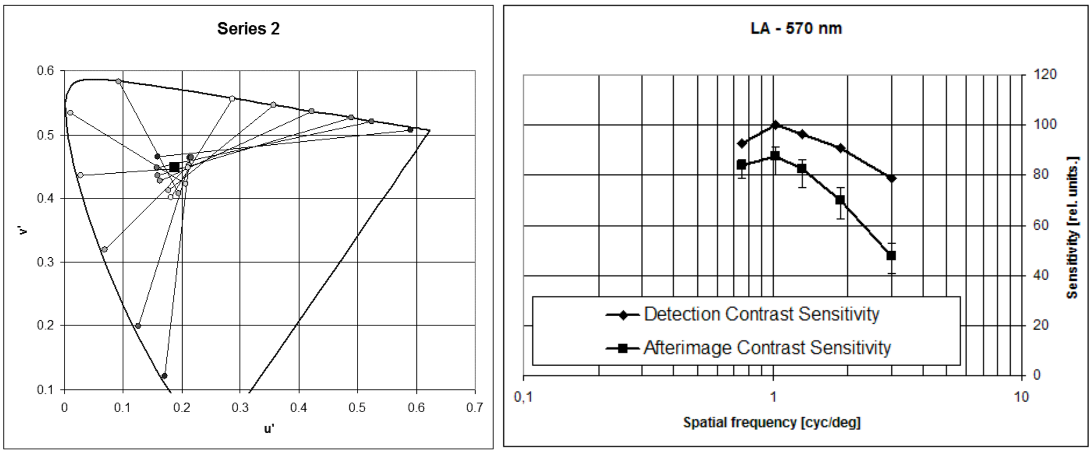


Fig. 1: Example Results of the Afterimage Experiments

These first results of our chromatic investigations show that the empirical statement of attributing an opposite hue to the afterimage can be confirmed, but it differs significantly from the 180 degree (CIECAM02) hue difference concept. In the second method ("blank rotation"), afterimages were matched with samples of higher chroma, compared to the first method ("timed out matching"). This finding may point toward a dynamic effect i.e. the time derivative of the amplitude of the inducer stimulus may be proportional to the chroma of the afterimage.

The results of the second experiment show that afterimage contrast sensitivity has a band-pass spatial frequency characteristics, with a peak frequency seemingly shifting towards higher spatial frequencies with the increase of the inducing wavelength, and, that the detection sensitivity and the afterimage sensitivity curves may join at lower spatial frequencies (possibly around 0.5 cyc/deg). Afterimage contrast sensitivity has a steeper breakdown in higher spatial frequency ranges than detection sensitivity. This may serve as an evidence for the larger receptive fields of the afterimage mechanism.

Conclusion

We described two experiments with an efficient apparatus to investigate the spatial and chromatic properties of negative afterimages. We intend to conduct further experiments on this complex dynamic phenomenon.

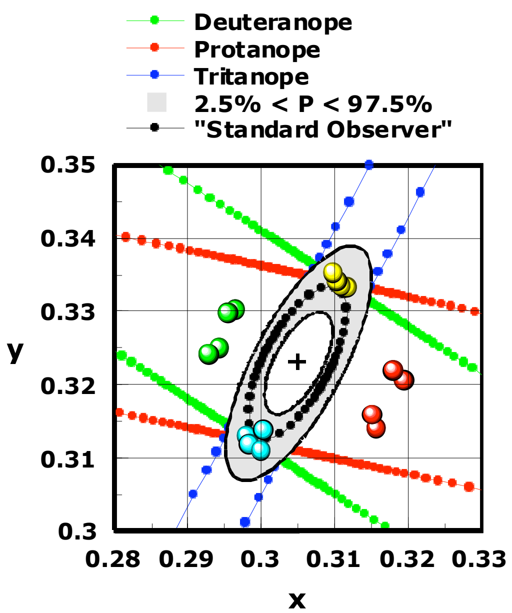
Reference

Anstis, S., Rogers, B., Henry, J. (1971). Interactions Between Simultaneous Contrast and Colored Afterimages. Vision Research. Vol. 18. 899-911.

Establishing the statistical limits of “normal” chromatic sensitivity

John L Barbur, Marisa Rodriguez-Carmona and Alister Harlow
Applied Vision Research Centre, The Henry Wellcome Laboratories for Vision Sciences, City University, London UK

Novel methods developed to assess chromatic sensitivity often yield statistically significant, inter-subject differences that can, in principle, be attributed to either congenital or acquired colour deficiencies(1, 2). The high sensitivity of such techniques can be used to monitor changes in colour vision in the same subject, a clear benefit when monitoring the progress of disease or the effects of treatment. The advantage of improved test sensitivity is however less useful in detecting “abnormal” colour vision, largely because of the large variance within the “normal” population and the lack of test-specific, statistical data to describe the parameters of the normal population. The variation in chromatic sensitivity in normal trichromats can be large. In addition to small differences in the wavelength tuning of photopigment genes, other factors such as differences in the optical density of cone photoreceptors or / and variation in post-receptoral amplification of cone signals can also cause significant changes in chromatic sensitivity(3). Colour vision is currently assessed using a wide range of tests. In the absence of an internationally recognized standard procedure for examination of colour vision, clinical assessment relies on the use of a battery of tests that can produce inconsistent results for a number of different reasons(4).



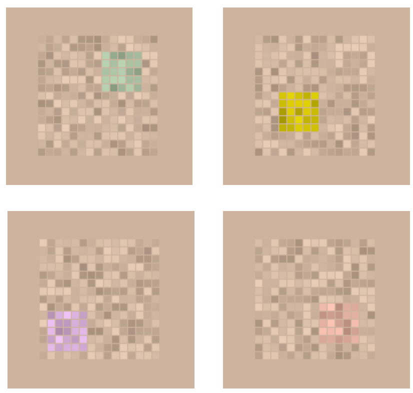


Fig. 1. The large colored discs show typical CAD test results for a subject with minimum deuteranomaly that passes the Ishihara test. The results are plotted in the CIE – (x,y) 1931 chromaticity chart. The black cross at the centre of the diagram plots the chromaticity of the white background i.e., 0.305, 0.323. The dotted black ellipse represents the median values computed from the distribution of r-g and y-b thresholds in 230 normal trichromats. The corresponding 2.5% and the 97.5% statistical limits were used to plot the innermost and outermost ellipses. Thresholds that fall within the grey region are taken to reflect “normal” chromatic discrimination sensitivity. The red, green and blue lines denote “colour confusion bands” based on data measured in protanopes, deuteranopes and tritanopes. The distribution of the eight data points in the r-g direction changes significantly in minimal protanomaly and this makes it possible to classify accurately the class of deficiency involved. The inserts show the appearance of the moving colored stimulus during the test. The subject’s task is to press one of four buttons placed at the corners of a square box to indicate the direction of motion of the colored stimulus. The CAD test employs four-alternative, interleaved staircases with a chance probability of 1/16. The subject’s task was to discriminate the direction of motion of a colour-defined stimulus buried in dynamic luminance contrast noise, a technique that isolates the use of colour signals(5, 6). http://www.city.ac.uk/avrc/colourtest.html

The principal aim of this study was to exploit the use the CIE-(x,y) 1931 system and to extend the work of MacAdam (7) by assessing the variability in red-green (r-g) and yellow-blue (y-b) chromatic discrimination sensitivity within normal trichromats using a new Colour Assessment and Diagnosis (CAD) test(8)

The data describing the statistical parameters of the normal population were used to produce a template that allows immediate classification of normal and deficient colour vision (Fig. 1). 250 colour deficient observers were also examined in order to assess the usefulness of the new template. The median values for r-g and y-b discrimination can be used to express all data in "*standard normal*" CAD units. The data for the 230 normal trichromats and the 250 colour deficient observers (plotted in CAD units) are shown in Fig. 2. Section B shows the usefulness of the CAD test in separating unambiguously the subjects with minimal deficiency from the cluster of normal trichromats. Full comparison of CAD data and results obtained using the Ishihara and Nagel anomaloscope tests will also be presented.

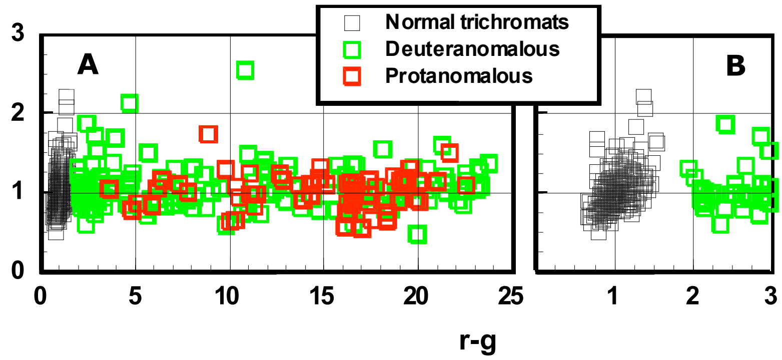


Fig. 2. The graph (section A) shows yellow-blue thresholds plotted against the corresponding red-green thresholds in 230 normal trichromats (black symbols) and 250 colour deficient observers (green and red symbols). The results are expressed in CAD units (i.e., median threshold values computed from measurements taken in 230 normal trichromats). The distribution of r-g thresholds in the range 0 to 3 units is shown expanded in section B to illustrate the clear separation between the cluster of points that define the "normal trichromats" and subjects with minimal deuteranomaly.

The CAD test detects minimum deficiencies and quantifies the severity of colour vision loss by evaluating both r-g and y-b thresholds in an internationally recognized colour system. When expressed in standard normal units the results are easy to understand and provide an immediate indication of the severity of colour vision loss. The test has proved particularly useful in assessing changes in chromatic sensitivity in subjects with diseases of the retina and the optic nerve and in specifying minimum colour vision requirements in occupational environments. The studies carried out so far suggest that the new test and the establishment of the standard normal CAD observer provide an accurate means of detecting and classifying deficiency, of assessing the severity of r-g and y-b colour vision loss (whether congenital or acquired) and of monitoring small changes in colour vision either in disease or treatment.

Reference List

1. Alpern, M. (1979) *Journal of Physiology (London)* **288**, 85-105.
2. Alpern, M. & Pugh, E. N., Jr. (1977) *Journal of Physiology (London)* **266**, 613-646.
3. Barbur, J. L. (2003) *Trends Cogn Sci.* **7**, 434-436.
4. Squire, T. J., Rodriguez-Carmona, M., Evans, A. D. B. & Barbur, J. L. (2005) *Aviat. Space Environ. Med.* **76**, 421-429.
5. Barbur, J. L. (2004) *Prog. Brain Res.* **144**, 243-259.
6. Barbur, J. L., Harlow, A. J. & Plant, G. T. (1994) *Proc. R. Soc. Lond. B. Biol. Sci.* **258**, 327-334.
7. MacAdam, D. L. (1942) *J. Opt. Soc. Am. A.* **32**, 247-274.
8. Rodriguez-Carmona, M. L., Harlow, J. A., Walker, G. & Barbur, J. L. *In* Proceedings of 10th Congress of the International Colour Association, Granada, 979-982, 2005.

Conspicuity of blinking LED lights of various temporal frequencies and duty ratios in a wide visual field

Miyoshi Ayama[1], Takanobu Fujima[1], Hitomi Fujii[2], Genji Yamamoto[3], Norihiro Ikeda[3], Masanori Nagata[4]

1 Department of Information and Control Systems Science, Graduate School of Engineering, Utsunomiya University
2 Department of Information Science, Utsunomiya University
7-1-2 Yoto, Utsunomiya, 321-8585 Japan

3 Research & Development section, Kictec Inc. Co., Ltd.
150 Umegaoka, Usaka, Aguicho, Aichi, 470-2295 Japan

4 Technical Research & Development division, Toyoda Gosei Co., Ltd.
30 Nishinomachi, Kitajimacho, Inazawa, Aichi, 492-8540 Japan

Introduction

LEDs are often used for road signs and some of them are utilized as intermittently on and off. The temporal frequency of flashing is, however, determined by local manufacturers according to their experiences. No studies have been reported on the relation between conspicuity/visibility of blinking LEDs and their temporal frequency. Thus, we conducted experiments to evaluate the conspicuity of a LED matrix of different colors blinking at various temporal frequencies lit in various places in the visual field. In addition to that, visual impression of blinking LEDs of several duty ratios was examined.

Experiment

The left part of Figure 1 shows the top view of the experimental apparatus, and the insertion in the right indicates the LED pole composed of five LED matrices of different colors. One matrix was composed of 3 X 3 dots of LEDs, and one cluster was composed of five matrices of red, yellow, green, blue and white LEDs. They are respectively marked as R, Y, G, B, and W as stimulus codes in this study. Background was dark. Only the central cluster (indicated by the arrow in Figure 1) was used. Five positions (pole # of 1, 3, 5, 7, and 9 in Figure 1) were used in the following experiments.

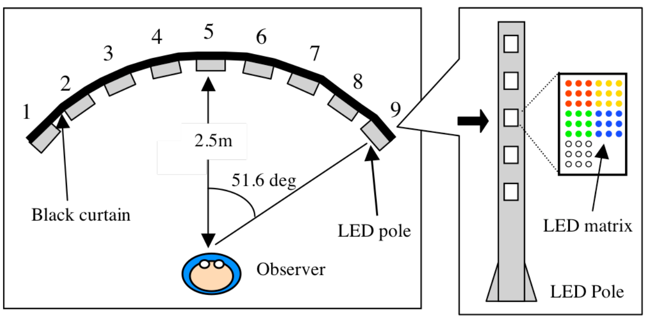


Figure 1. Left: the top view of the experimental apparatus. Numerals indicate the number of pole.

Right: LED Pole.

In the experiment 1, the conspicuity rank order among eight different temporal frequencies (1, 2, 3, 4, 5, 6, 8, and 10 Hz) were determined for each of five colors, at each of five positions. The duty ratio was kept constant. Two stimuli of the same color blinking at different temporal frequencies were successively presented on one of the five poles. Duration of each stimulus was 3 sec and the interval was 2 sec. The observer was asked to determine which stimulus was more conspicuous as a warning sign (pair comparison method). The observer was instructed to gaze at the center pole, thus in the cases of pole numbers of 1, 3, 7, and 9, they saw the stimuli using peripheral vision.

In the experiment 2, visual impression of four duty ratios (1:1, 1:5, 1:10, and 1:20) was examined. Notation of the duty ratio is as follows; 1:1indicates 50% on and off, 1:5 indicates 17% on and 83% off, etc. Two stimuli of different duty ratios, but the same color (R or B) and the same temporal frequency (1 or 6 Hz), were successively presented at the center pole (pole No.5). Visual persistence of on-duration, conspicuity, brightness, and glare were evaluated.

Results and Summary

Thurstone's case V method was applied to derive the interval scale of conspicuity for the eight temporal frequencies under each of five colors and each of five positions. Figure 2 shows the results of R and B at pole numbers of 5 (center) and 9 (right periphery). As shown in the figure, the R stimulus shows band-pass type at both the center and periphery, whereas the B shows band-pass type at the center but high-pass type at periphery. It is interesting that the Y stimulus shows the results similar to R, while G and W show the results similar to B. Curves in Figure 2 are the band-pass and high-pass filters typically used in electronic circuit. Results of the experiment 2 indicated that visual impression does not show clear difference between the stimuli that differ about twice in duty ratio, for example 1:5 and 1:10, or 1:10 and 1:20.

Our previous study showed that color appearance of B does not change with eccentricity while those of R and Y drastically change in periphery[1]. Underlying mechanism for the difference between R, Y stimuli and G, B, and W stimuli will be discussed.

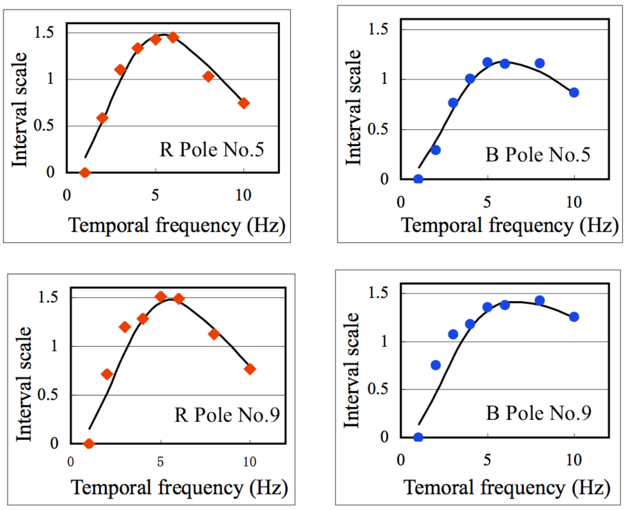


Figure 2. Interval scale of conspicuity for different temporal frequencies.

1) K.Hagiwara, M. Ayama, T. Fujima, G. Yamamoto, N. Ikeda, M. Nagata, "Visibility of Color Stimuli using LEDs in Driving Situation", Proceedings of CIE Expert Sympo.; LED Light Sources: Physical Measurement and Visual and Photobiological Assessment, pp.41-44, 2004.

Color Management and the CIE: A Virtual Roundtable

Robert Buckley*, Geoffrey Woolfe*, Jack Holm**, and Craig Revie*

**Xerox Corp*
Webster, NY, USA
***Hewlett-Packard*
Palo Alto, CA, USA
****Fujifilm Electronic Imaging*
Hemel Hempstead, UK

This presentation will be a virtual roundtable, combining the inputs from four experts in the field of color imaging and color management.

The theme of the roundtable is the relationship between color management and the color science principles upon which it is founded. These principles include colorimetry, the Standard Colorimetric Observer, color appearance, viewing environments and observer adaptation. There are elements that are critical to color management that are little discussed in the color science world. These elements include color encodings, image states, and color rendering, i.e. mapping scene colors to preferred reproduction colors, and mapping data between devices characterized by different gamuts and dynamic ranges, including displays and hardcopy.

Color management encompasses the data and methods used to capture, manipulate, communicate and reproduce color content in imaging systems. The need for color management arises because the different devices that comprise an imaging system can all differ in the way they represent color and in the range of colors they can represent. Besides device characteristics, there are also the human aspects of color management, including the communication of intent and color reproduction objectives.

The first part of the presentation will give a brief overview of color management and the general approaches used by the solutions available today. Central to the practice of color management are data conversions across different color spaces, image states, viewing conditions, device gamuts, and dynamic ranges to realize an intended or desired reproduction.

The second part of the presentation will focus on the issues and themes that the roundtable participants want to bring to the attention of the CIE community responsible for the Standard Colorimetric Observer, uniform color spaces and color appearance models. These issues have to do with color rendering to and from reference and actual media, the management of colors brighter than the adapted white (high dynamic range), spectral characteristics and measurements, and how to deal with flare and glare in measurements and viewing.

About a method to predict M-cone and L-cone photopigments from colour-matching functions

Francoise Viénot
Muséum national d'Histoire naturelle – CRCDG
Paris, France

Shift in the wavelength of peak sensitivity of the cone photopigments is a major cause of inter-individual variations in colour-matches. During the past 20 years, a polymorphism of the M-cone and L-cone photopigments has been shown in humans, by molecular genetics or psychophysics studies. Its consequence on Rayleigh matches (Neitz & Jacobs, 1990) has been studied. Global statistical indices have been extracted from known sets of colour-matching functions such as Stiles and Burch's colorimetric observers (Webster and MacLeod, 1988).

Here, we investigate a method that discloses the variations of M-cone and L-cone in individual colour-matching functions. Only data at longer wavelengths are considered since they are under the control of the absorption of photons by M-cones and L-cones only. In this part of the spectrum, colour matching is two-dimensional. Given the green primary, the red primary, and the spectral test stimulus, we predict the ratio of radiances rbar(λ)/gbar(λ) for a range of plausible values in terms of wavelength of the peak sensitivity of the M-cone and L-cone. An algorithm allows us to adjust the values of the peak wavelength of the cone photopigments in order to minimize the sum of squared differences between predicted and real results of matches. To create candidate M-cone and L-cone photopigments that best predict the set of equation values, we use the low density spectral absorbance curves of the M-cone and L-cone photopigments respectively, as tabulated by Stockman and Sharpe (2000), and shift each template along some function of wavelength.

For all observers, the system of colour-matching equations converges to a unique solution. M- and L- cone photopigments are estimated separately.

We discuss the distribution of M- and L- cone photopigments, the accuracy of the prediction, as well as the applicability of the method to any newly derived set of colour-matching functions.

References

Neitz J. and Jacobs G.H., "Polymorphism in normal human color vision and its mechanism", *Vision Research*. **30**, 621-636 (1990).

Stockman, A. & Sharpe, L.T. (2000a) The spectral sensitivities of the middle- and long-wavelength-sensitive cones derived from measurements in observers of known genotype. *Vision Research*, 40, 1711-1737.

Webster, M.A. & MacLeod, D.I.A. (1988) Factors underlying individual differences in the color matches of normal observers. *Journal of the Optical Society of America A*, 5, 1722-1735.

Color matching functions for a perceptually uniform RGB space

Joanna Marguier and Sabine Süsstrunk
School of Computer and Communication Sciences (IC)
Ecole Polytechnique Federale de Lausanne (EPFL)
Lausanne, Switzerland

Abstract

Perceptually relevant color differences have traditionally been evaluated using Euclidian distances (ΔE) in CIE standardized color spaces, such as CIE Lab and CIE Luv. Here we derive RGB color matching functions for a hue constant color space uniform in terms of color differences. We optimize the hue constancy of the RGB color matching functions based on a gamma and brightness independent hue representation.

I. INTRODUCTION

CIE Lab[1] 1976 [1] is based on the CIE 1931 XYZ color matching functions (CMFs). The non-linear relations for L, a and b values are an attempt to model the non-linear and opponent response of the human visual system, and to derive a color space representation where perceptually relevant color differences can be calculated with a simple metric. In the case of CIE Lab (and also CIE Luv, although we will not discuss it here), color differences are expressed as Euclidian distances (ΔE) between two color coordinates in the three dimensional color space.

As the CIE Lab color space is not perfectly perceptually uniform, i.e. equal Euclidian distances are not necessarily perceptually equal, new difference formulae (ΔE CIE94, ΔE CIE2000) were proposed based on new results of psychophysical studies. For ΔE CIE94 [2], weights were introduced to adjust for the respective influence of lightness, chroma and hue. ΔE CIE2000 [3], an improved version of CIE94, contains an additional term representing a hue-chroma interaction. These successive versions of color difference formulae, all based on CIE Lab 1976, give better overall perceptual performance but are also heavier to compute.

CIE Lab ΔE or one of the subsequent formulae are also applied to evaluate color differences in color imaging applications. CIE Lab is also used as an image editing color encoding and as a profile connection space (PCS) in ICC color management applications [4].

However, other color encodings that mimic the perceptual response of the human visual system are also often applied in image processing tasks. The well known YCrCb encoding [5], which is a linear transformation of (non-linear) RGB is used in compression to subsample image chrominance, and HSV is used in segmentation tasks. Thus, for many imaging applications, an approximation of a perceptual color space seems to be sufficient for engineering tasks.

In this study, we also take an engineering approach to define a RGB color space that is approximately uniform with respect to hue and to color differences, suitable for imaging applications such as editing. We are optimizing a linear transform from XYZ to RGB color matching functions (CMFs), which can form the basis of a RGB color encoding.

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[1] The correct notation is CIE L*a*b*. We neglect the (*) in this abstract.

I. EXPERIMENT

This experiment is an extension of the work done by Finlayson and Süsstrunk [6]. By sampling the surface of a sphere [7], which ensures that the length of the sensors is always equal to one, they tried different combinations of RGB CMFs to find the ones who result in the most hue constant color space. Their optimization was based on hue-constant psychophysical data by Hung and Berns [8]. The opimization criterion was line fitting of hue lines in a logarithmic, opponent color space. The hue definition used here is independent of gamma and brightness [9].

Here, we extend the experiment to the Munsell dataset [10] and introduce a new constraint on the hue uniformity. We calculate the XYZ values for the Munsell reflectances under D65, and apply a linear transform from XYZ to RGB for each combination of RGB CMFs.

Our optimization relies on geometrical considerations: we want a hue constant transform and a uniform space in terms of color differences. The first criterion is hue constancy, estimated by fitting a line through each hue angle. The deviation of each hue line from a straight line gives us a measure of hue uniformity. However, this still does not result in a suitable transform, the hue angles also should be equally distributed. We thus introduce a condition on the uniformity of hue angles.

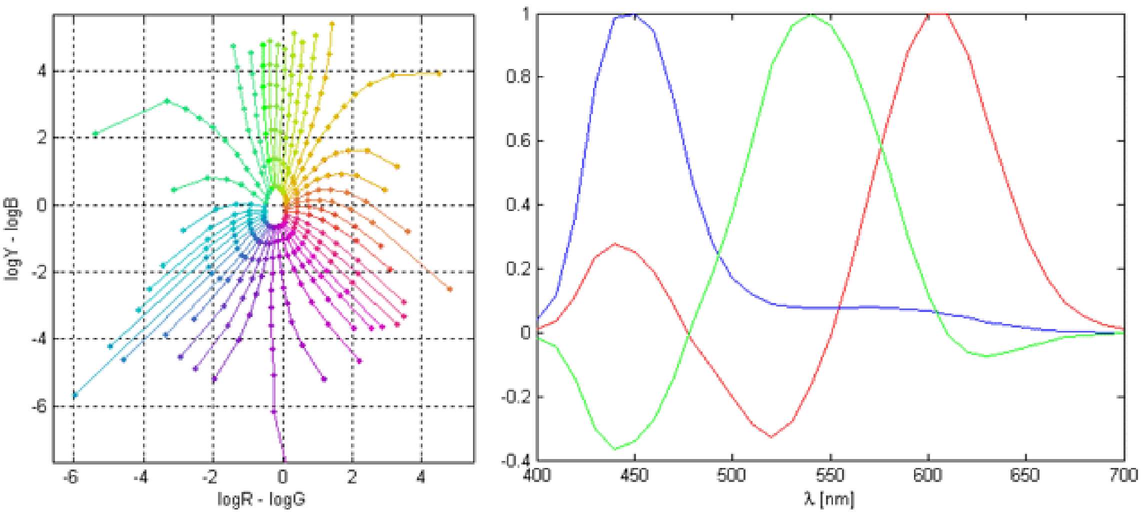

Figure 1. Log Opponent Color representation for a transform optimizing hue angles and corresponding sensors

Figure 1 shows the preliminary result obtained by optimizing for hue constancy and hue angle including transforms located in a 25° cone centered on sRGB coordinates. In the final paper, we will discuss the experiment in more details and present results performed on larger samples sets, with refined optimization criteria, and comparisons with standard color difference calculations.

Our method is flexible and offers many degrees of freedom. The different optimization criteria can be modified to suit the wanted properties of the CMFs.

III. REFERENCES

[1] CIE. Colorimetry. CIE Publication No. 15.2, 2nd Edition, Commission Internationale de L'Eclairage, Vienna, 1986

[2] CIE Publication 116-1995, "Industrial Colour-Difference Evaluation", Vienna: CIE, 1995

[3] CIE Publication No. 142, Improvement to industrial colour-difference evaluation, Vienna, 2001.

[4] Specification ICC.1:2003-09, File Format for Color Profiles *(Version 4.1.0)*

[5] C. Poynton, *A Technical Introduction to Digital Video,* John Wiley & Sons, Inc., 1996

[6] G.D. Finlayson and S. Süsstrunk , "Optimization for Hue Constant RGB sensors", *Proc. IS&T/SID 10th Color Imaging Conference,* 2002.

[7] G.D. Finlayson and S. Süsstrunk, "Spherical sampling and color transformations," *Proc. IS&T/SID 9th Color Imaging Conference,* 2001.

[8] P. Hung and R. Berns, "Determination of constant hue loci for a CRT gamut and their prediction using color appearance spaces," *Color Research and Applications,* 20, pp. 285-295, 1995.

[9] G. Finlayson and G. Schaefer, "Hue that is invariant to brightness and gamma," *Proc. British Machine Vision Conference,* 2000.

[10] Munsell renotation data, RIT Munsell Color Science Laboratory.

Physiologically-based colour matching functions

Andrew Stockman and Lindsay T. Sharpe
Institute of Ophthalmology, University College London
London, England

All colour matches depend ultimately on the transduction properties of the light-sensitive photoreceptors in the eye, and in particular on their spectral sensitivities. In most observers with normal color vision, there are three types of cone photoreceptors, which are referred to as long-, middle- and short-wavelength-sensitive (L, M and S), according to the part of the visible spectrum in which they are most sensitive. A knowledge of their spectral sensitivities is central to the understanding and modeling of visual function, and to the specification of colour.

Photoreceptors are essentially sophisticated photon counters, the outputs of which vary univariantly according to the number of photons that they absorb. With its three cone types, photopic human vision is a *trichromatic* or trivariant system, a behavioral consequence of which is that colours can be defined by just three variables: the intensities of three independent primary lights required to match them, which are known as the $\bar{r}(\lambda)$, $\bar{g}(\lambda)$ and $\bar{b}(\lambda)$ color matching functions or CMFs. This specification does not require any knowledge of the underlying cone spectral sensitivities, and was the approach adopted by the CIE in 1931 and 1964 to define colour matches for small (2-deg) and large (10-deg) viewing conditions, respectively.

CMFs can be linearly transformed to any other set of real primary lights, and to *imaginary* primary lights, such as the all-positive **X**, **Y** and **Z** primaries favored by the CIE to define international lighting standards or the physiologically-relevant **L**, **M** and **S** cone *fundamental* primaries. In particular, the three *fundamental* primaries (or "Grundempfindungen" - fundamental sensations) are the three *imaginary* primary lights that would uniquely stimulate each of the three cones to yield $\bar{l}(\lambda)$, $\bar{m}(\lambda)$ and $\bar{s}(\lambda)$ CMFs, or the L-, M- and S-cone spectral sensitivity functions.

Since the establishment of trichromatic colour theory, a central goal of colour science has been the accurate determination of the three cone spectral sensitivities, $\bar{l}(\lambda)$, $\bar{m}(\lambda)$ and $\bar{s}(\lambda)$. Most estimates depend on measurements made in normals and in dichromats: protanopes, deuteranopes and tritanopes, who lack the L-, M- and S-cones, respectively; and the assumption—known as the "loss", "reduction" or "König" hypothesis—that their remaining cone classes are normal (*1, 2*). Although cone fundamentals can be estimated from dichromatic and trichromatic colour matches, the most straightforward method is to measure the cone spectral sensitivities directly in normals and dichromats using special procedures to isolate the appropriate cone response.

The cone fundamentals of Stockman and Sharpe (*3*), which are to be proposed by CIE Technical Committee 1-36 as new physiologically-relevant cone fundamentals, are based on a series of such measurements (*3-6*). The $\bar{l}(\lambda)$ and $\bar{m}(\lambda)$ CMFs were derived from measurements made in red-green or X-linked dichromats of known genotype [including knowledge of their L-cone polymorphism, L(ser^{180}) or L(ala^{180})]: M-cone sensitivities in 9 protanopes, and L-cone sensitivities in 20 deuteranopes. The $\bar{s}(\lambda)$ CMF was derived in two ways: (i) from spectral sensitivity measurements made in three blue-cone monochromats, who lack functioning M- and L-cones, and in normal trichromats under intense long-wavelength adaptation; and (ii) from a direct analysis of the 10-deg CMF data of Stiles & Burch (*7*).

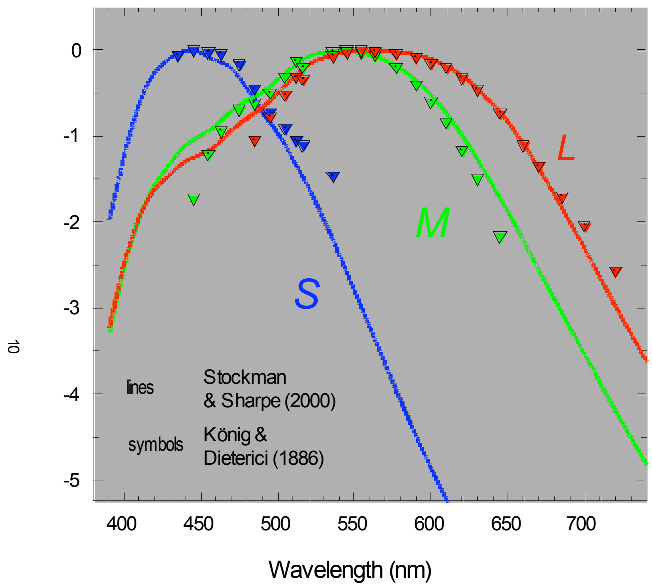

Figure 1. *120 years on: S-, M- and L-cone fundamentals of Stockman & Sharpe (3) (coloured lines) compared with the historical estimates of König & Dieterici (2) (inverted triangles).*

Although the cone spectral sensitivities could be defined simply as the direct sensitivity measurements, it is customary to define them in terms of linear combinations of a set of CMFs, which are more precise. All that is required is to find the linear combinations of $\bar{r}(\lambda)$, $\bar{g}(\lambda)$ and $\bar{b}(\lambda)$ that best fits each cone spectral sensitivity, allowing for differences in prereceptoral filtering and photopigment optical density. The Stockman & Sharpe (*3*) cone fundamentals are defined for 2- and 10-deg fields in terms of the "large-field" 10-deg CMFs of Stiles & Burch (*7*), which can be corrected for 2-deg viewing conditions. Measured in 49 subjects from approximately 390 to 730 nm (and in 9 subjects from 730 to 830 nm), these data are probably the most secure set of existing color matching data, and are available as individual as well as mean data. The cone fundamentals derived for 2-deg viewing conditions are shown in Fig. 1. More details about their derivation can be found in the original papers (*3, 5*).

We have, in addition, generated a consistent new estimate of $\bar{y}(\lambda)$, which is defined as a linear combination of $\bar{l}(\lambda)$ and $\bar{m}(\lambda)$, based on new luminous efficiency measurements made in 40 observers of known genotype (*8*).

All CMFs, properly measured, are "physiologically-based". The problem with the CIE 1931 CMFs (and with the CIE 1924 V(λ) luminous efficiency function used to construct them) is that they are seriously flawed—particularly at short-wavelengths. Seventy-five years on, it is time not only to celebrate them, but also to replace them.

References

1. J. C. Maxwell, *Philosophical Transactions of the Royal Society of London* 150, 57 (1860).
2. A. König, C. Dieterici, *Sitzungsberichte Akademie der Wissenschaften, Berlin* 1886, 805 (1886).
3. A. Stockman, L. T. Sharpe, *Vision Research* 40, 1711 (2000).
4. L. T. Sharpe *et al.*, *Journal of Neuroscience* 18, 10053 (1998).
5. A. Stockman, L. T. Sharpe, C. C. Fach, *Vision Research* 39, 2901 (1999).
6. A. Stockman, L. T. Sharpe, *Vision Research* 40, 1739 (2000).
7. W. S. Stiles, J. M. Burch, *Optica Acta* 6, 1 (1959).
8. L. T. Sharpe, A. Stockman, W. Jagla, H. Jägle, *Journal of Vision* 5, 948 (2005).

The colorimetric capability developed at NIM-Romania

Mihai Simionescu, Amadeu Seucan
National Institute of Metrology
Bucharest, Romania

1. General

Currently NIM-Romania is performing colour measurements which results are traceable SI via it`s own a primary reference **[1]** consisting in an absolute spectrophotometer that employs the modified Taylor – Budde method and meets the CIE Communication 44 requirements. Traceability chain, technical solutions and relevant comparisons are briefly reported.

Keywords: Traceability, spectral reflectance, absolute spectro-reflectometer.

2. Traceability chain maintained at NIM-Romania

0/d spectral reflectance calibration of a sample against the primary standard developped by NIM-Romania, the absolute spectro-reflectometer SFRA 1 [2] is performed in two steps: absolute spectral reflectance measurement of the sphere inner surface (i) unknown sample calibration against the integrating sphere wall (ii). This way transfer to NIM reference standards (aselective MS 20 and Carl Zeiss diffusing plates) is performed. Aselective spectral reflectance and colored working standards are calibrated against the reference standards. For the 0/45° working standards calibration is performed in two steps: direct comparison against a 0/d reference standard (i) followed by correction of the obtained spectral reflectance values for the non-perfect lambertian behaviour estimated by relative goniophotometric measurements using an CCD array spectrophotometer. The colorimetric values for different CIE illuminants are derived using the classical equations.

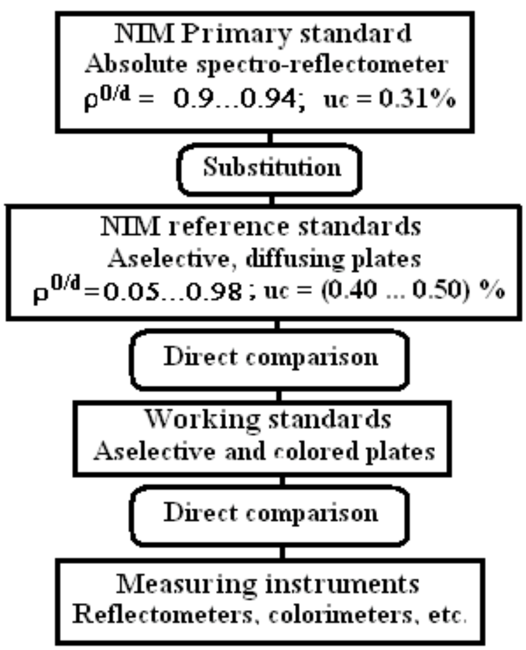

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Figure 1. *Spectro-reflectometric and colorimetric measurements traceability at NIM, Romania.*

3. Primary standard of NIM-Romania

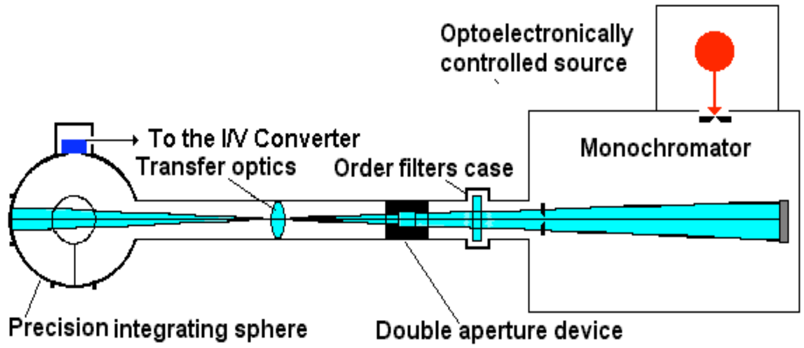

Figure 2. *SFRA 1: the NIM, Romania spectro-reflectometric primary standard layout*

4. Validation

The first validation of the primary standard was obtained in 2001 following the COOMET DE 152 a/97 comparison results **[4].** The INM-PTB bilateral comparison **[5]** confirmed the previously estimated specifications of the instrument. Spectral reflectance working standards calibration capability of NIM, Romania was evaluated following bilateral comparison with BAM-Berlin **[6].** Colorimetric capability of NIM-Romania (working standards level) is currently checked by a bilateral comparison with BAM-Berlin. The comparison is in progress and according to the protocol **[7]** final results are expected by mid 2006.

5. Conclusion

A comprehensive colorimetric capability based on an integrating sphere absolute spectro-reflectometer was developed by NIM-Romania. At the primary standard-reference standard level and unit transfer capability were validated by relevant comparisons. At the working standards level full validation for the spectral reflectance standards was attained while for the colorimetric standards a relevant comparison is in progress.

Acknowledgement

The authors gratefully acknowledge the inspiring work of Dr. Horst König of PTB-Berlin.

References:

1. CIE Communication 44
2. Mihai Simionescu, Amadeu Seucan, Maria Lucian, SFRA 1- absolute spectro-reflectometer SFRA 1, Metrologia Aplicata nr. 4/1986.
4. Horst König, Eleonora Aden and others, International Comparison on Spectral Reflectance Measurements (COOMET DE 152 a/97), PTB-Opt-64, 2001
5. Horst König, Mihai Simionescu, Amadeu Seucan, The SFRA 1 absolute spectroreflectometer characterization, report on the PTB, Germany - NIM, Romania co-operation project, 2002.
6. Wolf Czepluch, Mihai Simionescu, Final report on the BAM, Berlin – NIM, Romania spectro-reflectometric bilateral comparison, 2003.
7. BAM, Berlin – NIM, Romania bilateral colorimetric comparison protocol, 2005.

CIE recommendations and standards on colorimetry, what next?

János Schanda
University of Veszprém
Veszprém, Hungary

Introduction

CIE published its first colorimetric recommendations in 1931. Despite the fact that it was intended only as a preliminary recommendation for signal lights and similar applications, it survived the past 75 years and became used in many other areas of science and technology. As our colour vision knowledge progressed the system became amended and several new parts have been added. From time to time CIE updated its fundamental colorimetric publication (CIE 15: Colorimetry), and published recommendations and state of the art reviews in many colour related subjects. In the present paper we will provide a short overview of the most important developments in colorimetry and will try to offer an outlook on possible further developments.

CIE 15: Colorimetry

The 1931 system of CIE colorimetry and its amendments were originally published only in CIE Session Proceedings, treasure houses of light and lighting knowledge, but having very limited circulation. Due to this fact the spreading of information was via secondary publications: journal articles and books. As colorimetry is used in many areas of science and technology, books, where the authors were experts in a non-colorimetric field wrote the book, and unfortunately in such publications one finds quite often colorimetric misinterpretations. CIE – realizing this situation – published in 1971 its first specialized document on colorimetry.

Colorimetric progress required periodic updating of this document, so in 1986 a second edition was published and in 2004 a third edition became available. This enables authors and teachers to check their knowledge and get up to date information on fundamental CIE colorimetry. The document uses up to date colorimetric terminology, and one can only advise everybody who has to write on colour to consult this publication for the correct use colorimetric terms. CIE 15:2004 summarizes information on the CIE standard and other recommended illuminants and sources, on the CIE standard observers and on the standard reflectance. These chapters are more or less following the previous edition of the publication.

The chapter dealing with geometric conditions for reflection and transmission measurement contains a number of new recommendations. The reader will find new material also in the chapters on calculations, uniform colour spaces and colour difference evaluation and metamerism indices.

A CD-ROM accompanies the publication, where all the important CIE numeric tables are available, together with some important auxiliary programs.

Colorimetry: Understanding the CIE system

To celebrate the 75th anniversary of the CIE system of colorimetry CIE experts write a book dealing not only with the questions of fundamental colorimetry, but discussing also issues of advanced colorimetry, i.e. colour appearance, and many aspects of using colorimetry. (A preprint volume of this book, with draft versions of most of the chapters of the book will be available for the participants of the Symposium. Chapters will deal, beside of fundamental colorimetry, with issues of tristimulus and spectral colorimetry, colour management and colour rendering and many hot items of colour science, as e.g. colour appearance models, image colour appearance, temporal and spatial problems.)

Possible new work

CIE technical committees are active in a number of questions that will influence the progress both in fundamental and advanced colorimetry.

Since the middle of the last century colorimetrists were aware of the fact that the CIE 1931 standard observer does not describe the colour vision of the average population well, and in vision science several updates are in use. Two of our TCs are working in this field and we can hope that a supplementary observer will become available soon. But this will probably not solve all the questions, as e.g. it is intended only for field sizes between 1° and 10°. Field sizes are often much larger, and a colorimetry dealing with this question is certainly needed.

New developments of colorimetry are expected not only on the observer side, but also on the source side: Both further illuminants are needed for the proper evaluation of materials containing fluorescent agents (indoor daylight), and the realizations of standard illuminants, i.e. standard daylight sources is still jacking. Such sourcess, or at least much better simulators are urgently needed. Using LEDs this question seems to be solvable. LEDs pose, however, an other problem: the present colour-rendering index is not a good descriptor of RGB LED sources.

In the field of colour-difference calculation one can hope that the CIEDE2000 formula brought some stability. All the formulae recommended by the CIE up to now were just experimentally optimised equations. The next step has to be a vision mechanism based equation, and with colour difference equations based on colour appearance models the first steps in this direction have been made.

In colour appearance description we are certainly not at the end of development. One very important issue is the description of colour image appearance: how the adjacent coloured patches influence each other, and w how a size effect can be described.

Summary

In summary we can state that CIE colorimetry has well served industry and science for the past 75 years. But it has not solved all the questions of colorimetry, there are a number of pressing items to be tackled. In this work CIE colorimetry is relying heavily on colour vision science, and one can hope that as the understanding of the functioning of higher visual cortex levels becomes available, those vision science results will help to build better colorimetric systems.

Scaling of comfort for a colored scene and development of a colour comfort meter

Ken Sagawa, Soichi Takizawa*, Tatsuo Saito* and Toshikazu Doi*
National Institute of Advanced Industrial Science and Technology (AIST)
Advanced Systems Co. Ltd*
Tsukuba/ Ibaraki/ Japan
Tachikawa/Tokyo/Japan*

Introduction

Comfort or discomfort feeling when we see a colored scene is one of the most important aspects of coloring objects or environments. However, the properties of this colour comfort feeling has not been fully understood yet and the method of scaling of it in terms of colours has not been developed yet. Sagawa reported that two colorimetric measures are useful to evaluate the color comfort: One is the averaged saturation over a colored image and the other one is the number of fundamental colors contained in the image (Sagawa, 1999; Sagawa, 2000). Being based on these basic properties of the color comfort, scaling of the color comfort was developed and a comfort meter based on the scale was developed.

Scaling of the colour comfort

It was found in previous studies that two major factors affect the extent of the feeling of the color comfort, (1) the average saturation and (2) number of fundamental colours. The former factor was further divided into 4 components of opponent colors, such as red, green, yellow and blue. The psychological experiment was carried out to investigate how these components affect the subjective evaluation of the color comfort for natural colored scenes, and the relative weighting factors for the four components were determined. Including an additional factor of number of colours, the final form of the formula to express the colour comfort in the arbitrary 100 point scale is as follows;

$$C \text{ (100 point scale)} = w_n N + w_r R + w_y Y + w_g G + w_b B + const \qquad (1)$$

Where N means number of fundamental colours contained in an image and R, Y, G, B are averaged components of opponent colours over the image, all being able to be derived from the distribution of colorimetric values over the scene.

A set of 36 colored images were presented on a large (50 inch) display and subjects who watched them were asked to evaluate the scenes in terms of the color comfort , and from those data weighting factors for the 5 components in the equation (1) were obtained by using the multi-regression method.

Development of a color comfort meter

Being based on the developed formula for the color comfort a measuring system was developed to objectively obtain the comfort value. The system consists of digital camera and a computer system to analyze and calculate the comfort scale for a captured scene.

Figure 1 shows the outlook of the comfort meter developed. The meter can capture a colored image through a digital camera and calculate chromaticity value of each pixel of the image in terms of the CIE colorimetry. The meter then analyze the number of fundamental colors contained in the image by using the concept of categorical colour perception, as well as four opponent colour components i.e. red, yellow, green, blue. Finally, the system calculates the comfort value for the scene.

Conclusion

Comfort feeling of for natural colored scene was scaled by using 5 variables i.e. 4 variables related to color opponency and the number of fundamental colours in the image. A measuring system was developed to obtain the comfort value objectively.

Figure 1. A color comfort meter

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References

K. Sagawa: Visual Comfort to Colored Images Evaluated by Saturation Distribution. Color Research and Application 24 (1999), 313-321.

K. Sagawa: Visual Comfort to Evaluated by Number of Categorical Colors in a Colored Image. Color Research and Application, 25（2000）193-199

The Colour of the Canadian Flag

Alan R. Robertson[*]
National Research Council
Ottawa, Ontario, Canada

Introduction

As important and ubiquitous as the CIE Standard Observer has become in its 75 years, there may be only one instance where it was used as a direct consequence of an edict from a head of government. Such was the case in 1965 when the Prime Minister of Canada, Lester B. Pearson expressed concern about the considerable variation in the shades of red appearing in specimens of the national flag. He directed that action be taken at once to achieve standardization on the basis of the correct colour.[1]

Historical Background

A recent CBC documentary[2] reports that "In the 1960's Canada was trying to outgrow its colonial adolescence and define itself as a grown-up nation. Nationalism was taking root in Quebec, and a new flag was the most obvious way of demonstrating independence from Britain. But the birth of Canada's flag in 1965 was anything but simple. The flag debate began in the House of Commons in 1964 and carried on for weeks, taking up parliamentary time and bringing the nation's business to a standstill." Finally, on 15 February 1965, the red maple leaf was flown for the first time as Canada's official flag. After all the turmoil, it was a great disappointment to the supporters of the new flag that it quickly faded to an orange colour on a dirty grey background or even, in some extreme cases, to white on white.

First Standards

The National Research Council (NRC), and in particular Gunter Wyszecki, were called in to help. The task was to select and precisely define the red colour of the flag which was to be printed on 1.9 oz nylon taffeta. The colour was to have the same appearance as the red colour of the old ensign flag which had traditionally been produced on cotton bunting. Consultation with dyestuff manufacturers and laboratory tests carried out at NRC revealed that dyestuffs could be formulated in the desired shade with an excellent degree of light fastness. To facilitate control of the color in flag production, Wyszecki recommended that manufacturers be provided with two limit standards, one a light red showing the orange limit, the other a dark red showing the blue limit.[3] The desired shade would be between the two – preferably closer to the darker shade.

For the purpose of a permanent record, the two standards were measured on a General Electric Hardy recording spectrophotometer and CIE colour coordinates were calculated using CIE illuminant C and the CIE 1931 Standard Observer. The results were as follows:

Sample	x	y	Y(%)
No.1 (light-orange limit)	0.571	0.311	10.4
No.2 (dark-red limit)	0.577	0.309	8.3

[*] Much of the work described in this paper was performed by the late Gunter Wyszecki.

It is believed that this was the first use of CIE colorimetry for the specification of the colour of a national flag.

1972 Modifications

The 1965 specifications were based on illuminant C and on measurements relative to smoked magnesium oxide. Over the next few years, CIE recommendations changed and it was realized that it would be better to have a specification in terms of the new CIE standard illuminant, D_{65} and to use measurements relative to the perfect reflecting diffuser as the reference white.[4] With these changes, the specifications of the two limits became:

Sample	x	y	Y(%)
No.1 (light-orange limit)	0.574	0.315	10.1
No.2 (dark-red limit)	0.579	0.314	8.1

At the same time, it was decided to recommend a single standard colour with tolerances on each coordinate. On this basis, the specification became:

$$x = 0.576 \pm 0.028$$
$$y = 0.315 \pm 0.012$$
$$Y = 9.5 \pm 1.5$$

In later modifications, the tolerances were changed to be expressed in terms of the CMC (2:1) colour-difference formula[5] and a specification was added for the white part of the flag.

The complete specification of the flag, including many other factors in addition to colour, is published as a national standard.[6]

References

1. R.G. Robertson, Letter from Canadian Privy Council Office to E.B. Armstrong, Deputy Minister, Department of National Defence, 1 June 1965.

2. Canadian Broadcasting Corporation Documentary Special: A Flag for Canada, 1 July 2003, http://www.cbc.ca/documentaries/flagforcanada.

3. G. Wyszecki, Specification of Color of Canadian Flag, National Research Council of Canada Memorandum, 20 October 1965.

4. A.R. Robertson, The Colour of the Canadian Flag, National Research Council of Canada Report, PRO-388, September 1972.

5. F.J.J. Clarke, R. McDonald and B. Rigg, Modification to the JPC79 colour-difference formula, J. Soc. Dyers & Colourists, **100**, 128-132 (1984). Errata, J. Soc. Dyers & Colourists, **100**, 281-282 (1984).

6. CAN/CGSB-98.1-2003, Amendment No. 1, Corrgendum No. 1, *National Flag of Canada (Outdoor Use)*, December 2005.

Device dependent linear relative CIELAB data *lab** and colorimetric data for corresponding color input and output on monitors and printers

Klaus Richter
Federal Institute for Materials Research and Testing (BAM)
D-12200 Berlin, Germany

An image includes a large variety of colors and shades. There are many different user requirements between *absolute* and *relative* CIELAB reproduction. The focus of this paper is a *relative* CIELAB reproduction which maintains the CIELAB hue and the *relative* CIELAB chroma and lightness in any hue plane. There is only one solution shown in Fig. 1 which includes the *absolute* and *relative* CIELAB chroma and lightness.

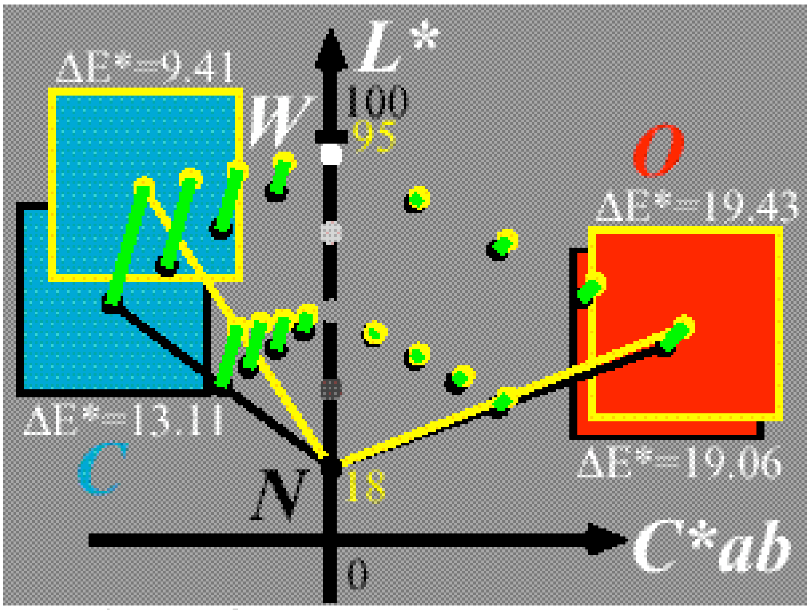


Fig. 1: Monitor and printer colors for complementary colors Orange red (O) and Cyan blue (C) in the CIELAB diagram *(L*, C*ab)*. The delta E* data are CIELAB color differences for the 5 step color series C–W and O–W of the standard monitor and printer.

In Fig. 1 the 5 step color scales C–W and O–W are equally spaced in CIELAB and shown as yellow and black balls at the surface and inside the color gamut. A *linear* relation between the *relative* digital coordinates, for example *rgb* in the file and the measured *absolute* CIELAB chroma and lightness in the CIELAB diagram *(L*, C*ab)* is a basic user requirement. After device linearization for example according to ISO/IEC TR 19797:2004 this is fulfilled and this is the setup_state for an efficient output on monitors or printers. Further for an efficient recognition of the color output the available maximum color gamut of the monitor and printer should be used.

In this paper instead of the color data *rgb* the colorimetric data *rgb** (star coordinates) are used which have a linear relationship to *L** and *C*ab*. For example in Fig. 1 for the achromatic series N–W the three *rgb** data (0.5, 0.5, 0.5) produce the intermediate CIELAB lightness *L** =56.7 = (95.5–18)/2 between black N and white W. Similar for the cyan series C–W the *rgb** data (0.5, 1, 1) produce the intermediate color between C and W. If instead of the color data *rgb* the colorimetric data *rgb** are used then there is a linear relationship to *L** and *C**ab. As a result there is a well defined connection between the colorimetric data *rgb** and the CIELAB data for any color inside and outside the color triangle of Fig. 1 and similar for any hue. For any device, for example for 5x5x5 colors, a table *rgb – L*a*b** is produced by measurement and a table *rgb* – L*a*b** can be calculated. If the device is linearized this table is identical. Otherwise for the same *L*a*b** data a mapping between *rgb** and *rgb* solves the user requirement to produce a linear relation for the *rgb** input data and the CIELAB output.

Many examples and application for an equally spaced input on scanners and an equally spaced output on monitors and printers are given in ISO/IEC TR 24705:2005. From different sources digital ISO/IEC-test charts are available with 16 step color scales which are equally spaced in *rgb** and analog ISO/IEC-test charts with *L*a*b** measurement data for CIE standard illuminant D65, 2 degree, and the 45/0 geometry.

According to Fig. 1 the output on monitors and printers will produce the same CIELAB hue and the same *relative* CIELAB chroma and lightness. If the luminance and the chromaticity of the white point on the monitor and the printer is the same, then the same *relative* **color appearance** is produced. In Fig. 1 the two CIELAB colors on the monitor and the printer of the same hue are called **corresponding colors**.

For a better understanding some more information about the different *rgb* data is added. In image technology there are color and colorimetric data *rgb*. Colorimetric data have a relationship to CIELAB by simple equations, for example the *rgb* data of the color spaces sRGB (IEC 61966-2-1) and Adobe RGB (www.adobe.com). The colorimetric data *rgb** of this paper have additionally a *linear* relationship to CIELAB.

Device	**rbg data**	**Relation to CIELAB**
TV	*rgb* TLS18, not linearized	nonlinear and complex (e.g. tables 9x9x9)
TV	*rgb* sRGB (IEC 61966-2-1)	nonlinear and simple equations
TV	*rgb* Adobe RGB (www.adobe.com)	nonlinear and simple equations
TV	*rgb** TLS18, linearized	linear and simple equations
PR	*rgb* ORS18, not linearized	nonlinear and complex (e.g. tables 9x9x9)
PR	*rgb** ORS18, linearized	linear and simple equations

Table 1: rgb data and relation to CIELAB for monitor (TV) and printer (PR)

According to Fig. 1 the *L** and *C*ab* data of Cyan on the monitor and the printer are different. Therefore for both devices the colorimetric data *rgb* in the sRGB or Adobe RGB color space are different. But for the monitor and printer the colorimetric data *rgb** are equal for the corresponding CIELAB colors of a printer and monitor, for example *rgb** = (0,1,1), if the Cyan on the monitor and the printer has the same hue.

There are *equivalent* color data, for example the CIELAB measurement data *L*a*b** or *L*C*H**. Instead of the absolute coordinates *LAB*LCH* the relative coordinates *lab*lch* are used in image technology. Similar instead of the relative data *lab*rgb* equivalent colorimetric data *lab*cmy* (Cyan, Magenta, Yellow) or *lab*nce* (blackness, chromaticness, elementary hue) are appropriate. A relative color image technology defines the calculations, the coding and the transformations, see Richter (2005). Example ISO/IEC-test charts and device outputs will be shown at the meeting.

References

ISO/IEC TR 19797:2004-09, Device output of 16-step colour scales, output linearization method (LM) and specification of the reproduction properties

ISO/IEC TR 24705:2005-10, Method of specifying image reproduction of colour devices by digital and analog test charts

Klaus Richter, Relative Colour Image Technology (RCIT) and RLAB lab* (2005) Colour Image Encoding, see the URL (73 pages, 900 kByte) http://www.ps.bam.de/RLABE05.PDF

A New Method For Calibrating Colorimeters

Maria Luisa Rastello
Istituto Elettrotecnico Nazionale Galileo Ferraris
Torino, ITALY

Introduction

This paper discusses a new method for calibrating colorimetric devices with a devoted Least- Squares approach, allowing the uncertainty to be taken into proper account.

Let us consider two different colorimetric devices and try to calibrate one with respect to the other. A typical example is to compute the CIE 1931 XYZ tristimulus co-ordinates from the response of a colour camera. Let subscript R denote the reference device and D the device under test, and M be the number of sensors in both devices.

Now let us suppose to have $N > M$ test colors as input to both devices. The output signals from the devices will be denoted by $\Gamma_R \equiv \{\Gamma_{Ri,n}\}$ and $\Gamma_D \equiv \{\Gamma_{Di,n}\}$, respectively, with $i = 1,2,\ldots M$ and $n = 1,2,\ldots N$. Taking into account that both Γ_D and Γ_R are affected by errors $\tilde{\Gamma}_D$ and $\tilde{\Gamma}_D$ with zero averages and different variances, more generally we have

$$\Gamma_{Ri,n} \to \Gamma_{Ri,n} + \tilde{\Gamma}_{Ri,n} \qquad i = 1,2,\ldots M \quad n = 1,2,\ldots N$$

$$\Gamma_{Di,n} \to \Gamma_{Di,n} + \tilde{\Gamma}_{Di,n} \qquad i = 1,2,\ldots M \quad n = 1,2,\ldots N$$

To calibrate the device *D*, we determine a linear transformation *C* such that

$$\Gamma_D \cdot C = \Gamma_R \qquad (1)$$

The conventional Weighted Least Squares (WLS) techniques cannot be applied to solve the over-determined system of linear equations (1), as they assume that independently distributed (i.d.) errors affect only the known terms Γ_R. So, we apply the Least Squares formulation with Element-wise Weighting, hereafter called Element-wise Weighted Least Squares (EWLS), to solve the problem in a appropriate way.

The Element-wise Weighted Least Squares method

EWLS considers linear models described by a linear algebraic system of equations $AX = B$. Here $D := [A, B]$ contains the *measured data* and X is the *parameter* matrix, to be estimated. With less parameters than equations and with noisy data the model equations cannot be exactly satisfied, the residual matrix $R = AX - B$ is considered, and an approximate solution for X is sought.

The classical least squares (LS) approach minimises the *Frobenius norm* of the residual matrix, by applying the correction ΔB with the smallest Frobenius norm to the right-hand side B in order to make the corrected system exactly solvable. The LS method is the best linear unbiased estimator when *A* is noise free and *B* is corrupted by independent and identically distributed (i.i.d.) errors.

The total least squares (TLS) technique is a parameter estimation technique for the linear model when all elements of D are perturbed by i.i.d. errors. In this case, a correction $\Delta D = [\Delta A \, \Delta B]$ is applied on D, so that the corrected system of equations

$(A_0 + \Delta A)X = B_0 + \Delta B$ becomes exactly solvable. Again the smallest correction, according to the Frobenius norm, is sought. The TLS approach requires that all variances are coincident, so in some sense TLS requirements are more strict than WLS ones, where the variances of each known term can be chosen independently, and consequently fit more difficultly to statistics of actual data. The generalisation for the case when the errors are independent but not identically distributed with element-wise different error variances is called *element-wise weighted total least squares* [1].

Solving the EWLS problem consists in finding the optimal values of the problem variables X and ΔD minimising the cost function

$$\min_{X,\Delta D} \sum_{i=1}^{m} \Delta d_i^{\mathrm{T}} \left[V_i^d\right]^{-1} \Delta d_i \qquad \text{subject to} \qquad \left(D + \Delta D\right)\begin{bmatrix} X \\ -I \end{bmatrix} = 0$$

where $\Delta D \equiv \left[\Delta d_1 \quad \Delta d_2 \quad \cdots \quad \Delta d_m\right]^{\mathrm{T}}$ are the correction on measured data to compensate for the measurement error $\widetilde{D}$, random matrices defined as $\widetilde{D} = \left[\widetilde{A} \quad \widetilde{B}\right]$, with zero mean and independent rows $\widetilde{d}_i$ with known $m \times m$ covariance matrices V_i^d.

An example: the calibration of tristimulus colorimeters

Traditionally, for the calibration of a tristimulus head, the CIE illuminant A is recommended, as it is characterized by chromaticity coordinates $\{x_{\mathrm{A}}, y_{\mathrm{A}}, z_{\mathrm{A}}\} = \{0.44758, 0.40745, 0.14497\}$ known *a priori.* Provided a tristimulus head with $M = 3$ channels, x, y, z, is illuminated with a CIE illuminant A source, photocurrents V_x, V_y, V_z are measured. If multiplied with the calibration factors c_x, c_y, c_z the tristimulus values X, Y, Z are found. The values assigned to the calibration factors are found from the solution of the exact equation system defined by

$$\Gamma_D \cdot C = \Gamma_R$$

where $\Gamma_D = \begin{bmatrix} V_x & 0 & 0 \\ 0 & V_y & 0 \\ 0 & 0 & V_z \end{bmatrix}$, $C = \begin{bmatrix} c_x \\ c_y \\ c_z \end{bmatrix}$, and $\Gamma_R = \begin{bmatrix} x_A \\ y_A \\ z_A \end{bmatrix}$.

Calibration factors are simply given by $C = \Gamma_D^{-1} \cdot \Gamma_R$. If the device under test is only to be used for measurements on tungsten based sources, then the calibration could give good results. If this is not the case, you can get odd results. To overcome these drawbacks, the here-proposed method makes use of $i = 1, \ldots, N > M$ test colors and solves the over-determined equation system (1) in a EWLS environment, where

$$\Gamma_D = \begin{bmatrix} \cdots & \cdots & \cdots \\ V_{xi} & V_{yi} & V_{zi} \\ \cdots & \cdots & \cdots \end{bmatrix}, \qquad C = \begin{bmatrix} c_{xx} & c_{xy} & c_{xz} \\ c_{yx} & c_{yy} & c_{yz} \\ c_{zx} & c_{zy} & c_{zz} \end{bmatrix}, \qquad \Gamma_R = \begin{bmatrix} \cdots & \cdots & \cdots \\ X_i & Y_i & Z_i \\ \cdots & \cdots & \cdots \end{bmatrix},$$

and covariance matrices are taken into account appropriately. Experimental results will show the capabilities of the proposed method for accurate calibrations.

[1] Ivan Markovsky, Maria Luisa Rastello, Amedeo Premoli, Alexander Kukush and Sabine Van Huffel, *The element-wise weighted total least-squares problem*, Computational Statistics & Data Analysis, Volume 50, Issue 1, 10 January 2006, Pages 181-209

Test of the transformation of primary space: forward- and inverse-matrix methods.

Boris Oicherman, Ronnier Luo, Alan Robertson*
University of Leeds, Leeds, UK

Introduction

At the basis of the CIE system of colorimetry lies the Trichromatic Generalisation (TG),[1a] which is a mathematical formulation of Grassmann's assumption of additivity, and allows the handling of quantities of colour stimuli in accordance with standard rules of algebra. Assuming the validity of the TG, the result of a colour matching experiment in which a test stimulus is matched in colour by an *additive mixture* of three primary stimuli can be expressed as:

$$\mathbf{Q} = R\mathbf{R} + G\mathbf{G} + B\mathbf{B} \qquad (1)$$

where **Q** is the unit amount of the test stimulus, and its *tristimulus values* R, G and B are the scalar multipliers of unit amounts of the primaries **R**, **G** and **B.**

Furthermore, tristimulus values measured with one set of primaries can be transformed to another set by two methods, both equally valid mathematically.[2] The conventional *inverse-matrix* method requires the knowledge of the tristimulus values of the primaries of the destination system in terms of the source system, and can be summarised as

$$\mathbf{T}_d = \mathbf{M}_I^{-1}\mathbf{T}_s \qquad (2)$$

where $\mathbf{T}_d$ is the 3×1 vector containing the tristimulus values of a test stimulus in the destination primary space d, $\mathbf{T}_s$ is the vector containing the tristimulus values of the same stimulus in the source primary system s, and $\mathbf{M}_I$ is the 3×3 matrix containing the tristimulus values of the primary stimuli of the space d measured by means of the primaries s. The superscript "-1" represents the matrix inverse operation.

An alternative method develops if the tristimulus values of the primaries of the source system in the destination system are known:

$$\mathbf{T}_d = \mathbf{M}_F\mathbf{T}_s \qquad (3)$$

where $\mathbf{M}_F$ is the 3×3 matrix containing the tristimulus values of the primary stimuli of the space s measured by means of the primaries d. This method is denoted as *forward-matrix* in the following text.

Two maximum-saturation[1b] colour matching experiments have been set up to test the TG for the case of single observer using small (2°) and large (6°) fields. Both transformation procedures (Equations (2) and (3)) were used. Apart from the field size, the experimental conditions in the new 2° experiment were identical to the previously reported 6° study.[3] Results concerning the validity of the assumptions of additivity are reported, along with a discussion of the consequences of the choice of the mathematical method of primary space transformation.

Results and Discussion

Two sets of narrow-band primary lights were employed: one similar to the Prime Color[4] (PC) set, and one similar to the final set used by Stiles and Burch[5] in the experiment that led to the 1964 Standard Observer (T, for traditional). One colour-normal observer performed ten repeated matches of each of six stimuli, thus allowing intra-observer variability to be taken into account in analysing the results. The six stimuli were the three primary stimuli of the other set and three "test" narrow-band stimuli: 461, 541 and 661 nm. The matches of the primary stimuli of the other set were used to construct the transformation matrices $\mathbf{M}_I$ and $\mathbf{M}_F$ (Eq. (2) and (3)), which were then used to transform the tristimulus values of the test stimuli between the primary spaces. The Null Hypothesis that the additivity assumption holds in the conditions of our experiment was tested by the statistical T test (at 95% confidence level) of the equality of the tristimulus values measured directly and the values predicted by the models (2) and (3).

* *Authors wish to thank Mike Brill for his helpful comments on the draft of this abstract*

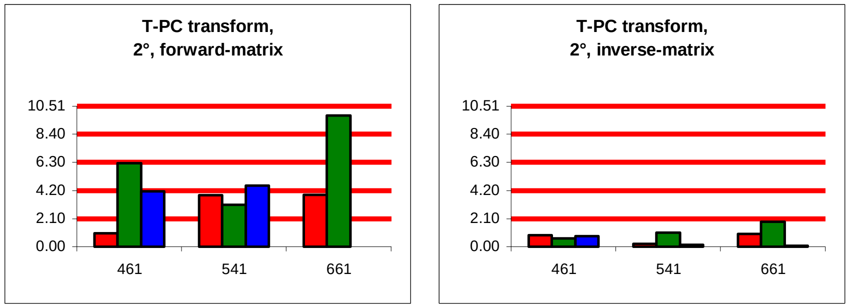


Figure 1: Results of the t-test statistics for each tristimulus value of each test stimulus for the 2° field and two transformation methods. The abscissa indicates the test stimulus in nm; the ordinate indicates the 95% critical values from the t-distribution table. A bar crossing the first gridline signifies a failure of additivity.

The results for the small field and the T-PC transformation are illustrated graphically in Figure 1, which shows a striking difference in the results of the analysis of the same 2° data by the two methods of transformation. When the traditional inverse-matrix method is employed, the results indicate no statistically-significant failure of additivity. With the forward-matrix method, however, the transformation fails for two or more tristimulus values of all three test stimuli. The results for the PC-T transformation for the small field and for both transformation methods for the large field differ slightly in details, but show similar trends.

Numerical analysis of the outcomes of the two procedures reveals that the major cause for the differences in the results they produce is the inflation of experimental uncertainties in the process of the inversion of the matrix $\mathbf{M}_I$ (Eq. (2)). In other words, the results illustrated by the right-hand chart of Figure 1 show no additivity failure merely because of the larger uncertainties entering the Null Hypothesis test, and not because the failure itself does not take place.

Additivity failures have been reported by numerous researchers;[4,6-8] however, there is no general agreement for their possible causes. Zaidi[7] performed perhaps the most comprehensive test of additivity so far; he found intra-observer failures of additivity mainly in matches made in the short-wave region of the spectrum, and concludes that they could be caused by post-receptor processing. The results of the present experiment also indicate statistically significant failures of additivity. However, they also indicate that the choice of the calculation procedure can have a dramatic effect on the conclusions. The consequences of this choice need to be further investigated.

References

1. Wyszecki G, Stiles WS. Color Science, Concepts and Methods, Quantitative Data and Formulae: John Wiley and Sons, Inc.; 1982. a) p. 117 b) p. 293
2. Brill MH, Robertson AR. Open problems on the validity of Grassmann's Laws. Colorimetry: Understanding the CIE System: John Wiley and Sons, Inc.; 2006 (to be published).
3. Oicherman B, Luo RM, Robertson A, Tarrant A. Uncertainty of colour-matching data. 2005; Scottsdale, Arizona, US.
4. Thornton WA. Toward a more accurate and extensible colorimetry, Part I: Introduction. The visual colorimeter-spectroradiometer. Experimental results. Color Research and Application 1992;17:79-122.
5. Stiles WS, Burch JM. NPL colour-matching investigation: final report (1958). Optica Acta 1959;6:1.
6. Blottiau F. Les défaults d'additivité de la colorimétrie trichromatique. Rev. d'Opt. (Théor. Instrum.) 1947;26:193.
7. Crawford BH. Color matching and adaptation. Vision Research 1965;5:71-78.
8. Zaidi Q. Adaptation and Color Matching. Vision Research 1986;26(12):1925-1938.

Additive colour mixing model based on human colour vision

Takako Nonaka*, Morimasa Matsuda**, and Tomohiro Hase*
****Ryukoku University, **Mitsubishi Electronics Microcomputer Application Software Co., Ltd.***
*Otsu, Shiga, Japan, **Nagaokakyo, Kyoto, Japan

Introduction

This paper proposes an analytical model of an additive colour mixing widely applied in fields of colour printing and colour imaging, etc.

First, an outline of the proposed model is shown by using both characteristics of human vision and colour signals of sample images. Next, the human characteristics of colour vision are formulated. Finally, the phenomenon of colour mixture is qualitatively discussed by using analytical results of this proposal.

Outline of an Additive colour mixing model

Figure 1 shows the proposed model of an additive colour mixing in the case where red and green are mixed and looked yellow.

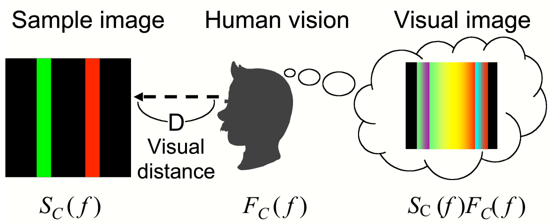


Figure 1. Proposed model of colour mixture based on human colour vision

The proposed model treats the additive colour mixing as the following phenomenon; colour signals of a sample image attenuate because of human colour vision, and overlap with each other.

The colour signals' characteristics of the sample patterns are described as the power spectrum density of the Fourier coefficient $S_C(f)$ of rectangle waves; where f is a spatial frequency [1].

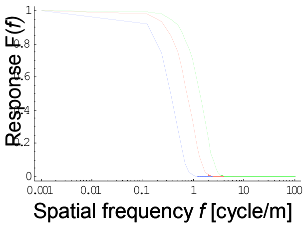
Human visual characteristics of spatial frequency response of colour

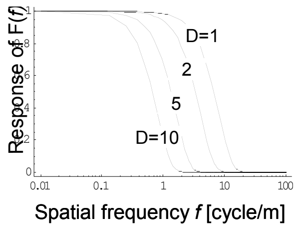
The characteristics of human colour vision are considered as spatial frequency responses of colour here. There have been some experimental reports that a low pass filter (LPF) is a reasonable choice for modeling the visual characteristics of the colour spatial frequency. Therefore, the spatial frequency responses of colour vision are expressed as $F(\nu, \nu_C)$ with the Gaussian LPF in this paper. Where, ν is the frequency [cycle/degree] of the colour in the sample pattern according to the viewing angle. The ν_C [cycle/degree] means the frequency of each colour when the amplitude becomes half of the original. The ν_C of red, green, and blue are applied by referring to Kurahashi's report with the following values [2]; $\nu_R = 5.0$, $\nu_G = 8.8$, and $\nu_B = 2.4$.

The original spatial frequency ν [cycles/degree] is converted by using the frequency of the sample surface f [cycle/m] and the visual distance D [m] as parameters [3]. D means the distance between the sample image and the observer. Therefore, the visual characteristics can be expressed as follows;

$$F(f) = \exp\left\{ -\left[\frac{1}{2\nu_C \cdot \tan^{-1}\left(\frac{1}{2fD} \right)} \right]^2 \right\}. \quad (1)$$

Figure 2a shows analytical examples of Formula 1 for RGB, and Fig. 2b shows the analytical results for green only. When the visual distance D is longer, the characteristics of visual LPF works better.





(a) Each colour (D = 5 m) *(b) Green signal (D = 1, 2, 5, 10 m)*

Figure 2. Analytical examples of visual spatial features with colours and visual distances as parameters.

Analytical results and conclusions

The behavior of the signal is obtained as a multiplication of the signal characteristics $S_C(f)$ and the visual characteristics $FC(f)$ in the frequency domain. The wave shapes of the perceived colour signals in the time domain are calculated by the inverse Fourier transform of $S_C(f) \times FC(f)$. This signal seems to indicate the secondary colour with additive mixing.

Figure 3 shows how the signal behaves under the influence of the human visual LPF. Where, $F^{-1}(x)$ means the inverse Fourier transform of x. When the visual distance D is longer, the waveform of the colour signal becomes broader in the time domain. It is assumed that when more than 10 % density of both the original signals of red and green overlapped with each other, they are seen as yellow here. These results show that the apparent yellow area increases according to the visual distance.

The proposed model can explain qualitatively the process of an additive colour mixing by using the colour arrangement of samples and the visual distance as parameters. Therefore, it can be said that this model simulation will be useful in the efficient design of colour images, optimal colour displays for many purposes, etc.

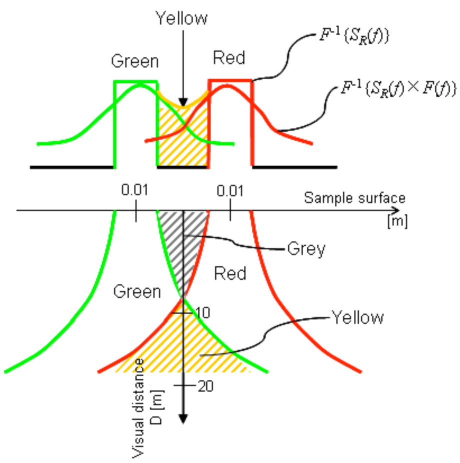


Figure 3. The behavior of colour signals under the influence of human colour vision in the time domain.

References

[1] T. Nonaka, M. Matsuda and T. Hase: Modulation Transfer Function Model of Assimilation Phenomenon Based on Visual Characteristics, *pd. AIC 05*, 983-986, 2005
[2] K. Kurahashi: Visual Color Shifts in Spatial Array of Three Primary Colors, *Journal of the Institute of Television Engineers of Japan*, 40, 5, 392-397, 1986 (in Japanese)
[3] T. Nonaka, M. Matsuda and T. Hase: Two-dimensional Modulation Transfer Function Model of Assimilation Phenomenon, *pd. SMC 2005*, 3035-3042, 2005

Standards for Color Legibility

Thomy Nilsson
University of Prince Edward Island
Charlottetown, P.E.I., Canada

Effective color graphics are the essential front-end of the post-industrial information economy. In most applications, color is used to convey information about the shape of something. Since all visual shapes are defined by their color and the color of their background, information is lost if those color combinations make the shape difficult to see. Yet, until recently there seemed to be no reason to involve color in shape discrimination. Numerous studies had shown that discrimination of colored shapes, such as letters, only depended on the lightness contrast between shape and background.[1]

Let's call how readily a shape can be discriminated as its "legibility". The legibility of colored shapes appeared to depend only on lightness contrast because legibility was defined in terms of the time required for shape recognition. Color combinations of shapes and backgrounds that enabled more rapid recognition were considered more legible. Unfortunately, this definition overlooked the fact that color information is conveyed by slow conducting parvo-cellular visual pathways, while lightness contrast is conveyed by rapid conducting magno-cellular pathways. Thus when asked to respond as quickly as possible, decisions about shape were made primarily on the basis of the information that arrived first - the color information was not used. When color is involved, legibility can not be operationally defined in terms of processing speed.

In fact, legibility is more commonly defined in terms that relate to the number of visual pathways needed to convey enough information to enable recognition of shapes such as letters. That number depends on the size of the image, which is readily measured in terms of the size and distance (i.e. visual angle) of the letters. Thus the 20/20 system uses letters of standard color (black/white), lightness contrast, and various sizes, to measure observer acuity in terms of distance. With a standard observer, this procedure can be reversed to measure legibility in terms of distance.

Several studies have used observers with normal color vision and the method of limits to measure recognition distance thresholds of colored letters and other shapes viewed against colored backgrounds.[2] Colors of the printed shapes were standardized in terms of the Pantone System and the Natural Color System as illuminated by a close approximation to standard illuminant A. These legibility measurements differ markedly from those based on recognition time. Several color combinations were found to be significantly more legible than black/white for letters, symbols and line drawings. Therefore, color legibility can not depend only on lightness contrast. Indeed, the best. colorimetric prediction of legibility ® = .95) had a larger factor for chromaticity than for lightness contrast. A colorimetric standard to define color legibility looked promising.

However, this success was based only on combinations of the six primary colors: black, white, red, yellow, green, blue. When 100 color combinations that included intermediate colors (like orange) and some saturation and lightness variations (like pink and brown) were tested, legibility could no longer be predicted from colorimetry.[3] The best equations could account for barely one-third of the variance. There is no colorimetric solution to color legibility.

One way then to ensure color legibility is to establish a guideline list of color combinations and their legibility distance thresholds. Since legibility distances involve the same metric as 20/20 descriptions of acuity, minimal legibility criteria for such a list could be set on the basis of the acuity of intended viewers and the viewing conditions. Following the example of the 20/20 system, the distance threshold of black/white could be used as a reference, and the other colors rated according to the ratio of their distance thresholds to that of black/white. This ratio varies somewhat from subjective evaluations of legibility - more noticeably so the greater its difference from 1/1. The reason becomes clear when one considers that legibility distances are not proportional to retinal image area and the number of visual pathways required for recognition. An inverse ratio of legibility distances-squared, "relative legibility", provides a better fit to subjective judgements.

The problem with a standard legibility list is the vast number of colors. Expanding such alist from 100 selected color combinations to the combinations of even a few hundred colors would be an impossible task. A general solution to establishing standards for color legibility is needed.

An alternative is a dynamic standard that specifies a certain method of measuring legibility. The method proposed uses observers who are similar to a standard observer and a legibility reference standard which for printed text would be a certain message printed in black/white using a font such as Helvetica Medium. The procedure uses the method of limits to measuring legibility distance thresholds. The colored targets are illuminated by a standard source such as illuminant A, which is readily approximated by 100 watt incandescent bulbs. This illumination should be incident from 45 degrees on each side as recommended by ASTM: D1729-89 to ensure uniformity. Further specification of the apparatus and procedure to include font size, source distance, geometry of an enclosure to eliminate glare and stray light, motion speed and available distance, a minimum standard error, etc. also need to be considered and involve some interactions. (A 35 pt font, 8 meter range, and 14 cm/sec speed were a suitable combination using readily available technology.)

The proposed standard method would compare the legibility distance threshold of any color combination displayed as text to the threshold of the black/white standard. It could also be used for symbols and other graphics. Acceptability of any color combination would require an agreed minimum relative legibility value such as 68%. The proposed method would be robust since slight differences that changed legibility distance of the tested colors would have a similar effect on the standard.

1. Knoblauch K, Arditi A & Szlyk J (1991) *J.O.S.A. A*, 8, 428-439. Legge GE & Rubin GS (1986) *J.O.S.A. A*, 3, 40-51. Tinker MA (1963) *Legibility of Print*. Iowa St.U.Press.
2. Nilsson TH & Connolly GK (1997) *Invest. Opthal. & Vis. Sci.* 38, S640, abs. Nilsson TH & Kaiserman M (2004) Legibility of warnings in color, in I Noyes & W Karwowski (eds) *Handbook Human Factors in Litigation*, Taylor & Francis, 32 1-18.
3. Nilsson TH (2005) *Proceedings of the 10th Congress of the International Colour*

Association (AIC), 749-752. <www.upei.ca/~psych/color.pdf>

Individual Difference of Color Matching Functions and Its Cause

Y. Nakano, Y. Nakayasu, H. Morita, K. Suehara, J. Kohda, T. Yano
Hiroshima City University / Dept. of Information Machines & Interfaces
Hiroshima / Japan

Abstract

Using a new colorimeter that can present a color having an arbitrary spectral power distribution, we measured color matching functions for 9 individuals, and analyzed a cause of their individual difference. We found that a main cause of the individual difference is the difference of individual spectral lens density.

Introduction

Recently, several studies showed that CIE standard observer fails to predict individual color-matches[1-2] and it causes serious problem in practical applications such as designing new color display using six-color primaries[3]. There are two possible reasons why standard observer fails to predict color-matches: 1. additivity of color matching is failing, 2. individual color matching functions are different from those of the standard observer. To test these possibilities, we developed a new colorimeter that can present a color having an arbitrary spectral power distribution by utilizing a digital micro-mirror device developed by Texas Instruments as spectrum modulation engine. We first applied this colorimeter to test the additivity of the color matching functions and found its failure is small[4]. In this study, we applied the colorimeter to measure color matching functions for individual observers and analyzed the cause of the individual differences.

Methods

The colorimeter we developed can control the powers of 31 monochromatic lights from 400 nm to 700 nm in 10 nm intervals independently. Color matches were conducted between a test light and a reference light. The test light composed of about 16 monochromatic lights according to 32 bits M-sequence pattern where each bit correspond to one of 31 monochromatic lights, and the reference light composed of three primary colors having the wavelengths of 450, 540 and 610 nm. Observer adjusted powers of three primary colors so as to match the color appearance to the test light for 31 independent M-sequence patterns. RGB color matching functions of wavelength λ were then calculated by solving the following equation,

$$\begin{pmatrix} D_{1,400} & D_{1,410} & \cdots & D_{1,700} \\ D_{2,400} & D_{2,410} & \cdots & D_{2,700} \\ \vdots & \vdots & \ddots & \vdots \\ D_{31,400} & D_{31,410} & \cdots & D_{31,700} \end{pmatrix} \begin{pmatrix} \bar{r}_{400} & \bar{g}_{400} & \bar{b}_{400} \\ \bar{r}_{410} & \bar{g}_{410} & \bar{b}_{410} \\ \vdots & \vdots & \vdots \\ \bar{r}_{700} & \bar{g}_{700} & \bar{b}_{700} \end{pmatrix} = \begin{pmatrix} R_1 & G_1 & B_1 \\ R_2 & G_2 & B_2 \\ \vdots & \vdots & \vdots \\ R_{31} & G_{31} & B_{31} \end{pmatrix}$$

where $D_{i,\lambda}$ represents the spectral power distribution of ith M-sequence pattern, $\bar{r}_\lambda$, $\bar{g}_\lambda$ and $\bar{b}_\lambda$ represent color matching functions, and R_i, G_i and B_i represent the powers of the three primaries matched to the test light by the observer for ith M-sequence pattern.

Results

Figure 1 shows the results of the above measurements and the calculations for 9 observers. The results showed that reasonable color matching functions were obtained compare to the CIE 1931 color matching functions as shown in thick dotted lines except for short wavelength region. Large deviations from CIE color matching functions and large individual differences were observed in the short wavelength region. One of 9 observers was age 42 who showed lowest B color matching function, and the ages of other observers were early 20's who showed higher B color matching functions in the short wavelength region. From this observation, we hypothesized that the main cause of the individual differences were the individual differences of spectral lens density. To prove this hypothesis, we estimated spectral lens density for two observers of age 42 and 22 by comparing dark adapted peripheral sensitivity (rod sensitivity) to the action spectrum of rhodopsin. We found that color matching functions of the two observers become close to each other by compensating individual spectral lens density.

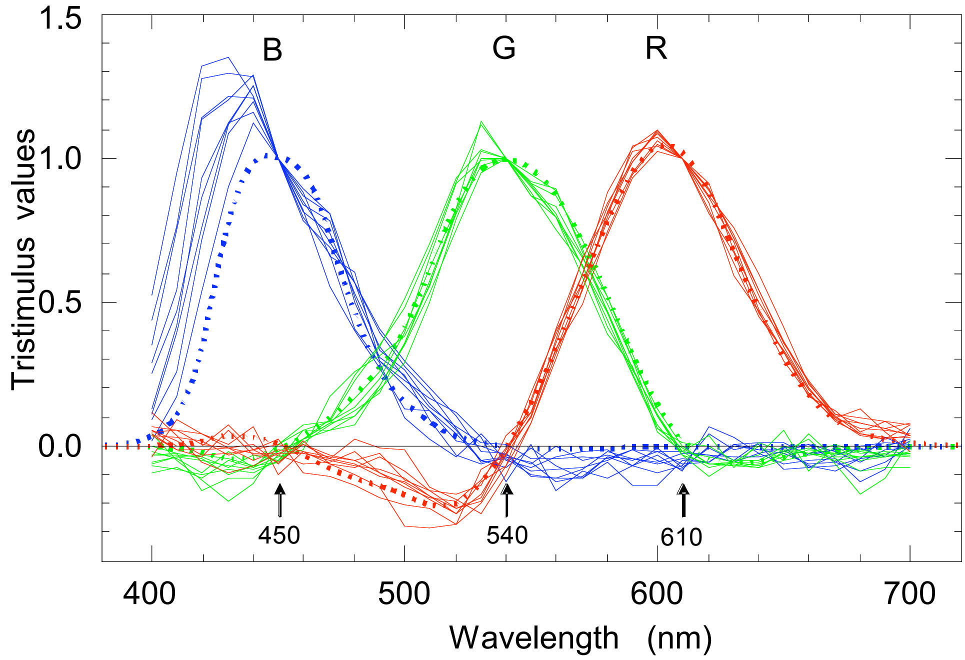


Figure 1. RGB color matching functions for 9 observers (solid lines). Thick dotted lines are the CIE 1931 color matching functions adapted to our RGB primaries.

References

1. Thornton W A, Toward a more accurate and extensible colorimetry. Part I. Introduction. The visual colorimeter-spectroradiometer. Experimental Results, *Color Res. Appl.,* **17,** 79-122, 1992.
2. Alfvin R L and Fairchild M D, Observer variability in metameric color matches using color reproduction media, *Color Res. Appl.,* **22,** 174-188, 1997.
3. Ohsawa K, Teraji T, König F, Yamaguchi M and Ohyama N, Color matching experiment using 6-primary display, Personal communication.
4. Nakano Y, Moriki H, Suehara K, Kohda J and Yano T, Polychrometer using digital micro-mirror device and its application to additivity test of color matching, *Proceedings of the 25th session of the CIE,* Vol.1, Division 1, pp.56-59, San Diego, USA, 2003.

Colour Difference Formulae: Past, Present and Future

M. Ronnier Luo
University of Leeds, Leeds, UK

Introduction

The *Commission Internationale de l'Eclairage* (CIE) is responsible for the development of international colour standards. One important goal is to establish a colour difference formula that would provide objective colour decision-making to colour-using industries, i.e. a pass/fail decision based on a single number colour difference value (ΔE) from a standard, regardless of the colour of the standard. Over 40 colour difference formulae have been developed since the first CIE colorimetric system.[1] Table 1 lists most of them. The goal has been growing closer via the latest CIE recommendation, the CIEDE2000 formula.[2] This paper reviews the important development according to three different periods: before 1976 (the adoption of CIELAB and CIELUV [1]), between 1976 to 2001 (the recommendation of CIEDE2000) and after 2001. In the final period, new research areas have been identified and some recent results will be introduced.

The Formulae Developed Before 1976

Over twenty formulae were derived before 1976. They can be grouped into three families, i.e. those derived to fit MacAdam ellipses,[3] to fit the Munsell data,[4] to be linearly transformed from the CIE tristimulus colour space. The Munsell system was based on steps of equal visual perception. The spacing of the colour samples was intensively studied by the Optical Society of America and the CIE tristimulus values of ideally spaced samples were published in 1943.[4] It can be considered the earliest colour discrimination data and demonstrated the non-uniformity of the CIE XYZ system. The earlist Munsell based colour difference formulae is the Nickerson's index of fading[5] and the most successful formula in this family is ANLAB.[6] A series of cube root formulae were later derived to simplify the ANLAB formula which involves a cumbersome fifth-order polynomial function. This resulted in the CIELAB colour difference formula introduced in 1976.[1]

The MacAdam data[3] including 24 colour centres were studied using a split field visual colorimeter. This set of data also demonstrated the poor uniformity of the CIE XYZ system. Although a number of formulae were developed from the data, none of these formulae are widely used now because large differences have been found between the experimental results based on visual colorimeter and surface colours.

The formulae in the family of linear transformation from XYZ have been widely used for additive colour mixing such as that involving coloured lights and emissive phosphor displays. Some earlier formulae were developed including the CIE U*V*W* apace.[7] In 1976, it was refined to become CIELUV.[1]

CIELAB and CIELUV have been widely used, mainly because it is relatively easy to relate colours as seen with positions on the diagram. The ΔE values are calculations of the distance between the standard and sample in these spaces. They are used for industries concerned with subtractive mixture (surface colorant) and additive mixture of coloured light (TV), respectively.

The Formulae Developed Between 1976 and 2001

As mentioned in the last section, the formulae developed before 1976 were mainly derived to fit the Munsell and MacAdam data. The viewing conditions applied in these experiments are very different from those used in industries. With this in mind, many sets of experimental results were published. Most of them were conducted using large surface samples viewed under typical industrial viewing conditions. The medium to small colour-difference data sets show that CIELAB and CIELUV formulae do not accurately quantify small to medium size colour differences. Of these, the important data sets in terms of larger number of observers and sample pairs, smaller observer variations, are those accumulated by Luo and Rigg,[8] RIT-Dupont,[9] Kim and Nobbs,[10] Witt.[11] These data sets were used to develop more advanced formulae based on modifications to the CIELAB formula: *CMC(l:c),*[12] *BFD(l:c),*[13] CIE94.[14] (In general, one or two of these data sets were used to develop each formula.) All these formulae showed a much better improvement than

CIELAB in predicting the available data sets. However, detailed comparisons of these formulae reveal there are large discrepancies between their structures.

With this in mind, a CIE Technical Committee (TC) 1-47 on Hue and Lightness Dependent Correction to Industrial Colour Difference Evaluation was formed in 1998. After close collaboration between the TC members, a new formula, named CIEDE2000, was recommended by CIE in 2001. It includes five corrections to CIELAB: a lightness weighting function, a chroma weighting function, a hue weighting function, an interactive term between chroma and hue differences for improving the performance for blue colours, and a factor for re-scaling the CIELAB a^* scale for improving the performance for grey colours. The results showed that there is a considerable improvement from the more advanced formulae such as CIE94 or CMC to CIEDE2000 for all individual data sets.

Development Since 2001

As mentioned earlier, a very good colour difference formula, CIEDE2000 was developed. This great breakthrough is mainly due to the accumulation of many comprehensive and reliable data sets. However, new directions in colour difference research have been identified and described below.

- Almost all of the recent efforts have been spent on the modifications of CIELAB. CIE TC1-55 was formed to recommend a new perceptually uniform colour space from colour vision theories. Uniform colour spaces [15] based upon a colour appearance model such as CIECAM02 [16] could be an ideal solution.

- All colour difference formulae can only be used in a set of reference viewing conditions defined by the CIE.[14] It will be valuable to accumulate new data to investigate the visual effect due to variation of viewing parameters such as illuminant, coloured background, medium, physical size, colour difference magnitude, separation, texture, luminance level.[17,18] Subsequently, a formula capable of taking into account different viewing parameters can be derived.

- Almost all of the colour difference formulae were developed only to predict the colour difference between a pair of large single objects/patches. More and more applications require to predict colour differences between a pair of pictorial images. The current formula does not include necessary components to consider spatial variations for evaluating images. There is a need to develop a formula for this purpose.[19]

References

1. CIE, Colorimetry, CIE Pb. 15:2004, Central Bureau of the CIE, Vienna, 2004.
2. Luo M. R., Cui G. H. and Rigg B., The development of the CIE 2000 colour difference formula, *Color Res. Appl.* 26, 340-350, 2001.
3. MacAdam D.L., Visual sensitivities to color differences in daylight, *J. Opt. Soc. Am.,* 32, 247-274, 1942.
4. Newhall S. M., Nickerson D. and Judd D. B., Final report of the O.S.A. subcommittee on spacing of the Munsell colors, *J. Opt. Soc. Am.*, 33, 385-418, 1943.
5. Nickerson D, The specification of color tolerance, *Tex. Res.*, 6, 505-514,1936.
6. Adams E. Q., X-Z planes in the 1931 ICI system of colorimetry, *J. Opt. Soc. Am.,* 32,168-173, 1942.
7. Wyszecki G., Proposal for a new colour-difference formula, *J. Opt. Soc. Am.,* 53, 1318-1319, 1963.
8. Luo M. R. and Rigg B., Chromaticity-discrimination ellipses for surface colours, *Color Res. Appl.* 11, 25-42, 1986.
9. Berns R. S., Alman D. H., Reniff L, Snyder G. D. and Balonon-Rosen M. R., Visual Determination of Suprathreshold Color-Difference Tolerances Using Probit Analysis. *Col Res Appl.* 16, 297-316, 1991.
10. Kim H. and Nobbs J. H., New weighting functions for the weighted CIELAB colour difference formula, Proc. Colour 97 Kyoto, Vol. 1, 446-449 (1997).
11. Witt K., Geometric relations between scales of small colour differences. *Color Res. Appl.* **24**, 78-92 (1999).
12. Clarke F. J. J., McDonald R., and Rigg B., Modification to the JPC79 colour-difference formula. *J Soc Dyers Col.*, 100, 128-132 and 281-282, 1984.

13. Luo M. R. and Rigg B., *BFD(l:c)* colour difference formula, Part I- Development of the formula, *J. Soc.Dyers Col.* 103, 86-94, 1987.
14. CIE (1995), Industrial Colour-Difference Evaluation, CIE Publ.116, Central Bureau of the CIE, Vienna, Austria.
15. Luo M. R., Cui G., Li C., Uniform Colour Spaces Based on CIECAM02 Colour Appearance Model, *Col. Res. Appl.,* 31, 000-000, 2006.
16. CIE. A colour appearance model for colour management systems: CIECAM02, CIE Pub. 159 (2004).
17. Cui G. H., Luo M. R., Rigg B. and Li W, Colour-difference evaluation using CRT colours. Part I: Data gathering, *Col. Res. Appl.,* 26, 394-402, 2001.
18. S. S. Guan and M. R. Luo, Investigation of parametric effects using large colour differences, *Color Res. Appl.*, **24** pp356-368 (1999).
19. X. M. Zhang and B. A. Wandell (1996), A spatial extension of CIELAB for digital color image reproduction, Proc. of the 4th IS&T/SID Color maging Conference.

Table 1 A list of most of the colour difference formulae.

Category of formulae	Munsell Data	MacAdam Data	Linear transfromation from XYZ	Other
Before 1976				
1935			Judd	
1936	Index of Fading			
1937			MacAdam	
1939	Balinkin			
1942			JHNBS	
1943	Munsell Renotation			
1944	ANLAB			
1946	Saunderson & Milner			
1951	Godlove			
1955				DIN
1958	Reilley cube root	Simon-Goodwin	Hunter LAB	
1963			CIEU*V*W*	
1965		Friele		
1967		FMC-I		
1969	Moton cube root			
1971	MLR	FMC-II		
1972	MCR			
1974	ΔEa			OSA
1976	CIELAB		CIELUV	
After 1976				
1978		FCM		
1980	JPC79	LABHNU		
1984	CMC	ATD		
1986		SVF		
1987	BFD			
1991	KC-III			
1995	CIE94			
1997	LCD			
1999	Kuehni			
2001	CIEDE2000	Oleari		

Intransitive colour matching and metamerism

Alexander D. Logvinenko

Department of Vision Sciences, Glasgow Caledonian University, Glasgow, UK

Human colour vision starts from processing light by three colour mechanisms (presumably, the cone photoreceptors). The spectral sensitivity of these mechanisms (cone fundamentals) is supposed to be derived from colour matching data. Specifically, the cone fundamentals are assumed to be a linear transformation of the colour matching functions (Smith & Pokorny, 2003). This linear relationship results from Grassmann's laws which are widely believed to take place for colour matching (Wyszecki & Stiles, 1982, p. 118). Two most important of these are
Law of transitivity:

$$\text{for any lights } a, b, \text{ and } c, \text{ if } a \text{ matches } b \text{ and } b \text{ matches } c, \text{ then } a \text{ matches } c. \quad (1)$$

Law of additivity:

$$\text{for any lights } a, b, \text{ and } c,\ a \text{ matches } b \text{ if and only if } (a+c) \text{ matches } (b+c)\,. \quad (2)$$

Lights a and b are believed to match each other (i.e., to be subjectively indistinguishable) if, and only if, the response of each of the colour mechanisms to the light a equals that to light b. However, there is every indication that colour match does not entail the equality of the colour mechanisms' responses. There are some lights that produce different cone responses, and yet a human observer cannot distinguish between them. For example, two monochromatic lights with close wavelengths. Such lights will match each other despite that the colour mechanisms' responses to them are different.

It follows that colour matching is not transitive. Indeed, in a series of monochromatic lights, $\delta(\lambda), \delta(\lambda+\Delta\lambda), \delta(\lambda+2\Delta\lambda), \ldots, \delta(\lambda+n\Delta\lambda)$, each adjacent pair $\delta(\lambda+i\Delta\lambda)$ and $\delta(\lambda+(i+1)\Delta\lambda)$ may match each other provided $\Delta\lambda$ is small enough. However, the pair $\delta(\lambda)$ and $\delta(\lambda+n\Delta\lambda)$ will obviously be well discriminable (i.e., mismatch each other) for sufficiently large n. While the intransitivity of human colour matching judgements is often assumed to be due to "piling up of small errors" which "must be eliminated by making matches with sufficient statistical precision" (Krantz, 1975, p. 289), it can not be reduced to statistical inference, not to mention ignored.

If one defines metamerism as the equality of the colour mechanisms' responses (i.e., lights a and b are metameric if and only if the response of each colour mechanism to light a equals that to the light b), then metamerism implies colour matching but the converse is not true. This may happen when an observer judges that lights a and b match each other when the response of each colour mechanism to light a is close enough (but not necessarily equal) to that to light b. In the latter case colour matching will be reflexive and symmetric but not transitive.

Moreover, failure to meet the transitivity law (1) implies that of the additivity law (2). Specifically, we prove that if (2) holds for a reflexive and symmetric relation σ then it is transitive. This is in line with those who claimed invalidity of the additivity law on experimental grounds (Thornton, 1992b, 1992a).

In this report we show how metamerism can be defined in terms of colour matching (when the latter is not transitive) so as to satisfy Grassmann's law.

Let A be a set of all lights considered as visual stimuli. Let σ be a *colour matching relation* on A. Thus, $x\sigma y$ stands for "x and y match each other". We assume that σ is a reflexive (for each a $a\sigma a$) and symmetric ($a\sigma b$ implies $b\sigma a$) binary relation on A. Let us define a binary relation $\sim_\sigma$ on A (called *matching metamerism*) as follows. For each a and b in A

$$a \sim_\sigma b \text{ if, and only if, for each } c \in A \; a\sigma c \Leftrightarrow b\sigma c. \tag{3}$$

Therefore, two lights, a and b, are metameric if, and only if, they can substitute each other without breaking matching relation with any light c.

We establish laws which intransitive colour matching σ should follow so that the metamerism $\sim_\sigma$ satisfies Grassmann's laws. Firstly, we prove that colour matching metamerism $\sim_\sigma$ is an equivalence relation providing σ is reflexive and symmetric. Secondly, denote $\sigma(x)$ the set of all lights which match x, that is, $\sigma(x) = \{y \in A : x\sigma y\}$. We prove that $\sim_\sigma$ meets the additivity law (2), and Proportionality law (Wyszecki & Stiles, 1982, p. 118), if the following two axioms are satisfied:

Law of translatory invariance

$$\text{for any lights } a, b, \text{ and } c, \; \sigma(a) = \sigma(b) \text{ if and only if } \sigma(a+c) = \sigma(b+c)\,. \tag{4}$$

Law of positive homogeneity

$$\text{for any lights } a \text{ and } b, \text{ and } t > 0, \text{ if } \sigma(a) = \sigma(b)\,, \text{ then } \sigma(ta) = \sigma(tb)\,. \tag{5}$$

Since $a \sim_\sigma b \Leftrightarrow \sigma(a) = \sigma(b)$, then the law of translatory invariance (4) entails the additivity law for $\sim_\sigma$ (i.e., for any a, b, and c in A if $a \sim_\sigma b$ then $(a+c) \sim_\sigma (b+c)$), and the law of positive homogeneity (5) entails the proportionality law (i.e., for any a, b in A and any positive real number t, if $a \sim_\sigma b$ then $ta \sim_\sigma tb$).

The law of translatory invariance (4) means that if the set of the lights matching light a is equal to that of b, then the set of the lights matching light $a+c$ will be equal to that of $b+c$. More specifically, if light a can substitute light b without breaking matching relation with an arbitrary light, then so will the mixture of light a with any light c for the mixture of lights b and c.

The law of positive homogeneity (5) implies that if the light a can substitute the light b without breaking matching relation with an arbitrary light, then it can also be done when the intensity of the lights a and b changes by a factor t. While these axioms are to be tested experimentally, they do not seem to contradict any known fact concerning colour matching (at least to the author's knowledge).

A serious consequence of the invalidity of the additivity and transitivity laws for colour matching is that the cone fundamentals cannot be derived from the colour matching functions. Indeed, if these laws fail then the cone fundamentals are not a linear transformation of the colour matching functions. Besides, if the colour match between lights a and b does not imply the equality of the colour mechanisms' responses to these lights, then there should be some volume around any point in the cone excitation space such that any other light the colour signal of which is inside this volume, will be a match. There is an indication that these volumes are not symmetrical (Logvinenko, Tyurin, & Sawey, 2002). Therefore, averaging matching data brings about a biased estimate of the volume center. This, in turn, will affect the estimate of the cone fundamentals.

The spectral sensitivity of the hypothetical colour mechanisms underlying intransitive colour matching, can be evaluated by using psychophysical techniques similar to those developed for measuring spatial and temporal sensitivity of visual channels (Logvinenko, 1995, 2003).

References

Krantz, D. H. (1975). Color measurement and color theory: I. Representation theorem for Grassmann structures. *Journal of Mathematical Psychology*, *12*, 283-303.

Logvinenko, A. D. (1995). On deriving analyser characteristics from summation-at-threshold data. *Biological Cybernetics*, *73*, 547–552.

Logvinenko, A. D. (2003). Method of quadratic approximation: A new approach to identification of analysers and channels in human vision. *Journal of Mathematical Psychology*, *47*(5-6), 495–506.

Logvinenko, A. D., Tyurin, Y. N., & Sawey, M. (2002). Equi-discrimination contours around an achromatic colour are convex but not balanced. *Journal of Mathematical Psychology*, *46*(4), 486–509.

Smith, V. C., & Pokorny, J. (2003). Color matching and color discrimination. In S. K. Shevell (Ed.), *The science of color* (2nd ed., pp. 103–148). Amsterdam e.a.: Elsevier.

Thornton, W. A. (1992a). Toward a more accurate and extensible colorimetry, Part II: Discussion. *Color Research and Application*, *17*, 162–186.

Thornton, W. A. (1992b). Toward a more accurate and extensible colorimetry, Part I: Introduction. The visual colorimeter-spectroradiometer. experimental results. *Color Research and Application*, *17*, 79–122.

Wyszecki, G., & Stiles, W. S. (1982). *Color science: Concepts and methods, quantitative data and formulae* (2nd ed.). New York: John Wiley and Sons.

Full 3D BSDF spectroradiometer

*F. Leloup, T. De Waele, J. Versluys, P. Hanselaer, M. Pointer**
*KaHo St.-Lieven, NPL**
Gent, Belgium/*Teddington,UK

Introduction

To expedite colour and gloss measurements, the CIE has recommended some basic geometries regarding illumination and viewing angles. For colour measurements, the 45:0 geometry, d:8 geometry and multi-angle geometry are recommended in reflection as well as in transmission. Gloss measurement requires angles of incidence of 20°, 60° or 85° dependent on the gloss value. These specific geometries are usually implemented in colour and gloss measuring instruments respectively.

There are, however, many surfaces that cannot be adequately measured using such limited conditions. Gonio-apparent or special-effect colours (e.g. coloured, metallic finishes, applied to many automobiles) which change in colour according to the angle of illumination and viewing, have rapidly grown in popularity over the last 50 years. Nowadays, dramatic colour effects can be achieved. Furthermore, gloss values of very matt and black samples are too low to be measured accurately by industrial gloss meters.

Any gloss and colour measurement can be related to some particular value of the general spectral Bidirectional Scatter Distribution Function (BSDF). The use of a multifunctional spectroradiometer to measure this BSDF is an interesting tool to study all issues related to colour and gloss characterization.

Description

In our laboratory, we have built a goniospectroradiometer which allows us to determine the absolute Bidirectional Scatter Distribution Function (BSDF) of an object (Fig. 1). Spectral properties can be measured at any spherical angle of illumination of the sample and at almost any spherical viewing angle using a detector circulating around the sample with two degrees of freedom. A Xenon light source is used for the illumination of the specimen. Having large emission intensities in the blue-violet region of the spectrum, a good signal to noise ratio can be achieved over the whole visible spectrum. While measuring the dark current, the incident light beam is directed to a silicon photodiode. The response of this detector allows us to compensate for the fluctuations in the light source output. The detector head consists of a lens and a very small integrating cavity which is coupled to a spectrometer/CCD detection system with a quartz fibre. The fibre is immobile during measurements. The spectral bandwidth is 10 nm. The diameter of the lens is 20 mm. The distance from the specimen to the detector head is 750 mm. An aperture stop before the lens enables us to decrease the angular resolution below 1.5°. The use of an automated filter-wheel carrying three neutral density filters and of the CCD integration time results in a dynamic range of 6 decades. This is necessary as we measure the incident power on the sample with the same detector head. Absolute spectral BSDF-values can be calculated from dark current corrected CCD readings (counts) according to ASTM E1392.

Fig. 1 Picture of the BSDF goniospectroradiometer

Measurements

Absolute test measurements were executed on the CERAM matt tile and a good agreement with NPL measurements was obtained. Regular transmittance of a glass plate indicate 92% as expected. BRDF values as low as 0.015 sr^{-1} on a black textured PU sheet used in automobile dashboards were obtained.

Finally, we did a full characterization of a gonio-apparent ChromaFlair® sample, of a glass plate with a dichroic coating and of a set of black, grey and white NCS gloss samples. In Fig. 2, gloss measurements on different grey NCS gloss scale samples, with an angle of incidence of 60° are shown.

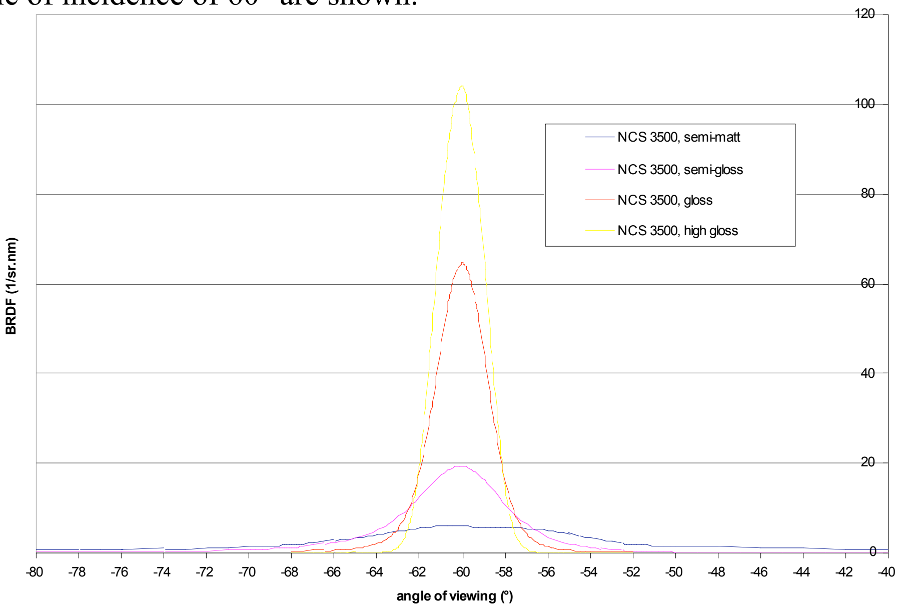


Fig. 2.Gloss measurements on the NCS gloss scale colour 3500

Trials on Integrating Spatial Information in Color Appearance Models

Mohamed-Chaker Larabi, Olivier Tulet, Christine Fernandez-Maloigne
University of Poitiers, SIC Laboratory
Poitiers, France
larabi@sic.univ-poitiers.fr

Introduction

The goal of this study is to model the influence of spatial frequencies on color perception. This model aims to correct the variation on perception like the current models do with flat stimuli. To create this model and to introduce the influence of the spatial frequencies on the perceptual features we conduct a psychophysical campaign.

The aim of this study is to extract a model of the behaviors of the HVS with regards to spatially modulated stimuli. These tests allow to measure the variation perceived between a flat pattern with a given color and a pattern with the same color, to which a given spatial frequency has been added, on the three output parameters of the CAM.

The experiments are conducted in a dedicated room, which respects standard conditions (lightness, screen calibration,…).

Experimentation

Test pattern

For this study, we used rectangular pattern of 11.8 degrees of visual angle. The modulating frequency varies from 1 cpd to 17 cpd. The patterns are constructed with three primary colors (red, green, blue). This property allows obtaining 63 configurations. The Figure 1 gives a snapshot of the test on the screen.

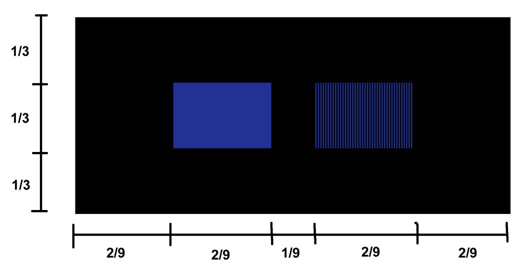


Figure 1 – Psycho Visual Test

Test procedure

In this psychophysical test, the observer is asked to tune some color properties such as (lightness J, Brightness Q and hue h) in order to obtain a perceptual similarity between a flat stimulus and another modulated by a spatial frequency.

This preliminary study has been realized with one background in order to reduce the number of psychophysical tests that are very difficult to construct and are time consuming. The test procedure is the following:

The observer is installed in the psychophysical test-room at a fixed distance from the display after a measure of visual acuity and a verification of color blindness. The test procedure is explained to him with the different tasks to do.

When the test starts, the observer is asked to tune only one of the three criteria (J, Q, h) of the modulated pattern in order to obtain similar color with the flat one. Notice that the tuning criterion is improved by the test. This last step is repeated 63 times with 7 frequencies, 3 primary colors and 3 criteria. Notice that the test sequence is randomized and the starting color of the modulated stimulus is randomized too.

Test observers

With regard the recommendations given by ITU [7] the number of observers must be greater or equal to 15. Table 1 gives the repartition between men and women and vision affections.

	Normal	Myopic	Other affections	Total
Men	10	5	1	16
Women	2	3	0	5
Total	12	8	1	21

Table 1– Table of observers.

Results and discussion

This section gives the results of the experiments described above. These experiments allow us to characterize the variation of the color perception according to the spatial frequencies.

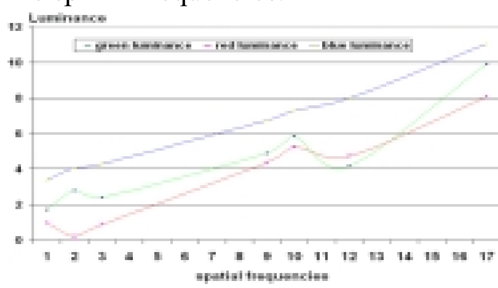


Figure 2 – Luminance perceived function of spatial frequencies on a black background

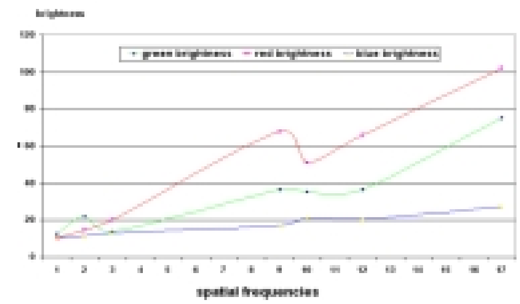


Figure 3 – Brightness perceived function of spatial frequencies on a black background.

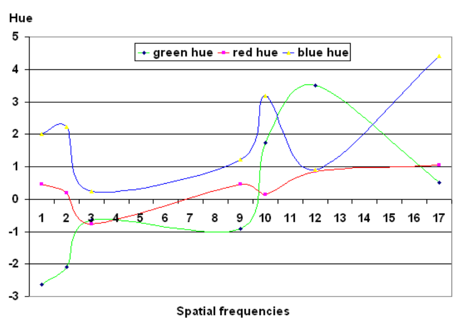


Figure 4 – Hue perceived function of spatial frequencies on a black background.

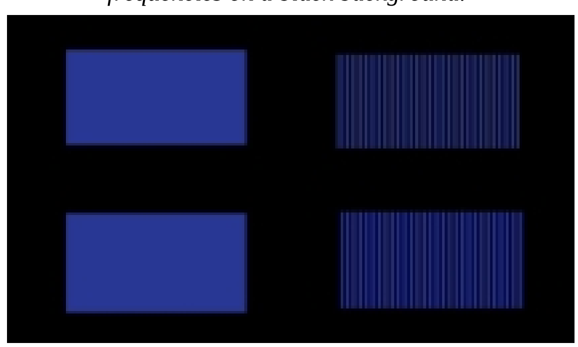


Figure 5 – Example of corrected pattern.

Figure 2, 3 and 4 show the gap perceived by the observer between a flat pattern and a modulated one for the three criteria (J, Q, h).

These figures show that on a black background the perceived difference on luminance and brightness increases according to the increases of spatial frequency.

This behavior was foreseeable because of the increase of the black repartition in the pattern. Nerveless this experiment allows us to quantify this increase, which is not linear. Some incomprehensible phenomena could be seen at medium frequencies (9 to 11 cpd). These problems will be investigated in the future experiments.

This model has been integrated to CIECAM02 in order to make a correction of modulated patterns. An example is given by the figure 5.

Color appearance of aged observers

Gabor Kutas*, Youngshin Kwak**, Peter Bodrogi*, Du-Sik Park**, Seong-Deok Lee**, Heui-Keun Choh**, Chang-Yeong Kim**

****University of Veszprém***

Veszprém, Hungary

*****Samsung Advanced Institute of Technology (SAIT),***

Kyeongki-Do, Yongin-Shi, Kiheung-Eup, Nongseo-Ri, San 14-1, Korea

Introduction

The human visual system (HVS) seems rather stable over much of the life span, though it is well known that it ages constantly with the advance of life[1]. Besides the contribution of neural factors, the optical density rise of the crystalline lens and therefore the decreased illuminance of the retina seem to be the major answer for the age-related weaknesses e.g. in color discrimination or the intensity of color perception. The transmittance of the lens decreases and its spectral characteristics also change[2]. There is some evidence that the HVS adapts to these changing circumstances and re-compensates itself across the life span, and therefore a kind of long-term color constancy holds [3]. To see this more in detail, our research concentrated on typical HVS functionalities that are expected to exhibit losses or shifts in color vision if aging is considered as a factor, namely, color balance (white point), chroma perception, unique hues, and preferred hues. In the present work, these changes related to aging were investigated in terms of CIECAM02 measures, by using a computer-controlled CRT display based experimental set-up in a dark laboratory room. We conducted experiments by employing five elderly (average age: 66.6) and five young observers (average age: 25.8) and the following types of observations were carried out.

White point experiment

Observers were presented three different tasks: 1. a full-screen high luminance nearly achromatic field with a picture in the centre of it; 2. a full-screen high luminance nearly achromatic field with a full-screen picture appearing after 10 seconds; and 3. a full-screen high luminance nearly achromatic field without any picture. The observer's task was to set the chromaticity of the white background by the aid of two sliders on the user interface of the experimental program which enabled changing the CIECAM02 a_c and b_c parameters of white (near the D65 and the Planckian curves) until a "preferred white" (perceived achromatic) was found. For the tasks containing an image, the image was transformed simultaneously with the observers' adjustments so that the 'white balance' of the image always matched the adjusted white background. We found that, for all tasks, elderly observers preferred warmer whites than young observers. The preference of elderly observers was 7535 K and the preference of young observers was 7835 K in the 1st (small picture) condition. Similar results were found also in the 2nd and 3rd conditions. This contradicts the hypothesis of the preference of bluish tones to counterbalance the short wavelength absorption of the eye lens.

Unique hue and preferred hue experiments

The aim of this experiment was to point out unique hue and preferred hue differences between young and elderly observers. Observers were shown a homogenous color patch on a mid-grey background. The hue of the patch was adjustable. The CIECAM02 lightness (*J*) and chroma (*C*) of the patch were constant. The task of the subject was to change the hue of the patch by adjusting a track bar until the hue perception of the patch matched one of the requested unique hues (unique red, unique green, unique yellow and unique blue). Observers were carefully instructed about the concept of unique hue. In another task, they had to reproduce their most preferred color corresponding to the following color names: red, green, yellow, and blue, with a similar experimental set-up. Observations were performed at different lightness and chroma levels.

Results showed that the most remarkable differences occurred at low lightness levels, and generally, elderly observers' unique hues were slightly shifted toward shorter wavelengths.

Chroma perception

The observer's task was the adjustment of the chroma of color disks of different hues displayed on the monitor until all disks exhibited equal amount of perceived chroma to a reference color of given chroma. The hue angles of the adjustable disks differed 45° each in the CIECAM02 a_C-b_C plane. 8 hues were investigated at different lightness levels (*J*) and for different values of chroma (*C*) of the reference colors.

The equal amount of chroma found by the observers depended both on hue angle and on the *J* and *C* parameters. For the same hue angle, elderly observers required more chroma than young observers, see Figure 1.

The white preference and the chroma perception differences between young and elderly observers seemed to be of larger importance than the unique hue and preferred hue differences.

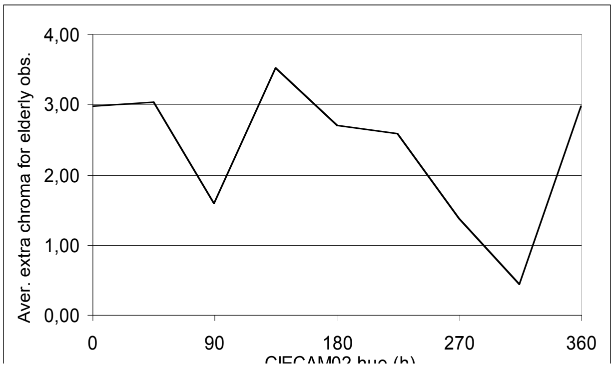


Figure 1. Average chroma difference (ΔC CIECAM02) as the function of hue, between the elderly and the young

References

[1] C. Owsley, and M. E. Sloane, "Vision and Aging," in Handbook of Neuropsychology, F. Boller, J. Grafman, eds. (Elsevier Science Publishers, 1990), pp. 229-249.

[2] J. Pokorny,V. C. Smith, and M. Lutze, "Aging of the human lens," Applied Optics **26**, 1437-1440 (1987).

[3] J. S. Werner, "Visual problems of the retina during aging: compensation mechanisms and color constancy across the life span," Prog. Retin. Eye Res. **15**, 621-645 (1996.)

Looking for potential indicators of human tetrachromacy

Zoltán Jakab and Klára Wenzel
Budapest University of Technology and Economics
Budapest, Hungary

Cases of human tetrachromacy are those in which two variants of either the L or M cone, differing in spectral sensitivity, are present in the subject's retina. Due to the sex-linked inheritance of the L and M photopigments, this condition occurs in women only. Given the frequency of certain photopigment allele variants and their corresponding sensitivity profiles, red tetrachromacy appears to be more frequent than green tetrachromacy (Jameson et al., forthcoming). Another suggested difference is between weak vs. strong tetrachromacy depending on whether the responses of the two variants of the L (or M) photopigment are differentially processed by the nervous system (Jordan and Mollon, 1993; Nagy et al., 1981).

We are currently testing a combination of three different methods for its capacity to separate potential tetrachromatic subjects from trichromats. The methods are the following.

(1) Discrimination of wavelengths over 700 nm. Looking into an aperture, subjects are shown a circular field the left and right halves of which comprise two such wavelengths (we used 700, 720, 730, 740, and 750 nm interference filters). The task was to achieve a match by adjusting the intensities of the two sides, or indicating refusal. Subjects did 12 different trials two of which involved identical wavelengths on the two sides to control for false alarms.

(2) Spectrum delineation. This task was originally devised and used by Jameson et al (2000). Subjects saw a picture of the spectrum, in our case brought about by a projection of a linear interference filter on a sheet of tracing paper. Their task was to mark with a pencil the borders of all the different color bands seen within the spectrum.

(3) The FM hue test was administered three times for each subject with about 40 minutes passing between subsequent testings.

(4) The Welhagen-Broschmann isochromatic plates were also given to the subjects to check for color deficiency. Only subjects who performed normally on this test were included in the study.

Expectations.

(1) Our main question is whether there is any systematic difference in discrimination pattern between a subgroup of women heterozygous for color deficiency (those heterozygotes who, according to other measures, have better-than-average color vision), and trichromats with no indication of heterozygocy.

(2) Jameson et al (2000) found that as a group, women heterozygous for color deficiency delineated a significantly greater number of bands than females and male controls.

(3) There have been hints in the literature (Jordan and Mollon, 1993; Jameson et al., 2000) that some heterozygous women who have better-than-average color vision show a worse-than-average performance on the FM test (and in some cases on isochromatic plates as well). We hypothesized that (i) genuine color deficiency or poor color discrimination results in errors that, although tend to occur in the same critical ranges in subsequent testings, will be largely random regarding the particular ordering of caps. However, (ii) if some heterozygous subjects exhibit more correlated erroneous orderings in subsequent testings, that may indicate that they see a slightly non-standard order among the FM colors.

Results.

So far we have examined a control group (18 university students, 13 females, 5 males). Data collection and analysis of carriers of color deficiency is currently in progress.

LW discrimination:

Subjects made discriminations in a rather consistent way. For our subjects examined so far, 740 nm differed in hue from most or all other wavelengths used. All other wavelengths could be matched with one another by adjusting intensities. Individual differences are found in terms of how many other wavelengths 740 nm was discriminated from. We made the same observation in an earlier pilot study using a similar method (Jakab and Wenzel, 2004). For an explanation of these findings we appeal to the phenomenon of Brindley's isochromes (Wyszecki and Stiles, 2000, p.424), and the possibility that M cones have a small secondary sensitivity peak beyond 700 nm. However, the exact pattern that we found cannot be understood based on these phenomena alone.

Spectrum delineation:

(i) Number of bands delineated by the subjects was independent from FM performance; somewhat surprisingly, we did not find a negative correlation between total error score and number of bands delineated. (ii) The range of values is wider than Jameson et al. (2000) found. Number of bands indicated by our subjects varied between 5 and 22 (5 and 16 for Jameson et al., 2000). (iii) The number of bands delineated repeatedly by the same subject is fairly stable. (Each subject repeated delineation six times, the first three of them light adapted, the second three dark adapted.) However, the borders of individual bands vary substantially (presumably due to changes in adaptation). Naming the color bands at the time of drawing their borders did not influence perfromance (compared with a no-naming condition). Nor did light versus dark adaptation have a significant effect on the number of bands delineated.

Repeated FM tests: In our group examined so far we did find that erroneous orderings in subsequent FM tests are uncorrelated. We are currently collecting and analyzing data of heterozygotes for comparison.

References

Jakab, Z., Wenzel, K. (2004). Detecting tetrachromacy in human subjects. *Perception* **33**, p. 64, Suppl. S.

Jameson, K., A., Highnote, S., M., Wasserman, L., M. (2001). Richer color experience in observers with multiple photopigment opsin genes. *Psychonomic Bulletin & Review,* **8** (2), 244-261.

Jameson, K., A., Bimler, D., Wasserman, L., M. (forthcoming). Re-assessing Perceptual Diagnostics for Observers with Diverse Retinal Photopigment Genotypes. To appear in *Progress in Colour Studies 2: Psychological Aspects*. Pitchford, N.J. & Biggam, C.P. (Eds). Amsterdam: John Benjamins Publishing Co.

Jordan, G., Mollon, J., D. (1993). A study of women heterozygous for color deficiencies. *Vision Research*, **33**, 1495-1508

Nagy, A., L., MacLeod, D., I., A., Heynemann, N., E., Eisner, A. (1981). Four cone pigments in women heterozygous for color deficiency. *Journal of the Optical Society of America,***71** (6), 719-722.

Wyszecki, G., Stiles, W., S. (2000). *Color Science*. New York: J. Wiley

Span of colors similarities of the low vision

Nana Itoh*、*Ken Sagawa

National Institute of Advanced Industrial Science and Technology

Tsukuba, Ibaraki, Japan

Introduction

Color is one of the important information to characterize visual appearance of objects and environments. However, considering the low vision, whose symptoms are extremely varied, it is difficult to figure out what is the most appropriate color combination distinctly perceptible to the low vision.

Berlin and Kay (1967)[1] have proposed that the order of evolution of colour words is highly conserved across languages. On the other hand, Uchikawa (2000)[4] studied that the categorical difference effects the search time of target (color) among the heterochromatic stimuli. From these previous studies, it seems that some span of colors may exist which becomes the key to select easily distinguishable color combinations.

Therefore, in this study, span of colors for the low vision based on the similarity to basic colors were measured. In addition, comparing with the data of young subjects[5] who have normal vision, the fundamental knowledge of color usage recognizable to the low vision are discussed.

Method

Fig. 1 illustrates the experimental set up and the reference color chips. Total 18 reference colors including the basic colors of categorical color theory are selected from the three dimensional Munsell color space (MCS). Each one of the reference colors is compared similarity with the total of 103 test color samples. The experiments were carried out under two illumination conditions, 500 lx, and 3 lx. The subject judged 'same', 'similar', or 'different'. Seven low vision patients were participated in the experiment.

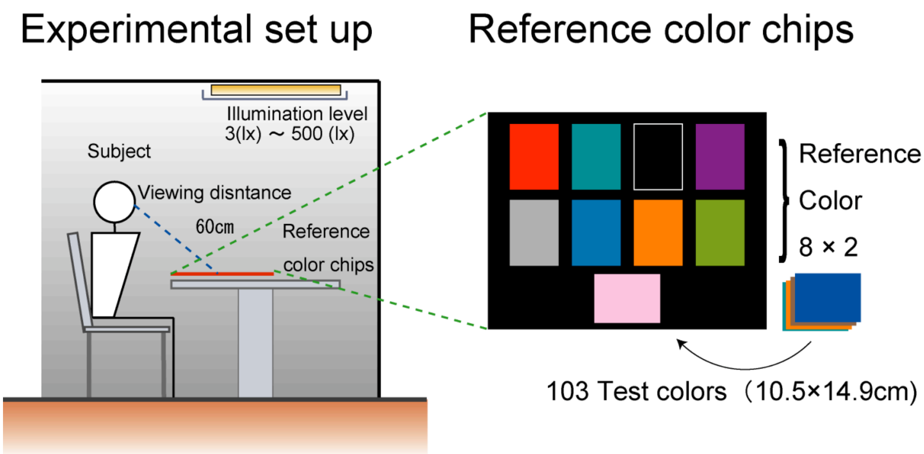


Figure1. Experimental conditions

Results and Discussion

Fig.2 shows the span of color expressed in value 5 and 7 plane of MCS for four fundamental colors, 5R5/12(red), 5G5/8(green), 5B5/8(Bleu) and 5Y7/12(yellow). The solid line shows the span of color judged by the 7 low vision subjects and dotted line shows the span judged by normal vision young subjects. Star shaped color marks show the reference colors. And solid color circles show the test colors which were judged either same or similar to the reference colors. Also the larger circles show the position of the colors which were judged as the same category of colors, red, green, blue, and yellow.

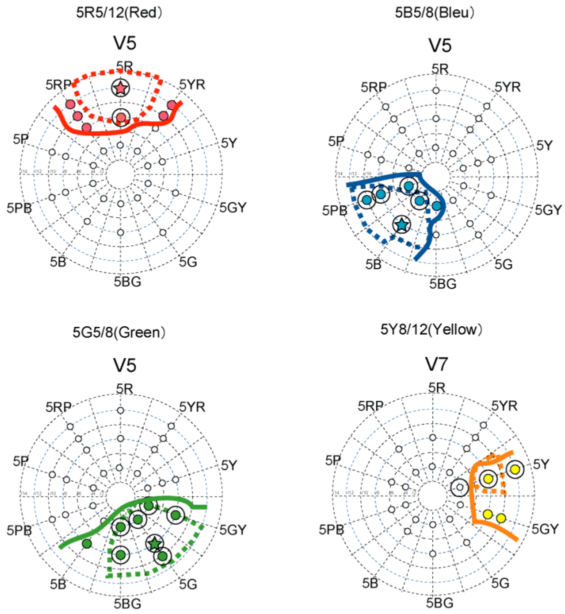


Figure2. Span of similarities

Comparing with the data of the normal young subjects, the span of fundamental colors are broader for the low vision patients in both photopic and mesopic conditions. It is also found that the areas of the span spread widely on the same value plane but do not spread so much on the different value plane. On the other hand, span of the categorical color naming is not so broad as the span of color similarities. Although number of the subjects is not enough to conclude, it is inferred from this experiment that the judgment of similarity by some low vision patients are more dependent on the value plane of colors than the chroma or verbal coding. Therefore the difference of value plane (of colors) is the guideline to select the distinctly different color combination perceptible for the low vision.

Reference

1. Berlin B. and Kat P. (1969): *Basic color terms: Their universality and evolution,* Berkeley: University of California press.
2. Yokoi K, Uchikawa K. (2005).Color category influences heterogeneous visual search for color. *Journal of the Optical Society of America. A, Optics, image science, and vision,* 22(11), 2309-2317.
3. Sagawa K. and Takahashi Y. (2003): Span of categorical colors measured by similarity of colors, *Proceedings of the 25th session of the CIE*, International Commission of Illumination, D1-64-D1-67.

CIE Colour Appearance Models, Their Past and Future

Robert W.G.Hunt
Colour Consultant
Salisbury, England

Introduction

Early CIE measures related to colour appearance included dominant wavelength and purity, but it was not until the CIELUV and CIELAB colour spaces were introduced in 1976 that approximately uniform correlates of lightness, hue, chroma, and saturation, became available. These spaces provide no correlate of brightness that includes the effects of adaptation, and no correlate of colourfulness; also, there is no allowance for the effects of changes in the colour and level of illumination, the nature of the background, and the type of surround. The CIE Colour Appearance Models CIECAM02 and CIECAM97s make allowance for these effects, and include the missing correlates.

Comparison of CIECAM02 with CIECAM97s

Chromatic adaptation transforms

In both models, the chromatic adaptation transform (CAT) is based, not on cone responses, but on sharpened cone responses, R, G, B; this results in better predictions of corresponding colours (colour stimuli that in a reference adaptation condition have the same appearance as a that of a test colour in a test set of adaptation conditions). A disadvantage of the CAT used in CIECAM97s was the inclusion of a power function in the blue channel; this made reversing the transform difficult. By optimising the matrix used to go from XYZ values to the RGB sharpened responses, the power function in the blue channel could be eliminated without impairing the predictions. The corresponding-colour tristimulus values, X_c, Y_c, Z_c, are then transformed to cone responses, ρ, γ, β.

Cone dynamic response functions

The cone dynamic response function used in CIECAM02 covers a greater range, and this results in the saturation of colours in shadow series (kX, kY, kZ, where k is a constant) remaining almost exactly constant, whereas in CIECAM97s the saturation varies; better chroma predictions of pale colours also results in CIECAM02.

Correlates of yellowness-blueness, *b*, and redness-greenness, *a*

In both models three colour difference signals are inherent, $C_1 = \rho - \gamma$, $C_2 = \gamma - \beta$, and $C_3 = \beta - \rho$; and yellowness-blueness, b, is determined as the average of the departures from unique red (for which $C_1 = C_2$) and unique green (for which $C_1 = C_3$); and redness-greenness, a, is determined as the departure from unique yellow (for which $C_1 = C_2/11$). Because the criteria for the four unique hues are all diffferent (that for unique blue being $C_1 = C_2/4$), there is a discontinuity as the colour considered passes from one, to a neighbouring, hue quadrant. It would, therefore, be more correct to have, in future, two correlates of redness-greenness, a_y for yellowish colours, and a_b for bluish colours and two for yellowness-blueness, b_r for reddish colours, and b_g for greenish colours.

Correlate of brightness, *Q*

In both models the correlate of brightness, Q, depends on the achromatic signal for the reference white, A_w. As the adapting luminance decreases, A_w, decreases, and this decreases Q, as required; but in CIECAM02 the decrease is insufficient, so the formula includes a power of F_L, a luminance-level adaptation factor. However, if F_L were altered, in future, to increase the separation of the dynamic-response function curves along the log stimulus-intensity axis, it might be possible to avoid having to use F_L in the formula for Q, (as in CIECAM97s); a more physiologically plausible result.

Correlate of colourfulness, *M*

In both models, the correlate of colourfulness, M, depends on the correlate of chroma, C, and on F_L. The correlate of chroma, C, is derived as a ratio of $[(a^2 + b^2)^{0.5}]$ over $[\rho + \gamma + (21/20)\beta]$, and hence if ρ, γ, and β are all multiplied by the same constant (as tends to happen when the adapting luminance changes), the value of C is not changed. This necessitates the inclusion of a power of F_L in the formulae for M, to make M decrease as the adapting luminance decreases. But if, in future, M were made to depend on $[(a^2 + b^2)^{0.5}]$ without the $[\rho + \gamma + (21/20)\beta]$ divisor, then the decrease in M would depend only on the dynamic response function; a more physiologially plausible result.

Correlate of saturation, *s*

Saturation is colourfulness judged in proportion to brightness. In CIECAM02 the correlate of saturation, s, depends, correctly, on the ratio of the correlate of colourfulness, M, to the correlate of brightness, Q : the formula being: $s = 100(M/Q)^{0.5}$. But the correlate of saturation in CIECAM97s does not depend on this ratio, but on the ratio $[(a^2 + b^2)^{0.5}]/[\rho + \gamma + (21/20)\beta]$, which is less satisfactory.

Performance of the models in predicting colour percepts

The performance of both models in predicting colour percepts was evaluated by comparing experimentally-determined magnitude estimations, V, with model predictions, P. Coefficients of variation, CVs, were computed as $100[\Sigma(V_i - P_i)^2/n]^{0.5}/[\Sigma(V_i)/n]$ where n is the number of samples, and i is the sample considered in a particular data set. For a perfect performance by a model the CV should be zero.

CV for	CIECAM02	CIECAM97s	Observer Spread
Lightness	14	14	13
Brightness	20	20	10
Hue	7	7	8
Colourfulness	19	18	18
Saturation	22	44	16

The performance of the two models is similar except for saturation, where CIECAM02 is far superior. Also shown are the CVs for the spread of the observers results. It is clear that for lightness, hue, and colourfulness, the CVs for the predictions and for the observer spread are similar. This is a level of model performance that is about as good as can be expected. For brightness and saturation there is room for improvement.

Future models

The CIECAM97s model was recognised as being simple in that there were many aspects of colour appearance that were not included. The CIECAM02 model did not attempt to address these shortcomings, concentrating instead on improving convenience and performance in the same domain. More comprehensive models are needed, and the following are among the features that such models should ideally include: the Purkinje effect, cone bleach factors, the Helson-Judd effect, a low-luminance tritanopia factor, the Helmholtz-Kohlrausch effect, the Bezold-Brűcke effect, simultaneous contrast, the effects of gloss and translucency, spatial and temporal effects, and the rod response. A model for unrelated colours is also required. Finally models that combine both colour appearance and the evaluation of colour differences would be very useful.

An Active Vision System for 3D surface Color Measurements

A.Balsamo[a], A.Chimienti[b], P. Grattoni[b], R. Nerino[c], G. Pettiti[b], M.L. Rastello[c], M. Spertino[b]

[a] IMGC - CNR, [b] IEIIT - CNR, [c] IEN

Torino – Italy

Common surfaces have reflection characteristics that differ considerably from those of a reference standard for colorimetry. They are neither totally diffusing nor regularly reflecting, and their reflectance strongly depends on the viewing angle and the illumination geometry. As a consequence, reliable measurements can be achieved only if the measuring geometry is fixed or known. To solve this problem, the Commission Internationale de l'Eclairage (CIE) recommended four standard geometries, defining both irradiation and observation conditions. Unfortunately, when dealing with 3D objects, with large dimensions in space, like for instance monuments or automobiles, geometry can hardly controlled and new-concept instrumentation is needed to obtain results reproducible in different times and/or locations.

Traditional instrumentation on the market rarely offers colorimetric and geometric measurements combined in a single device and when it happens one function is just a support to the other without any accuracy indication. In fact, accurate geometric and colorimetric data permit detecting changes of surfaces at a given resolution (e.g. erosion, mould growth, chemical alterations, …) when these data are strictly correlated for effective surveying analyses. Moreover, the assessment of the measurement accuracy would allow establishing a possible correlation between the geometric and colorimetric data of surfaces and the chemical-physical changes of the surrounding environment with a number of possible implications of interest.

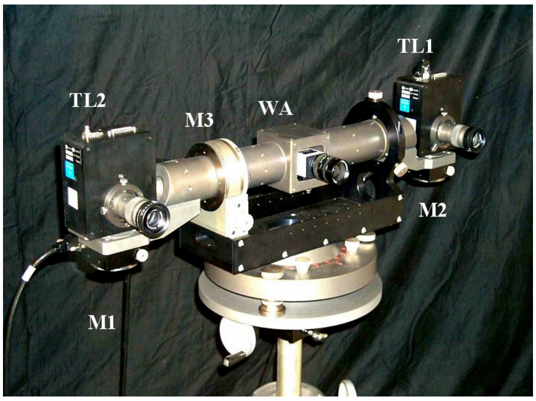
Concerning geometric measurements, devices and techniques for the acquisition of three-dimensional structures can be grouped in three categories: topographic, photogrammetric and laser-based techniques. Due to their physical working principle, each of them has a specific range of operation within which it supplies its best performances. In particular, all techniques merged together leave almost uncovered the range from two - three meters to twelve-fifteen meters.

Concerning colorimetric measurements, techniques and devices on the market can perform accurate measurements on single spots of at least some mm in size, or more. Colorimeters can be roughly grouped in two categories based on their measuring characteristics: in-contact and not in-contact. In-contact devices are equipped with an internal calibrated source of light while the other ones need external sources of light, possibly satisfying CIE recommendation on their spectral content. Even if all devices require less than some seconds to carry out a single measurement, the dense sampling of a surface can be very time-consuming because of the time needed for repositioning. In addition, the color-to-geometry correlation is not immediate and can be difficult establishing it.

In this context, there is a definite demand for a flexible, multifunctional (geometric and colorimetric) instrumentation which should integrate the traditional peculiar ones to easier the on-site data collection and promote its diffusion. The Active Vision System (AVS) described in this paper has been designed and developed to answer these needs. AVS works over a range from two to ten meters in depth and carries out integrated colorimetric and geometric measurements with assessed accuracies. Thanks to its computerized control for the automatic management of the operations, it allows the in-field processing of the acquired data and their comparison with databases for monitoring purposes.

The global functions of the SVA are essentially: the ***measurement of the 3D position of a point in the scene*** of the imaged surface and the ***measurement of the tristimulus values*** of this point. Then, the whole large scene is reconstructed with high resolution by scene tessellation and image mosaicing, and the 3D surface is obtained from sparse points or by dense reconstruction from the stereo TLs images. All these functions are automatically performed under computer control and a man-machine graphical interface has been developed for managing the whole system easily. The acquisition and registration of accurate geometric and colorimetric parameters concerning a given survey, such as the relative position between AVS and scene, the spatial co-ordinates of the test points, and the spatial position of artificial light sources, allow the system to carry out automatic and accurate repetition of that survey in successive measuring campaigns.

AVS is composed of three B/W TV cameras aligned along a common axis γ (see Fig.). Two of these cameras (TL1 and TL2) are equipped with long focal-length lenses to frame only small portions of a scene at high resolution. They can be rotated by known angles both around the parallel pan axes $\alpha_1$and α_2 and the tilt axis γ, to perform the fixation of some points of a scene. One TL is equipped with spectral filters, allowing the acquisition of high accuracy colour images of the examined surface. The third camera is equipped with a wide-angle lens (WA) to frame the whole region of interest at a lower resolution.



When the field size framed by TL cameras is too small for analysis, a wider field can be acquired as a sequence of partially overlapping tiles by automatically scanning the Region Of Interest (ROI) with TLs. The ROI can be interactively selected by an operator looking at the WA image on the computer display. In addition to texture and colour information, the spatial position, orientation and gaze direction of each tile are acquired at each step so that the entire framing geometry is completely controlled by the system and can be saved for reliable repetitions of the measurements at different times, i.e. for monitoring tasks. The reconstruction of the whole ROI information is obtained by image mosaicing. The mosaicing procedure differs from the ones described in literature mainly because the transformation of the acquired images is aimed at compensating systematic acquisition errors and parallax effects independently of the image contents, and not at minimizing the matching errors between adjacent images. Therefore, this method is intrinsically non-iterative and offers the advantages of being simple and fast, but accurate enough to satisfy the application requirements.

Mathematical properties of the RGB chromaticity diagram inconsistent with the three-cone theories of color vision

Vitaly V. Gavrik
BRYG
Cologne, Germany

Extended abstract

The color space is three-dimensional since any color can be described by the values of the three color matching functions, CMFs. The recent studies have shown the CMFs are not linear combinations of the spectral sensitivity curves of the short-wave (S), middle-wave (M), and long-wave sensitive (L) cones even if modified by the spectral absorption of colored eye media. An additional, fourth spectral sensitivity curve is required representing a kind of rod contribution [1]. The controversy contributes to the doubts about the real existence of the three cones. The general intensity of spectrum color is not the sum of linear combination of the CMFs [2, 3] in contrast to the assumptions of the three-cone theories. It is shown below the basic white sensation, the Helmholtz's white component of a pure spectrum color that determines its relative saturation [4], cannot also be the sum of the three cone signals.

A spectrum hue is a linear combination of the two basic opponent chromatic sensations, blue-yellow and red-green, whose spectral intensities were calculated by Schrödinger [5] from the CMFs. Similar opponencies of alternate electric sign were repeatedly measured in the retinas [6], suggesting the complementary opponent signals to interact like the electrical charges of opposite sign. The basic sensations underlie the current Young-Helmholtz-Hering theory, YHH, of color vision that explains the alternate basis functions with subtractive interaction of M, L, and S-cones [7]. The third, non-negative basis function of the white sensation has never been calculated due to absence of the linear-transform criteria and the general intensity of color was used instead.

The method of detecting the relevant criterion mathematical properties of basis functions from their experimental linear combinations [8] has been applied to the RGB matching functions independently obtained by Stiles & Burch [2], Sperling [3], and Fry [9] with different primary colors and field sizes. The mutual dependences of CMFs have had the linear portions heading for the origin of coordinates and indicating that two of the three basis functions of color space were zero or all of them were proportional to one another over 660 nm. After division of the CMFs by their sum, the mutual dependences respectively turned out a point after 660 nm. They also were the straight lines under 417 and over 545 nm, indicating that a basis function was zero or proportional to another basis function there. The basis functions cannot be the subtractive combinations of the M, L, and S-cone signals as predicted by the YHH theory. For instance, the long-wave thresholds of the red-green and blue-yellow sensations differ by 40 nm (at 700 and 660 nm, respectively) although the theory expects them to coincide as both the sensations should be formed with participation of the L-cone (its signal should be subtracted from the M-cone signal or from the sum of the S and M-cone signals, respectively). The zero portion of a basis function below 417 nm can be ascribed to no kind of the cones and to no YHH combination of the cone signals.

It was the basic white sensation whose spectral intensity function equated with zero below 417 nm and was proportional to the blue-yellow basis function over 545 nm as its non-negative spectral intensity function cannot be proportional to the red-green basis function changing its sign at 570 nm, and both the chromatic basis functions are not zero below 417 nm. The spectral intensity function calculated has been maximal at 540 nm and followed the saturation of the pure spectrum colors, and reflected the effect of the macular pigment at different field sizes.

The basic white sensation can be explained within the scope of the recent opto-electric mechanism of intrareceptor opponent color separation [10]. It follows from the fact that the light-sensitive outer segment in the rod and cone is constituted by the two successive structural anatomic portions (basal and distal) whose electric potentials affect the membrane potential of respective cell in opposite way [11] and subtract each other. The other fact underlying the theory is the long-living intermediates [10, 12] of the visual pigments, rhodopsin in the rod and iodopsin in the cone. Their screening effects produce the spectral differences between the basal and distal portions of the outer segment. Within the scope of the mechanism, the long-wave threshold difference of the two chromatic basis functions is the difference between the thresholds of rhodopsin and iodopsin. The properties of the basis function of the achromatic, white sensation show it to be produced by rhodopsin of the distal portion of the rod outer segment. The data by Nagel and Schaternikoff [13] showed the same sensitivity maximum at a mesopic illumination which evoked no cone signal (no color sensation still was observed).

The alternate sign of chromatic basis function describes the mutual subtraction of the intensities of complementary opponent hues if they simultaneously occur in a mixture of the primary colors what was neglected by Grassmann. A white mixture of two complementary spectral colors can be 'very obviously' darker than a single component [14]. A white sensation sums up all the achromatic components of constituent monochromatic colors while their chromatic components are being mutually nullified. The chromatic components of a single spectrum color originate from different opponent pairs and are non-opponent. All their intensities add to each other (Helmholtz-Kohlrausch effect) at any wavelength so that their general intensity rather should correspond to the sum of the modules of basis functions that are their non-linear transforms. Some colorimetric inaccuracies may result from assuming the simple intensity summation in the cases and disregarding the differences above even if they are inconsistent with the current three-cone theories of color vision.

[1]. Stockman, A. & Sharpe, L.T.: Cone spectral sensitivities and color matching. *In: Gegenfurtner, K. & Sharpe, L.T., eds., Color Vision: From Molecular Genetics to Perception.* Cambridge Univ. Press, S. 53-87, 1999

[2]. Stiles, W.S. & Burch, J.M. (1955). Interim report to the Commission Internationale de l'Eclairage, Zurich, 1955, on the N.P.L. investigation of colour-matching. *Optica Acta 2*, 168-181; (1959). N.P.L. colour-matching investigation: Final report. *Optica Acta 6*, 1-26.

[3]. Sperling, H.G. (1958). An experimental investigation of the relationship between colour mixture and luminous efficiency. In: *Visual Problems of Colour, Symp. Natl. Phys. Labor., London*, 251-277.

[4]. Helmholtz, H. (1855). Über die Zusammenesetzung von Spektralfarben. *Annalen der Physik <und Chemie> (Poggendorf) 94*, 1-28.

[5]. Schrödinger, E. (1925). Über das Verhältnis der Vierfarben- zur Dreifarbentheorie. *Sitzungsberichte der Akademie der Wissenschaften, Wien IIa, Nr.134*, 471-490; (1995) *Farbe 41*, 178-197.

[6]. Svaetichin, G. (1956). Spectral response curves from single cones. *Acta Physiologica Scandinavica 39*, *Supplement 134*, 17-46; MacNichol, E.F.& Svaetichin, G. (1958). Electric responses from the isolated retinas of fishes. *American Journal of Ophthalmology 46(3), Part II*, 26-46.

[7]. Boynton, R.M. (1979). *Human color vision*. Holt, Rinehart & Winston: N.Y. 438 p.

[8]. Gavrik, V.V. (2001). Criteria for a linear structure of variance and obtaining physical process functions from the principal components. *3rd Intl. Conf. "Independent Component Analysis and Blind Signal Separation"*, UCSD, 200-205.

[9]. Fry, G.A. (1988/9). Analysing color mixture data at the blue end of the spectrum. *Farbe 35/36*, 31-40.

[10]. Gavrik, V.V. (1999). A mechanism for single-pigment color opponency in a photoreceptor cell. *Proc. Intl. Joint Congress on Neural Networks, Washington, DC,* IEEE, 174-177.

[11]. Steinberg, R.H., Fisher, S.K. & Anderson, D.H. (1980). Disc morphogenesis in vertebrate photoreceptors, *Journal of Comparative Neurology 190*, 501-518.

[12]. Lewis, J.W., van Kuijk, F.J.G.M., Carrunters, J.A. & Kliger, D.S. (1997). Metarhodopsin III formation and decay kinetics. *Vision Research 37*, 1-8.

[13]. Schaternikoff, M. (1902). Neue Bestimmungen über die Verteilung der Dämmerungswerte im Dispersionsspektrum des Gas-und des Sonnenlichts. *Zeitschrift für Psychologie 29*, 255-263.

[14]. MacAdam, D.L. (1950). Loci of constant hue and brightness determined with various surrounding colors. *JOSA 40*, 589-595.

Color Appearance in Image Displays

Mark D. Fairchild
Munsell Color Science Laboratory, Rochester Institute of Technology
Rochester, New York, USA

Abstract

Color appearance models extend basic CIE colorimetry as embodied by XYZ tristimulus values and the CIELAB color space to enable prediction of appearance attributes (brightness, lightness, colorfulness, chroma, saturation, hue) across a wider range of viewing conditions (illumination color and level, surround, background, *etc*.). Research on the formulation and testing of color appearance models progressed to the point that CIE models could be published in the late 1990's (CIECAM97s) and significantly refined and improved several years later (CIECAM02). While better color appearance models will almost certainly be derived in the future, CIECAM02 provides a very effective method to predict color appearance for relatively simple patches of color on essentially uniform backgrounds and surrounds.

Colorimetry in its many forms from XYZ to CIECAM02 JCh has been successfully applied in the development and characterization of all types of image displays from photographic film, to the early development of color television, to color printing technology, to modern digital systems. However, image displays also present additional challenges since the color stimuli vary significantly in size and are arranged in complex spatial and temporal arrays (still and moving images). In many imaging applications, traditional colorimetric models are very helpful because the spatial and/or temporal variations in color are approximately replicated between original and reproduced images. However, in some cases it is necessary to reproduce colors across significant changes in spatial and temporal scale or to pull a color out of one context and reproduce its appearance in a completely difference spatio-temporal context. In such cases, colorimetric models that do not explicitly account for more complex spatial and temporal properties of the visual system (and the stimuli) might not provide satisfactory results.

To address these more complex appearance issues, color appearance models have become part of a natural process of scientific evolution and been joined with models of spatial and temporal vision to create image appearance models. Such models allow the prediction of color appearance across much more complicated changes in viewing environments and have a number of applications including image and video quality metrics and the rendering of high-dynamic-range images and video. The iCAM framework illustrates one approach to image appearance modeling that has been developed recently and continues to be refined.

This presentation reviews the history of the development of colorimetry for image displays from CIE XYZ, to CIELAB, to CIECAM02, to image appearance models and presents some recent experimental results. In addition, some future directions for related research are briefly previewed. The specific research topics from the past, present, and future are listed below.

Previous research results that will be reviewed include:

- •Use of an image appearance model to predict perceived image quality attributes such as sharpness and contrast,
- •Rendering of high-dynamic-range (HDR) images through the modeling of local adaptation to luminance and contrast, and
- •HDR video rendering through modeling the time-course of chromatic adaptation.

Recent research on image color appearance and quality is also described as follows:

- •Evaluation of HDR rendering accuracy and preference,
- •Measurement and enhancement of perceived color gamut volumes,
- •The effect of surround on image appearance,
- •Adaptation to noise in image displays, and
- •The derivation of orthogonal opponent-colors dimensions for image quality modeling.

Lastly, some research topics that are just underway and aimed at improving fundamental aspects of colorimetry for image displays are briefly introduced including:

- •Improved HDR rendering techniques,
- •An HDR photographic and color appearance survey,
- •Spectral adaptation modeling,
- •Transformability of primaries,
- •Color difference modeling in color appearance spaces,
- •Perceived color gamuts and the perception of brilliance,
- •Observer metamerism and a fully specified system of colorimetry, and
- •An educational resource aimed at putting it all together for future scientists.

Development of the NIST

Detector-based Color Temperature Scale

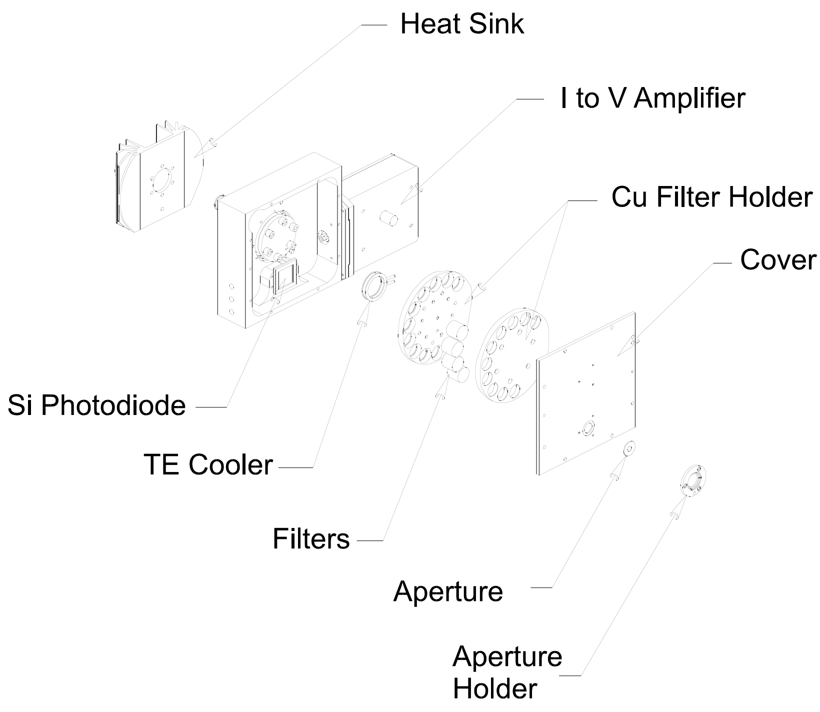
George Eppeldauer and Yoshi Ohno
National Institute of Standards and Technology
Optical Technology Division
Gaithersburg, Maryland. USA

Abstract

Improvements in detector technology over the past decade have opened a new era in radiometric and photometric calibrations. The detector-based calibration approach is being extended to colorimetry as well. Based on the spectral responsivity of the channels of a tristimulus colorimeter, a colorimetric scale can be realized and maintained [1, 2].

The low uncertainty of the spectral responsivity measurements can dominate the color measurement uncertainty. The achievable detector-based color measurement uncertainties are smaller than the uncertainties of current primary lamp standards. The uncertainty goal for the NIST developed reference tristimulus colorimeters is 4 K at 2856 K (k=2) which is a factor of two improvement over the current NIST source-based scale (8 K).

Since the successful preliminary realization of the trap-detector based tristimulus colorimetric scale at NIST [3, 4], new generation, single-photodiode based tristimulus colorimeters are being developed. The large-area single photodiodes are sealed with windows to perform excellent long term stability. The filter wheel is temperature controlled and the filter combinations are individually matched to the photodiode to perform the smallest possible spectral mismatch to the CIE color matching functions.



Exploded view of a new-generation tristimulus colorimeter.

The four channels of a reference tristimulus colorimeter are calibrated on the NIST facility for Spectral Irradiance and Radiance Responsivity Calibrations using Uniform Sources (SIRCUS). The new tristimulus color scale, based on SIRCUS performed spectral responsivity calibrations, is traceable to NIST cryogenic radiometers. A relative expanded uncertainty of less than 0.15 % (k=2) can be achieved in the spectral irradiance responsivity determination of the colorimeter channels. This expanded uncertainty will result in a change of 0.0004 in the x, y chromaticity coordinates when measuring a Planckian radiator. The broad-band calibration factors of the colorimeter channels are calculated using the measured spectral irradiance responsivity functions of the channels [1]. After the calculation of the calibration factors and the measurement of the tristimulus values of test light sources using these calibration factors, variable reference source models are applied [4]. These models can adjust the reference spectral source distribution (used to calculate the channel calibration factors) with iterative calculations until the reference spectral source distribution becomes nearly equal to the test source distribution. Using this approach, spectral mismatch errors can be removed from the tristimulus color measurement of tungsten test lamps. The project is funded by the U.S. Air Force where tungsten lamps are used for color temperature measurements.

References

[1] G. P. Eppeldauer, Spectral response based calibration method of tristimulus colorimeters. J. Res. NIST, 1998. **103**(6): p. 615-619.

[2] G. P. Eppeldauer, S. W. Brown, C. C. Miller, and K. R. Lykke, Improved accuracy photometric and tristimulus-color scales based on spectral irradiance responsivity, 25th Session of the CIE, 25 June to 2 July, 2003, San Diego, CA, Proc., **1**, p. D2-30 to D2-33.

[3] G. P. Eppeldauer, and M. Racz, Design and characterization of a photometer-colorimeter standard. Applied Optics, 2004, **43**(13) p. 2621-2631.

[4] G. P. Eppeldauer, S. W. Brown, K. R. Lykke, and Y. Ohno, Realization and application of a detector-based tristimulus color scale at the National Institute of Standards and Technology, USA, AIC Colour-05, 10th Congress of the International Colour Association, Proc. Part I (Editors, J. L. Nieves and J. H-Andres), p. 693-696, 2005.

Studies on Colorimetry, the Stiles-Crawford Effects I & II, and Fiber Optics Properties in the Laboratory of Walter Stanley Stiles at the National Physical Laboratory, Teddington

Jay M. Enoch
School of Optometry
University of California at Berkeley, USA

Abstract

The author had the good fortune to spend much of 1959-1960 as a post-doctoral fellow in the laboratory of Walter Stanley Stiles, OBE, FRS. While there, he had opportunity to reassemble partially, to realign, and to re-calibrate a meaningful part of the "Trichromator" after some modifications in design had been made (prior to his arrival).

Further, while this magnificent instrument was designed primarily for studies of color matching and for conduct of Stiles' two-color increment threshold experiments, it was also not difficult to adapt the instrument for studies of the Stiles-Crawford Effect I [SCE I] (the directional sensitivity of the retina, i.e., perceived luminance as a function of entrance pupil beam entry position here assessed for selected wavelengths), and Stiles-Crawford Effect II [SCE II] (the effects of directional sensitivity of the retina upon perceived hue and saturation). While at Teddington, Enoch participated in broadly-based studies of color matching, increment threshold studies, and experiments on SCE I and SCE II. He served as both experimenter and subject and worked closely with WS Stiles and his assistants Pamela Fowler, and Jeanne Vigil. Both Stiles (briefly) and JM Birch also served as subjects during this time period. Resultant research was published in Enoch, JM & Stiles, WS, Optica Acta **8(4)**, 329-357, 1961.

Separately, at NPL, the author was also studied fine single and double glass fiber-optics elements (kindly provided by Elias Snitzer, American Optical Corp, Southbridge, Massachusetts, USA) with diameters and index of refraction ratios similar to the core/cladding ratios of photoreceptors in vertebrate species. This work served as precursor for comments made in an Addendum to the Enoch & Stiles paper, and as a model for design of early experiments on waveguide modal patterns in vertebrate photoreceptors, including human, see Enoch, JM, J Opt Soc Am **50(10)**, 1025-1026, 1960; Science **133** (**# 3461)**, 353-1354, 1961; Am J Ophthalmol **51(Part II)**, 1107-1118, 1961. Katherine Tansley and Brian Crawford showed Enoch how to construct ring chambers needed to hold/view retinal specimens.

An added research apparatus was assembled by Enoch under direction of Stiles in preparation for the visit of Profs Robert Boynton and Mitsuo Ikeda. A recent conversation with Robert Boynton indicated the design of this instrument was later altered.

Good interactions were had with GBBM Sutherland (Director), Brian H Crawford, JM Birch, Frank JJ Clarke, David Palmer, and a number of others at NPL. While there, Enoch had opportunity to meet J Guild (then retired), and FZ Young (and to hear his discussion of, and to see his demonstration of experiments of Thomas Young at the Royal Institution). Enoch visited laboratories and libraries at the Institute of Ophthalmology in London (e.g., Sir Stewart Duke-Elder, Robert Weale, Katherine Tansley, H Dartnall, etc.), as well as the Cambridge University Physiological Laboratories (William Rushton, Alan L Hodgkin, Fergus Campbell, Giles Brindley, Horace Barlow, etc.), Imperial College (WD Wright), University of Redding (RW Ditchburn, DH Fender), Royal College of Surgeons (Arnold Sorsby, and there, Hamilton Hartridge), etc.

Clearly, this was a period of time when quite a number of physicists were active in colorimetry, lighting research, radiometry and photometry, as well as in other aspects of psychophysics. And there were many distinguished scholars active in physiology and in other scientific endeavors. These individuals brought very special skills to their research, and this, in turn, enriched interdisciplinary, or what today might be termed translational research.

Enoch will describe his experiences at the laboratory and with individuals with whom he interacted. He will discuss an interesting statement made by WS Stiles during data analysis. Stiles noted that JME's color-matching data sets most closely matched the defined CIE observer of any set of data that had been obtained to that date, except possibly for one test point in the blue-green part of the spectrum.

One of the great delights experienced by Enoch during his stay at Teddington was having had opportunity to read carefully the voluminous correspondence of WS Stiles and W Rushton over a lengthy time period. They clearly were close friends. Each taught the other, and one appreciated the results of this in their individual research. It is very unfortunate that this fascinating correspondence seems to have been lost. Enoch called this material to the special attention of Prof M Alpern when he wrote the obituary of Stiles for the Royal Society of London, but these records were nowhere to be found.

Additionally, alignment, calibration and experimental skills learned at NPL have proven to be of great value. At NPL such techniques reached a level of quality which Enoch has sought to emulate throughout his career. WS Stiles and BH Crawford were indeed worthy teachers!

Evaluation of color difference formulae for color rendering metrics

Wendy Davis and Yoshi Ohno
National Institute of Standards and Technology
Gaithersburg, MD, USA

Background

CIE's color rendering metric, the color rendering index (CRI) [1], will likely be updated or replaced in coming years. The CRI has a number of problems, including its use of the 1964 W*U*V* uniform color space. This color space is outdated and no longer recommended for use. Instead, the CIE currently recommends CIE 1976 L*a*b* (CIELAB) and CIE 1976 L*u*v* (CIELUV) [2] spaces. CIELAB is widely used in many applications, and it seems reasonable that it will be used in a new color rendering metric. The calculation of color differences ΔE^*_{ab} is simply the Euclidian distance between points in the CIELAB color space.

CIELAB is not without its own problems, as a number of researchers have conducted vision experiments that show that perceived color differences are not uniform across the space [e.g., 3]. To attempt to correct for the known non-uniformities, different methods of calculating color differences have been proposed, most recently ΔE_{00} [4].

There are several hesitations to implementing ΔE_{00} for the calculation of color differences in a new color rendering metric. The calculation of ΔE_{00} is considerably more complicated than ΔE^*_{ab}. Further, the use of ΔE_{00} is only recommended when ΔE^*_{ab} is less than five. For the range of color differences typical in color rendering, the use of both methods would then be required. If the new metric considers hue shifts and chroma shifts differently, as does the saturation factor of the proposed Color Quality Scale (CQS) [5], additional computational complexity arises in how to properly compute these shifts, as ΔE_{00} includes an interactive term between chroma and hue differences. Longevity is also an important concern [6]. Care should be taken to minimize the probability any one component of the new color rendering metric would become obsolete well before the others.

Effect of ΔE_{00} on color rendering calculations

Computations were performed to characterize the changes in calculated color differences for typical color rendering samples and lamps (fluorescents and LED models) that would be observed when ΔE_{00} was implemented instead of ΔE^*_{ab}. Two sample sets were used in the example presented here: the eight samples used in the calculation of R_a in the CRI [1] (low-moderate chroma) and the 15 samples proposed for use in the CQS [5] (high chroma). The calculation of ΔE_{00} was performed with the Excel spreadsheet provided by Sharma, Wu, and Dalal [7]. In the calculation of ΔE_{00}, when ΔE^*_{ab} was five or greater, its value was used; when less than five, ΔE_{00} was used.

Though both negative and positive changes were found when color differences of individual samples were calculated with ΔE_{00} rather than ΔE^*_{ab}, the mean of the color differences for each sample set (eight CRI, 15 CQS samples) was smaller when calculated with ΔE_{00} for all lamps presented here. Figure 1 shows the mean calculated color differences for a group of sources for each sample set, the eight CRI samples in the top panel and the 15 CQS samples in the bottom panel. The first three sources are typical fluorescent lamps and the remaining four sources are RGB white LED models (peak wavelengths indicated in parentheses). The white and grey bars show the color differences calculated by ΔE^*_{ab} and ΔE_{00}, respectively.

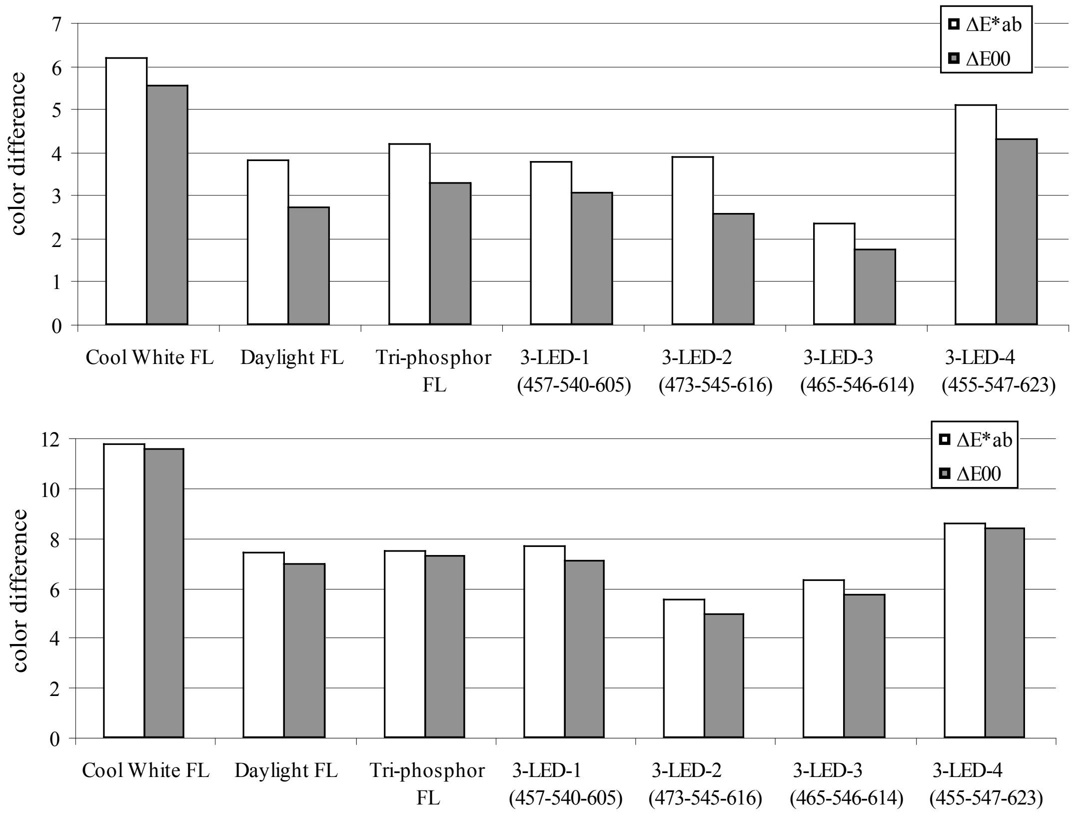


Figure 1. Calculated color differences for the eight CRI samples (top panel) and 15 CQS samples (bottom panel) when ΔE^*_{ab} is implemented (white bars) and when ΔE_{00} is implemented (grey bars).

The overall influence of ΔE_{00} is smaller for the 15 high-chroma CQS samples. This is expected, since only small color differences are calculated by ΔE_{00}, and samples higher in chroma tend to have overall higher color differences. Differences in CQS scores caused by implementing ΔE_{00} will be presented. Several aspects of the CQS are shown to reduce the effects of implementing ΔE_{00}, including its use of samples of high chroma and its application of root-mean square instead of averaging of individual samples' color differences.

References

1. CIE, 1995. CIE 13.3-1995. *Method of measuring and specifying colour rendering properties of light sources,* 1995.
2. CIE, 2004. CIE 15:2004. *Colorimetry*, 2004.
3. Luo, M.R., Rigg, B., 1986. Chromaticity-discrimination ellipses for surface colours. *Color Res. Appl.*, **11**, 25-42, 1986.
4. CIE, 2001. CIE 142-2001. *Improvement to industrial colour-difference evaluation*, 2001.
5. Davis, W., Ohno, Y, 2005. Toward an improved color rendering metric. *Fifth International Conference on Solid State Lighting, Proc. SPIE*, **5941**, 59411G, 2005.
6. Kuehni, R.G., 2002. CIEDE2000, Milestone or final answer? *Color Res. Appl.*, **27**, 126-127, 2002.
7. Sharma, G., Wu, W., Dalal, E.N. Supplemental test data and excel and matlab implementations of the CIEDE2000 color difference formula. Available at: http://www.ece.rochester.edu/~gsharma/ciede2000/

Colour Matching Based on Fundamental Spectral Sensitivity Functions

Csuti P
University of Veszprém,
Virtual Environment and Imaging Technologies Laboratory
Veszprém, Hungary

Introduction

Modern light sources are in advance such as light emitting diodes (LEDs) and gas discharge lamps. Colorimetry is based on visual experiments. The good old CIE 2° standard colorimetric observer is 75 years in age. His colour matching functions (CMFs) are functioning well with wide-band illuminants. We get problems if we try to use those CMFs in connection with narrow band light sources and metamer colour patch pairs. The results of an earlier colour matching experiment showed that a greenish colour shift appeared when metamer colour pairs were calculated using the CIE 2° standard colorimetric observers CMFs and the relative SPD of narrow band test illuminants. The aim of this experiment is to show that better results can be achieved when the fundamental colour matching functions are used to calculate the metamer colour patch pairs. The only condition to see metamer colour pairs is that the stimuli of the cone receptors should be identical in both cases.

Experiment setup

Figure 1 shows the experiment setup of the white patches of two Macbeth colour checker charts. The reference and the test side are separated using a matt black cover plate. The white patch on the left side was illuminated with the reference wide-band light source, which was a halogen incandescent lamp. On the test side a cluster of narrow band light sources was used, an LED cluster with red, green and blue 1 watt power LEDs. (Figure 2) The RGB channels are independently adjustable by the observer. The experiment compares both, the 2° and also the 10° standard colorimetric observers CMFs with the fundamental spectral sensitivity functions. The observer had the task to adjust the channels of the LED cluster until he/she sees the same colour under both illuminants. After the matching the spectral power distribution of the reflected light were measured and evaluated. Using those reflection spectra both colour spaces was tested.

Figure 1: Experiment setup, the two white colour patches under an incandescent lamp (left side) and an RGB LED cluster (right side)

Results

In the presentation the experiment setup will be detailed and the results of both experiment series will be presented. The results will show that the CMFs based on the cone sensitivity functions of the human eye are better useable with narrow band light sources then the CIE standard colorimetric observers CMFs.

Figure 2: The RGB LED cluster used in the experiment

Origins and history of the Standard Observers

Françoise Viénot
Muséum national d'Histoire naturelle
Paris, France

Historical background and aims

The investigation of colour-mixture data began in the XIX° century. Once Young (1802) had stated the trichromatic hypothesis, several approaches were explored. Maxwell (1852) designed an apparatus to study colour matches and verified the trivariance of vision. Grassmann (1853) generalized the properties of colour matching. Helmholtz (1860) synthesised the experimental and the physiological approaches. Later, König and Abney produced high standard data.

The need for standardization of colour measurement emerged with the advancement of industry. Specifically, the need for a standard observer for colorimetry was expressed soon after "Average Normal Visibility Values" (the CIE standard photometric observer) were published in 1924. By that time, several scientists had already elaborated rules for establishing a conventional colorimetric system.

The standard observers

In the late twenties, colorimetric measurements were performed in two different laboratories (Wright, 1928-29; Guild, 1931). The close agreement between the two sets of experimental measurements is quite impressive. This is due to the accuracy of the measurements as to the reproducility of the observers colour matches. The data were presented in terms of "trichromatic coefficients of the spectral colours" (spectral chromaticity co-ordinates). It was stated that "the spectral distribution curves" (colour-matching functions), when weighted by the luminosity factors of the primaries, summate exactly to the standard 'normal' visibility curve" (quoted from Wright, 1981),. The curves incorporate the standard visibility function.

The choice of reference primaries **X**, **Y**, **Z** was made for the sake of simplicity. First, it would produce an all-positive system and facilitate colorimetric computations. Second, the luminance information would be given by the Y tristimulus value, an advantage that we still enjoy. This work resulted in the adoption of the "CIE 1931 standard colorimetric observer".

Later, the V(lambda) curve has proved to be in error at the violet end of the spectrum. For sure, such an error has been harmful to the standard colorimetric observer. Nevertheless, as the colour-mixture data were free of error, any corrected visibility curve would improve the derivation of colour-matching functions. Such an improvement V'(lambda) was proposed by Judd in 1951, but not adopted by the CIE at that time.

The "CIE 1964 supplementary standard colorimetric observer" meets the needs for large-field colorimetry. Rules for establishing the data basis were the same as in 1931 but a different experimental protocol was designed (Stiles & Burch, 1959). Tristimulus values were directly derived from 10 degrees colour-matches, without input from any external photometric data basis. The result is acknowledged by the industrial community and by the scientific community as a safe data basis.

Perspectives

Nowadays, colorimetry is spread among many industrial fields. Eminent scientists have written excellent study books (Wyszecki & Stiles, 1982). Colour-matching functions form the basis for modelling colour vision.

Division 1 Meetings

National Research Council of Canada
100 Sussex Drive
Ottawa, Ontario, Canada

Below is the tentative schedule for the Division 1 meetings on 18-19 May, 2006.

Thursday, 18 May 2006 – Technical Committee Meetings

<table>
<tr><th>Room 3001</th><th>Time</th><th>Room 3109</th></tr>
<tr><td rowspan="3">TC1-57 (C) Standards in Colorimetry</td><td>9:00</td><td rowspan="2"></td></tr>
<tr><td>9:30</td></tr>
<tr><td>10:00</td><td rowspan="4">TC1-58 (V) Visual Performance in the Mesopic Range</td></tr>
<tr><td>Break *</td><td>10:30</td></tr>
<tr><td rowspan="3">TC1-63 (C) Validity of the Range of CIEDE2000</td><td>11:00</td></tr>
<tr><td>11:30</td></tr>
<tr><td>12:00</td><td rowspan="2">Lunch*</td></tr>
<tr><td rowspan="2">Lunch*</td><td>12:30</td></tr>
<tr><td>13:00</td><td rowspan="4">TC1-60 (V) Contrast Sensitivity Function (CSF) for Detection and Discrimination</td></tr>
<tr><td rowspan="3">TC1-66 (C) Indoor Daylight Illuminant</td><td>13:30</td></tr>
<tr><td>14:00</td></tr>
<tr><td>14:30</td></tr>
<tr><td rowspan="4">TC1-67 (V) The Effects of Dynamic and Stereo Visual Images on Human Health</td><td>15:00</td><td rowspan="4">TC1-42 (V) Colour Appearance in Peripheral Vision</td></tr>
<tr><td>15:30</td></tr>
<tr><td>16:00</td></tr>
<tr><td>16:30</td></tr>
</table>

Friday, 19 May 2006 - Division Meeting

Time	NRC Council Chambers (Room 1147)
9:00	Division 1 Meeting
10:00	Break*
10:30	Division 1 Meeting
12:00	Lunch*
13:00	Division 1 Meeting cont.
14:30	Break*
15:00	Division 1 Meeting cont.
16:30	Close of Meeting

*On May 19th, refreshments will be provided at morning and afternoon breaks. Otherwise, attendees are responsible for their own meals and refreshments. Lunch and refreshments can be purchased at a reasonable price in the NRC cafeteria or across the street in the cafeteria of External Affairs.

People

The members are the heart and soul of the ISCC. The ISCC is unique in that its members come from so many different walks of life, yet they share a common interest in color. Included on this CD is a slide show. We invite you to watch it at your leisure and see how many ISCC members you can recognize before their names appear.

Just double click on Faces of the ISCC to watch the show.

If you would like to know more about some of the people whom you saw in the Faces of the ISCC show or have read about earlier on this CD, choose a name from the list below to read about them or just read the following pages.

Paula J. Alessi
Eugene Allen
David H. Alman
Sandra Austin
David Battle
A. Nurhan Becidyan
Roy S. Berns
Fred W. Billmeyer, Jr.
Faber Birren
David Brainard
Karen Braun
Michael H. Brill
Robert Buckley
Shashi Caan
Ellen C. Carter
Gultekin Celikiz
Jozef B. Cohen
Sy Commandy
Therese Commerford
Edward T. Connor
Hugh R. Davidson
Jerald A. Dumas
Ralph Evans
Mark D. Fairchild
Hugh Fairman
Scot Fernandez
Stephen D. Glasscock
I. H. Godlove
Peter Goldmark
Louis A. Graham
Walter Granville
Franc Grum
Charla S. Haley
Harry K. Hammond III
Henry Hemmendinger
Michael J. Henry
David Hinks
Kevin W. Houser
Robert W. G. Hunt
Richard S. Hunter
John Hutchings
Tarow Indow
Kimberly A. Jameson
Craig Johnson
Garrett Johnson
Deane B. Judd
Kenneth L. Kelly
Mary Killoran
James G. King
Eileen Korenic
Alan Kravetz
Rolf Kuehni
Romesh Kumar
Jack A. Ladson
Ann Campbell Laidlaw
Yan Liu
Joy Turner Luke
David MacAdam
Norman Macbeth
Robert T. Marcus
Calvin S. McCamy
John McCann
Mary McKnight
Margaret Miele
Ethan D. Montag
Patty Monteleone
Nathan Moroney
Maria E. Nadal
Dorothy Nickerson
Britt Nordby
FrancisX. O'Donnell
Noboru Ohta
Daniel G. Phillips
Irwin G. Priest
Charles D. Reilly
Danny C. Rich
Richard W. Riffel
Jim Roberts
Alan R. Robertson
Max Saltzman
Mark Shaw
Louis D. Silverstein
Frederick Simon
David Spooner
Arthur W. Springsteen
Ralph Stanziola
Edwin Stearns
Evelyn Stephens
Johnny Suthers
Lawrence Taplin
Joann M. Taylor
Lisa Thieme
Michael Vrhel
Brian A. Wandell
James A. Worthey
John A. C. Yule
Mary Ellen Zuyus
Joanne Zwinkels

Paula J. Alessi

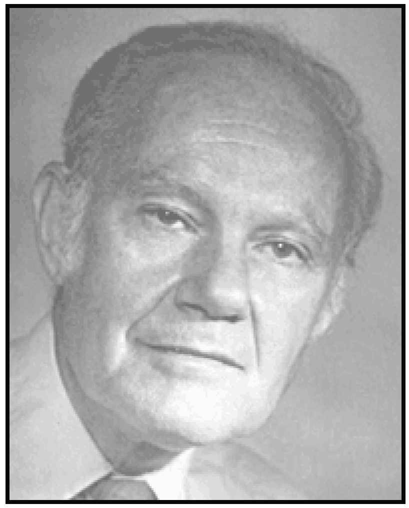
Paula J. Alessi received the Nickerson Service Award in 2001. She joined the ISCC in 1978 and has been an active member since that time. Alessi was on the ISCC Board of Directors from 1986 to 1989 and served as its President from 1992 to 1994. She chaired ISCC Project Committee 32 "Image Technology" from 1982 to 1992, and was co-chair of Interest group II on Appearance, Vision and Modeling until 1992. In 1986, she co-chaired the ISCC Annual Meeting, which was a joint meeting with the Canadian Society for Color in Toronto, Ontario, Canada featuring a symposium on Color Reproduction State-of-the-Art. In 1989 at the ISCC Annual Meeting in Chicago, she put together a Vision and Color Appearance Symposium featuring such prominent speakers as Dr. Robert W. G. Hunt, Dr. Yoshinobu Nayatani, Dr. Joel Pokorny, and Dr. M. Ronnier Luo. Finally, she has made numerous contributions to the ISCC News over the years including many very comprehensive summaries of talks given at ISCC Annual Meetings.

Ms. Alessi is a Senior Staff Research Scientist in the Color Systems Engineering Laboratory of the Imaging Science Division of the Eastman Kodak Company Research Laboratories. Her current work involves color investigations of Organic Light Emitting Diode (OLED) technology and color management systems. She has done work on color appearance evaluation for hardcopy/softcopy image comparisons. From 1985 through 1995 she spent much of her research efforts optimizing color reproduction of Kodacolor Gold 100 and Ektar 125 color print films.

Ms. Alessi received her B.S. in Chemistry from St. John Fisher, and her M.S. in Chemistry (Color Science) from Rensselaer Polytechnic Institute.

She a former President of the AIC. Ms. Alessi has also served as Division 1 Editor of the International Committee on Illumination (CIE) and Chair of Technical Committee TC1-27 on Specification of Color Appearance for Reflective Media and Self-Luminous Display Comparisons. She is the U.S. voting member of CIE/USA to CIE Division 1. Ms. Alessi is a member of the American Society for Testing and Materials (ASTM).

Eugene Allen



Professor Allen has played a very important role in the research and application of computer color-matching programs that are routinely applied today. His papers describing the mathematical methods for applying Kubelka-Munk equations to computer color matching laid the foundation on which all subsequent methods have been based. His 1964 generalization of colorant formulation to fluorescent materials has also been salient. Allen's interest in radiative transfer theory and mathematics has extended to the application of advanced theories for explaining the interaction of light and matter that will be of interest to scientists for generations. In addition to these accomplishments, Allen authored a paper on observer metamerism that eventually evolved into a CIE standard (the "standard deviate observer") for quantifying observer differences in color matching. Also, he was the first to develop the formalism of color-mismatch regions to quantify the color mismatches that could be possible by changing illuminant or observer.

Professor Allen became interested in color upon graduating from Columbia University in 1938. He obtained his Master of Science from Stevens Institute in 1944 and his Ph.D. from Rutgers University in 1952, majoring in spectrophotometry. He received these advanced degrees while working for Picatinny Arsenal during the war years and then at American Cyanamid from 1945 to 1967. He received the Senior Research Award from Cyanamid in 1958, enabling him to study in England for half a year on the effect of ionizing radiation on textiles. In 1967, he joined Lehigh University's Center for Surface and Coatings Research as Director of the Color Science Laboratory. Professor Allen retired from Lehigh in 1981. In 1982 he received the Armin J. Bruning Award from the Federation of Societies for Coatings Technology in recognition of his significant contributions to the science of color in the field of coatings technology. In 1983 he received the Godlove Award, the ISCC's highest honor, for his long term contributions in the field of color. Since then he has served on several ISCC committees, including the Godlove Award Committee. Dr. Eugene Allen was elected to be an Honorary Member of the ISCC in 2000. He died in 2005.

Additional information about Eugene Allen can be found in the "In Memorium" in the ISCC *News* #414, March, April 2005.

David H. Alman

The Inter-Society Color Council (ISCC) honored Dr. David H. Alman with the presentation of the Macbeth Award during its 1998 Annual Meeting in Baltimore, Maryland. Dr. Alman, a Research Fellow at the E. I. du Pont de Nemours and Company in Troy, Michigan, was recognized for his outstanding contributions to the advancement of industrial color difference metrics.

During the middle 1980's, Dr. Alman recognized a need for an improved color difference equation in comparison to then widely used equations such as FMCII, Hunter Lab, and CIELAB. The CIELAB equation is currently recommended for use by the International Commission on Illumination (CIE). Weighted CIELAB color difference equations, including JPC79 and CMC, provided further evidence of the inadequacy of CIELAB, especially for setting color differences and tolerances. Both the JPC79 and CMC equations were based on textile data and might not be appropriate for the automotive coatings manufactured by DuPont. Accordingly, Alman obtained funding and began a research initiative with RIT's Munsell Color Science Laboratory (MCSL). Dr. Alman was largely responsible for designing the visual experiments, introducing probit analysis at MCSL, and managing the DuPont technicians in the considerable amount of sample preparation. This relationship lasted for six years and led to the RIT-DuPont dataset.

In 1989, Dr. Alman agreed to chair the CIE Technical Committee TC 1-29, which is concerned with developing an improved color difference equation. Dr. Alman defined a set of guiding principles for the committee including statistical validation, defining a set of reference conditions, not over-modeling the data during equation development, and continuous improvement. Through his leadership, the improved CIE94 equation was developed and announced in 1994. CIE94 is the first major step taken by the CIE in the area of industrial color differences and tolerances since 1976.

The introduction of CIE94 has led to many new studies and re-examinations of the data leading to the CIE94 and CMC equations. The result has been the formation of a color difference consortium at the MCSL with broad industrial support for activities at the National Research Council (NRC) in Canada, the Bundesanstalt für Materialforschung und -prüfung (BAM) in Germany, and several universities around the world.

In 1997, the CIE called upon Dr. Alman to chair CIE Technical Committee TC 1-47. The goal of TC 1-47 is to improve CIE94. Alman has garnered enthusiastic participation, including scientists responsible for the CMC equation.

Because of Dr. David H. Alman's vision, leadership, and technical expertise, the industrial community has a clear path to continued improvements in automated tolerance metrics.

Sandy Austin

Sandy has a BA in Economics from George Washington University. (GWU) and a Master's in City Planning (MCP) from the Graduate School of Design at Harvard University. She was the director of, and taught at, GWU's Landscape Design program, specializing in basic design theory for landscape designers and architects, and horticulturalists. Sandy left there to write (*Color in Garden Design*, Taunton Press), to photograph, and to teach independently. She taught courses in color and design at the Smithsonian, the US National Arboretum and the US Botanic Garden locally, as well as other arboreta and public gardens. Sandy has her own business called, Horticolour.

David Battle

David Battle is the Director of Hardware Engineering at GretagMacbeth where he leads a team of engineers designing color measurement instrumentation. Mr. Battle has been in the color measurement industry for 23 years starting with Instrumental Color Systems in England where as Technical Director he was responsible for the development of the Spectraflash 500 spectrophotometer and a broad range of color related software products. Battle relocated to the US in 1992 where he led instrument development and engineering for Datacolor International. In 1995 he wrote the color measurement section of "Color Science for Industry", an international reference textbook published by the Society of Dyers and Colorists in England. Mr. Battle received is B.Sc. in Electronics from the University of Kent at Canterbury, England and his MBA from Temple University in Philadelphia, PA. He served on the Board of Directors for the ISCC from 2003 – 2006.

A. Nurhan Becidyan

Mr. Becidyan is President and Chief Operating Officer of United Mineral and Chemical Corporation in Lyndhurst, NJ. He has been working in the color industry for almost 30 years in which his main interests are in phosphorescence and fluorescence (both visible and UV/IR activated) and applications of color for security industries. After earning a graduate degree in the United States, Becidyan returned to Turkey to work for a folding cardboard company, as technical service representative to the printers. He also worked as the interim mill superintendent. After serving in the Turkish Armored Corps, Becidyan joined the only tissue mill in Turkey as their Technical Director. He became a sales engineer in 1976 at Sandoz Ltd. (now Clariant Corporation) of Switzerland and was transferred to the U.S.A. in 1982. In 1986 he joined United Mineral & Chemical Corporation and has been the President and Chief Operating Officer of the company since 1996. He has a B.S. in Chemical Engineering from Robert College, School of Engineering, Istanbul, Turkey and a M.S. in Pulp and Paper Engineering from the Institute of Paper Chemistry (currently called IPST) of Appleton, Wisconsin. Currently he is the Chairman of the Cadmium Pigments Subcommittee Colored Pigment Manufacturer's Association (CPMA) and is an active member of ASTM International, and serving on the ISCC Board of Directors (2005 - 2008).

Roy S. Berns

Dr. Roy S. Berns is the Richard S. Hunter Professor in Color Science, Appearance, and Technology at the Munsell Color Science Laboratory and Graduate Coordinator of the

Color Science master's degree program within the Center for Imaging Science at Rochester Institute of Technology. He received B.S. and M.S. degrees in textile science from the University of California at Davis and a Ph.D. degree in chemistry with an emphasis in color science from Rensselaer Polytechnic Institute. His research includes multi-channel visible spectrum imaging, archiving, and reproduction of cultural heritage; spectral modeling of multi-ink printers; quantifying the optical properties of painting varnishes and the impact on appearance, colorant selection for painting, and colorimetry. Dr. Berns is active in the International Commission on Illumination (CIE) having contributed to the derivations of the CIE94 and CIEDE2000 color-difference equations as well as other technical contributions in CRT colorimetry, color tolerances, and spectrophotometry. He has served on the board of directors of the Council for Optical Radiation Measurements and the Inter-Society Color Council (ISCC). In 1990, he received the ISCC Macbeth award for significant contributions to the field of color. In 1999 he, along with Koichi Iino, received the Society for Imaging Science and Technology journal award (science), which recognizes an outstanding contribution in the area of basic science, published in its technical journal during the preceding year. Also in 1999, Berns received the best paper award from the Society of Plastics Engineers Color and Appearance Division. He has authored over 100 publications and lectured widely throughout the world. During the 1999-2000 academic year, he was on sabbatical at the National Gallery of Art, Washington, DC as a Senior Fellow in Conservation Science. During 2000, Dr. Berns was invited to participate in the Technical Advisory Group of the Star-Spangled Banner Preservation Project. Also during 2000, he wrote the third edition of *Billmeyer and Saltzman's Principles of Color Technology*. He is currently involved in a joint research program in museum imaging with the National Gallery of Art, Washington, DC and the Museum of Modern Art, New York. He was named IS&T Fellow for his numerous significant contributions to the field color imaging.

Fred W. Billmeyer, Jr.
(1919-2002)

On Sunday, December 12th, 2004 Fred Wallace Billmeyer, Jr. died peacefully at a retirement community in Rexford, New York. Fred was born on August 24, 1919 in Chattanooga, TN. Fred received his B. S. Degree in chemistry from the California Institute of Technology in 1941, and his Ph. D. in physical chemistry from Cornell University in 1945. At Cornell, he studied light scattering in synthetic rubbers under Nobel Laureate Peter Debye.

From 1945 to 1964, Dr. Billmeyer was associated with the Plastics Department of E. I. du Pont de Nemours & Co., Wilmington, Delaware. In addition, from 1951 to 1964 he was Lecturer in High Polymers in the Department of Chemistry, University of Delaware, and in 1960-1961 he was Visiting Professor in Chemical Engineering at the Massachusetts Institute of Technology. In 1964, he relocated to Rensselaer Polytechnic Institute in Troy, NY, where he established the Rensselaer Color Measurement Laboratory. As Professor of Analytical Chemistry at RPI, he taught and directed research in both polymer science and color science until his retirement in 1984 after which he held the title of Professor Emeritus.

Professor Billmeyer was a member of the Phi Kappa Phi and Sigma Xi honor societies; Elected in 1987 as an Honorary member of the Inter-Society Color Council (ISCC), since 1995 an Honorary member of the Colour Group (Bulgaria), a Life Member of the U.S. National Committee of the International Commission on Illumination (CIE); a Fellow of the American Association for the Advancement of Science, the American Society for Testing and Materials (ASTM), the American Physical Society, the Optical Society of America (OSA), and the Society of Plastics Engineers (SPE); a member of the

American Chemical Society (ACS) for 50 years, the Council for Optical Radiation Measurements (CORM), the New York Society for Coatings Technology and the Federation of Societies for Coatings Technology (FSCT). He was a former member of the American Association of Textile Chemists and Colorists (AATCC), The Colour Group (Great Britain), and the Society of Dyers and Colourists (Great Britain).

He was the author of over 280 papers in the fields of polymer chemistry and color science, and of the books Textbook of Polymer Chemistry, Textbook of Polymer Science, (3 editions), Synthetic Polymers, Experiments in Polymer Science (with E. A. Collins and J. Bares), Principles of Color Technology with M. Saltzman, (2 editions), and Entering Industry, A Guide for Young Professionals (with R. N. Kelly). His latest book is Billmeyer and Saltzman's "Principles of Color Technology", third edition by Roy S. Berns.

Dr. Billmeyer was active on many committees, including D-1 (Coatings), D-20 (Plastics), and E-12 (Appearance) of the ASTM; the Vision and Colour and Physical Measurement of Light and Radiation Divisions of the CIE, and the U. S. National Committee of the CIE. He was a past member of the Board of Directors of the Color and Appearance Division of the Society of Plastics Engineers, was a Trustee and Secretary of the Munsell Color Foundation, a Director, the President-Elect, President, and Secretary of the ISCC, and a Director and Secretary-Treasurer of CORM. He was Founding Editor, and served as Editor-in-Chief, of the journal Color Research and Application, from 1976-1986), and was a Section Editor for Chemical Abstracts.

Dr. Billmeyer received the following major awards from professional societies: the FSCT Roon Award for 1962 for best publication in the paint journal; the Mattiello Memorial Lectureship (1968), and the Armin J. Bruning Award (1977) from the FSCT, the Macbeth Award (1978), the Godlove Award (1993), and the Nickerson Service Award (1983) from the ISCC, and the Award of Merit (1990) from the ASTM; the Frank W. Reinhart Award on Terminology from the ASTM; the committee on Terminology Award of the ASTM Standing Committee, and recognition of work on ANSI Committee Z535 on Safety Signs and Colors. In 1992 Dr. Billmeyer was recognized as a 50-year lifetime member of the American Chemical Society.

Of particular interest are two of Dr. Billmeyer's most recent awards, the Judd – AIC (International Colour Association) Medal for 1999. In 1975, the AIC established the Deane B. Judd Award to recognize work of international importance in the fields of color perception, color measurement, or color technology. He also received the first award of the ASTM Committee E-12 on Color and Appearance Award of Appreciation, named the Fred W. Billmeyer Jr. Award and presented to Dr. Billmeyer in the year 2000.

Professor Billmeyer is survived by his wife, Annette (Trzcinski), formerly of Wilkes-Barre, Pennsylvania. They have three adult children (Eleanor, Dean, David), and four grandsons. He has a son, Fred S. Billmeyer, by a previous marriage.

Faber Birren
1900 – 1988

[Reproduced from ISCC *News* #318, March/April 1989]

"Farber Birren, an ISCC member for many years and one of the nation's foremost consultants on color and its role in the human experience, died December 30, 1988, after suffering a stroke a week earlier. … He had been in robust health until about the time of his 88th birthday, September 21 last, when he had an aneurysm in his leg. He recovered well from the surgery required, but close friends say he became aware of a weakening heart.

Faber (as he was known to all) was born in Chicago, son of Joseph (a landscape painter born in Luxembourg) and Crescentia (a musician). His early training in art began at the School of Art Institute of Chicago. A class on color taken at the University of Chicago sparked his interest in the subject. Conceding that he fell short on artistic talent, he became an industrial color consultant, though he continued to paint throughout his life; the paintings this writer has seen, four of which were published in the first of some 10 articles for *Color Research and Application,* featured geometric designs and emphasized color effects.

Faber set up shop in Chicago in 1929, starting an almost 60 year career in color. He moved to New York in 1936, and relocated to Stamford, Connecticut in 1949. He resided there until his death. His career was concentrated on three different aspects of color.

In color marketing research, Faber kept sales records of color trends in paints, wallpapers, textiles, plastics, home furnishings, and other building materials and consumer items. On the basis of these cumulative sales records and of market studies and retail sales tests, he made color usage predictions for industry. His contributions to the House & Garden Magazine in this area were well known and extended over many years.

Faber was also well known in the fields of environmental color and human response to color. Studying the visual, physiological, and psychological effects of color, he developed manuals of standard color practice for buildings and equipment for the U. S. Army, Navy, and Coast Guard, and for such businesses as DuPont, Monsanto, General Motors, and the Walt Disney Studios. He wrote color specifications for industrial plants, offices, schools, hospitals, and neuropsychiatric facilities here and abroad.

Faber was a prolific writer. He produced some 26 books on color, the latest, The Symbolism of color, being published just months before his death. In addition, he wrote more than 260 articles, and edited and annotated the works on color of ten early colorists, some famous and some obscure, including Chevreul, Ostwald, Munsell, and Rood. ISCC News No. 317 contains a list of 12 of his books that are currently in print. His favorites among his books were *Color – A Survey in Words and Pictures* (1963) and *The History of Color in Painting* (1965, 1981).

Faber left two lasting legacies in addition to his writings. In 1981 he established the Faber Birren Collection of rare books on color at Yale University, where an entire room is devoted to the collection. It is considered the largest and most authoritative color library in America, and is probably the second largest in the world. Also in 1981, Faber endowed an award for original and creative expression with color, presented annually by the Stamford Art Association. The national competition for the Faber Birren Award is considered the only artistic event devoted exclusively to the use of color in the nation.

Many “hard” color scientists considered some of Faber’s writing controversial, especially as it dealt with more subjective matters such as symbolism, mysticism, and physiological response to color. They probably did not appreciate his writings on art, either. No Matter. Each to his own tastes. The fact is that Faber was a dynamic, colorful character, who contributed a vast amount to the filed of color. Undoubtedly, he did more to bring color to the attention of the public than any other person.

All who knew Faber well will sorely miss him. He told this writer last spring that he expected to live to be 100. Alas, he did not make it, but his spirit will surely still be around when he would have reached that age, and beyond.

Faber is survived by his wife Wanda, two daughters, and four grandchildren. A memorial service was held in Stamford on January 7. This writer and at least three other present or former ISCC members (Nadine Bertin, Raymond Spilman, and Margaret Walch) were in the large group attending.

Fred W. Billmeyer, Jr.”

[from the same issue]
“Remembering Faber Birren

I met Faber Birren in the [sic] 1930s when we both worked in Chicago. Already he was using color in a functional yet decorative manner, both in offices and factory areas. I remember that R. R. Donnelley was one of his clients and that they thought well of his color plans for them. If anyone can be considered dean of color consultants in this century, it is he.

Birren was a pioneer in the development of paint color systems. In the late 1940s he designed one for the Bennett companies in Salt Lake City. This appeared about the same time as the Nu-Hue Custom Color System by Martin Senour with Carl Foss.

Faber carefully studied color atlases and was one of the proponents of the Ostwald triangle as a simple organization of color space. His paper at the Symposium on the Ostwald System, published in the July, 1944 JOSA explains why. His main interest was in the human response to color, rather than measurement. Some persons think he didn’t appreciate the merits of the Munsell System. This is nonsense; he simply thought Ostwald was better for some uses.

Birren was continually on the lookout for new attitudes towards color, sponsoring, promoting and writing about the work of artists and others who had a fresh approach. A few months before his death we were corresponding because his recent article in *Color Research and Application*. His last letter to me was written a day or two before he became ill. It accompanied a copy of a book he had distributed to friends and colleagues some years ago and he was sending me his last copy.

The book is a compilation of paintings and explanations of the painter’s feelings, by people who went wrong (i.e., spent time in the cooler). I found it fascinating. The title of the book is *Right Brain People in a Left Brain World as espressed to Evelyn Virshupthrough art as therapy*, 1970. This illustrates Birren’s continuing interest in and search for color truths.

I write this because I wasn't to say something about a colleague I admired and to wonder how he managed to write some 26 books and 260 articles. Yet he believed that 'color is like music, it requires no rational explanation". His place in the history of color is secure."

Walter C. Granville"

David Brainard

Professor Brainard is currently the Chair of the Psychology Department and Co-Director of the Vision Research Center at the University of Pennsylvania. He is a Fellow of the Optical Society of America and a member of the board of editors of the *Journal of Vision*. He received his undergraduate education at Harvard and his graduate degrees from Stanford, an MS in Electrical Engineering and a PhD in Psychology. Before joining the faculty at the University of Pennsylvania, he was a Professor of Psychology at the University of California at Santa Barbara from 1991 to 2001.

Prof. David Brainard is of the recipient of the 2006 Macbeth Award. The award recognizes Prof. Brainard for his application of Bayesian methods to problems in color appearance and for his contribution as a principal author of the Psychophysics Toolbox, a set of software tools that assists vision researchers in performing vision experiments and color modeling.

His research interests include human vision, machine vision, and computational modeling of visual processing, with a primary focus on how the visual system uses the information available in the light signal incident at the eye to estimate object properties. His published work is notable for its contributions to both color science and color engineering. He is probably best known for his fundamental work on color appearance. In particular, a 1997 paper he co-authored introduced a statistical framework for thinking about color perception as a Bayesian estimate of the properties of the light spectral power distribution and the surface reflectance functions. This has been an influential paper and has been cited over 200 times.

At this year's ISCC Annual Meeting, Prof. Brainard will deliver an address on *Bayesian Models of Color Appearance* during the Interest Group III – Art, Design and Psychology session on Sunday, May 14.

Karen Braun

Dr. Braun is a Color Scientist at the Digital Imaging Technology Center at Xerox Corporation, focusing on color reproduction, gamut mapping, and color perception. She has published numerous journal articles on color appearance modeling and gamut mapping, presented her work at conferences, and co-authored Recent Progress in Color Science in 1997. Dr. Braun received her B.S. degree in Physics from Canisius College and her Ph.D. in Imaging Science from Rochester Institute of Technology. She has been an active member of ISCC for ten years. Dr. Braun helped create the first student chapter of the ISCC at RIT in March 1993 and served as its first president. She was associate editor of ISCC News, a voting delegate of the ISCC for three years, and chairman of the Individual Member Group. Dr. Braun recently served on the steering committee for the 9th Congress of the International Colour Association, AIC 01, in Rochester, NY, chairing the Student Paper Award selection committee and the Congress poster design team. She is an active member of the Society for Imaging Science and Technology, IS&T, having served on the Technical Committee of the IS&T/SID Color Imaging Conference for the past five years and as Poster Chair for three years. She served on the ISCC Board of Directors from 2002 until 2005.

Michael H. Brill

Michael H. Brill is Principal Color Scientist at Datacolor in Lawrenceville, NJ. Since obtaining his Ph.D. in physics at Syracuse University, he has carried out extensive theoretical research in color in human and computer vision, in geometric/photometric invariance, and in physics-based vision. He holds nine U.S. patents, and co-invented the Emmy-Award-winning Sarnoff JNDmetrix™ Vision Model.

Dr. Brill is a past president of the Inter-Society Color Council (ISCC), and received the 1996 Macbeth Award from the ISCC for his work on color constancy. He also has served on the Board of Directors and as chairman of several committees and meetings.

Outside the ISCC he chairs CIE Technical Committee TC1-56: Improved Colour Matching Functions. Dr. Brill is a member of the Editorial Board *of Color Research and*

Application and an Associate Editor of *Physics Essays*. Dr. Brill is also a member of the American Society for Photogrammetry and Remote Sensing (ASPRS) and of the Optical Society of America (OSA), and ASTM International.

He is author of over 80 refereed technical publications, numerous national standards, and a SID test pattern. He has also been awarded eight U.S. patents. Dr. Brill has delivered invited lectures at the University of Pennsylvania, Johns Hopkins University, Simon Fraser University, Oxford University, and other institutions.

Robert Buckley

Dr. Buckley is a Research Fellow with the Xerox Imaging & Services Technology Center in Webster, NY. Since joining the Xerox Palo Alto Research Center in 1981, he has held several management and individual contributor positions within Xerox corporate research. He has been involved in all aspects of color image processing, including color data interchange, color printing and color standards, and has several patents in color imaging. Dr. Buckley has a B.Sc. in electrical engineering from the University of New Brunswick, an M.A. in Psychology and Physiology from the University of Oxford, which he attended as a Rhodes Scholar, and a Ph.D. in electrical engineering from the Massachusetts Institute of Technology. Dr. Buckley chairs the CIE Division 8 Technical Committee on the Communication of Color Information and has led sections of the ISO JPEG2000 and IETF TIFF-FX activities. Dr. Buckley was the General Co-chair of the first IS&T Archiving Conference in April 2004 and later this year will co-chair the IS&T/SID Color Imaging Conference. He was on the ISCC Board of Directors from 2000 to 2003 and was the ISCC liaison for AIC 2001, which the ISCC hosted in June 2001 in Rochester, NY. He will become President of the ISCC this year.

Shashi Caan

Ms. Caan is currently an Associate and Senior Designer with Gensler Associates & Architects. Previously she has held similar positions with Knoll International and Swanke Hayden Connell Architects. She earned her Bachelor of Arts (with honors) from the Edinburgh College of Art, and a Masters of Industrial Design and Architecture from Pratt Institute. Ms. Caan has been on the faculties of Pratt Institute, the School of Visual Arts, where she is presently on the Curriculum Advisory Committee, and the New York School of Interior Design, where she serves on the Board of Trustees. Other civic and professional activities include the Board of Directors of the United Nations Association of New York, and the chair of a subcommittee on Interior Design for the American Institute of Architects. Ms. Caan has presented her research and work at conferences in New York, Newport, Budapest, and Helsinki. Her work has also been widely quoted and published, most recently in John Pile's "Color in Interior Design" (New York: McGraw-Hill, 1997). Ms. Caan curated an exhibit, "Virtual Color: Light, Hue and Form Integrated" at the New York School of Interior Design. A catalogue of the same title was published to accompany the exhibit. Also, in the fall of 1997 a new line of upholstery fabrics for both the commercial and the residential market will be launched under the name of "Shashi Caan." She was elected to the ISCC Board of Directors in 1997.

Ellen C. Carter

Ellen C. Carter received her B.A. in chemistry from Manhattanville College in Purchase, NY and her Ph.D. in chemistry from Rensselaer Polytechnic Institute in Troy, NY. She has authored a number of technical papers. Dr. Carter is the Division 1 (Vision and Color) Editor of the International Committee on Illumination (CIE). She is a member of ASTM International, the Council on Optical Radiation Measurements (CORM), the

Detroit Colour Council (DCC), the Optical Society of America (OSA), the Society for Imaging Science and Technology (IS&T), the American Association of Textile Chemists and Colorists(AATCC), the Society of Sigma Xi, and the U.S. National Committee of the CIE (CIE/USA).

Ellen joined the ISCC in 1969 and has been an active member since that time. Dr. Carter was President of the ISCC from 1996 through 1998 and was on the Board of Directors from 1991-94. She was heavily involved in establishing the ISCC Office. Her early work on project committees included chairing Committee 22 on Materials for Instrument Calibration, which produced ISCC Publication 78-2 and later helped in its revision 89-1. In 2003, Carter received the Nickerson Service Award. She currently chairs Committee 52, which is developing a 21st Century Comparative List of Color Terms to replace the one published by the ISCC in 1949.

Dr. Carter has been the editor of the journal *Color Research and Application* since 1990. She also is a consultant in color science. She previously worked in industry and in the field of education. She was a Senior Color Scientist for the Sherwin-Williams Company and later in the Instrument Systems Division of Minolta Corporation (now Konica Minolta).

Gultekin Celikiz

Prof. Celikiz, now emeritus, has been a faculty member at the Philadelphia University for 38 years. Celikiz received a B. S. degree from Robert College, Istanbul, Turkey, a B. S. in textile engineering from Philadelphia University and an M. S. degree from Georgia Institute of Technology. His teaching subjects include General and Physical Chemistry. He also initiated the following courses at the University: Color Science, Colloid Chemistry, Physical Chemistry of Dyeing and Instrumental Methods of Analysis.

Since 1995 Tek, as he is known to most friends, has been serving as Editor of the ISCC *News.* Also he was an active member of Problem Committee 25 – Determination of the Strength of Colorants. The committee published three reports: “A General Procedure for the Determination of Relative Dye Strength by Spectrophotometric Transmittance Measurement”, “A General Procedure for the Determination of Relative Dye Strength by Spectrophotometric Measurement of Reflectance Factor”, and “Reproducibility of Dye Strength Evaluation by Spectrophotometric Transmittance Measurement.” These three papers along with other papers in the field of color were edited by Gultekin Celikiz and Rolf G. Kuehni and published by the American Association of Textile Chemists and Colorists, a member body of the ISCC.

Gultekin Celikiz was active in the Eastern Analytical Symposium, serving on its Board for a number of years. He was also a member of the Society for Applied Spectroscopy and the Coblentz Society.

Jozef B. Cohen
1921 – 1995

Jozef Cohen joined the ISCC in 1946 where he was listed as from Cornell University, which is where he earned his doctorate. He has earned his undergraduate degree from the University of Chicago. Later we see an announcement that he is joining the University of Illinois. Prior to his retirement in 1991 he had been a professor of psychology for forty-five years.

Dr. Cohen is best known in the color community for his development of what has come to be known as "Matrix R Theory." In 1986 the Rochester Institute of Technology's Munsell Color Science Laboratory held a conference to examine the work. It is for Matrix R Theory that he was honored by the ISCC with the 1991 Macbeth Award.

Dr. Cohen was well known in the psychology community. He published a series of twenty pamphlets called the *Eyewitness Series in Psychology* (1968-1972). He authored the *Encyclopedia Britannica* article on "Psychology" and he is also recognized for his articles on the history of ideas.

After his retirement he and his wife established the Jozef and Huguette Cohen Innovation Fund at the University of Illinois. This fund helps support the efforts of selected researchers as they explore ideas that may be so innovative that it is difficult for them to obtain funding from traditional sources.

Sy Commanday

Sy Commanday received his BS in Chemistry from Brooklyn College (located in the city of his birth, Brooklyn, N. Y.) and continued graduate studies in Chemistry at both the U. of Arizona and Stevens Institute in Hoboken, N. J.

After a few years as an analytical chemist at Ciba Pharmaceutical in Summit, NJ, he started his career in color in 1964 with another division of Ciba (called, at that time, Ciba Chemical and Dye Company). Since then he has worked in various positions, all in color, with Burlington Industries, Beckman Instruments, Phillips Fibers (now known as Drake Extrusion), Ampacet and Hercules Fibers (now known as FiberVisions). He took early retirement in 1994, after 15 years with Hercules. Retirement was not fulfilling enough, so after a year of color consulting Sy joined Techmer PM, LLC, where he continues to work as a Color Scientist. During his 39-year career in color, Sy has presented many papers covering various aspects of color technology. Many of these papers concentrated on the problems and techniques of working with color in polypropylene and other fibers.

Sy is a member of the ISCC (where he twice served on the board of directors), AATCC, SPE and the Detroit Colour Council. Sy presented his technical papers at the various meetings of these organizations. Sy is married and has five children and eight grandchildren. His hobbies take him from the sky (as a pilot) to undersea (as a SCUBA diver).

Therese Commerford

Ms. Therese R. Commerford was elected as an Honorary Member of the ISCC in 2002. She served as an ISCC Director from 1977 until 1980 and ISCC Secretary from 1982 until 1990. After she completed her tenure as Secretary, that position was split into two positions – Recording Secretary and Membership Secretary. She also served as a delegate from the American Association of Textile Chemists and Colorists (AATCC) to the ISCC Individual Member Group. Ms. Commerford contributed to the work of several ISCC Problems Committees, notably Problem Committee 16 "Standard Methods for Mounting Textile Samples for Colorimetric Measurements," which completed its work in 1968, and Problem Committee 25D "Determination of the Strength of Colorants (Dyes

Section) for which she contributed a paper "Difficulties in Preparing Dye Solutions for Accurate Strength Measurements," which appeared in *Textile Chemist and Colorists* ***6***: 14 (1974).

Ms. Commerford worked as a research chemist with the Chemical Technology Team of the Individual Protection Directorate at the U. S. Army Natick Soldier Center, Soldier Biological, Chemical Command (SBCCOM) where she worked on a Joint Service program to provide chemical/biological protective clothing for aircrew personnel. After earning her B. S. degree in chemistry from Lowell Technological Institute (now University of Massachusetts-Lowell), Ms. Commerford began her professional career with the Derby Company in Lawrence, Massachusetts where she spent 27 years. For the majority of those years she served as Supervisor of the Color Laboratory.

Ms. Commerford served as Vice-President of the AATCC, a member of its Executive Committee on Research, a member of AATCC's Technical Committee on Research and a member of its Long-Range Objectives Committee. She was active on AATCC Research Committee RA 50 (Colorfastness to Light) and RA 36 (Color Measurement). She chaired the AATCC 1979 Symposium on Color Science in the Textile Industry held in Charlotte, North Carolina. In addition to the ISCC and AATCC, Ms. Commerford has been a member of the Sigma Xi Honor Society and the Optical Society of America (OSA). She has lectured on color at the color courses sponsored by Clemson University and during workshops on color given by AATCC.

Edward T. Connor

Edward T. Connor was Director of the Gardner Laboratory Physical Testing Department of Pacific Scientific Company in Silver Spring, Maryland. He earned a B.S. degree in Electrical Engineering at the University of Pittsburgh. He spent ten years with the General Electric Company and was later President of Instrument Development Laboratories, Inc. prior to joining Gardner [now BYK-Gardner] in 1971. Over the years he served as President and a Director of the Manufacturers Council on Color and Appearance and as a Director of Collaborative Testing Services, Inc. He was a Senior Member of the Instrument Society of America and a 25-year member of the ISCC, becoming Treasurer in 1980. He was heavily involved in community affairs serving as President of his Citizens Association, a past President of the Rotary Club, a Director of the YMCA, as well as active the United Fund, Little League, and Zoning Board. He and his wife Louise have six children and ten grandchildren.

Hugh R. Davidson

Mr. Hugh R. Davidson was elected an Honorary Member of the ISCC in 2000. Davidson is most well-known for his work in computer color matching and for his educational seminars, but he also has many accomplishments in the areas of instrumental developments for industrial color control, color differences and color-order spacings.

After earning a B.S. degree in Engineering Physics from Lehigh University in 1941, Davidson worked for the National Research Council and for the Operations Research Group of the Navy. For six years after World War II, he worked as a physicist for General Aniline and Film Corporation. Davidson co-founded the firm Davidson and Hemmendinger with Henry Hemmendinger in 1952 to do color consulting and color measurement.

In 1954, Davidson developed (jointly with the Librascope Corporation) the first automatic tristimulus integrator and attached it to the GE-Hardy spectrophotometer. For the first time in the history of the color measurement, tristimulus integration could be carried out automatically at the same time that the spectrophotometric curve of a colored sample was being recorded. Davidson and Hemmendinger painted the first glossy edition of the Munsell Book of Color for the Munsell Color Company. They developed the analog Colorant Mixture Computer (COMIC), the first computer dedicated to making computer assisted color-matches. They also developed a color rule -- a series of painted panels used to evaluate observer and illuminant metamerism.

When Davidson and Hemmendinger merged with Kollmorgen Corporation in late 1967, Davidson became the vice-president of the Color Systems Division. In 1973, Davidson left Kollmorgen to form Davidson Colleagues with Thelma Roesch, where he has been developing digital software for computer color matching and continuing to teach color seminars. He taught color and computer color matching in the 1950's, and approximately 2500 students have attended his seminars. Davidson developed the pigment plan, and painted the samples, for Optical Society of America's Committee on Uniform Color Scales.

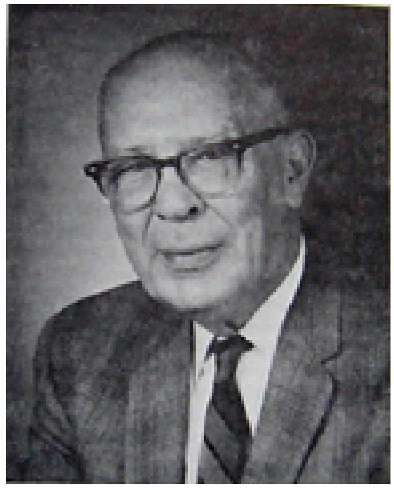
In 1996, Davidson Colleagues became affiliated with Resource III, a company formed to develop color-matching and color-control software.

Davidson joined the ISCC in 1951 and served on the ISCC Board of Directors from 1962 until 1964. He has published over 40 papers and has been granted several patents in the field of instrumental color matching. In 1966 Davidson received the Armin J. Bruning Award from the Federation of Societies for Coating Technology's in recognition of his outstanding contribution to the science of color in the field of coatings technology. In 1977 he received the Godlove Award, the ISCC's highest honor, for his long term contributions in the field of color, and in 1988 Davidson received the Millson Award from the American Association of Textile Chemists and Colorists for inventing the COMIC. Davidson is a member of the American Association of Textile Chemists and Colorists (AATCC), the Federation of Societies for Coatings Technology (FSCT), and the Optical Society of America (OSA).

Jerald A. Dimas

Jerald A. Dimas is Vice President, Technical at Color Communications Inc. (CCI). He has 27 years experience in the industrial applications of color science. Since joining Color Communications 21 years ago, Mr. Dimas has made consistent contributions helping to make CCI a world-class leader in the production of color cards, color tools, color systems and color control programs for the paint, coatings, and fabrication industries. His direct responsibilities include Technical Support, Research, and New Product Development. Mr. Dimas attended the University of Missouri in Rolla, Rochester Institute of Technology and the College of DuPage (COD), specializing in Coatings Formulations, Color Science, and Graphic Arts. He is a member of ASTM International, the Council for Optical Radiation Measurements (CORM), the Detroit Colour Council (DCC), and the Federation of Societies for Coatings Technology (FSCT), and the Society of Plastics Engineers (SPE). Currently he is serving on the ISCC Board of Directors (2005-2008).

Ralph Evans



"Ralph Merrill Evans, 68, ISCC president 1946-7, Secretary 1951-70, died in Rochester, NY on January 29, 1974.

Many of us heard Ralph Evans for the last time give one of his famous lectures at the 1973 O.S.A. meeting in Rochester. As featured speaker on a special Visual Science program he gave a profusely illustrated but highly technical lecture on "Trichromatism and Color Perception," providing a glimpse of the work on color perception on which he concentrated after retirement from Kodak in 1970. Nor shall we forget the very spirited discussion that took place at the Color Technical Group meeting the following evening, much of it relating to discussion and refutation of the points raised in Ralph's Monday evening lecture. He was ill at the time – he knew that the illness was terminal – nevertheless he took part and enjoyed the session, pleased that his efforts had sparked so much controversy, for it meant that people were thinking about his ideas, and that is what he wanted! His friends will be glad to know that his recently completed book on color perception is scheduled for 1974 summer publication.

Ralph Evans was a man of ideas in color, a pioneer in opening up new fields for color study. Fortunately this was recognized by early research heads at Kodak, and for a period in the 1940s and 50s the psychologists began to have their day in laboratories directed by Evans. There the work of many – among them Newhall, Burnham, the Hurviches – was either started, or encouraged to develop further. The 1948 Evans book, Introduction to Color, was one of the first and best of modern books on color. In a review Dean Farnsworth (another of our few real thinkers and pioneers of modern color study) recalled that "Leonardo da Vinci was one the last men to study color as a whole" -- that it has been studied since then by a host of specialists, but the Evans book "is a most successful attempt to recombine all the scientific approaches into one orderly discussion." Many of Ralph's ideas were first presented in lectures, ideas which he never accepted until they could be successfully illustrated. His slides are memorable – prepared by unusually capable and talented associates whom he had a knack for discovering.

A native of Massachusetts, Ralph Evans graduated from the Massachusetts Institute of Technology in 1928 with a degree in Optics and Photography. On graduation he worked briefly for Kodak but left to work for Twentieth Century Fox Film

Corporation, 1929-33, then DeLuxe Laboratories, Inc. in New York, 1933-35 in research and control work, after which he returned to the Kodak Research Laboratories as supervisor in the Color Process Development Department, becoming Superintendent of the Color control Department in 1945. In 1953 he was named Director of the Color Technology Division, where he served until a reorganization that placed him in charge of the new and larger Photographic Technology Division, where he served until retirement in 1970.

He was the author of four books published by Wiley: An Introduction to Color, 1948; Principles of Color Photography, with Brewer and Hanson, 1953; Eye, Film, and Camera in Color Photography, 1959; and one on color perception now in process for 1974 summer publication. A list of his published research papers and lectures prior to 1959 is contained in *ISCC Newsletter* NO. 140, April 1959, in the report of the 1959 Annual Meeting at which Ralph Evans received the Godlove Award for his contributions to color knowledge. Several important papers since 1959 are published in the Journal of the Optical Society of America. He held 17 patents for inventions.

Ralph Evans was active as a member of the Society of Motion Picture and Television Engineers, the Optical Society of America, the Society of Photographic Scientists and Engineers, the Photographic Society of America, the Illuminating Engineering Society. In all of these he was recognized as a Fellow Member. His awards, in addition to the Godlove Award of the ISCC, included three from SMPTE, the Warner Medal in 1949, Progress Medal in 1957, Kalmus Gold Medal in 1961. He was an honorary member of Sigma Xi, and held a 1955 citation from the Photographer's Association of America which honored him for "contributions to the solution of the enigma of how we see color' and for "sponsoring at Eastman Kodak Company creative experimentation to delimit the boundaries of color photography."

He is survived by his wife, Pauline Fowler Evans; three sons, Dr. David R. Evans of Amherst, Mass., Dr. John P. Evans of Portland, Oregon, and Robert H. Evans of Warsaw; a brother, Charles, of Rochester, and four grandchildren."

[written by Dorothy Nickerson, and published in ISCC *News* #228, January-February 1974.]

Mark D. Fairchild

The Inter-Society Color Council (ISCC) honored Dr. Mark D. Fairchild with the presentation of the Macbeth Award in 2002. Dr. Fairchild, Director of the Munsell Color Science Laboratory at Rochester Institute of Technology in Rochester, New York was recognized for his recent work on color appearance models, his textbook on color appearance and for the development of the world's first international standard color appearance model — CIECAM97s.

During the early 1990's Fairchild worked closely with several notable color scientists, such as R. W. G. Hunt and Y. Nayatani in trying to derive the optimum empirical color appearance model. The best of the models were very complex and required input data that most people were unable to acquire. The CIE Technical Committee doing research on these models decided to formulate a single model with a simple version for many practical applications and a comprehensive version for a wide range of viewing conditions and phenomena. Fairchild's task was to develop the Technical Committee's recommendation within a year. He was able to do so, and the resultant formula was reported in CIE Publication 131-98, *The CIE 1997 interim colour appearance model (simple version) CIECAM97s*. That formula is now widely used in electronic imaging and is the benchmark against which all new models are tested. CIECAM97s has been successfully applied in many complex image viewing environments including its use as a color difference formula for the prediction of metameric color differences. Recently Dr. Fairchild has devised an improved version of the formula.

Dr. Fairchild received his B.S. with Highest Honors and his M.S. in Imaging Science from the Rochester Institute of Technology and his Ph.D. Vision Science from the University of Rochester. Upon completion of his B.S. and M.S. degrees, he joined the Department of Color Science at R.I.T. and currently holds a tenured faculty position in the Center for Imaging Science, which houses the Munsell Color Science Laboratory. In 1996, he became Director of the Munsell Color Science Laboratory, which includes 5 faculty, 5 staff, and approximately 30 students and visiting scientists. Dr. Fairchild has been actively involved in research in the areas of colorimetric measurement and standardization, color perception, color vision, color-appearance modeling, digital color reproduction, and computer graphics. He has authored more than 100 papers, presentations, and technical reports in those areas. His book, *Color Appearance Models*, was published in 1997. He spent the 1997-98 academic year on sabbatical leave as a Visiting Associate Professor in Cornell University's Program of Computer Graphics. In 1995, Fairchild received the C. James Bartleson Award from the Colour Group of Great Britain. He is a member of the Council for Optical Radiation Measurements (CORM), the Society of Imaging Science & Technology (IS&T), the Optical Society of America (OSA), the Society for Information Display(SID), the U. S. National Committee of the International Commission on Illumination (USNC/CIE), the Association for Computing Machinery-Special Interest Group on Graphics and the International Color Consortium.

Dr. Fairchild serves as the Color Imaging Editor for *Journal of Imaging Science and Technology* and on the technical committees for the Color Imaging Conference, the European Conference on Color in Graphics, Imaging, and Vision, the AIC Color 01 Congress and the International Conference on Multispectral Color Science.

Hugh S. Fairman

Fairman received the Nickerson Service Award in 2000. He joined the ISCC in 1964 and has been an active member since that time. Fairman served as the ISCC President from 1990 to 1992 and has been the ISCC Treasurer since 1996. He chaired ISCC Project Committee 27 "Indices of Metamerism" from 1984 to 1990, Project Committee 44 "Uniform Color Scales" from 1988 to 1992, and the Problems Committee from 1984 to 1988. In 1996, he co-chaired the ISCC Annual Meeting, Instrumental Methods of Color and Appearance Assessment, in Orlando, Florida.

While in the coating industry with John L. Armitage & Co., he obtained expertise in color and appearance science. Mr. Fairman joined Henry Hemmendinger as a partner in the Hemmendinger Color Laboratory in 1994. He has a B.S. in Analytical Chemistry (1958) from Princeton University. During the early part of his career in the coating industry, Fairman specialized in exterior exposure, corrosion control, and accelerated weathering. While in the coating industry, he obtained expertise in color and appearance science. Fairman's current interests include metamerism, tristimulus integration, the origins and derivation of the CIE system for colorimetry, and the study of error detection and correction in spectrophotometry. He was the United States representative to the AIC from 1988 to 1992, and is a member of the American Society for Testing and Materials (ASTM), serving on committees D-1 on Paint and Related Coating Materials, and E-12 on Appearance.

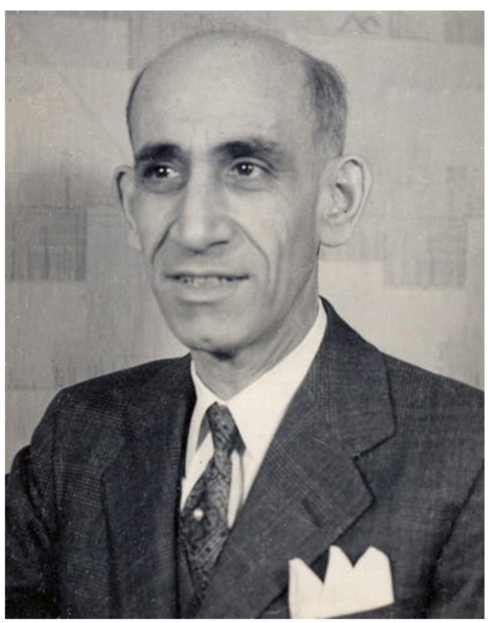
Scot Fernandez

Scot R. Fernandez joined the Imaging and Digital Workflow team at Hallmark Cards Inc. in 2003 as a Publishing Engineer. In his current assignment he shares research and development responsibilities for color/imaging systems. To date he has supported the integration of a distributive inkjet proofing solution that simulates a multi-channel litho environment for greeting cards. Current research interests include soft proofing of multi-channel files, as well as virtual simulation for secondary print processes, and artwork reproduction. Prior to joining Hallmark, Scot completed his education at Rochester Institute of Technology (RIT) with a B.S in Imaging and Photographic Technology, an M.S. in Color Science, and an M.S. in Imaging Science. His graduate research was completed within the Munsell Color Science Laboratory (MCSL). The emphasis of his graduate research included the evaluation of observer preferences for "preferred" color reproduction intents across varied cultura! l backgrounds, as well as the performance evaluation of iCAM as a complex image difference model against observer preferences for color reproduction. His professional affiliations include the Inter-Society Color Council (ISCC), Photographic Marketing Association (PMA), Society for Imaging Science and Technology (IS&T), and the International Color Consortium (ICC).

Stephen D. Glasscock

Mr. Glasscock is a Senior Scientist at Hallmark Cards, Inc. where he has worked in Technical Research and Development for over 30 years. His current interests include the visualization and enhancement of printing system color gamuts, the measurement of fluorescent colors and digital color technology. Before joining Hallmark, he worked for five years in research and development for Gulf Oil's Plastics Division. At Hallmark, he has been involved with projects on greeting cards, envelopes, gift-wrap, tissue, ribbon, candles, markers, ornaments and partyware. Glasscock has wide-ranging experience in many types of printing and coating, ink formulation, color specification and matching, appearance measurement and novel decorating techniques. He has presented and published papers on transfer metallizing, transfer printing and polymer rheology. Mr. Glasscock earned his B.S. and M.S. degrees in Chemical Engineering from Northwestern University. He is a member of the American Institute of Chemical Engineers and the Society of Rheology. Currently he is serving on the ISCC Board of Directors (2005-2008).

I. H. Godlove



(photo courtesy of Terry Godlove)

"I. H. Godlove's professional life was concerned with the physics and chemistry of color, particularly its measurement and specification. His interests also encompassed aesthetic problems of color, color harmony and the history of color in art and archaeology.

Isaac Hahn Godlove was born in Saint Louis, Missouri on June 13, 1892. He received the B. s. (1914) and A. M. (1915) degrees from Washington University, St. Louis, and the Ph.D. (1926) in Chemistry from the University of Illinois. He taught chemistry at the University of Illinois (1916-1921) and was an Associate Professor at the University of Oklahoma (1921-1925). Dr. Godlove was Director of the Munsell Research Laboratory (1926-1930). He held several positions between 1931 and 1935. He directed the exhibit on color for the New York Museum of Science and Industry (1930-31). He was with E.I. du Pont de Nemours Co. Research laboratory, Wilmington, De (1936-43) and General Aniline and Film Co., Easton PA 1943-54). He was Chairman of the Inter-Society Color Council (1948-49) and served on the Boar of Trustees of the Munsell Color Foundation from 1942 until the time of his death. I. H. Godlove died on August 14, 1954 from complications following an emergency appendectomy.

I. H. Godlove was an extraordinary color scientist who participated in all three of the disciplines represented by the Inter-Society Color Council triangle, science, art and industry. In reading ISCC newsletters and other material from 40-50 years ago, we are impressed with the diversity of his interests and skills. It is evident that his colleagues had high regard for him. When we talk with ISCC members who were contemporaries of Godlove, they refer to him affectionately as "IH".

SCIENCE:

I. H. Godlove made significant contributions to color science. He was active in the Optical Society of America and published frequently in the Journal of the Optical Society. A few representative publications are:

The wavelengths of complimentary hues. J. Opt. Soc. Am. 20:411-418, 1930.

Neutral Values Scales; I, Munsell Neutral Value Scale. J. Opt. Soc. Am. 23:394-411, 1933 (with A.E.O. Munsell and L.L. Sloan)

Improved color-difference formula with applications to the perceptibility of color changes in fastness tests and "on-tone" fading. J. Opt. Soc. Am. 41:760, 1951.

INDUSTRY:

Dr. Godlove worked for most of his professional life in industry. He was active in the American Association of Textile Chemists and Colorists and he was Chairman for many years. A few representative publications are:

Color measurement in the dyestuff industry with special reference to fastness tests. Am. Dystuff Rptr. 27:148-156, 1938.

Perceptibility and acceptability of color changes in fastness tests and "on-tone" fading. Am. Dyestuff Rptr. 40:549-558, 1951.

ART:

Dr. Godlove was also deeply involved in the history of color and its use. He was a member of the Archaeological Society of America. He was a joint author of *The Science of Color,* authored by the OSA Committee on Colorimetry and published by the Optical Society of America in 1953. Dr. Godlove wrote the history of the use of color from the first cave paintings up until the time of the Greeks. Here is an excerpt from the history.

> "Apparently sculpturing, engraving, and painting on the walls and ceilings of caves more or less simultaneously marked the awakening of the artist in man… The earliest paintings were simply outlines in red, black, and yellow which have no more relation to the actual colors of the object than do our own drawings in black pencil… The next artists were the Cro-Magnons, … Their mural paintings showed some modeling of the colors but this variegation was not yet developed…. European cave man's art reached its zenith, after the last glacial [sic] were beautifully done. The outlines were usually black, as were the eyes, horns, mane, and hoofs. The modeling was skillfully executed with various colors produced by mixing yellow, red and black pigments…" [Committee on colorimetry, The Science of Color. 1953, Washington, D.C.: Optical Society of America, pp 16-17]

The ISCC Newsletter was first published in 1933. Dr. Godlove served as editor of the ISCC Newsletter from 1936-1954. This was a period in which some remarkable changes in science and technology changed the lives of people worldwide. Dr. Godlove witnessed television develop for the initial commercial broadcasts to the development of the NTSC Standard for color vision. Fluorescent lamps were first publicly demonstrated at the World's Fair in New York in 1939.

At the time of his death Dr. Godlove was preparing a "Jubilee Issue" of the ISCC Newsletter to celebrate the 100th issue under his editorship. The issue was completed by his wife, Margaret Noss Godlove. The cover for the Jubilee Issue was designed and painted in spring of 1954 by I. H. Godlove to illustrate the coordination of color represented by the membership of the Inter-Society Color council in the fields of science, art and industry. Godlove invited about 30 persons to review the progress made during the 18 years of his tenure as Newsletter Editor. The list of contributors was outstanding; these were the individuals who inaugurated the modern science and technology of color. Included in the list were Norman Macbeth, Deane B. Judd, Richard S. Hunter, Sidney M. Newhall, Walter Granville, Kenneth L. Kelly, Farber Birren, Forrest L. Dimmick, Ralph M. Evans, and Commander Dean Farnsworth.

I. H. Godlove was an extraordinary man who played a critical role in the growth of the Inter-Society Color Council…"

[Reprinted from the remarks on receiving the 1995 Godlove Award by Joel Pokorny and Viviane C. Smith as reprinted in the ISCC News No. 356, July 1995, pp. 8-10]

Peter Goldmark

Peter Carl Goldmark was born in Budapest, Hungary in 1906. He obtained his B.S. in Physics in 1929 and received the Ph.D. in Physics in 1931 both from the University of Vienna. He then embarked on his professional career working at Pye Radio, Ltd. in Cambridge, England in charge of TV Engineering from 1931-33. He emigrated to the United States in 1933 and worked as a construction engineer until he was hired as chief engineer in the television department of the Columbia Broadcasting System (CBS) in 1936. He founded CBS Laboratories in Stamford, Connecticut in 1954 serving as President and Director of Research and remained in that position until 1971 when he founded Goldmark Communications Corporation. Dr. Goldmark was responsible for more than 160 inventions in the fields of acoustics, television, phonograph recording, and film reproduction. Of note, he developed a scanning system used by the Lunar Orbiter spacecraft in 1966 to transmit photographs to the earth from the moon. Two other of his inventions are perhaps most widely known. The long-playing phonograph record (LP – $33^{1/3}$ rpm), and the first practical color television system. His pioneering field-sequential approach to television systems, laid the groundwork for closed-circuit television and his development of electronic video recording (EVR). It was for the development of the EVR system that Dr. Goldmark was awarded the first ISCC-Macbeth Award in 1972.

He was elected to the National Academy of Engineering in 1967, to the National Academy of Sciences in 1972, and to the Connecticut Academy of Sciences and Engineering in 1976. He was a Trustee of the Connecticut Educational Telecommunications Corporation and a Visiting Professor at the University of Pennsylvania Medical School in Medical Electronics and of Fairfield University in

Communications Technology. He was a Fellow and Life Member of IEEE, a Fellow of the SMPTE, a Fellow of the Audio Engineering Society, a Fellow of the British Television Society, a Fellow of the Franklin Institute, and a Fellow of the American Academy of Arts and Sciences. Among the twenty-three awards Dr. Goldmark received are the Morris Liebmann Memorial Prize for Electronic Research (1946), Zworykin Prize for Television Technology (1961); the National Urban Service Award "for his efforts in the War on Poverty" (1968), the David Sarnoff Gold Medal Award "for outstanding scientific contribution to the Advancement of Television Technology" (1969); the Elliott Cresson Medal, Franklin Institute, "for his many outstanding contributions to the Field of Electronics, and particularly with respect to the development of the long-playing record, a practical color television system and the home video playback system" (1969); the Carnegie-Mellon Institute Medal "for continuing leadership and contribution to the Betterment of Science for Mankind" (1972); and the National Medal of Science, which was bestowed upon him in 1977 only a few days before his death. Among the honorary degrees awarded to him were the Doctorate of Humane Letters from Dartmouth College, Doctorate of Science from Fairfield University, and Doctorate of Engineering from Polytechnic Institute of New York.

Written by Joann Taylor

Resources:

Memorial Tributes: National Academy of Engineering, Volume 1 (1979) pp. 105-107.
Inter-Society Color Council Newsletter, Number 217, March-April 1972, pp. 1-4.

Louis A. Graham

Mr. Louis A. Graham is an ISCC Honorary Member. Mr. Graham joined the ISCC in 1957 while employed by the American Viscose Division of FMC and has been an active member since that time. Mr. Graham has served as a delegate and delegation chairman for the American Association of Textile Chemists and Colorists (AATCC). He has served on and chaired numerous ISCC committees. As a member of ISCC Project Committee 23, Expression of Historical Color Usage, he was instrumental in the formation of the Color Marketing Group (CMG) in 1962 and served as CMG's first president (1962 - 1965). Mr. Graham was president of the ISCC from 1982 to 1984, and was chairman of the Council's Long Range Planning Committee from 1988 to 1993. He received the ISCC’s Nickerson Service Award in 1998.

Mr. Graham received his B.S. in Chemical Engineering from the University of Virginia and his M.S. in Chemical Engineering from the University of Louisville. Mr. Graham was a Senior Manager of Corporate Research and Development at Burlington Industries from 1967 until 1987, with responsibility for dyeing, computer and color laboratories. Following retirement from Burlington Industries, he served on International Executive Service Corps projects in Zimbabwe and Mauritius. He formed Lou Graham and Associates, Inc. and developed the HVC Color Vision Skill Test.

Mr. Graham was a thirty year resident of Greensboro, North Carolina, and now resides in Temple, Texas, with his wife Jean and family.

Walter Granville

[Excerpts from ISCC *News* #319 May/June 1989, 1989 Nickerson Service Award]

… "Active since the very early days of the Council and an Honorary Member, Walter Granville is an especially worthy recipient of the ISCC Nickerson Service Award as he too has exemplified for half a century the type of effort and commitment for which this award was created. Walter served as an ISCC Counselor form 1948 – 50, a position later designated Director. Walter also served as a Director for 1954 – 56 and again from 1960 – 62. He was Vice President of the Council from 1956 – 58 and President from 1958 – 60. Anyone who has served as an Officer or Director or merely observed those positions from a distance knows that the preceding short sentences speak volumes about the time and dedication devoted to the Council.

Walter served as the Chairman of the ISCC Membership Committee for 25 years, from 1949 – 1974. In ISCC Newsletter No. 224 he published a three-page historical tabulation of the attendance of member-body organizations from 1931 – 1972, including the dates when each had joined. The table provides a comprehensive view of the breadth and interdisciplinary character of the ISCC, which had been carefully nurtured and maintained by Walter's work on the Membership Committee.

In the course of his professional career Walter was affiliated with the Interchemical Corporation, then with the Container Corporation of America, and was later active as an independent consultant. He had a broad range of interests in all aspects of color including formulation, production of specific colors in pain or lacquer, spectrophotometric measurement of color, color charts, color-mixture, and color order systems, particularly the Ostwald System. He is well known as the co-producer of the "Color Harmony Manual," which is based on the Ostwald System, and the associated "Descriptive Color Names Dictionary."

These interests led him to active associations with the ASTM and the OSA, which in turn strengthened his bonds to the ISCC. While an individual member of the Council and an OSA delegate he was appointed to the ASTM delegation. M. Rea Paul, the founding Secretary of the ISCC was then Chairman of the ASTM delegation, and in 1946 Walter Granville was made Vice-Chairman. When Paul founded and then headed ASTM Committee E-12 on Appearance of Materials, Granville was made Chairman of the Optical Properties Subcommittee of the Paint Committee, and Harry Hammond served as Secretary.

The classic color texts all cite Granville's important contributions and collaborations with Dorothy Nickerson and Carl Foss on the colorimetric specification through spectrophotometric measurements of colors in the Munsell System and in the Color Harmony Manual. These interests led to his 1947 appointment as chairman of the reconstituted ISCC Problem #7 Committee, "A Survey of Color specifications." Walter also served on the Munsell Foundation Board of Trustees from 1965 – 1974.

Reports in the ISCC Newsletters give further examples of his wide-ranging concerns and contributions to the literature and to the color community. The September 1945 issue mentions an article co-authored by Granville in which color charts of apple leaves are provided to apple growers to determine the degree of utilization of nitrogen fertilizer. The March 1954 issue contains a Granville letter on color-chip permanence. An FSPT [now FSCT] report in the July-August 1962 issue mentions a lecture given by Granville to the New England Society on “Attitudes and Trends in Color Usage.” One wonders if this bears any relationshipt to a quote in a July 1954 issue from a Granvill letter on the topic “Granville on color and Jail Breaks.”

At the 31st Annual Meeting Walter gave a paper on “Dynamic Metamerism” at the “Symposium on Lighting for Color.” This was followed in the May and August 1963 issues with an historical essay on “Metamerism and Color Stability.” At the 1985 Annual Meeting he presented “Color Harmony – What’s That?”, a view from a half century of experience.

Walter’s ongoing interest in color harmony and the role of color in our daily lives led to his involvement with Problem Subcommittee 33, Human Response to Color. He co-chaired the committee from 1982 – 1984 and was the Chairman for 1986 – 1987. He published in the May/June Newsletter a long report on this complex topic outlining the many factors which affect the human response.

Walter has also contributed in a personal way to his friends, co-workers and the color community at large. In 1974 he presented the Macbeth Award to Midge Wilson. The Nov/Dec, 1986 Newsletter contains an obituary he wrote on his good friend and collaborator, Carl Foss. In 1973 he donated his personal color library of 320 titles, some rare or unique, many accompanied by charts, swatches, or chips, to the Cooper-Hewitt Museum.

Although he seems to have made several attempts to “retire” or reduce his activity, the Jan/Feb 1989 Newsletter shows that Walter Granville’s enthusiasm and desire to contribute continue to prevail, as does his personal color library. That issue contains his review of the Bradley exhibit of sculpture at M.I.T. as well as his review of the book “Round Buildings, Square Buildings, & Buildings That Wiggle Like a Fish.” His spirited review is every bit as infectious and enticing as the title of the book. It also convinces one that not only are Walter’s contributions towards the advancement of the council and its aims and purposes outstanding and long term, they continue to this day.

Paul Hoffenberg”

Franc Grumm
1922-1985

[Excerpts taken from ISCC News #299, 1986]

The Color Science Community has lost a colorful, capable contributor. The life of Franc Grumm was ended abruptly when his automobile was struck head on by another car lat Friday afternoon, December 20, 1985. …

After 32 years with Eastman Kodak Company, Grumm took an early retirement in 1982 to become the Richard S. Hunter Professor of Color Science, Appearance and

Technology at Rochester institute of Technology (RIT) and to oversee the development of the newly established Munsell Color Science Laboratory. Two years earlier he had begun teaching an under-graduate course in Color Systems. Quite recently he had been working very hard to establish the master's degree program in color science. It was approved just two weeks before his death. ...

Grumm had long wanted to teach. A native of Slovenia, Yugoslavia, he earned a doctoral degree in classical languages from the University of Ljubljana. He was fluent in Latin, classical Greek and Hebrew as well as in a half-dozen modern languages. He planned to be a professor and briefly taught languages. …

[After emigrating to the United States in 1950 and eventually settling in Rochester] Realizing that it would be difficult to obtain a teaching position in the USA, Grumm began to work as a technician at Kodak. He pursued his interest in science and mathematics by taking night courses at the University of Rochester. He obtained a bachelor's degree in physics and then a master's degree in optics in 1962. … In 15 years he progressed from technician to Senior Laboratory Head of the Photometrology Laboratory where he directed research in photometry, radiometry and color-image stability and evaluation. …

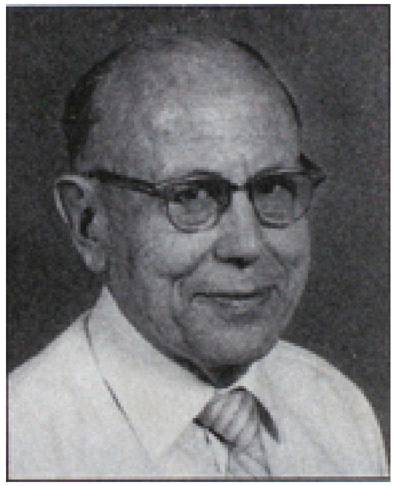
He served as a director of the Inter-Society Color Council (ISCC) from 1974076, as President-Elect from 1976-78, and as President from 1978-80. At the April 1985 ISCC Annual Meeting, he received the Godlove Award…. Grumm was one of the organizers of the Council for Optical Radiation Measurements, formed to advise the director of the National Bureau of Standards (NBS) [now NIST] of the needs of Industry, and he was currently serving as Vice President. Grumm served as President of the U. S. National Committee (USNC) of the International Commission on Illumination (CIE) from 1979-1983. He was chairman of the international technical committee, TC2.3, on Materials from 1975 until the CIE was reorganized into divisions in 1983, at which time he was appointed Director of Division 2, Physical Measurement of Light and Radiation, comprising 17 technical committees. In June 1985, the USNC Executive Committee nominated Grumm as its candidate for CIE President for the quadrennial 1987-1991.

Grumm was also editor or author of a number of books. Five volumes have appeared in the series on Optical Radiation Measurements published by Academic Press: Radiometry (1979), Color Measurement (1980), Measurement of Photo Luminescence (1982), and Physical Detectors of Optical Radiation (1983), and Visual Measurements (1984). …

Charla S. Haley

Charla Haley is Color/Sample Development Manager for Techmer PM, LLC in Clinton, Tennessee, where she is involved in color matching and product development for plastics applications. She received her BS in Chemical Engineering from Georgia Tech. She has several publications and a US patent on Flame Retardant, Light Stable Composition. Ms. Haley is a member of the Society of Plastics Engineers (SPE). Ms Haley served as a director of the ISCC from 1998 – 2001.

Harry K. Hammond, III



Harry K. Hammond, III has been a long time member of both the ISCC and ASTM. Hammond is an active member of the ISCC, serving as director for the ISCC from 1974 to 1976 and as editor of the ISCC News in 1986. He served as Chairman of the ASTM delegates to the U. S. National Committee of the International Commission on Illumination and as a voting delegate representing ASTM on the Inter-Society Color Council (ISCC). For years, he provided information about ASTM to the larger color community by writing news reports for the ISCC News. He worked tirelessly to introduce younger color scientists to both the ISCC and ASTM E-12 and get them involved. Many members became involved because of his encouragement.

Hammond received a B. S. degree in Engineering Physics from Lehigh University. He then joined the staff of the then National Bureau of Standards (NBS), where he worked from 1939-1977 in the Photometry, Colorimetry, Radiometry, and Product Evaluation Technology sections. His work involved development of standards and test method in the fields of light, color, and vision, and their relation to appearance properties of objects and materials. After retiring from then National Institute of Standards and Technology (NIST) in 1977, Hammond joined the staff of Gardner Laboratory, now BYK-Gardner. Mr. Hammond was commissioned a 2nd Lieutenant of the Army Reserve upon graduation from Lehigh. He served four years in the European Theater with the Army Signal Corps during World War II. He continued to be active in the Army Reserve until retiring in 1966 as a Lieutenant Colonel.

Harry was a member of the Testing Procedures Committee of the Illuminating Engineering Society (IES), and the Optical Methods Committee of the Technical Association of the Pulp and Paper Industry (TAPPI). On occasion he served as delegate to the International Standards Organization (ISO) Committees on Paint and on Paper. He has been active in CIE since 1967, and served as secretary of the US National Committee from 1967 to 1971. He was elected a Fellow of the Optical Society of America (OSA), received the ISCC's Nickerson Service Award in 1988, the ASTM Award of Merit in 1963 and with it the designation of Fellow of the Society, and Honorary member of the ISCC in 1991. ASTM Committee E-12 on Color and Appearance, an ISCC member body, selected Harry K. Hammond III as the first recipient of its Richard S. Hunter

Award, which was presented in conjunction with the National Institute of Standards and Technology (NIST) workshop on metrology and modeling of color and appearance to be held at the NIST in 2000. This is the highest commendation awarded by E-12.

Henry Hemmendinger
(April 1, 1915 – August 16, 2003)

"Henry Hemmendinger, an eminent authority in color science and standardization, died August 16 at the age of 88 in his home in Princeton, NJ. In his later years he was heard to lament, "Where are the giants in color?" A mirror would have revealed at least one.

Born in Bernardsville, NJ, Henry studied at Harvard and Princeton, from which he received a Ph.D. in astronomy in 1939 under the direction of Henry Norris Russell. His career as a physicist working in color measurement, specification, and control spanned the last half-century, first in a partnership, Davidson and Hemmendinger, and later as a consultant operating Hemmendinger Color Lab from his home. He was a widely recognized authority on color science, a member of international committees, and recipient of numerous honors---most recently the Godlove Award from the Inter-Society Color Council and Honorary Membership in the Council. Henry was a member of the American Society for Testing and Materials, a Fellow of the Optical Society of America, and a lifetime member of the U.S. National Committee of the CIE.

Henry's career focused on quantifying performance errors in colorimetry, incurred by photometric equipment and also by human observers. He brought to bear a deep knowledge of how spectral reflectance curves can aid in the formulation of products with desirable appearance attributes. He was also a leader in understanding metamerism, a breakdown in a color match incurred by changing either the illuminant or the observer.

Tirelessly, Henry worked to establish and to publish methods for precision spectrophotometry of reflecting materials. He devoted himself to getting good practice and good standards into the hands of industrial colorimetrists, a task in which his contribution has been compared to that of Deane Judd at the National Bureau of Standards. For many years, he was the sole U. S. supplier of calibrated colored materials used to evaluate the performance of color-measurement instruments. He presented numerous papers on this subject and is a leading expert on spectrophotometric precision and accuracy.

Henry contributed too many technological innovations, especially in collaboration with Hugh Davidson, with whom he founded D&H in 1952. In the 1950s, Davidson and Hemmendinger became pioneers of computer-directed colorant formulation, having developed the colorant-mixture analog computer COMIC, whose lineage is still visible in the world of formulation products. In addition, Davidson and Hemmendinger evaluated the curve shapes for candidate formulations for the Munsell Book of Color, to ensure good color constancy under change of illumination. They used their studies to embody the Munsell system in glossy paint. That was a significant achievement: current embodiments are nowhere near as color-constant. Many photographic products today are designed based on the rules they developed for the glossy Munsell Book of Color. Davidson and Hemmendinger developed the D&H Color Rule, a device to gauge the extent of observer metamerism. This rule is still viewed as indispensable in teaching the principles of observer metamerism.

In 1970, Henry founded the Hemmendinger Color Laboratory (HCL), devoted to the preparation and distribution of spectrophotometric and colorimetric color standards. In 1994 Hugh S. Fairman joined Henry as a partner in HCL, and now operates the company out of Tatamy, PA.

In addition to these contributions, Henry fruitfully combined his areas of expertise. For example, he used metameric pairs as a tool to assess instrument performance.

Colleagues and former employees remember Henry as a decent human being and as a vigorous and generous mentor, freely sharing his knowledge and wisdom. Rigorously honest in his scientific and personal life, Henry always searched for the truth, and when he found it he spoke up---with all due tact but unambiguously.

Besides pursuing scientific work, Henry was a passionate gardener who created a small oasis at his Princeton home, as he had previously done in Belvidere, NJ. He was interested in plant propagation and worked with a local garden club to cultivate the rare blue gentian flower.

Henry's first wife Miriam, a daughter, Carol Selikowitz, and his long-time companion Sylvia Crane predeceased him. He is survived by two brothers, his sons David of Schenectady, NY and Mark of Mill Valley, CA, and by five grandchildren. Henry's family is grateful to friends in the Princeton area who supported him during his illness. The family invites contributions in his name to be made to the Center for Constitutional Rights, 666 Broadway, NY, NY 10012, or The Nature Conservancy, 425 N. Fairfax Drive, Arlington, VA 22203, in honor of his long-standing commitments to social justice and to the environment."

Compiled by Dr. Michael H. Brill

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Michael J. Henry

Michael J. Henry is the Instrumental Color Coordinator for PPG Industries' Automotive OEM Decorative Products business unit. He is a member of the ISCC and has served as a board member of the Detroit Color Council. He is a member of the ASTM E12 committee on Color and Appearance. Mike has 20 years of industrial color experience. He has been teaching and conducting customer seminars for PPG since 1991. He contributes to classes sponsored by the Detroit Colour Council and is currently serving on the DCC/SAE J1545 update committee.

David Hinks

DAVID HINKS received a B.S. degree in color chemistry from the University of Leeds in the United Kingdom in 1989, and a Ph.D. in colour chemistry from the same university in 1993. In 1993, he moved to North Carolina State University as a Post Doctoral Research Fellow, and later Visiting Assistant Professor, where he investigated and co-patented a series of non-genotoxic pigments. In 1996, he joined Milliken & Co. in Spartanburg, South Carolina, as an R&D Chemist. In 1998, he returned to NC State University as Assistant Professor, where he teaches color science and dyeing and finishing. His current research interests include lighting variability and color constancy, dye synthesis and modeling, and dyestuff applications using supercritical fluid technology. He is chair of the American Association of Textile Chemists and Colorists' Color Measurement and Test Methods Committee (RA36). He is also Academic Editor for the Society of Dyers and Colourists in the United Kingdom.

Kevin W. Houser

Dr. Houser, Ph.D., PE, LC, is an Assistant Professor of Architectural Engineering at the University of Nebraska-Lincoln. His research and teaching are focused on advancing the quality of our luminous environments. Dr. Houser's current research focuses on the relationship between the spectral composition of light and human vision. His instructional responsibilities include developing and teaching courses in illuminating engineering and lighting design.

Prior to joining the University of Nebraska Dr. Houser was Manager of Lighting Education for Philips Lighting Company, where he was responsible for program development and course content for all education programs at the Philips Lighting Center. Dr. Houser has also worked for Public Works and Government Services Canada, as an applications engineer at Elliptipar Corporation in Connecticut, and as a Co-Op Engineer with Edwards and Zuck, P.C. in New York City. In addition to his work at the University of Nebraska, Dr. Houser is the owner of Loucetios, LLC, a lighting consulting firm based in Omaha.

Dr. Houser is a licensed Professional Engineer in the state of Nebraska and is Lighting Certified by the National Council for the Qualification of the Lighting Profession (NCQLP). He is an active member of the Illuminating Engineering Society (IES), serving on the Quality of the Visual Environment, Educational Materials, Effects of Lamp Spectral Distribution and Color committees. Dr. Houser is also a member of the International Association of Lighting Designers (IALD), the United States National Committee of the Commission Internationale de l'Eclairage (CIE), and the Inter-Society

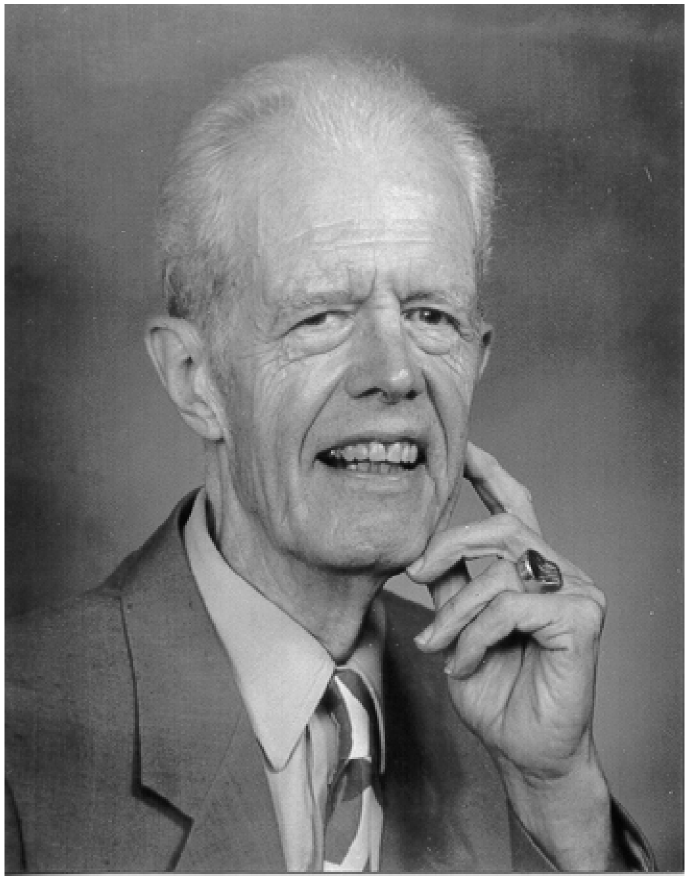
Color Council (ISCC). Dr. Houser is a member of the Board of Directors of the Nuckolls Fund for Lighting Education.

Dr. Houser earned Bachelor and Ph.D. degrees in Architectural Engineering from Penn State. As a doctoral student his major course of study was Illuminating Engineering with a minor in Statistics. During that time he also studied structural engineering in England and architecture in Italy, and also served as the student representative on the Board of Directors for IALD.

Robert W. G. Hunt

Robert W. G. Hunt received B. S., Ph. D., and D. S degrees from London University. Dr. Hunt was a member of Kodak Research Laboratories for 36 years and a Visiting Professor of Physiological Optics at City University, London, England. Currently he is a consultant and lecturer. He has published two books, which have gone through several editions, and many articles. His current research interests center on the human color vision system and applying color science to industrial problems. He was chairman of the Colorimetry Committee of the CIE from 1975-1983 and President of the International Colour Association from 1981 to 1985. In 2002, Dr. Hunt was awarded the Society of Information Display's Johann Guttenberg Prize.

Richard S. Hunter
1909 – 1991



Mr. Richard S. Hunter, outstanding pioneer in appearance measurement and founder of Hunter Associates Laboratory, Inc., died on Wednesday, January 16, 1991 four days after hip replacement surgery. On May 7th of that year the ISCC presented the Godlove Award to his heirs. He had been selected for and knew of the award before his death. The following is excerpts from an article about him published in the ISCC *News #330*, March/April 1991.

"Richard Hunter's career in color spanned more than 60 years. In 1927 he began work in the colorimetry section at the National Bureau of Standards (NBS) now the National Institute of Standards and Technology (NIST), as a laboratory assistant to Irwin G. Priest and later to Dr. Kasson S. Gibson and Dr. Deane B. Judd. In 1929 he devised the Hunter L, a, b square root color scale, accepted worldwide and still in use. He presented his first technical paper in 1922 at the meeting of the Technical Association of the Pulp and Paper Industry (TAPPI). Except for a year beginning in 1933 when there was a 40% reduction in staff, he remained at the Bureau until 1946.

Contact with various industries coming to the Bureau for advice and for development of national standards, convinced Hunter of the need for appearance measuring instruments. In 1934 the first visual reflectometers and gloss meters were developed and sold in cooperation with Dr. Henry A. Gardner, who was then working for the National Paint, Varnish and Lacquer Association (now the National Paint and coatings Association) and who also had a private laboratory. In 1946 Hunter left the Bureau to join the Henry A. Gardner Laboratory as chief optical engineer, leading the work to improve instruments that Gardner was then selling. In 1948 he developed the tristimulus color-difference meter. In 1952 he left Gardner to launch his own consulting and instrument development company, Hunter Associates Laboratory, commonly know throughout the world as Hunterlab. His son Philip is now President and Chief Executive Officer of the company.

In addition to his business, which pioneered ways to characterize appearance, Richard Hunter was vitally interested in color education and in standards development. He devoted his time unstintingly to furthering knowledge about color, gloss, haze, reflectance and transmission. He has been active in the Inter-Society Color Council and its Problems Committees since the Council's early years. He served as an ISCC director in 1962, President-elect in 1970, and President from 1972 to 1974. His achievements in color education and standardization culminated in publication by John Wiley Interscience in 1975 of his book, The Measurement of Appearance. The Council recognized his work and book by presenting him the Macbeth Award in 1976. …

Hunter was made an Honorary member of the Council in 1982 and the 1987 ISCC Williamsburg Conference on Appearance was dedicated to him. His work with the American Society for Testing and Materials (ASTM) began in 1936 …. In recognition of his long and outstanding service he was given the ASTM Award of Merit in 1961 with the honorary title of Fellow. …

Hunter was the author of over 100 technical publications, including the classic papers "Methods of Determining Gloss" (1937), "A Multipurpose Photoelectric Reflectometer" (1940) and "Photo-electric Tristimulus Colorimetry With Three Filters" (1942), which are still consulted by students of these subjects. His concern with color education was evident in the outstanding appearance measurement seminars conducted by HunterLab throughout this country and abroad. He also collected and preserved an excellent color library at Hunterlab. In 1983 Richard Hunter and his wife Elizabeth presented the Rochester Institute of Technology (RIT) with a gift to establish the Richard S. Hunter Professorship of Color Science, Appearance and Technology. The chair was established in conjunction with the Munsell Color Science Laboratory and is part of the new RIT Center for Imaging Science. …"

John Hutchings

John Hutchings is a physicist who has been in and around color and appearance science for almost 50 years during which time he developed the total appearance concept and its application to foods. After retirement from Unilever Research Laboratory in Bedford England, he has extended application of the concept to the study of color in design, architecture, biological nature, archeology and, in oral tradition. During his present career as color and appearance consultant he is pursuing the application of color calibrated digital analysis to food total appearance in collaboration with the Colour and Imaging Institute of the University of Derby. *Food Color and Appearance* is in its second edition and *Expectations and the Food Industry – the Impact of Color and Appearance* is published this year. He is past chairman, Newton Medalist and honorary member of the

Colour Group (GB), honorary member of the Grupo Argentino del Color and a past executive committee member of the International Colour Association. In 2005, he received the Deane B. Judd Award from the AIC.

Tarow Indow

Tarow Iindos received a Ph.D. degree from Keio University in Tokyo, Japan. He then worked as an assistant professor and professor of psychology at Keio University for 28 years (1951-1979). While in Japan he served on the Committee on Sensory Evaluation in Industry. He also served as President of the International Colour Association (AIC) from 1973 to 1977 and has served on the editorial board of *Color Research and Application* since its founding in 1976. After moving to the United States as a visiting scientist, in 1980 he became a professor in the Department of Cognitive Sciences at the University of California – Irvine. His primary research interests lie in the area of quantitative analysis of perception. In 1988, he received the AIC Judd Award. For that award he is cited for his work on the method of multidimensional scaling and his work in which the global structure of the Munsell color space is examined by that method and its variations. His experiments were supported by the excellent technology of Japan to produce color chips and included tests of various methods of quantifying perceptual color differences of ranges within which color differences are meaningful for human eyes, of algorithms to define the configuration and the proof of some non-additivity involved in human assessment of color differences.

He has published five books in Japanese relating to quantitative methods of analysis of human responses and contributed a chapter in the *Handbook of Color Science* and a chapter in the *Handbook of Sensory Evaluation in Industry*.

Kimberly A. Jameson

Kimberly A. Jameson received a B.A. degree in general psychology in 1983, M. A. and Ph. D. degrees in cognitive psychology in 1988 and 1989, all from the University of California-Irvine. She has held post-doctoral fellowships at Institut für Psychologie, Universität Bonn, Germany, University of California-San Diego, and Institut für Psychologie, Christian-Albrechts Universität, Kiel, Germany. After receiving her Ph. D., she was awarded National Science Foundation-NATO postdoctoral fellowships and a research associateship from the National Research Council. Currently she is an assistant professor in the Department of Psychology at the University of California-San Diego. Her research studies cover areas such as gender-based differences in color perception, genotype/phenotype relationships of human color vision, color as a coding dimension in user-interface design, and cross-cultural variation in color categorization and naming.

Craig Johnson

Currently Craig Johnson works for Hunter Associates Laboratory. Craig served on the ISCC Board of Directors from 1998 – 2001. Mr. Johnson worked for the Instrument

Systems Division of Konica Minolta Corp. from 1998 until 2006, most recently as Assistant General Manager. Before that he was the Color Products/ Market Segment Manager for the plastics industry at BYK-Gardner USA in Silver Spring, Maryland, where he is responsible for the determination of product line mix for the plastics industry as well as product marketing for all industries for color products. At BYK he was also responsible for the development and implementation of regional and corporate seminar programs, program management for in-store point of sales color matching and directing various software and hardware projects. Mr. Johnson received his BA in Economics from Boston University. He is a member of the American Society for Testing and Materials (ASTM), the Society of Plastics Engineers (SPE), and the Technical Association of the Graphics Arts (TAGA).

Garrett M. Johnson

GARRETT M. JOHNSON is a color scientist in the Munsell Color Science Laboratory at Rochester Institute of Technology (RIT). He is also pursuing a Ph. D at the Chester F. Carlson Center for Imaging Science at RIT. He currently holds a B. S. degree in imaging science and an M. S. degree in color science both from RIT. His research interests include image and color appearance, image differences, and computer graphics.

Deane Brewster Judd

“Dr. Dean B. Judd, with the National Bureau of Standards since 1927, died on October 15, 1972, at his home at 3115 Leland Street, Chevy Chase, Maryland. He had been ill since December 1970, but had rallied several times, even to spending the winter months of 1971 and 1972 at St. Croix, is favorite vacation spot.

One of the world’s foremost scientists in the filed of colorimetry and color vision, Dr. Judd served on committees of many national and international organizations concerned with color. He was past president of the Optical Society of America (1953-55), president of the Inter-Society Color Council (the only person to server two terms, 1940-44). From each of these societies he received top awards, the Ives medal of the Optical society (1958), the Godlove Award of the Inter-Society Color Council (1957). In 1950 he was awarded the Exceptional Service Award of the U. S. Department of Commerce; in 1961 the Illuminating Engineering Society awarded him their Fold Medal. As early as 1936 the Society of Motion Picture Engineers had given him their “Journal Award.”

Dr. Judd’s field of work was broad; it covered research in vision, color-blindness, measurement of color, development of color standards, studies of uniform color spacing. For the International Commission on Illumination he served many years as chairman of its committee on colorimetry (1955-1963); he was a member of the National Academy of

Science – National Research Council's Committee on Vision; since its establishment in 1942, he had been president of the Munsell Color Foundation. His work took him to Europe frequently where he lectured on color in London, Stockholm, Berlin, Madrid, and Lucerne, Switzerland. He was the author of more than 100 research papers on color, the author of the book Color in Business, Science, and Industry (1952), and with Günter Wyszecki (National Research Council, Ottawa) a co-author of the second edition (1963). Dr. Judd remained active, even after his periods of concentration became limited to no more than one or two hours a day. On the Friday before his death he taped a message for the International Color Association that will meet in York, England, in July 1972, where the Newton Medal of the British Colour Group will be awarded to him for his Newton Lecture.

Deane Brewster Judd was born in South Hadley Falls, Massachusetts, November 15, 1900. He attended Ohio State University where he received a B. S. degree in 1922, an M. A. in 1923. He then went to Cornell where he received a Ph.D. degree in physics in 1926. He served as instructor in physics at Ohio State in 1923-24, and as Munsell Research Associate in colorimetry at the National Bureau of Standards the summer of 1926-27. Since 1927 he had been continuously at the National Bureau of Standards, where he helped the Bureau to maintain its world-wide reputation as a leader in the field of colorimetric research. He retired in November 1969, but remained as a guest worker. …"

[Written by Dorothy Nickerson and taken from the ISCC *News* #220, September-October 1972]

Kenneth L. Kelly

"Kenneth L. Kelly, 81, a retired physicist of the National Bureau of Standards (NBS) died suddenly on Monday December 30, 1991, at his home in Southern Pines, North Carolina.

Mr. Kelly was a research colorist who worked closely with Dr. Dean B. Judd at NBS. Together they published the ISCC NBS *Method of Designating Colors and a Dictionary of Color Names,* NBS Circular 553, Nov. 1, 1955. Kelly later published A Universal Color Language, Color Engineering v 3, p2-7 March-April 1965. After Judd's death in 1972 Kelly was responsible for the publication of NBS Special Publication 440, (1976) COLOR – UNIVERSAL LANGUAGE AND DICTIONARY OF NAMES; this publication included the Circular (158 pages) and the Universal Language (19 pages) with 10 color plates. [Sic] and a color photograph of the Munsell Color Solid on the soft cover. Nearly 20,000 copies were sold and distributed at the price of $3.25. His most recent scientific contributions were two book reviews in *Color Research and Application.* His review of Color in Our Daily Lives, by Deane B. Judd is in volume 2 (1977), page 98. The review of *Chroma Cosmos 5000* by Japan Color Research Institute is in volume 6 (1981), page 59.

Born in Baltimore, Maryland, November 19, 1910, Kelly obtained a B. S. in physics from Johns Hopkins University in 1934 and an M.Sc. from Philadelphia College of Pharmacy in 1935. Early in his career, Kelly worked for his father who was Director of the American Pharmaceutical Association. He came to NBS in 1936 as a Research Associate for this Association. One of his early papers was entitled Instructions for Determining the Color Names for Drugs and Chemicals, published as a Bulletin of the National Formulary Commission of the American Pharmaceutical Association, Vol 8, 339 (1940).

In 1943, Kelly joined the NBS staff as a research chemist. From 1948, until his retirement he was employed as a physicist first in Photometry and Colorimetry Section of the Metrology Division and later in the Sensory Environmental Section of the Center for Building Technology.

Kelly was a charter member of the Color Marketing Group formed about 1962 and a member body of the Inter-Society Color council (ISCC) since 1965. He was awarded a life membership in the Group in 1967 and served as a director in 1969. He was also a member of the American Association for the Advancement of Science, the Optical Society of America, and an honorary member of ISCC. He was a lifetime member of the Saint Andrew's (Scottish) Society of Washington, DC. He was very proud of his Scotch [sic] heritage. He wrote a book, *The McIver Family of North Carolina* that included the history of his Scottish ancestors and many of the McIver and Kelly cousins who have lived and who still live in North Carolina. The 285-page volume was published in 1964 by McIver Art and Publications, Inc., Washington, DC.

Kelly was a collector of firearms, an expert rifleman, and a member of the National Rifle Association. He was also a devout churchman and served as an elder in the Bradley Hills Presbyterian Church, Bethesda, Maryland.

Kelly is survived by his wife, Helen Whelchel. They were married July 15, 1956 in Union Presbyterian Church, Cameron, North Carolina. Everyone who met Kenneth marveled at his ability to surmount a major lifelong physical handicap. Those of us who had the privilege of working with him admired his genial, always pleasant personality. He was an inspiration to many another handicapped people."

[Written by Harry K. Hammond III and published in the ISCC *News*#337, May/June 1992.]

Mary Killoran

MARY KILLORAN has worked as a Senior Development Chemist in the Refinish Business Unit of PPG Industries. She is a member of the ISCC, the DCC and a former member of ASTM E12, Committee on Color and Appearance. At PPG she has focused on color instrumentation, pigment selection, and dispersion studies, and has conducted internal seminars on pigment chemistry and basic color theory. Mary has a Ph.D. in Physical Organic Chemistry from Dartmouth College.

James G. King

Before retiring, Mr. King was a Research Fellow at DuPont's Automotive Finishes R&D Laboratory in Troy, Michigan. After joining DuPont in 1964, King has worked in a succession of R&D and Marketing assignments. In 1978 he assumed his current responsibilities for color styling and pigmentation technology. Currently King is involved in selecting and qualifying color pigments for use in automotive topcoats, preparing and presenting color styling shows for automotive customers, and global consulting on the use of color pigments and the resolution of color-related problems. He also participates in DuPont's color marketing of automotive finishes in Europe and Japan. King holds several patents on pigment and dispersion technology. King received his B.A. in Chemistry from the College of Wooster (Ohio), and served on the Board of Directors of the Detroit Colour Council (DCC). He was a Chair holder in the Color Marketing Group (CMG) and completed a term on the CMG Board of Directors. King also supports color education activities at Eastern Michigan University and other local color organizations. In the ISCC he served on the Board of Directors from 2001 – 2004.

Eileen Korenic

Dr. Korenic is an Assistant Professor of Physics at the University of Wisconsin-River Falls. Her primary research interest is the colorimetry of liquid crystals, and she is also extremely interested in activities that promote science literacy at all levels of education. Prior to joining the University of Wisconsin, Korenic worked for the Display Materials Technology Group of 3M Corporation. Korenic received her Ph.D. from the University of Rochester - Institute of Optics in 1997; her thesis was awarded the Glenn Brown prize for outstanding thesis from the International Liquid Crystal Society in 1998. She is an active member of the Optical Society of America (OSA), serving on its Membership and Educational Services Council, on the editorial advisory board of Optics and Photonics News and as chair of the K12 education subcommittee. Korenic is also a member of the National Science Teachers Association, the American Physical Society, the American Association of Physics Teachers, the Wisconsin Association of Physics Teachers, and the International Liquid Crystal Society. In the ISCC she served on the Board of Directors from 2001 – 2004.

Alan Kravetz

Alan Kravetz has over 25 years experience in the research, design, development, market introduction and application of electro-optic color measurement instrumentation for spectrophotometry, medical diagnostics, near-infrared gauging, and electronic imaging. He worked for Macbeth Division of Kollmorgen Corp., (now GretagMacbeth), Newburgh, NY for over 17 years where he served as Technical Manager of Advanced Product Development, Project Engineer and Design and Development Engineer. He worked on instrumentation including: new electro-optical, μP-based color measurement and control instruments; Spectral Densitometers using pulsed xenon electro-optical μP-based instrument used for on-line measurement of specialty and process inks in the printing and packaging industry, off-line reflection and transmission densitometers for the photographic and graphic arts, on-line and off-line pulsed xenon dual beam abridged spectrophotometer for color measurement in the paint, plastics and textile industries, special reflection modules for Cary 14 and Perkin-Elmer laboratory spectrophotometers, and absorption & multilayer optical filters to provide instruments with desired special response, color temperature, whiteness and brightness. Later he moved to the Instrument systems Division of Minolta Corporation (now Konica Minolta) as a Special Projects Manager and Product Line Manager for 3-D Digital Imaging Products.

Mr. Kravetz attended Carnegie-Mellon University, Pittsburgh, PA, where he received a B.S. in Physics (1974) and an M.S. in Applied Physics – Instrumentation (1975). He is active in several national and international standards and professional organizations, including CIE/USA, ISCC, ASTM, IES, and the Optical Society of America. He served on the ISCC board of directors from 2000-2003 and is the US voting delegate of CIE Division 8 on Imaging. He is active in several ASTM committees, has served as chair of two subcommittees of ASTM in D-1 on Paints and as Secretary of E-12 on Color and Appearance.

Rolf G. Kuehni

Mr. Rolf G. Kuehni was presented the prestigious Godlove Award during the ISCC Annual Meeting in Chicago, in 2003 and is the 2005 recipient of AATCC's Olney Medal.

Mr. Kuehni received the degree of Textile Chemist from Fachhochschule Niederrhein in Krefeld, Germany. After a 30-year career with Bayer in the United States, where he became a divisional vice president, he joined DyStar L.P, a textile dyes joint venture of Bayer and Hoechst (and now BASF) serving as Vice President of Staff and Services.

After his retirement, Kuehni continued to actively pursue the study of color and made significant contributions to the understanding of why color space metrics like CIELAB do not always agree with visual experience. He has studied color and color-differences both from a current technological standpoint and from a historical perspective, as demonstrated by his just released new book *Color Space and Its Divisions*. For more than two decades Kuehni has been a strong proponent of closer ties between the industrial scientists studying and applying color technology and the academic scientists studying color vision and developing the basis of color science.

Mr. Kuehni is an Adjunct Professor at North Carolina State University in Raleigh, NC. He has authored four books and some 60 peer-reviewed papers. Kuehni has served on the Editorial Board of *Color Research and Application* since its inception and as Editor from 1987 to1989. He was a Director of the ISCC from 1982 through 1985. Kuehni is active in two technical committees of the International Commission of Illumination (CIE) and he chaired and was active in several ISCC Problem Committees. He is a member of the American Association of Textile Chemists and Colorists (AATCC), where he is the incoming chairman of the color measurement committee.

Romesh Kumar

Dr. Kumar is the Technical Manager for Coatings for Clariant Corporation in Coventry, Rhode Island. His current responsibilities include promotion of Clariant pigments and preparations by way of technical solutions to the Coatings industry in the NAFTA region.

Dr. Kumar received his M.S. in electrochemistry from Laurentian University and his Ph.D. in Color Science from Rensselaer Polytechnic Institute. He has made over 100 presentations at national and international meetings and won the Best Paper Award at the Society of Plastics Engineers meeting in 1982. Kumar was an invited speaker at the 2000 CIE meeting in Seoul, Korea. He has taught Color and Pigments courses at the University of Southern Mississippi and at DePaul University. Kumar also chaired the

Optical Properties of Coatings Subcommittee (D01.26) of ASTM International and is the current chairman of the ISCC delegation from the Federation of Societies for Coatings Technology (FSCT).

In 2002 Dr. Kumar was awarded the Nickerson Service Award. He joined the ISCC in 1978 and has been an active member since that time. Kumar was on the ISCC Board of Directors from 1990 to 1993. He chaired ISCC Annual Meetings in Newport, Rhode Island (1993) and Charlotte, North Carolina (2000). In 1990 Kumar co-chaired a Symposium on Color and Appearance Instrumentation (SCAI), which was held in Cleveland, Ohio. Dr. Kumar has been the ISCC Arrangements Chair since 1993. Under his innovative leadership the ISCC meetings have always been exciting and within budget.

Jack A. Ladson

Jack Ladson currently is a principle in Color Science Consultancy, which supplies color solutions through out the enterprise, solving industrial problems. For twenty-five years Ladson has worked in the field of color and appearance technology. His current interests are in digital color technology, spectrophotometry & colorimetry, digital imaging, and global color control. He has extensive experience in many aspects of business, including: R&D, Operations, and Sales & Marketing.

Ladson is actively involved in the Inter Society Color Council. He was just elected Secretary this year, and in the past served as President and on the Board of Directors. He is an active member of the American Society for Testing and Materials (ASTM). He chairs the sub-committee ASTM E12.02 on Colorimetry and Spectrophotometry, E12.06 on Digital Imaging, and is task group chairman of Effect Coatings (Metallic and Pearlescent). He served as an advisor to PENN State Advisory Board on Nanoparticles. Ladson is an invited lecturer in the US, Europe, and Asia; and has published over 30 papers on color.

Ann Campbell Laidlaw

Ann Campbell Laidlaw received the Inter-Society Color Council's (ISCC) Nickerson Service Award during the ISCC's 1997 Annual Meeting in Baltimore, Maryland. Ms. Laidlaw was the Manager of Applications at SheLyn, Inc. (which became part of GretagMacbeth) in Greensboro, North Carolina. She was the ISCC's first Membership Secretary, serving from 1990 through 1995. She served on the Board of Directors from 1990 to 1993 and chaired the ISCC 1995 Annual Meeting in Greensboro, North Carolina. When the ISCC opened its Reston, Virginia office in 1996, Ms. Laidlaw offered continuing support by transferring membership information and advice, including the many protocols that she had found essential to the smooth running of the ISCC. She has worked tirelessly at the registration desk at a number of ISCC Annual Meetings encouraging new members and solving problems.

Ms. Laidlaw received her B.S. in Textile Science from the University of California, Davis, and her M.S. in Textile Chemistry from Clemson University. She serves as a delegate to the ISCC from the American Association of Textile Chemists and Colorists and as chair of their RA 36 Committee on Color Measurement. Ms. Laidlaw is also a member of the Council for Optical Radiation Measurements.

Prior to joining SheLyn, she worked in the Color Science Laboratory of Burlington Industries. Her interests in color include video color rendition, spectrophotometry, color difference measurements, and instrumentation, including calibration issues, textile measurement and formulation.

Yan Liu

Yan Liu served on the ISCC Board of Directors from 1998 – 2001. At that time Mr. Liu was a Research Associate with the Research Department, Gemological Institute of America in Carlsbad, California, where his current research interests include color measurement of gemstones, instrumentation for color measurement, visual color grading of faceted gemstones, standard light sources, origin of color in gemstones, color vision, and gemological optics. He received a B.S. degree in physics from Shandong University, Jinan, China. Mr. Liu studied color optics as a graduate student in the Institute of Color Optics, Shandong College of Textile Engineering, Qingdao, China; and received an M.S. degree in Optics from the Changchun Institute of Optics and Fine Mechanics, Chinese Academy of Sciences. He also received an M.S. degree in color science from the Rochester Institute of Technology. He is a member of the Optical Society of America (OSA).

Joy Turner Luke

Mrs. Luke is a painter and owner of Studio 231 in Sperryville, Virginia, where she conducts intensive courses on color and artists' paints. She also lectures widely on these topics for art schools and other groups with a specialized interest in color. Mrs. Luke studied art and color at Rollins College, Southern Methodist University and American University and has taken technical courses on color at Rensselaer Polytechnic Institute and Hunter Associates Laboratory. Beginning in 1960 she exhibited paintings in many of the large painting exhibitions in the Washington-Baltimore area, winning several awards. Her paintings were handled by several galleries and shown in three one-man exhibitions at the Studio Gallery in Washington, DC. Mrs. Luke has been teaching painting, composition and drawing classes since 1967 and serves as a judge for art exhibitions.

She writes articles on color and artists' materials for professional journals and other publications. Since 1976, Mrs. Luke has served on the Editorial Board for the international journal Color Research and Application. From 1993 to 1997 she edited the National Artists Equity Association's newsletter on art materials, Pen, Pencil and Paint. Mrs. Luke is the author of the book, The Munsell Color System: A Language for Color, and has authored computer software, Color Cleaver, that makes the Uniform Color Scales developed by the Optical Society of America more useful to people working with color.

The Inter-Society Color Council (ISCC) selected Mrs. Joy Turner Luke as an Honorary Member in 1999. Mrs. Luke served as one of the ISCC Historians. She was ISCC President from 1988 to 1990 and on the Board of Directors from 1980 to 1983. Mrs. Luke chaired ISCC Project Committee 37 "Artists' Materials" from its inception in 1976 to 1981 and again from 1989 until its completion 1991. In 1988 Mrs. Luke received the ISCC's Macbeth Award for her work relating to artists materials. In 1988 she also received a Distinguished Service Award from the Art and Craft Materials Institute. Mrs.

Luke received the Gardner Award and the Award of merit from the ASTM International. She is also a member the National Artists Equity Association.

David L. MacAdam

Dr. David L. MacAdam with a model of the "Uniform Color Scale"

"David L. MacAdam (1910-1998), died at Fairport Baptist Homes in Rochester, NY on March 9, 1998. Born in Philadelphia, Dr. MacAdam attended Lehigh University and graduated *Magna Cum Laude* and *Phi Beta Kappa.* He entered MIT in 1932 and studied for his doctorate under Prof. George R. Harrison. He was a charter member of *Sigma Xi* and a teaching fellow. Under Prof. Arthur C. Hardy, he originated the first course in color measurement and assisted Prof. Hardy in the preparation of "Handbook of Colorimetry". Upon graduating from MIT in 1936, Dr. MacAdam joined the Research Laboratories of the Eastman Kodak company. He retired from Eastman Kodak as a Senior Research Associate in 1975 and served as Adjunct Professor at the University of Rochester, Institute of Optics until 1995.

Dr. MacAdam was instrumental in establishing the theoretical basis for color photography, including color masking as compensation for unwanted dye layer absorptions, (JOSA, Vol. 28, 1938, p.466).

Dr. MacAdam single-handedly opened up the field of color difference measurement. He is often remembered for the work he did that resulted in the now famous MacAdam ellipses, published in the Journal of the Optical Society of America under the title, "Visual Sensitivities to Color Differences in Daylight" (JOSA, Vol. 32, May 1942, p.247). It is easy in retrospect to forget the prodigious amount of work that went into that paper, which reported color tolerances in many directions from 25 target chromaticities at different luminance levels.

With Deane Judd and Günter Wyszecki, Dr. MacAdam performed the first principal-component analysis of daylight (JOSA, Vol. 54, 1964, p1031). By showing that daylights are effectively linear combinations of only a few basic spectra, Dr. MacAdam opened the way to the algorithms that now are being proposed in computer vision to perform robotic object-color recognition independently of illumination.

Dr. MacAdam proposed several color spaces based on his color-difference ellipses as metric, one of which was the 1960 Uniform Color Space. He has developed equations for evaluation of color differences as the basis for standardization by the CIE, (e.g., FMC Color Difference Equation). This was adopted by the CIE and accepted as an industrial standard for several years before it was refined to produce the CIELUV and CIELAB uniform color spaces that are in use today.

Another color-space contribution by Dr. MacAdam is the OSA Color Order System, replete with its own color atlas samples according to crystallographic principles.

Dr. MacAdam has also made many contributions to the fields of colorimetry, color photography, color television, camouflage detection, and color standardization. He established the reliability of the automatic recording spectrophotometry and initiated the use of computers in 1946 for research in colorimetric studies of mixtures in color photography. He invented a Tristimulus integrator for colorimetry and developed a geodesic chromaticity diagram to facilitate determinations of hue and saturation in evaluation of fidelity of color reproduction in color photography and color television.

He was a leader of Great Books discussion group and his interest in the classics inspired him to writ a book in 1970: *Sources in Color Science*, (The MIT Press, 1970). MacAdam collected portions of articles from Plato's *Timeaus 68,* Thomas Young, Erwin Schrödinger, John Guild and Stephen Polyak to Sir Wilfred E. Le Gros Clark.

He has written numerous articles on color. Some of the articles have become classics in their field. Several of his papers contained materials that were subsequently named for the author, a rare honor. Examples are the MacAdam limits for the maximum possible luminous transmittance or reflectance at a given chromaticity and the MacAdam ellipses for color discrimination as a function of CIE coordinates. Dr. MacAdam was the first recipient of the Adolph Lomb Award from the Optical Society of America. He was the President of the Optical Society of America in 1963 and editor of its Journal from 1964 to 1975.

Dr. MacAdam was an honorary member of the Inter-society Color council and recipient of the Godlove Award of the Society in 1963. In 1966 he received the Mattiello Award of the Federation of Societies for Paint Technology and Hunter and Driffield Medal from the Royal Photographic society. In 1974 he received the highest award of the Optical Society of America, the Frederic Ives medal for his contributions to color and optics. In 1983 he received the Judd Medal from Association Internationale de la Colour (AIC) and in 1985 Newton Medal from the Colour Group of Great Britain.

Dr. MacAdam was a hike with the Genesee Valley Hiking Club and a member of the Immanuel Baptist church. His wife of 58 years, Muriel Faulkner MacAdam died in 1996. Survivors include their four children, David Pearce MacAdam (Chatham, MA), Keith Bradford MacAdam (Lexington, KY), Lewis Kempton MacAdam (Shrewsbury, MA) Muriel Susan MacAdam (Rochester, NY) and seven grandchildren. Contributions in his memory may be made to the Institute of Optics, University of Rochester.

Michael H. Brill"

Reprinted from ISCC *News* #373, May, June 1998

Norman Macbeth

[Excerpts taken from the article entitled "Norman Macbeth, Senior" written by Dorothy Nickerson in ISCC *News* #216 January-February 1972]

"Norman Macbeth was born September 9, 1873 in Stayner, Ontario. He came to the United States from Canada in 1902 and after brief stops in Boston and New York settled in the Philadelphia area. While there he worked as lighting engineer for Welsbach and Westinghouse and in 1911 formed the Macbeth Arc Lamp Company. In 1915, when Artificial Daylighting Company was formed, he moved to New York City.

Prior to 1910 his first involvement was with the evaluation and correction of electric meters, at that time extremely inaccurate. He developed techniques for testing their accuracy. In 1908, while lighting engineer for the Welsbach Company, Camden, N. J. (1908-1911), during the time when gas and electricity were in competition for lighting, he developed an "Amber Light" gas mantle that reduced the excess green in the gas lighting, bringing its color closer to that of the warmer incandescent lamp color preferred for home lighting. He did much in that early period to create an interest in the use of illuminating engineering in connection with gas lighting; he wrote a Handbook on Gas Illumination and presented a number of papers at gas association conventions.

In 1910, after development in 1907 of a special arc lamp for photo-engravers' use, he invented the high-current-density white flame carbon arc. This led to the formation in 1911 of the Macbeth Arc Lamp Company under which this lamp earned a world reputation as leader in carbon arcs for photoengraving, a reputation held until the 1950s when pulsed xenon and halogen tungsten took over. During this decade he organized an illuminating engineering department at the Westinghouse Lamp Company. In fact, during this period he carried on several activities simultaneously, for from 1912-1917, Norman Macbeth owned and edited Lighting Journal, at that time the only publication devoted exclusively to the advancement of the lighting industry. He invented the Macbeth Illuminometer – one of his greater gifts to illuminating engineering – patented in 1914 and produced by Leeds and Northrup, Philadelphia. He also began the experiments that led to the production of artificial daylight and, in 1915, to the formation of Artificial Daylighting Company, forerunner of the present Macbeth Corporation. With Ives he developed and patented a circular slide rule for converting measurements of illumination and brightness. He developed and patented the use of high and low color temperature illuminants for testing metamerism. His interests were so wide, and his enthusiasm for Lighting Journal so great, that the consequent financial strain made it necessary for him to relinquish his interests in the Macbeth Arc Lamp Company in order to continue with the publishing venture. He continued with this until 1917 when he sold Lighting Journal to McGraw-Hill Publishing Company where it was combined with Electrical Merchandising and Electrical World.

In the period following 1920 Norman Macbeth's active association with the Illuminating Engineering Society, which he joined in 1906, continued and in 1927-1928 he became its president. Use of the Macbeth Illuminometer was further developed by the addition of various filters to allow measurement of the quantity and brightness of line sources such as mercury and sodium, and by including a colorimetry attachment. With Dr. H. P. Gage he developed the daylight glass subsequently known as Corning 5900, and he pioneered in development of surgical lamps of high intensity, equipping them with heat absorbing glass to remove infrared radiation. During this period use of Macbeth filtered-incandescent daylight lamps increased, particularly the textile, graphic arts, and later in color motion picture fields where color matching and color fidelity was, and still is, an important part of any successful operation. He was an expert who became the trusted consultant in fields where color was a problem.

Norman Macbeth took and active part in formation of the Inter-Society Color Council. He was present at the February 26, 1931 preliminary conference in new York, and attended the first few annual meetings as one of the first two “cooperating associates,” – as individual members were called in those days. In 1934 he was appointed one of three IES delegates and in that capacity served until his death on September 2, 1936. He was named Honorary Member in 1968.

It was a privilege to know Norman Macbeth, for he was a man of great competence and integrity. We agree wholeheartedly with the following quotation taken from the 1936 IES Council resolution in its Memorial to him: “His exceptional ability, his clear judgment and wise counsel, combined with his loveable personality and high sense of honor commands the admiration, affection and respect of all those who had contact with him, and the memory of his sterling character will be an abiding inspiration to all who enjoyed his friendship.”

The Inter-Society Color Council is proud to have an award named in honor of Norman Macbeth, one of its earliest and valued members, pioneer in the art and science of color and illumination.”

Robert T. Marcus

Robert T. Marcus is a Senior Color Scientist at Sun Chemical Corporation in Carlstadt, New Jersey. Dr. Marcus has co-authored a monograph on Color and Appearance, written chapters on color in two books, published a number of papers on industrial color control and received a patent on a metallic color-matching system. He received the Federation of Societies for Coatings Technology's Armin J. Bruning Award in 1996 for his outstanding contribution to the science of color in the field of coatings technology. Dr. Marcus is currently chairman of ASTM International Subcommittee E12.07 on Color Order Systems. He was Chairman of ASTM Committee E12 on Color and Appearance from 2000 through 2005.

Dr. Marcus' involvement in color began over 35 years ago as an undergraduate at Rensselaer Polytechnic Institute (RPI) in Troy, NY. In addition to a B.S. in Physics, he also earned a Ph.D. in Chemistry (Color Science) from RPI. His graduate research investigated the visual spacing of the Munsell Color Order System and was done under the direction of Professor Fred W. Billmeyer, Jr.

Much of his early career was spent installing industrial color matching systems in the paint industry and training personnel in color control techniques. Later, Dr. Marcus researched color matching in metallic paints. He gained hands-on manufacturing experience while managing in-plant color control laboratories in the plastics industry. Dr. Marcus has been responsible for color standards and color tolerance sets for a variety of materials including paints, textiles and printing. He is currently working on commercial color matching problems related to the ink industry.

Calvin S. McCamy

Mr. McCamy was in the U.S. Navy, 1942-1947, attaining the rank of Lieutenant, j.g. He received a B.S. in Chemical Engineering and M.S. in Physics at the University of Minnesota and taught mathematics there, 1947-1950. He taught physics and did early research in colorant formulation at Clemson University, 1950-1952.

At the National Bureau of Standards, 1952-1957, he established principles of fire detection in aircraft engines, discovered the mechanism of fire extinguishment by dry chemicals, and studied the hazards of liquid oxygen. As Chief of the Photographic Research, Section and then the Image Optics and Photography Section, 1958-1970, he conducted research on precise measurement of transmission and reflection, image structure, satellite photography, photography at extreme reduction, optical information theory, optical filters, color perception, and preservation of microfilms. He designed hands-on experirnents for the U.S. Science Exhibit at the Seattle World's Fair.

As Vice President for Research of the Macbeth Division of Kollmorgen, 1970-1990, he conducted research on optical design, precise transmission measurements, color measurement, optical filter design, simulation of daylight, geometric attributes of appearance, densitometry in photography and color printing, color order systems, color standards, and related mathematics. He designed the Macbeth ColorChecker Color Rendition Chart™ used internationally to evaluate color imaging systems of all kinds.

He was a member of the National Research Council. At the request of Congress, in 1978 he analyzed photographs and x-rays related to the assassination of President Kennedy and testified before the House Select Committee on Assassinations. His method of identifying images of firearms is used routinely by the FBI.

He has been active in national and international standardization of photography, color printing, and color science, since 1957, chairing committees of the American National Standards Institute, the American Society for Testing.and Materials, the International Commission on Illumination (CIE), and the International Organization for Standardization (ISO). He wrote the spectral specifications for optical character recognition for the banking industry and the Universal Product Code for the grocery and other retail industries.

He is on the Advisory Board of the Munsell Color Science Laboratory at the Rochester Institute of Technology, and was Adjunct Professor at Rensselaer Polytechnic Institute. He was president of the Kollmorgen Foundation and trustee of the Munsell Foundation, both of which awarded doctoral scholarships in color science. He presented seminars on color science around the world, fourteen in Brazil alone.

He has published over a hundred scientific papers. He was an officer or board member of several scientific societies. He was elected fellow of the Optical Society of America, Society of Photographic Scientists and Engineers, Royal Photographic Society of Great Britain, Society of Motion Picture and Television Engineers, and the Washington Academy of Sciences and has been honored for his lectures. He was elected Honorary Member of the Inter-Society Color Council and the Hong Kong Society of Dyers and Colorists, Life Member of the U.S. Committee of the CIE, and member of the New York Academy of Sciences. He received the 1997 Bruning Award of the Federation of Societies for Coatings Technology and the 1999 Godlove Award of the Inter-Society Color Council.

He has been a consultant in color science since 1990. His avocations include photography, astronomy, and playing a 240-stop digital organ he built. His compositions include songs, a string quartet, and a circus march "Clown Alley", which is played on the calliope at the Barnum and Bailey Circus. He lived in Wappingers Falls, NY, with his wife, Mabel for many years, but recently moved to Edgewater, Maryland. They have been married 61 years, traveled the world, and have three children and five grandchildren. Further information may be found in Marquis "Who's Who in the World."

John McCann

John McCann, a consultant based in Belmont, Massachusetts, was served as Secretary for the ISCC (2002-2006). Mr. McCann is a consultant on color and image processing. Before retiring in 1996 to become a consultant, McCann had been a Senior Manager in the Research Laboratories of Polaroid Corporation. He had done research on rods as color receptors, low-spatial-frequency vision, mathematical models of color vision, quantitative tests of Retinex theory, and managed research on very-large format Polaroid photography. Since 1974 he has been studying vision with computer processed digital images. This basic research has concentrated on techniques for calculating color sensations and developing film recorders that control film exposures so that the photographic image is a record of color sensations rather than the record of light coming from the scene. His work has led to 81 publications and 12 patents. He received his A.B. in Biology from Harvard University. He is a Fellow of the Society of Imaging Science and Technology (IS&T) in which he has served as Vice President, President and Past-President. He has also served as Trustee and President of the Artists Foundation, Boston, and as Chairman of the Cultural Committee of the Polaroid Foundation.

Mary McKnight

Mary McKnight worked as a researcher at NIST for about 25 years. Among other things she conducted service life prediction of coatings, was the senior research chemist in the Building and Fire Research Laboratory, and led the new multi NIST laboratory project on predicting appearance of fabricated objects using material microstructure and formulation parameters.

She received a Ph. D. in physical chemistry from the University of Nebraska. Prior to her career at NIST she was a chemist in the Avery International Research Laboratory. She is a member of CORM; ASTM E12, where she chaired the Symposium and Workshop committee and was secretary of the Multi-dimensional Aspects of Appearance Subcommittee; and ASTM D-1 where she served as Chairman of D-1 on paints, coatings, and related materials. She has been one of the directors of the Society for Protective Coatings and a member of the Federation of the Societies of Coatings Technology.

Within ISCC she has helped organize several meetings at NIST in Gaithersburg, MD; served on the Board of Directors from 2000 to 2003. Since her retirement as a full time NIST employee she has become increasingly involved with ISCC, and is currently in charge of the year-round time-consuming job of organization and layout of the ISCC News.

Margaret Miele

Margaret Miele is an assistant Professor of Psychology and Assistant Chairperson of the Social Sciences Department at the Fashion Institute of Technology (F.I.T.). Her specialty area is the Psychology of Color. In her capacity as a Color Psychologist, she has served as a consultant to the All Japan Fashion Teachers as well as to several private businesses. She served as an outside reader for <u>The New Munsell Color Set (2nd. Ed.)</u>.

In the ISCC she has served on the Board of Directors from 2001 – 2004. Dr. Miele is Faculty Advisor to the F.I.T. Student Chapter of the ISCC, Vice-Chair of the ISCC Interest Group Three on Art Design and Psychology and had assisted in the programming for the AIC 2001. Also, she currently is chair of the Education Committee.

Miele received her B.Sc. (Summa Cum Laude) from City University of New York and her M.A. from Hunter College. She is a member of American Association of University Women, the American Psychological Association and Psi Chi (The National Honor Society in Psychology).

Ethan D. Montag

Ethan D. Montag received his Ph. D. in experimental psychology in 1991 from the University of California at San Diego working in color vision. Dr. Montag was a postdoctoral fellow at the Center for Visual Science at the University of Rochester from 1991 to 1994 where he worked on the interactions between form and color under a National Eye Institute-NIH National Research Service Award fellowship. In 1994 he started a two-year postdoctoral position at the Munsell Color Science Laboratory at the Chester F. Carlson Center for Imaging Science at the Rochester Institute of Technology (RIT) where he worked on color gamut mapping. In 2000, after a number of years in a research position, Dr. Montag was appointed Assistant Professor at the Center for Imaging Science where he pursues work in color science in the Munsell Color Science Laboratory. His current interests include image quality, color gamut mapping, color vision, color tolerance measurement and the use of color in information display. Dr. Montag is a member of the Optical Society of America, the International Colour Vision Society, the Inter-Society Color Council, and the Society for Imaging Science and Technology.

Patty Monteleone

Patty Monteleone, Instrumental Color Specialist, in the Automotive Coatings Business Unit of PPG Industries, has worked in color and analytical research, customer support and manufacturing at PPG for 30 years. She is a member of the ISCC, DCC, and past member of ASTM E-12, and PPG Color Chapter. An alumna of the University of Pittsburgh majoring in chemistry, she has been active in color training for the PPG Coatings segment.

Nathan Moroney

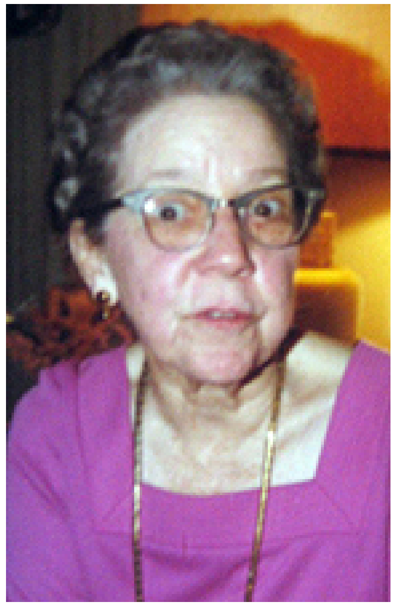
Nathan Moroney is a senior color researcher in the Color Imaging and Printing Technologies Department of Hewlett-Packard Laboratories. Previously, he worked for the Barcelona Division of Hewlett-Packard and at the RIT Research Corporation. He holds a B. S degree in color science from the Philadelphia University and a M. S. degree in color science from the Munsell Color Science Laboratory of RIT. Nathan designed and implemented the first generation of Hewlett-Packard printers with automatic closed-loop color calibration. His research interests include color appearance modeling and digital color imaging pipelines. He has publications and patents in the areas of image compression, halftoning, printer software, local color correction, and a range of other topics. He is currently the technical chair for CIE TC8.01 and is a member of the ISCC an IS&T. He started using the CIELAB equations the same year he learned how to drive.

Maria E. Nadal

Maria E. Nadal is currently involved with spectrophotometric measurements in the Optical Technology Division at NIST. Her primary areas of research are color and appearance. She is involved in developing new calibration services and standard reference materials for surface color and specular gloss, as well as research in the goniochromatic attributes of special effect coatings. These services are NIST's first for appearance measurements in many years, a response to needs articulated in recent reports of the Council for Optical Radiation Measurements. She received the Bronze Medal Award, the highest honorary recognition given by NIST for significant performance characterized by outstanding or significant contributions that have increased NIST's efficiency and effectiveness.

Maria E. Nadal received her Ph.D. in physical chemistry from the University of Colorado at Boulder in 1996. She is an active member of the Council on Radiometric Measurements (CORM) and ASTM International (ASTM), where she is chair of the E12 subcommittee on Precision and Bias. Also she served on the ISCC BOD from 2003-2006. In 2006 she became the new President-Elect for the ISCC. She has published more than 20 papers in the scientific and technical arena and is an active member of ASTM and CORM.

Dorothy Nickerson
1900 – 1985



"The science of color has lost one of its major figures. Dorothy Nickerson, 84, died of heart failure at the Alexandria Hospital on the outskirts of Washington, D.C. on Thursday, April 25, 1985. Her contributions to the ISCC had just been honored at the ISCC Annual Meeting on April 16 in Pittsburgh when she was awarded the ISCC Service Award. She was too ill at that time to attend the meeting, so the award was accepted in her name by Linda Taylor who took it at once to the hospital for Dorothy to see.

Walter Granville, who had known and worked with Dorothy since 1933, gave the citation for the Service Award. Joy Luke currently working with Dorothy on the OSA Uniform Color Scales added a few words. Both stressed the unique personal contribution Dorothy made both in knowledge and through encouraging others. She was always interested, always ready to contribute time, effort and even her own funds, to solve a problem; and she always had a direct common sense approach to the problem.

The ISCC was founded in 1931 as a society composed of representatives from organizations with strong interest in color. Dorothy was the first person to join when it was decided in 1933 to allow individual members and Walter believe he was the second or third member. Walter reminisced that in 1938 when he worked for International Printing Ink Company and was in New York in charge of the first Hardy GE spectrophotometer purchased by industry, Dorothy, who was working at the Department of Agriculture, would come to New York on her weekends and holidays carrying Munsell samples to be measured. It was typical. In 64 years her intense interest in color never flagged.

Many of the major developments in color science and technology that have taken place in the twentieth century have included Dorothy as author, organizer or participant. Miss Nickerson was born August 5, 1900 in Boston and attended Boston University in 1919 and John Hopkins University in 1923. She continued her education in a variety of summer-school and university extensions at Harvard University, University of Wisconsin, George Washington University, and the Graduate School of the U.S. Department of Agriculture.

Studying such subjects as psychology, physics, German, mathematics and advanced statistics, her aim was always to select courses that would provide a background for expanding her ability in the then-young science of color. She was in a unique position to explore possibilities for applying theory to practice, for she worked in collaboration with Irwin G. Priest, Deane B. Judd, and the other scientists at the U.S. National Bureau of Standards while, at the same time, earning her living in the practice of color technology. Her work with Deane Judd over many years was especially fruitful for the science of color. From 1925 until his death in 1972, the names 'Judd and Nickerson' were linked in a series of professional collaborations that covered virtually the entire basis of color technology as we know it today.

Dorothy joined the Munsell Color Company as a secretary and laboratory assistant in 1921, moving with the company to New York in 1922 and then to Baltimore in 1923, where she became Assistant Manager. Her valuable 'histories' of the Munsell Color Company and the Munsell Color Foundation (which she helped create in 1942) provide us with fascinating reading about the early days of color technology. Her association with Munsell did not end with her leaving the Munsell Color Company in 1926, however. Not only did she continue to work in close cooperation with Munsell, but she also was a Trustee of the Munsell Color Foundation beginning in 1942 and was its President from 1973 to 1975. She continued to serve the Foundation until its endowment was transferred to Rochester Institute of Technology in 1983 to help fund the new Munsell Color Science Laboratory.

In 1927 Dorothy was offered a post at the U.S. Department of Agriculture, the beginning of a tenure that lasted until her retirement from active service in 1964, AT USDA, she organized and conducted research which laid the foundation for many phases of color technology as it is practiced today. When she began in 1927 there was no international standards for colorimetry and no standards for illuminating and viewing conditions; the first photoelectric spectrophotometer was just being developed; color-difference specification did not exist; color rendering was a matter of individual preference; the language of color names was casual albeit colorful; and, in general, most of what we now take for granted in color science and technology simply did not exist. Dorothy Nickerson and her contemporaries had their life's work cut out for them.

In 1931 when the Commission Internationale de l'Èclairage (CIE) made its first recommendations for the practice of colorimetry, Dorothy began immediately to apply those methods to color technology. One of the principal applications was to derive conversion charts for the Munsell Color system to facilitate its use with instrumental methods of measurements. Her stimulation of this work in her own and other laboratories eventually led to the classic 1940 and 1943 issues of the Journal of the Optical Society of America (OSA) in which complete quantitative descriptions of the Munsell System appear together with the OSA Committee on the Spacing of Munsell Colors' smoothed representation of that color space in CIE coordinates. This work became the basis for an American Society for Testing and Materials (ASTM) national consensus standard, D1535, and a Japanese national standard.

Working with Carl Foss, Walter Granville, and others, she also provided similar information for the Ostwald system making possible publication of the last edition of the

"Color Harmony Manual." Her interest in perceptual ordering of color space continued with her activities of over 25 years in the OSA's Committee on Uniform Color Scales culminating in the publication in 1977 of a set of 558 colored samples that are still available through the OSA. Dorothy was OSA member #545, joining in 1927, and was elected a Fellow of the Society in 1959. She served as an OSA delegate to the ISCC from 1940 to 1972, and as chairman of the delegation from 1966-1972. She was also a member of the OSA Committee on Colorimetry from 1932 to 1953. The report of this Committee resulted in the book, "Science of Color" still offered for sale by the Optical Society. She was the OSA delegate on the U.S. Committee to the CIE from 1957 until 1975.

Dorothy's work on the specification of small color differences began in the early 1930's with a request from the Silk Commission of ASTM to derive a method for expressing degree of fading of colored materials according to a single index. Her work led to the 1976 CIE L*a*b* transformation and expression of color differences. Dorothy's work with Richard Hunter, based on earlier work with Carl Keuffel, produced a self-standardizing electronic instrument for classifying quality grades of cotton, the disk colorimeter. Ever conscious of the practical needs of color technologists, she designed one of the first modern-day color-measuring instruments that 'spoke' the same meta-language as the user, rather than requiring color technologists to adapt to the technical language of formal colorimetry.

This concern with translating the mathematical statements of colorimetry into common language, and thereby promoting widespread use of colorimetry, also motivated Dorothy to participate in the development of the ISCC-NBS *Dictionary of Color Names* which makes it possible for anyone to convert common color names to Munsell notation and to its corresponding areas of numerical CIE specification. That and related undertakings, combined with the collections of various representative material standards, open the door to widespread use of colorimetry in all areas of art, science and industry.

Dorothy worked with Norman Macbeth to develop and install standard artificial daylight illumination in the cotton classing rooms throughout the country. Methods of specifying color-rendering properties of illumination, first by the IES and subsequently through international CIE and ISO recommendations, owes much to Dorothy's industry and promotion. Her leadership in lighting was honored by the Illuminating Engineering Society of North America (IES) when she was made a Fellow of the IES in 1956 and awarded the IES Gold Medal in 1970. In 1961 she was awarded the Godlove Award by the ISCC.

As a member of the U. S. National Committee of the CIE and as a member of the Association International de la Couleur (AIC), Dorothy participated actively in the international color scene. She was honored for her national and international contributions to color by receiving the first Deane B. Judd Award given by the AIC in 1975. Through the years Dorothy was the author of over 155 papers on color. Until the time of her final illness Dorothy continued to work on problems of color spacing of interest worldwide. She was still studying the color planes in the OSA Uniform Color Scales and her latest work compares the spacing of the Swedish Natural color system to that of the Munsell System.

Dorothy was responsible for bringing up to date Dr. I. H. Godlove; definition and illustrations on color in the unabridged Webster's Third International Dictionary. To get this entry just right, Dorothy consulted with the editors over a period of several years. She was also responsible for the definition on color in the American Heritage Dictionary.

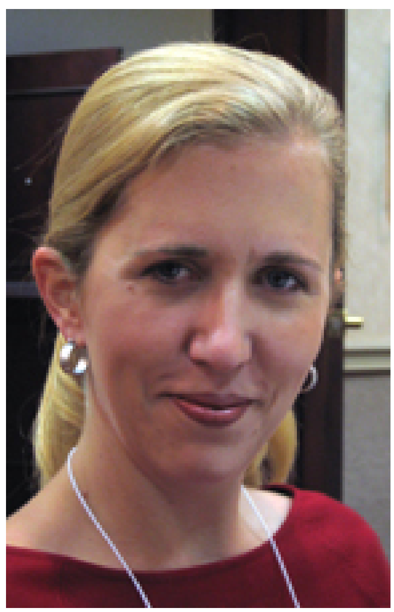
A large measure of Dorothy's impact on modern color technology stems from her continuing selfless cooperation with many people who have had problems to solve. Her main interest has always been in helping others to solve color problems. The list of people whom she has encouraged, and project to which she lent her unstinting aid, is much too long to cite here. But her enthusiasm and her practical suggestions for finding solutions to pressing problems endeared her to those who knew and worked with her. That warm enthusiasm combined with careful planning and skill for organization extended to everything she did and will be greatly missed by all who knew her."

C. James Bartleson
Joy T. Luke

[Taken from the Inter-Society Color Council *News*, #295, May-June 1985]

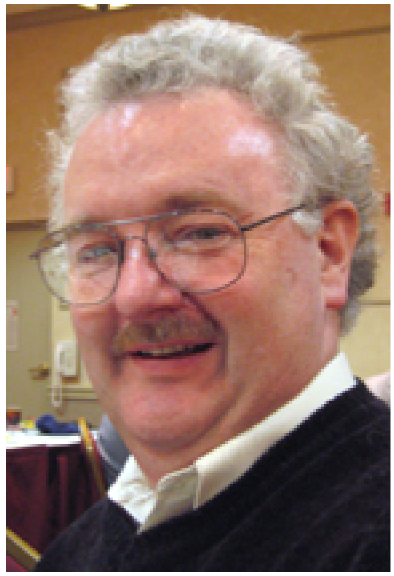
Interested people are referred to two other tributes to Dorothy Nickerson published in the same issue of ISCC *News*. One tribute was written by David L. MacAdam and the other by Harry K. Hammond, III.

Britt Nordby



Ms. Nordby is the Technical Manager of Color Science for Degussa Corporation, a manufacturer of Colorants for the coatings industry, where she oversees a wide range of color science-related activities for the company's Architectural & Industrial Colorants Business Lines. These include managing the Corporate Color Laboratory, providing technical support to customers, and the marketing of color systems for point-of-sale. Her current interests include improved color matching techniques, new color display methodologies, color management and reproduction. She earned her B.S. degree in Color Science from Philadelphia College of Textiles and Science. Ms. Nordby is currently a member of the Federation of Societies for Coatings Technology (FSCT), the Society for Imaging Science and Technology (IS&T) and the Society of Plastics Engineers (SPE). She served as Chairperson for ISCC Interest Group II (Industrial Applications of Color) for 4 years, then on the Board of Directors from 2004-2007.

Frank X. O'Donnell



Dr. O'Donnell is a Division Scientist with The Sherwin-Williams Company. He has worked for Sherwin-Williams for the past fifteen years -- ten years in the Automotive Finishes Division and six years in their Consumer Group. In both divisions his work has concentrated on color test methods and computer color matching. Prior to working at Sherwin-Williams he worked at Diconix Inc. where he developed ink-jet inks and worked on digital imaging. Dr. O'Donnell has published and presented papers on such diverse topics as appearance and print quality. He earned his B.Sc. in Chemistry from Manchester University in the U.K. and his M.Ed. in education also from Manchester University. He earned his M. S. and Ph.D. in Chemistry from Rensselaer Polytechnic Institute where his research advisor was Dr. Fred Billmeyer, Jr. Dr. O'Donnell has been a member of ISCC for more than twenty years and was Vice-Chair of Interest Group I from 1998 to 1999 and Chair from 1999 to 2000. He served on the ISCC Board of Directors from 2004-2007.

Noboru Ohta

Since 1968, Dr. Noboru Ohta has been a research scientist with Ashigara Research Laboratories of Fuji Photo Film Company. Between 1973 and 1976, he was a research associate at the National Research Council of Canada. In 1996 he was awarded a visiting professorship at Chiba University in the Department of Engineering. In 1998 he received the Xerox Professorship at the Center for Imaging Science of Rochester Institute of Technology. As such, he divides his time between Rochester, New York and Tokyo, Japan. He served as Associate Editor from Japan for the journal *Color Research and Application* and is currently on its editorial board.

Daniel G. Phillips

Dr. Phillips is Manager of the Color Science and the Industrial Colorants laboratories at Creanova, Inc., a major manufacturer of pigment dispersions. He has been involved professionally in plastics, ink, and for most of his career, the coatings industry. His interests in color science are in the industrial application of computer color matching and color difference measurement as well as color order systems and video-to-hard copy representation of color. Dr. Phillips received a B.S. and Ph.D. in Chemistry from Rensselaer Polytechnic Institute, where he was a graduate student in the color science program under Professor Fred Billmeyer. He has been an ISCC member for 25 years. Dr. Phillips is a member of the Federation of Societies for Coatings Technology (FSCT), the Society of Plastics Engineers (SPE), and the American Chemical Society. Dr. Phillips served on the ISCC Board of Directors from 1999 – 2002.

Irwin G. Priest

Irwin G. Priest received his early formal education at Mansfield Ohio High School, where he graduated in 1904. He then attended The Ohio State University, where he earned a B. A. in Physics in 1907. Upon graduation, he was appointed to the scientific staff of the National Bureau of Standards (Currently NIST) working his way from an entry position as Laboratory Assistant where his first job was to execute the precise wavelength measurements of Neon gas using the Bureau's newly developed Fabry-Perot Interferometer. He later held the position of Assistant Physicist. He was promoted to

Physicist in 1919, a title he held for the remainder of his professional career. During his tenure at the NBS, he also served as Chief of the NBS Colorimetry Section as well as Chief of the Spectroscopy and Applied Optics Section. These Sections were responsible for pioneering work in their respective fields throughout Mr. Priest's tenure, where their aim was to establish a broad scientific basis for color and its application. Among these was the paramount need for spectral definition for standardized white light along with its interplay with the spectral character of both object and observer – the cornerstone of all photometry and colorimetry. Between 1922-1925, he also spent time as a Research Associate of the Munsell Color Company, while on leave from NBS.

During his career, Mr. Priest obtained a patent on a rotary dispersion colorimetric photometer. He was the author of numerous papers on optical measurements, vision, and colorimetry. He was elected to Phi Beta Kappa and Sigma Xi. He was also a fellow of the American Association for the Advancement of Science, a Fellow of the American Physics Society, and a Member of the Optical Society of America where he served as Secretary (1921-1924), Vice President (1926-1927), and President (1928-1929). He was a member of the American Astronomical Society, the Philosophical Society of Washington, the Washington Academy of Science, and the American Oil Chemists Society. He was also an early member of the Cosmos Club, a Washington-based organization founded by and for the city's intellectual elite to promote the advancement of its members in science, literature, and art.

Mr. Priest is considered a founder of the Inter-Society Color Council. In 1931, he organized a meeting entitled *"Preliminary Conference on Organization of an Inter-Society Committee on Color Specification."* One of the five resolutions adopted at this meeting was the formation of an Inter-Society Color Council composed of delegates from national societies interested in the standardization, description, and specification of color. At the time of the first ISCC Meeting in September of 1931, Priest was attending the CIE Meetings being held in England that year. In July, 1932, Irwin Priest died at the age of 46, of a cerebral aneurysm never having attended a meeting of the ISCC in whose founding he was so instrumental.

By Joann Taylor

Sources:

Report for Irwin G. Priest, Alumni Records Division , Class of 1907, Office of the Registrar, The Ohio State University.

Alumni Newsletter, 1932, The Ohio State University - Class Notes for Class of 1907.

Personal Communication, Lisa Greenhouse, Office of Information Services, NIST (she sent the photo, too)

Obituary, The Evening Star, Washington DC, Thursday, July 21, 1932. (He died July 19th.)

D. Nickerson, *Remarks in Observance of ISCC's Annual Meeting (40th Anniversary*), ISCC Newsletter, Number 211, March-April, 1971. pg. 3.


(photo courtesy of NIST)

Charles D. Reilly

Charles "Chuck" D. Reilly, (1921 – 1997) who retired as a Research Fellow from DuPont's Engineering Physics Laboratory in 1983 and was the 1987 recipient of the ISCC Godlove Award, died Saturday, December 13, 1997 at his home in Longmont, Colorado.

The Godlove nominating committee cited Reilly for "his long term contributions to the field of color science". He was the co-inventor and major contributor to the development of the Cube Root Coordinate system, the basis for the CIELAB 76 Equations and all modern extensions like CMC and CIE-94. He led the DuPont development of many color instruments as well as the color science underlying their technology. The "Colormaster" and DuColor" colorimeters are two examples of such devices which gained wide use internationally.

During his 30-year career, Chuck was considered especially productive in adapting basic science to the manufacturing world. He was directly involved with research which led to major improvements in the measurement and control of coloring processes used in finishes, textile fibers, plastics, pigments, printing and lithographic products, photo products and dyes.

In addition to his technical contributions, Chuck devoted much energy towards teaching a whole generation of younger DuPont Scientists, in a quiet unassuming manner. He was an advisor, sponsor, teacher, confidant and role model to countless color scientists who continue to contribute to the field through research, publication, committee participation and organizational leadership.

Chuck was elected Fellow to the Optical Society of America in 1978. He served with distinction on the OSA Uniform color Scales Committee, resulting in a more uniform color coordinate system intended to replace Munsell System. He also received the Bruning Award from the Federation of Societies for Coatings Technology in 1988 for his contributions to color science. In 1996 the DuPont Company honored Chuck Reilly with the Lavoisier Medal, the company's highest scientific award, citing his achievements in the theory, instrumentation, measurement and control in applied optics and color.

Danny C. Rich

Danny C. Rich has B.S. in Physics (1973) from the University of Idaho and an M.S. in Physics (1978) from Virginia Polytechnic Institute and State University. His master's thesis was on the design and construction of a wide angle laser light scattering photometer for characterizing the particle size and size distribution of fresh water diatoms. He took his doctorate from Rensselaer Polytechnic Institute (1980) under the direction of Professor F. W. Billmeyer, Jr. His dissertation was entitled, "The perception of moderate color differences in surface color space", for which he developed the visual experimental conditions subsequently recommended by A. Robertson and the CIE for study of small and moderate color differences. After graduating from Rensselaer, Dr. Rich spent four years with the Sherwin-Williams Company in the Coatings Research Center. There he lead a group in the Advanced Technology Department and was responsible for technical computing and optical properties of coatings. In 1984 Dr. Rich joined Applied Color Systems as the Manager of Research. After joining ACS he was responsible for developing the technology for CRT calibration, gloss compensation, the design of the CS-5 spectrocolorimeter, instrument metrology and standards, color

difference equations and colorant formulation of pigment containing materials. In 1991 ACS became part of Datacolor International. In the fall of 1998 Dr. Rich joined Sun Chemical Corporation to set up a new Color Research Laboratory in Carlstadt, New Jersey. Dr. Rich has written and lectured on all aspects of color science and technology.
Dr. Danny C. Rich will be presented the Nickerson Service Award during the ISCC Annual Meeting in Vancouver, British Columbia, Canada. The presentation occurred at the ISCC business meeting on Friday, May 7, 1999.

Dr. Rich joined the ISCC in 1975 while a graduate student at Rensselaer Polytechnic Institute and has been an active member since that time. He served as the ISCC Secretary from 1990 to 1998 and was on the Board of Directors from 1984 to 1987. From 1981 until 1989, Dr. Rich was chair of ISCC Project Committee 22 "Materials for Instrument Calibration". In 1986 he co-chaired the Williamsburg Conference on Restoration and Preservation of Antiquities. Dr. Rich co-chaired the 1992 ISCC Annual Meeting and 25th Anniversary of the International Color Association (AIC) in Princeton, New Jersey and chaired the 1996 ISCC Annual Meeting, Instrumental Methods of Color and Appearance Assessment, in Orlando, Florida. In 1999 Dr. Rich was presented the Nickerson Service Award. More recently he served as President of the ISCC.

Dr. Rich is chairman of CIE Technical Committee 2-39 on the Geometric Tolerances for Color Measurement. He is also participates in the activities of CIE Technical Committee 1-27 on Cross-Media Color Reproduction, the Committee for Graphics Arts Technology Standards (CGATS), ISO Technical Committee TC6 on Optical Properties of Paper, ISO Technical Committee TC130 on Graphic Arts, and the National Printing Ink Research Institute (NPIRI) Task Group on Bronzing. Dr. Rich is a member of the American Society for Testing and Materials (ASTM), the Illuminating Engineering Society of North America (IES of NA) the Optical Society of America (OSA), the Society of Imaging Science & Technology (IS&T), the Society for Information Display (SID), the U. S. National Committee of the International Commission on Illumination (USNC/CIE), the American Association of Physics Teachers, the International Society for Optical Engineering (SPIE) and Sigma XI.

Richard W. Riffel

Mr. Riffel was Product Manager for Laboratory Products and is the Plastics Industry Manager at Hunter Associates Laboratories in Reston, Virginia, where he was responsible for product management, hardware and software product and applications development of spectrophotometric measurement systems, until he moved to Corning Glass Works. He graduated with BS and MS degrees in Imaging Sciences from Rochester Institute of Technology under Drs. Franc Grum and Roy S. Berns. Mr. Riffel is a member of the United States National Committee of the CIE (International Commission on Illumination), the Society of the Plastics Industry (SPI), and the Society of Plastics Engineers (SPE). He served as Secretary for the ISCC from 1998 until 2002, and earlier on the Board of Directors (1994-1997). Also he was the first webmaster for the ISCC website.

Jim Roberts

Jim Roberts graduated from Worcester Polytechnic Institute in 1975 with a B.S. with co-majors of Chemical Engineering and Life Sciences. He started his professional career with Cabot Stains in Chelsea, MA as a paint formulator. He was with Cabot until 1983. He continued on in the coatings world as Chief Chemist for a company in Baltimore, MD called Sportec, working with tennis court coatings and urethane running track systems. In 1989 he moved over to Duron Paints in Beltsville, MD. There he worked as a paint formulator until 1994 when he was promoted to Director of Color Systems. That position gave him great exposure to industrial color matching issues and solutions. He continues with that same line of work today as the POS Technical Manager for BYK-Gardner USA (now known as AltanaChemie). At Altana Jim is responsible for building and supporting color matching databases and software with such companies as Sears, Wal Mart, and a number of other paint and hardware chains. He is very active with the Color Marketing Group, where he currently serves as the Chairman of the TechKnow Committee. TechKnow deals with special effects pigments and films and the measurement of multi-hued materials. Jim is also Chairman of ISCC Interest Group I, Pure and Applied Research on Color.

Alan R. Robertson

The Inter-Society Color Council (ISCC) honored Dr. Alan Robertson with the presentation of the Godlove Award during its 2005 Annual Meeting in Cleveland, Ohio. Before his retirement, Dr. Robertson had been head of the Photometry and Radiometry Group and of the Chemical and Mechanical Standards Section of the Canadian National Research Council's Institute for National Measurement Standards. His main research specialties have been in the fields of spectrophotometry, color science and colorimetric standards with an emphasis on color difference evaluation and color order systems. He has been a leader both within the CIE and the AIC, serving as Associate Director of CIE Division 1 for many years, as CIE Vice President from 1995-1999 and as AIC President from 1990-1993. He has also been involved in the negotiation and implementation of various international agreements on measurement standards.

Robertson has been a leader in the development of color difference formulae and played an active role in the establishment of the 1976 CIELAB & CIELUV color difference formulae. He pursued further advances in characterizing color differences through the development of CIE94 and CIEDE2000. Robertson has served as a consultant to the CIE committees that have developed chromatic adaptation transforms and color appearance spaces.

Dr. Robertson has been actively involved in standardizing color. He is committed to teaching the world how to do color science the correct way and that is why the push for standards that would be available to organizations outside of the CIE was so important to him. He played a critical role in establishing the relationship between the CIE and the ISO (International Organization for Standardization). The result of this collaborative effort is that the CIE can publish standards instead of just recommendations. He played an important role in the establishment of the first CIE standards, S001 on Standard Illuminants for Colorimetry, and S002 on Standard Colorimetric Observers and was responsible for the formation of CIE Division 8 on Image Technology in 1999. Alan is the chair of CIE TC1-57 on Standards for Colorimetry.

Dr. Robertson was educated at King Edward's School, Birmingham, England. He received his B.S. in 1962 and his Ph.D. in 1965, both from Imperial College of the University of London, England. He received the Canadian Society for Color Merit Award in 1981. He is a member of the Colour Group (Great Britain) and the ISCC.

Max Saltzman
(1917 - 2001)

The Inter-Society Color Council (ISCC) selected Mr. Max Saltzman (1917 - 2001) as the recipient of the 2001 ISCC Godlove Award, but regretfully Mr. Saltzman did not survive long enough to receive the award in person. The award was presented to his son at the ISCC's Awards Luncheon during the International Color Association's (AIC) 9th Congress in Rochester, NY.

Mr. Saltzman had been active in the field of color for over 50 years. Saltzman received a B.S. degree in chemistry from the College of the City of New York in 1936. During World War II, he was in civilian service with the Chemical Warfare Service. Following the war, Saltzman joined the technical staff of Harmon Colors (later a part of Allied Chemical Corporation). From 1945 to 1961 he served in various research and development positions in the field of color pigments and color measurement. From 1961 to 1973 he held several management positions at the corporate headquarters of Allied. He retired as Manager of Color Technology in 1973. Saltzman was instrumental in the establishment of the Color Measurement Laboratory at Rensselaer Polytechnic Institute in the early 1960's and was an Adjunct Professor of Chemistry there for the 20 years it was established. In 1973, Saltzman established a color laboratory in the Institute of Geophysics and Planetary Physics at the University of California at Los Angeles where he was a Research Specialist until 1989.

His contributions were enormous, though often indirect. He received the ISCC Macbeth Award in 1986 for his pioneering research in dye identification of ancient textiles, and was an Honorary Member of the ISCC. At every opportunity, Saltzman challenged color scientists, engineers, technologists, and artists to defend their beliefs. He had thrown down the gauntlet at expert and novice with equal fervor. In this spirit he organized the first ISCC Williamsburg Conference, forming the tenets on which all are now based – small intimate gatherings with lots of time for interchange between participants. His goal had always been to bring a large dose of common sense to the forefront.

There can be no doubt that the book “Principles of Color Technology,” which he co-authored with Fred W. Billmeyer, Jr., has had a tremendous impact. Translated into German and Russian (without permission), it has been the primer for most color technologists worldwide. The book’s success is its accessibility and practicality. This was not fortuitous but by design; the book was for the common man and woman (the book is gender neutral, male and female observers depicted in the book were alternated throughout). To understand Saltzman’s motives, and consequently, his contributions to the field, the final pages of the first and second editions of Principles of Color Technology should be read. It is titled “Back to Principles.” These few paragraphs summarize his philosophy and in large part his motivation as a color curmudgeon. So many problems in color technology are often solved by using common sense and remembering the basics.

Saltzman had a dramatic impact in art conservation. He developed a novel technique of pigment identification using solution spectrophotometry that is still widely referenced. He was an active consultant for the Getty Conservation Institute and his advice was highly valued.

Saltzman was a member of the American Association of Textile Chemists and Colorists (AATCC), the American Chemical Society, the Color Pigments Manufacturing Association (CPMA), the Colour Group (Great Britain), the Federation of Societies for Paint Technology (FSCT), the Optical Society of America (OSA), the Society of Dyers and Colourists (U.K.) and the Society of Plastics Engineers (SPE). In 1967, he was awarded the FSCT's Armin J. Bruning Award. Saltzman was a Fellow of the American Institute for Conservation of Historic and Artistic Works and gave their prestigious George L. Stout Memorial Lecture in 1984.

Mark Q. Shaw

Mark Q. Shaw is currently employed as a Color and Imaging Research Scientist by Hewlett-Packard Company, Boise, Idaho. Previously he worked as a Color Scientist/Algorithm Engineer by Xerox Engineering Systems, Santa Clara, California. He received a B.S. degree in Graphic Arts Printing Technology from the University of Hertfordshire in the United Kingdom and an M. S. degree in Color Science from the Munsell Color Science Laboratory, Rochester Institute of Technology (RIT) in the United States. Mr. Shaw is a member of Technical Association of the Graphic Arts (TAGA), the ISCC, and the Society for Imaging Science and Technology (IS&T). His interests include applied colorimetry, image rendering, color modeling and color management. In 1999 he was awarded the Grum Scholarship from the Munsell Color Science Laboratory, RIT. In 1998 he was awarded the Varns Excellence in Printing Award, the AGFA Printing Award, and the Institute of Printing Bronze Medal.

Louis D. Silverstein

The Inter-Society Color Council (ISCC) honored Dr. Louis D. Silverstein with the presentation of the Macbeth Award during the Annual Meeting on May 10-12, 2004 at the National Institute of Standards and Technology (NIST) in Gaithersburg, Maryland. Dr. Silverstein, founder and Chief Scientist of VCD Sciences, Inc. in Scottsdale, Arizona, was recognized for his contributions to color rendering through liquid-crystal technology electronic displays and image capture devices. VCD Sciences, Inc. is a scientific research and consulting firm with project specialization in the areas of applied vision, color science, and display technology.

Silverstein received his B.S., his M.S. and his Ph.D. in psychophysics and vision science from the University of Florida. After earning his Ph.D., he spent two years doing advanced research in sensory neuroscience at the University of Wisconsin as an NIH postdoctoral fellow. Prior to founding VCD Sciences, Inc., he was a Senior Research Fellow at Honeywell's Systems and Research Center and a Research Scientist at the Boeing Company. Dr. Silverstein was awarded the Alexander C. Williams Award of the Human Factors Society in 1983 for his work on the advanced cockpit color CRT display systems for the Boeing 757/767 aircraft and the Honeywell Corporate Technical Achievement Award in 1989 for the development of visual simulation methods for color liquid crystal displays.

Dr. Silverstein is the author of over 120 journal articles, book chapters, technical papers, and technical reports. Among his thirty patents are several recent innovations in liquid crystal displays and liquid-crystal-based image-capture devices. He is a Fellow of the Society for Information Display (SID). He has been a past program and general chair of the SID international conference, has served as an Associate Editor of the *Journal of the Society for Information Display* and on the editorial board of the journal *Human Factors*, and currently serves on the editorial boards of the journals *Color Research and Application* and *Displays*. He currently serves on the U.S. National Committee of the C.I.E. (USNC/CIE) and had served on the U. S. National Academy of Sciences Committee on Vision. In addition to being a Fellow of the SID, he is a member of the Human Factors Society, the Optical Society of America (OSA) and the Society of Imaging Science and Technology (IS&T).

Frederick T. Simon

The ISCC elected Professor Frederick T. Simon an Honorary Member in 2002. Some of Professor Simon's most notable achievements are the development of the Simon-Goodwin charts for calculating color differences, the "555" system for shade sorting and for several methods for the measurement of fluorescent materials.

After his retirement, Professor Simon continued to teach half-time in the Graphic Communications Department of Clemson University. He began his professional career at American Cyanamid in Bound Brook, New Jersey. During World War II he worked for the US Army Quartermaster in Philadelphia. Professor Simon then worked in two different textile mills applying color science methods to textile processes. After gaining quite a bit of practical experience in the mills, he worked for the Union Carbide Research Division in Charleston, West Virginia where he did various projects mainly related to color measurement and polymer research. Following his tenure at Union Carbide, Professor Simon entered Academia where he spent 19 years teaching in the Textile Department at Clemson. His many fine students have their own successful careers and most of them have become ISCC members.

A native of Pittsburgh, Pennsylvania, Professor Simon did his undergraduate work at Carnegie Mellon University, Philadelphia University where he obtained a BS in

1938, and University of Charleston where he received another BS in 1956. Simon earned his MS in 1958 at Marshall University.

Professor Simon has been married to his wife, Irene, for 56 years, has two married daughters and two grandsons. Professor Simon was an active member of the American Association of Textile Chemists and Colorists (AATCC) and is a fellow of the Society of Plastics Engineers (SPE).

David Spooner

Mr. Spooner is President rhoMetric Associates, Ltd., where he consults in the measurement and application of color and appearance data. He earned a Bachelor of Science degree in Electrical Engineering from Washington University in Saint Louis, and is registered as a Professional Engineer in Ohio. He has worked extensively in the development of governmental and industrial electronic and optical instrumentation and data analysis. Early in his career he participated in the ARPA Vela-Uniform program, where he investigated the use of spectral remote sensing to detect underground nuclear tests. At Lockheed, Houston, Mr. Spooner was associated with the NASA Apollo program, where he used the lunar goniophotometric properties to derive lunar cartography from Lunar Orbiter photography and did exact lighting simulations for lunar-landing training. He joined DuPont’s Pigment Department in 1973 to work on the development of computer color matching techniques and the evaluation of pigmented products. During the four years prior to his retirement in 1994, he was engaged in the measurement and modeling of the color of prepress proofing and printed products. Mr. Spooner is a member of the Society for Imaging Science and Technology (IS & T), the Society of Plastics Engineers (SPE), and the Technical Association of the Graphic Arts (TAGA). Mr. Spooner served on the ISCC board of directors from 1997 – 2000.

Arthur W. Springsteen

Art Springsteen is one of the founding members of Avian Group. Earlier he spent much of his career at Labsphere, Inc. Dr. Springsteen was the Principal Scientist and Director for Advanced Development at Labsphere, Inc. where he held the position of Principal Scientist since 1993, before which he was head of the reflectance research division. Dr. Springsteen developed reflectance instrumentation, high and low reflectance materials and coatings, along with a variety of other materials during his tenure at Labsphere. He holds six patents.

Dr. Springsteen received a Ph.D. in Organic Chemistry from West Virginia University following an M.S. in Chemistry from Marshall University and a B.S. in Chemistry from St. Francis College.

Dr. Springsteen has been a member of the Council for Optical Radiation Measurements (CORM) serving on its Board of Directors for a number of years, then as secretary, also chair of the Optical Properties of Materials technical committee of CORM. Dr. Springsteen was a member of the National Research Council of the United States and is currently a member of the American Association of Textile Chemists and Colorists

(AATCC), the American Society for Testing Materials (ASTM), the American Chemical Society, the Council for Near-Infrared Spectroscopy and the Society for Applied Spectroscopy. In the ISCC he served on the Board of Directors from 1999 – 2002, and as chair of Project Committee #51 updating the *Guide to Material Standards.*

Ralph Stanziola

In May, l985 Mr. Stanziola founded Industrial Color Technology, which offers a variety of services primarily directed towards the solution of industrial problems that involve color control. In l970 he was one of the founders of Applied Color Systems, Inc. where he was the Executive Vice-President and Technical Director. He spent nine years as Technical Representative and General Sales Manager for Davidson and Hemmendinger, Inc. and later for Kollmorgen Corporation, which had acquired Davidson and Hemmendinger. Stanziola also spent nine years in Research and Technical Service for the Dyes Department of the American Cyanamid Company.

Mr. Stanziola received his B.S. degree in Chemistry from the Philadelphia College of Textiles and Science, which is now Philadelphia University. He holds three patents and has authored a number of technical papers. Stanziola developed the Color Curve System for color communication. In 1995, the Technical Association of the Pulp and Paper Industry presented him with their Finest Faculty Award. He is a member of the Federation of Societies for Coatings Technology (FSCT) from which he received the Armin J. Bruning Award for his outstanding contribution to the science of color in the field of coatings technology. He is also a member of the American Association of Textile Chemists and Colorists (ATTCC), and the Detroit Colour Council (DCC).

In 2004 Mr. Stanziola became the 19th recipient of the Nickerson Service Award. He joined the ISCC in 1962 and has been an active member since that time. He co-chaired with the very successful Annual Meeting in Princeton in 1992 that celebrated the 25th anniversary of the AIC. Stanziola also co-chaired the joint meeting the Detroit Colour Council in Detroit in 1994 on Color and Quality and most recently co-chaired the very successful Williamsburg Conference on Industrial Color Problems held at his alma matter, Philadelphia University. He was instrumental in setting up the Education Interest

Group when it would give tutorials and demonstrations on color technologies. He was also the first chairman of the Industrial & Applied Color Interest Group and organized several well attended sessions.

Edwin Stearns

[Excerpts reprinted from ISCC *News* #336, March/April 1992]

"Edwin Ira Stearns, 80, Former ISCC President and Godlove Award recipient, died on January 19, 1992 at his home in Clemson, SC. Born in Matawan, NJ on September 3, 1911, he was the son of the late Reverend Edwin Ira and Mary Beatrice Jeter Stearns.

He was graduated summa cum laude from Lafayette College in 1932 with a degree of Bachelor of Chemical Engineering. He obtained a Master of Science degree from Rensselaer Polytechnic Institute and a Doctor of Philosophy degree from Rutgers University. …

He was employed by the American Cyanamid Company for 39 years from 1933 to 1972 where he worked with dyes and textile chemicals. He was professor of textiles at Clemson University and head of the department from 1972 to 1977. He was the secretary of the Association for the Advancement of Textile Education. …

He was an honorary member and first president of the Inter Society Color Council which he helped incorporate. The Council awarded him its Godlove Award in recognition, in part, that he was the first person to calculate a color match from numerical data.

His avocation was ornithology. He was a founder and past president of the Urner Ornithological Club. Under its auspices he was the first person to study the migration of hawks from a blimp. For 20 years he held the unofficial record of number of species of birds seen in one day in New Jersey. His name was chosen by the New Jersey Audubon Society for the award given each year for the out-of-state team of birders that see the largest number of species in one day. He was a founder and life member of the American Birding Association. …

Evelyn Stephens

Evelyn Stephens received her B.S. in Chemistry from Brooklyn College and her M.S. in Science Education from New York University. She has a number of additional graduate school credits in physics and mathematics. She had been a member of the faculty at The Fashion Institute of Technology since 1960, and she was Professor and Chair of the Science and Math Department from 1973 until 1981. Mrs. Stephens is currently retired.

In the ISCC, Mrs. Stephens chaired Project Committee 40 on Color Education, Resources and Materials. She co-chaired Interest Group IV on Color Education. Also, Evelyn Stephens was elected as an Honorary Member of the ISCC in 2003.

She is a member of the American Association of Textile Chemists and Colorists (AATCC), ASTM International, the Color Association of the United States, Inc. (CAUS) and the Society for Imaging Science and Technology (IS&T)

Johnny Suthers

Mr. Suthers is a Principal Chemist in the Color Technology Development Group at Eastman Chemical Company located in Kingsport, Tennessee. He has worked in the area of color science for over 32 years. His special focus area is color formulation and production control. His areas of responsibility include the Colorant Technology Center at Eastman and color formulation development for Polyolefin and Polyester plastics. Mr. Suthers received his B.S. in Chemistry from East Tennessee State University. He is a senior member of the Society of Plastics Engineers, (SPE). He is past Chairman of the Holston Valley Section of the SPE. He holds the 1997 Outstanding Achievement Award from his local section. Currently Mr. Suthers is the Chairman for SPE's Color and Appearance Division. He was Co-Chair for the Technical Program of the 1995 SPE Conference "Coloring Plastics for Performance", Co-Chair for the 1997 SPE Conference "Color Quantifications: Adding Value with Instruments" with the ISCC, 2000 Chair for the Technical Program for the joint CAD-PMAD RETEC, "Your Ticket to Outstanding Color and Additives", and 2001 Co-Chair for the Technical Program for the SPE RETEC, "Hot Plastics, Cool Colors". He has presented numerous papers at technical meetings and conferences. Mr. Suthers is also a member of the American Chemical Society. In the ISCC he served as a director from 2002 – 2005.

Lawrence A. Taplin

Lawrence A. Taplin is a Color Scientist working in the Munsell Color Science Laboratory at RIT. He received a M. S. in color science from RIT and a B.S. in computer science from the University of Delaware. His research interests include spectral color reproduction and museum imaging.

Joann M. Taylor

Joann Taylor received a B.S. degree in Chemistry and M.S. and Ph.D. degrees in Color Science/Analytical Chemistry from Rensselaer Polytechnic Institute. Her work at the Rensselaer Color Measurement Laboratory, under the direction of Fred W. Billmeyer, Jr., focused on Multidimensional Scaling of the OSA Uniform Color Scales. After graduation, she became a member of the technical staff at Tektronix Laboratories. She was instrumental in the development of numerous color-related products, including the TekColor™ Color Management System – winner of the 1990 Electronic Design News Innovation of the Year Award. As director of Tektronix' Color and Imaging Laboratory, she was responsible for developing and implementing color technologies for numerous products throughout Tektronix – including the Xcms Color Management Extension for the X Window System and the VM700 Option 21 (TV) Camera Measurement Package, nominated for a technical Emmy.

In 1992, she started Color Technology Solutions, a consulting business aimed at providing a wide range of color consultation and assistance to a diverse client base, including the electronic, television, optical instrumentation, textile, plastics, video production, software development and other industries.

Dr. Taylor has published over 50 technical papers and given numerous tutorials and technical presentations and holds 3 US Patents. She is active in a number of professional organizations including the ISCC, IS&T, ASTM, SID, ACS, and serves on the Board of Directors of the Munsell Color Science Laboratory at RIT. She has also been a Director of the ISCC.

Lisa Thieme

Lisa Thieme is Vice President of Technical Coordination/Research & Development for Colwell Industries, Inc. in Kendallville, Indiana. She currently provides the technical coordination for Colwell Industries, manages the research & development department, color theory education, as well as the Colorcurve® product line. Ms. Thieme's career at Colwell began as a laboratory technician in the Colwell Color Laboratory where she formulated paint for color cards and color system merchandising tools. She was involved in the research and development of the Colorcurve System and later managed the production of the system tools. Ms. Thieme managed the Colorcurve Laboratory and the Colorcurve Division of Colwell Industries, which included sales and marketing responsibilities. Ms. Thieme is actively involved in the Marketing Committee, Automotive Committee, and Creative Team for Colwell Industries. She received her B.S. in Business Management from Indiana University, with minors in Psychology and Organizational Leadership and Supervision. Lisa is a member of the American Association of Textile Chemists and Colorists (AATCC), the Council on Optical Radiation Measurements, CORM, the Detroit Colour Council (DCC), Business and Professional Women and the International Management Council. She also served on the ISCC Board of Directors from 2002 – 2005.

Michael Vrhel

Dr. Vrhel is currently the Senior Scientist at ViewAhead Technology in Redmond Washington. From 1993 to 1996, Michael was a National Research Council, Research Associate at the National Institutes of Health (NIH) Bethesda Maryland, where he researched biomedical image and signal processing problems. In 1996, Michael was Senior Staff Fellow with the Biomedical Engineering and Instrumentation Program at NIH. From 1997 to 2002, he was the Senior Scientist at Color Savvy Systems Limited, Springboro, Ohio where he developed color device characterization software and low-cost color measuring instrumentation. He obtained two patents at Color Savvy Systems and has several pending. His current interests include, color image processing algorithms for embedded systems, color halftoning, and low-cost color/appearance measuring instruments. Dr. Vrhel earned his B.S. in electrical engineering (summa cum laude) from Michigan Technological University, his M.S. degree in electrical engineering from North Carolina State University and his Ph.D. in electrical engineering from North Carolina State University. During his Ph.D. studies he was an Eastman Kodak Fellow. He has published over 40 refereed journal and conference papers. Dr. Vrhel is a Senior Member of the Institute of Electrical and Electronics Engineers (IEEE) and a member of the International Society for Optical Engineering (SPIE). He is currently serving as a Guest Editor for the IEEE Signal Processing Magazine, Special Issue on Color Image Processing. He was a Conference Session Chair for ICIP-2002, ICIP-2000, and SPIE Wavelet Applications in Signal and Image Processing IV 1996. He is currently serving on the ISCC Board of Directors for the term 2004-2007.

Brian A. Wandell

The Inter-Society Color Council (ISCC) honored Dr. Brian A. Wandell with the presentation of the Macbeth Award during its Annual Meeting to be held in Charlotte, North Carolina in 2000. Dr. Wandell, a Professor of Psychology, Neuroscience, and Electrical Engineering at Stanford University in Stanford, California, was recognized for his work in color appearance, especially his spatio-chromatic models including spatial-CIELAB (S-CIELAB).

S-CIELAB measures how accurate the reproduction of a color is to the original when viewed by a human observer. The widely used CIELAB color difference equations are suitable for measuring the color difference of large uniform color targets. S-CIELAB extends CIELAB to color images that contain patterns. The S-CIELAB software is distributed freely on the internet, and it can be used by color engineers to incorporate effects of spatial pattern on color reproduction. This technology has been proven useful in machine vision and in quantifying the quality of digital half-tone printers.

Professor Brian Wandell joined the Stanford University faculty in 1979. His training included a B.S. in Mathematics and Psychology from the University of Michigan (1973), a Ph.D. in Social Sciences from University of California, Irvine (1977), and an National Institute of Health post-doctoral fellowship at the University of Pennsylvania (1979). His research includes image systems engineering and vision science. Professor Wandell is co-director (with J. Goodman) of the Image Systems Engineering Program at Stanford. He is also co-principal investigator (with A. El Gamal) of the Programmable Digital Camera program, an industry sponsored effort to develop programmable CMOS sensors. Wandell's work in vision science uses both functional MRI and psychophysics. His vision science work includes work on the computation and representation of color and measurements of reorganization of brain function during development and following brain injury. Wandell is the author of *Foundations of Vision*, a textbook on Vision Science. Wandell won the 1986 Troland Research Award from the U.S. National Academy of Sciences for his work in color vision; he was made a Fellow the Optical Society of America in 1990, and he was given a McKnight Senior Investigator award in 1997.

James A. Worthey

Jim is interested in lighting and vision of "real stuff", not video screens, but the non-luminous objects of the real world. James A. Worthey has a B. S. degree in electrical engineering from the University of Missouri, and M. S. degree from Michigan State University, and a Ph. D. degree in physiological Optics from Indiana University in Bloomington, Indiana. His color-related research has centered on color rendering, color constancy, and object color metamerism. He has also studied black-white issues in lighting, particularly light source size and its effect on shading, highlights and veiling reflections. Dr. Worthey states that he is interested in lighting and vision of real stuff, not video screens, but the non-luminous objects of the real world. He is active in ASTM International where he served as secretary of committee E-12 on Color and Appearance and chair of the task group on color constancy in technical committee E12.11 on Visual Methods.

John A. C. Yule

One of the world's leading color reproduction scientists and photomechanical researchers, John A.C. Yule, died on February 17, 2002 at the age of 95.

John Yule, who was born in Bradfield, United Kingdom, received a Bachelor of Science degree from the Royal College of Science (part of the University of London) in 1927. In 1932 he was transferred from England the United States by the petroleum company for which he worked. John was about to return to England in 1936 when an offer of employment arrived from Alexander Murray of the Kodak Research Laboratory. He accepted the offer and thus began his long association with the imaging science community of Rochester, New York.

At Kodak, he invented graphic arts products, was awarded some of the first (early 1940s) patents on color scanner technology, and authored numerous scientific and technical papers on color reproduction, film development and photomechanical processes. His 32 years at Kodak included service as an advisor to the United States Army Map Service during World War Two and, in 1951, four months of development work on the first successful color scanners at Time Inc.'s Springdale Laboratories in Connecticut. His early research is still cited regularly, particularly that concerning the Yule-Nielsen equation, a method for converting density measurements into dot areas.

Dr. Yule joined the Rochester Institute of Technology in 1968 as a Research Associate. His seven years at RIT included a series of pioneering studies conducted with Milton Pearson and Irving Pobboravsky on the optimum reproduction of color and, in 1971, collaborative work with Nathaniel Korman of the Ventures Research and Development Group on the first lookup table-based color scanner.

John Yule's contributions to the color and imaging sciences have received widespread recognition. The University of London conferred upon him one of its higher doctorates, the Doctor of Science degree, in 1967. This distinction was followed in 1968 by the presentation to him of the Institute of Printing's Gold Award. He received the Technical Association of the Graphic Arts (TAGA) Honors Award in 1975, and was recognized by the Society for Imaging Science and Technology with a Fellowship in 1974 and Honorary Membership (their highest honor) in 1984. The Graphic Arts Technical Foundation awarded him their 1978 Robert F. Reed Technology Medal, a prestigious award that honors scientists and engineers in the graphic arts.

In the years to come, John Yule will probably be best remembered as the author of the authoritative book Principles of Color Reproduction. This landmark text on the scientific foundations of color reproduction in the printing and related industries was first published by John Wiley, Inc. in 1967 and last updated in 2000 by the Graphic Arts Technical Foundation.

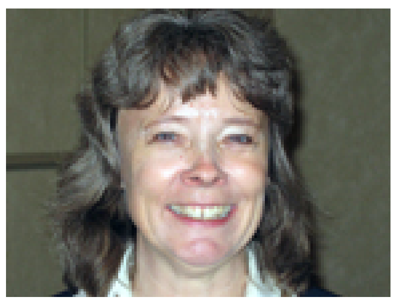
John's retirement years were spent with his wife June in Prescott, Arizona. He continued to follow developments in the color imaging field and his many hobbies, which included international folk dancing, hiking and music. John was a reserved but friendly man whose lively mind and physically active life produced an acclaimed career and a vital retirement that provides an inspiring example to those of us who seek to follow his path.

Contributed by Gary G. Field

Mary Ellen Zuyus

Mary Ellen Zuyus is Manager of Advanced Development Department at Hunter Associates Laboratory, Inc. in Reston Virginia. Ms. Zuyus received a Bachelor's degree from Dickinson College in Carlisle, Pennsylvania and a Master's degree from the University of Maryland. Mary Ellen was the editor of the ISCC News from 1981-1986 and on the Board of Directors from 1986-1989, as well as serving on several project committees.

Joanne Zwinkels



Dr. Zwinkels is a Senior Research Officer and the Head of the Photometry and Radiometry Group at the Institute for National Measurement Standards of the National Research Council of Canada (NRC). She earned her Ph.D. in Chemistry from the University of Alberta with specialization in the infrared optical properties of solids. Dr. Zwinkels' research involves the development of instrumentation and reference materials for high-accuracy spectrophotometry, spectrofluorimetry and gloss. She has designed, constructed and tested a high-accuracy spectrophotometer, which defines the NRC scale of regular transmittance, and a two-monochromator reference spectrofluorimeter, which is used for high-accuracy total radiance factor measurements of fluorescent materials. Currently she is developing a new goniospectrophotometer to improve the accuracy and range of NRC specular gloss calibration services.

She is an active member of the CIE, ISO, and ISCC. Dr. Zwinkels serves as the Canadian Member of CIE Division 2; chair of a CIE Technical Committee on calibrations methods and standards for photoluminescent measurements; and a member of CIE and ISO committees on the characterization of spectrophotometers, geometric tolerances for colorimetry, practical daylight simulators, and optical properties of paper.

In the ISCC she is the currently the retiring President. She also was a former chair of the ISCC Interest Group on Fundamental and Applied Color Research, and served on the Board of Directors from 1997 - 2000.