Inter-Society Color Council *News*

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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 believes 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 Johns 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.

CALL FOR NOMINATIONS

This year ISCC will elect a slate of officers for the 1986-87 term (two years) and three members of the Board of Directors for the 1986-88 term (three years). Those wishing to submit names as candidates should consult the By-Laws of the ISCC. Names may be submitted to T. Commerford, Secretary and/or L. Graham, Past President and Chairman of the Nominating Committee. Names of current officers and the Board of Directors may be found on the last page of the Newsletter. Submissions should be received by June 30, 1985.

CALL FOR MACBETH AWARD NOMINATIONS

Every two years your Inter-Society Color Council is honored to be able to present the Macbeth Award. The Macbeth Award Fund was established by Mr. Norman Macbeth, Jr. in honor of the memory of his father, Norman Macbeth.

Nominations for the Macbeth Award are now being considered by the Macbeth Award Committee, Charles Sherman, Chairman. Individuals, or groups of individuals, interested in having a specific nomination considered by the committee should submit such nominations as soon as possible to Charles Sherman, Sherwin-Williams Company, 10909 S. Cottage Grove Ave., Chicago, IL 60628 (phone: 312-821-3510).

Rules governing the nominations for the Godlove and Macbeth Awards are given on pages 31 and 32 of the By-Laws Booklet of ISCC. Please note that the confidentiality of the nomination is of the utmost importance. The person or group must insure that the nomination is not discussed with the proposed nominee. Should any of the information required in the By-Laws be difficult to obtain without the risk of such disclosure, information should be omitted from the nominating letter.

The other members of the Nominating Committee are: Ruth Johnston-Feller, Cal McMacy, Bill Shaeffer and Ray Kinmonth.

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 to 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, from 1973 to 1975, was its President. 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 were no international standards for colorimetry and no standards for illuminating and viewing conditions; the first photoelectric spectrophometer 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'Eclairage (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. National 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. That formulation led eventually 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 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 Internationale 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 projects 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

DOROTHY NICKERSON, PROPHETESS OF COLOR

Alas, the Prophetess of Color – inspired of Munsell – is silent.

Fifty years ago, Dorothy came to Cambridge from Washington bringing cotton from the Department of Agriculture for measurement on the new Hardy spectrophotometer. I ventured to tell her how to interpret the results and began my education in color under her instruction.

Her contributions to "The Science of Color," the report of the Committee on Colorimetry of the Optical Society of America (OSA), are acknowledged in the Preface: "Very complete and helpful comments and suggestions by . . . Dorothy Nickerson . . ."

Three momentous papers, based on studies of the results of the first spectrophtometric measurements of the Munsell colors appeared in the July 1943 issue of the Journal of the Optical Society of America (JOSA) under the authorship of Nickerson in collaboration with other famous names in color: Kelly, Gibson, Granville, Foss, Newhall and Judd. Vividly I remember long sessions with Nickerson, Newhall and Judd, intently studying the scatter of Munsell colors on the chromaticity diagram, marking with arrows to indicate how their notations should be revised to correspond to how their colors appeared, and to smooth the scales.

Six years before the *Science of Color* was finally published (20 years after the appointment of the committee), Nickerson, Judd, and other long-suffering colorists undertook a fresh start to create a system of completely uniform color scales. Dorothy's story about that 30-year task was told in the Winter 1977 issue of *Optic News.* Her description of the resulting system was published in *Leonardo,* volume 12 (1979). Beautifully illustrated (with her text translated into German), a similar article was published in Farbe + Design, Volume 12 (1979).

Dorothy came full circle with "Munsell renotation for samples of OSA Uniform Color Scales" in the October 1978 issue of JOSA and in a beautifully illustrated article, based on the same information, in the Spring 1981 issue of *Color Research and Application.*

Such are only samples of Dorothy's voluminous contributions to color lore and science. Much of her influence was by personal acquaintance. She participated in almost every meeting of the ISCC, Association Internationale de la Colour (AIC), and since 1955 the Comission Internationale de l'Eclairage (CIE).

Dorothy Nickerson's infectious enthusiasm, prodigious energy, and helpful friendliness will always be remembered with love and respect by all who knew her.

David L. MacAdam

RECOLLECTIONS OF DOROTHY NICKERSON

Dorothy frequently came to the National Bureau of Standards (NBS) to consult with Deane Judd on color problems of mutual interest during the period from 1946 to 1970 while I was working in the Colorimetry Section. It is interesting to note that she did not write papers jointly with Judd. In the first edition of his book. *Color in Business, Science and Industry,* Wiley, 1952, Judd references 13 papers by Nickerson, more than any other single author except Judd (28 references). ISCC News may publish later a chronological list of all the papers by Nickerson; however, here are the 13 cited by Judd covering the period 1931 to 1950. They provide a respectable sample of her writings during that period.

D. Nickerson, A colorimeter for use with disc mixture, *J. Optical Soc. Am.,* 21, 640 (1931).

D. Nickerson, Disk colorimetry; including a comparison of methods for computing tristimulus values for certain disks, *J. Optical Soc. Am.,* 25, 253 (1935).

D. Nickerson, The specification of color tolerances, *Textile Research,* **6**, 509 (1936).

D. Nickerson, The illuminant in color matching and discrimination, *Illum, Eng.,* **36**, 373 (1941).

D. Nickerson and S. M. Newhall, Central notations for ISCC-NBS color names, *J. Optical Coc. Am.,* **31**,587 (1941).

D. Nickerson and S. M. Newhall, A psychological color solid, *J. Optical Soc. Am.,* 33, 419 (1943).

D. Nickerson and K. F. Stultz, Color tolerance specification, *J. Optical Soc. Am.,* **34**, 550 (1944).

D. Nickerson, Color measurement and its application to the grading of agricultural products. A handbook on the method of disk colorimetry, *U. S. Dept. Agr. Misc. Pub.* 580, 1-62 (March, 1946).

D. Nickerson, Interrelation of color specifications, *Paper Trade J.,* **125**, TS219 (1947).

D. Nickerson, Munsell renotations used to study color space of Hunter and Adams, *J. Optical Soc. Am.,* **40**, 85 (1950).

D. Nickerson, Tables for use in computing small color diferences, *Am. Dyestuff Reptr.,* 39, 541 (Aug. 21, 1950).

D. Nickerson and D. H. Wilson, Munsell reference colors now specified for nine illuminants, *Illum. Eng.,* **45**, 507 (1950).

D. Nickerson, R. S. Hunter, and M. G. Powell, New Automatic colorimeter for cotton.

Loke Judd, Nickerson was always working on the solution of one or more color problems. Also like Judd she had the ability to sense the color needs of people working with different materials and to enlist the help of others in the solutions, as seen by the coauthors in the references cited above and the variety of journals in which the papers were published. It is true that during this period of time the Optical Society of America was the favorite forum for discussing color problems, and the Society Journal was the favorite place for documenting the solutions.

Dorothy Nickerson was active in ISCC from the time of its founding in 1931. She served as Secretary from 1938 to 1952 and as President from 1954 to 1956. She seldom missed a meeting. She was still working on color problems when she contracted a virus in January 1985. She was obliged to cancel her plans to attend the Williamsburg Conference in February and the Annual Meeting in April. Earlier, in October 1984, she had attended the two-day meeting of the U.S. National Committee (USNC) of the International Commission on Illumination (CIE) in Gaithersburg, Maryland, and enjoyed it tremendously. Dorothy Nickerson will indeed be missed by many of us.

Harry K. Hammond III

NEWS OF MEMBERS

Applications For Individual Membership Approved at Board of Directors Meeting April 12-13, 1985

Mr. Michael Chrystof
5907 N. Fairfield
Chicago, IL 60659

Mr. Chrystof is associated with Rust-Oleum Corporation. His work includes computer color matching and formulation of maintenance paint coatings. He is a member of FSCT.

Ms. Gwendolyn J. Cooper
3509-41st Street
Lubbock, Texas 79413

Ms. Cooper is currently working towards a master's degree in interior design. Her interests are in the use of color in the design of health care facilities to meet the needs of both the professional and patient. She is a member of ASID and IES.

Mr. Peter G. Engeldrum
1920 Sherburne Road
Walworth, N.Y. 14568

Mr. Engeldrum is involved in color reproduction; i.e., dot matrix system, printing, color photography. He also does some teaching and consulting work. Mr. Engeldrum is a member of SPSE, OSA, and SID.

Mrs. Fran Greene
Visual Displays, AFANRL/HEA
Wright-Patterson Air Force Base
Ohio 45433-6573

Mrs. Greene's work involves basic psycho-physical research needed with color cathode ray tubes, to help in formulating specifications for chromaticity, saturation, etc.

Ms. Patricia L. Heddell
University of Iowa
School of Art and Art History
Iowa City, Iowa 52242

Ms. Hendell teaches color theory in the University of Iowa Art Department. Her particular interests are: color in commercial offset printing; color using Gouache paints in fine art.

Mrs. Darby Simpson Macfarlane
2500 Johnson Avenue
Riverdale, New York 10463

Mrs. Macfarlane's work is in the R&D area of cosmetics, hair tints and fashion. She is involved in the measurement of color for beauty application.

Ms. Patricia J. Moreau
RR #2
Chatham, Ontario N7M 5J2
Canada

Ms. Moreau is in the design area and her work relates to paint, textiles and lighting products. She is interested in color psychology, and the effects of color on a person.

Mrs. Susan Noel
955 Easton Road, B-15
Warrington, PA 18976

Mrs. Noel's work includes quality control of pigments and dyes at Colorcon, Inc., using an ACS system. Her color interests include color matching, metamerism and associated problems and spectro-photometry.

Mr. Duane Rosenberger
Mayor Blvd.
West Point, PA 19486

Mr. Rosenberger works with color concentrates for foods, drugs, and cosmetics, in the quality control area. His particular interests are color matching and color stability to light.

Mr. William E. Stearns
P.O. Box 519
Washington, PA 15301

Mr. Stearns is employed by Drakenfeld Colors (Division of Ciba-Gergy). His work involves ceramic pigments and glass enamels. His interests in color science include quality control, computer formulation and customer color service.

Mr. Antonia F. Torrice
1240 California Street #1
San Francisco, CA 94109

Mr. Torrice works with paints, fabrics, carpets and lighting as an interior designer. He is particularly interested in the psychobiological effects of color on humans, and the influence of the environment on children and the handicapped.

NEWS OF MEMBER BODIES

ASID

National ASID President Gail Adams has appointed Kenneth L. Smith Chairman of the ASID Delegation to ISCC for 1985. Mr. Smith comes to the position with a varied background and strong interest in color and design, having served as a representative for Ralph Wilson Plastics Company, R. Michael Brown Design Associates, and currently Pioneer Plastics, Division of Libbey-Owens-Ford. He was graduated with honors from Southwest Texas State University in 1980. He is an active professional member of ASID, a member of Color Association of the United States, and serves as a representative to Architectural Woodworking Institute.

Anna Campbell Bliss, retiring Chairman, will continue to serve on the Board of Directors of ISCC and as a member of the delegation.

Artists Equity Association, Incorporated

I'm grateful to Olive Mosier, Executive Director and Linda Taylor, ISCC delegate, for sending such a good selection of information on their organization – National Artists Equity. Much of this article was extracted from Olive's excellent account. Reading their Newsletter and various documents in support of visual artists one point comes through loud and clear – here's an organization that is extra conscious of the individual members' needs as well as representing the interests of artists as a group.

National Artists Equity is an association of about 3000 individual visual artists working together at local and national levels to improve the professional lives of all individual artists. It was founded in 1947 by a group of leading artists of the day who felt the practicing artist needed a voice in the affairs of their profession. Artists Equity is a non-profit organization and is aesthetically and politically non-partisan.

They are vigorously involved in lobbying efforts, both in Washington where their headquarters are located and at each of the 14 local chapters across the United States.

Members of National Artists Equity can take advantage of a wide range of benefits: (1) art magazine discounts; (2) insurance which protects artwork while in the studio and in transit; (3) group medical and life insurance (4) a quarterly newsletter which reports on Artists Equity actions and ideas employed by members individually or through local chapters; (5) debt collection service; (6) legal referral and information; (7) model contracts; and (8) publications such as policy papers on a variety of topics of concern to visual artists.

National Artists Equity works to educate artists to ensure their fair treatment. For instance, Artists Equity has published a series of "Action Kits" on the business of art which outline such areas as the rights and responsibilities of an artist participating in a juried show or consigning work with a dealer. In its efforts in advocating artists' rights, some of Artists Equity's notable legislative successes include California's Artist-Dealer Relations Law of 1975 and Resale Royalty Act of 1976 and Los Angeles "Live/Work" zoning regulations of 1979. In 1982, Artists Equity negotiated with the American Society for Testing and Materials to create The Art and Craft Materials Institute, paid for by seven manufacturers, which pledged to conform to safety labeling of art materials. As a result, there now exists a national voluntary standard on chronic health hazards in art materials. One of the National Artists Equity's current projects is to change the federal tax laws that treat an artist as a hobbyist if using a home as a studio.

National Artists Equity Association also operates the Artists Equity Fund, Inc., begun in 1948 as the first national nonprofit fund dedicated to facilitating the cultivation and diffusion of knowledge and understanding of the fine arts and the solution of the economic problems of those who work in the fine arts. This fund sponsors publications, lectures, research and seminars at all levels.

Ed Cairns

Color Computation Method Published

The "Standard Method for Computing the Colors of Objects by Using the CIE System," ASTM E 308-85, is a major revision of the 1966 document of similar name and number, now split into two parts. The method for computing the colors carries the original designation, but it is really the second part of the two-part revision. The revision of the computation portion was undertaken first because it was urgently needed due to the delay in the issuance of the revision of CIE Publication 15, designated 15.2, the final draft of which was approved April, 1983.

This very important revision of E 308 is also needed to achieve standardization among laboratories when computing colors from the same spectral data. The companion document, still only in outline form, is expected to be a standard practice for obtaining spectral data.

Method E 308-85 contains 43 pages of text and tables. It was published in April 1985, by ASTM (American Society for Testing and Materials), 1916 Race Street, Philadelphia, Pennsylvania 19103. The list price is $10. ASTM members receive a 20% discount on all publications. Both members and nonmembers can eliminate the charges for handling and postage by sending their remittance with the order. In the United Kingdom and Western Europe, contact the ASTM European Office, 68A Wilbury Way, Hitchin, Herts SG4 OTP.

The method now includes tables of the latest data recommended by the International Commission on Illumination (CIE) for computing tristimulus values from spectrophotometric data, specifically the CIE 1931 standard colorimetric observer (2°), the CIE 1964 supplementary standard colorimetric observer (10°), and spectral power distributions for nine illuminants, including A, C, D_{50}, D_{55}, D_{65}, D_{75}, F2, F7, and F11.

The method is designed to precisely standardize computation procedures of CIE tristimulus values X, Y, Z, so that when the same spectral data are used in different laboratories, the computed results will agree to within the rounding error, usually 0.02, in each tristimulus value. When different computation procedures are used, disagreement in results can amount to as much as several units. The high reproducibility of this method is achieved by providing explicit instructions for making computations.

Equations for computing CIELAB (L*a*b*) and CIELUV (L*u*v*) coordinates are also given.

The method includes 36 tables of weights for computation for any combination of 10 or 20 nanometer wavelength intervals, the 1931 or 1964 CIE observer, and the nine CIE illuminants listed above. Some people may prefer to store separately the basic observer and illuminant data in their computer rather than to store all the tables of weights because the separate listings require less storage space than do the weights. However, when separate listings are stored, the accuracy of the programming should be verified initially by checking the computed results with those obtained by use of appropriate weights.

References are included to important articles by Ed Stearns, Fred Billmeyer and Hugh Fairman.

Anyone making color computations from spectral data should have a copy of this method and follow the procedures contained therein. You may also wish to acquire a copy of the book of ASTM Standards on Color and Appearance before it goes out of print again. The price is $39. See Book Review in ISCC News No. 290 (May-June 1984), page 27.

Harry K. Hammond III

HELP WANTED

Publicity is assembling a list of non-members of ISCC who are interested in color. Such a list will extend interest in us and possible recruit new members. If you know of anyone who wants to be kept informed of our meetings, please send names to: T.G. Webber, 1722 Forest Hill Dr. Vienna, WV 26105

1986 WILLIAMSBURG CONFERENCE

"The Colors of History: Identification, Re-Creation, Preservation" will be the subject of the next ISCC Conference at Colonial Williamsburg, February 9 to 12, 1986. The program is being assembled by Robert L. Feller, who is well known for his work at the National Gallery of Art and at Carnegie-Mellon University, and by Danny C. Rich, Applied Color Systems, at Princeton.

The subjects that invited speakers will discuss include applications to architecture, textile re-creation, transportation (automotives and ships), and identification of dyes and pigments. Registration forms will be mailed to *ISCC members* in September. Others may contact T.G. Webber, 1722 Forest Hill Dr., Vienna, WV 26105, USA.

PRIZE FOR PAPER ON COLOUR MEASUREMENT

The Canadian Society for Color is very pleased to announce a first prize of US$700.00 and second prize of US$300.00 for papers on the instrumental measurement of colour.

The prize has been donated by Mr. John Bohman, General Manager of the J.B. Atlas Company, to honour the memory of Mrs. Margaret Burns who dedicated much of her working life to the science of colour. A HunterLab employee for 18 years, Margaret Burns died on March 19, 1983 after a long, courageous battle with cancer. She was a graduate of Stanford University and a member of Phi Beta Kappa. Mrs. Burns headed the HunterLab Education and Training Department for many years and was well known for her depth of knowledge on the subjects of color, gloss and their measurement. She was also known by many HunterLab friends and customers for her organization and skillful presentation of HunterLab seminars and workshops in Canada and across the U.S. Mrs. Burns was the author of a number of technical papers and an indispensible help to Mr. Richard Hunter in the writing of his book, "The Measurement of Appearance." During the period 1965-1982, as many as two thousand Canadian attendees enjoyed her lectures.

Anyone wishing to enter for the prize should submit a paper to Dr. Alan R. Robertson, Division of Physics, National Research Council of Canada, Montreal Road, Bldg. M-36, Ottawa, Ontario, Canada, before 1 December 1985. Papers may be written in English or French and should not exceed 10 double-spaced pages including figures. The topic should be any new technique or application of instrumental colour measurement. Papers should not have been published previously. A panel of judges will be appointed by the Board of Directors of the CSC and the majority decision of the panel will be final. The winning papers will be published in the Newsletter of the CSC with no restriction on subsequent publication elsewhere.

NEXT YEAR'S CALENDAR

For those of you who plan ahead here is a rundown of an exceptionally busy June schedule supplied by Peter Kaiser. Full details on all of these activities are not available at this time but remember to block out time for those that are of interest to you.

Joint ISCC-CSC Annual Meeting on Color Reproduction. June 16-18, 1986; Ryerson Polytechnic Institute, Toronto.

AIC Interim Meeting on Color in Computer Generated Displays. June 19-20, 1986; Ryerson Polytechnic Institute, Toronto.

RIT Color Meeting tentatively titled Color and Computers. June 23-24, 1986; Rochester Institute of Technology, Rochester, NY.

CVS Symposium tentatively titled Computer Vision and Human Vision. June 26-28, 1986; University of Rochester, NY.

1985 WILLIAMSBURG CONFERENCE

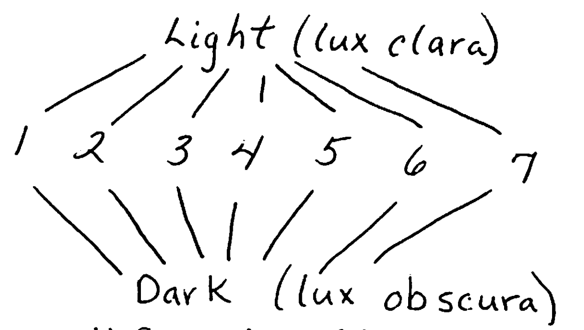
The topic of this year's Williamsburg conference was Color: Then and Now. It seemed fitting that such a conference would begin at the very beginning. Charles Parkhurst of Williams College Museum of Art (Williamstown, MA) began his talk on medieval color and art by referring to Aristotle as having had the strongest influence for centuries. In these earliest times, color precepts changed so slowly that they were almost undetectable throughout the centures.

Many beautiful mosaics and manuscripts from the 9th through the 11th centuries were shown. The first mosaic featured a beardless Christ (which was a sign of eastern intrusion in Italy) in a purple robe separating sheep from goats. The goats were led by a blue angel of darkness and the sheep were led by a red angel of light. As the manuscripts being shown went on into the 9th and 10th centuries, the predominant colors were red, green, blue, violet, and gold instead of a true yellow. Another common technique prevalent in these early works was the use of colors in striated bands extending from the bottom to the top of the piece. Color areas remained flat with no attempt to modulate lightness and darkness. Most of the artwork was linear in form meaning that folds and shapes were represented solely through the use of lines.

Charles Parkhurst expanded on the color theories of Aristotle, which must have influenced the artwork of the time. Aristotle proposed a seven color system consisting of white and black at the extremes and yellow, red, green, violet, and blue in the middle. It was a photometric scale. Light and dark were used to symbolize good and bad. Yellows and reds were considered to be always fixed at the light end of the scale and blue and violet at the dark end. Hence the blue angel watching over the goats in the first mosaic we saw was the angel of darkness and the red angel watching over the sheep was the angel of lightness. The banding concept so prevalent in these early works was a standard for distance, which stemmed from the belief that the emanation of rays from the eye controlled what we saw. Therefore close objects were drawn with light colors and the distance in striated bands of dark colors. Also explicit in the flat unmodulated colors was Aristotle's photometric scale and implicit was evidence of an appreciation for the concept of saturation level. Before closing this discussion, Charles Parkhurst assured us that color nomenclature problems started with Aristotle. His seven color system named eight colors. References were often made to a color known as leaden dark gray falling between blue and black. Thus the equivocal nature of color naming is not unique to modern times.

Next the artwork illustrations moved on in time to concentrate on the 12th through 15th centuries. Here there was a deliberate effort to get away from the basic colors that came from the most available pigments. This timeframe represents the earliest mixing of colors from individual pots. A new orange and a truer yellow began to appear. There became a greater distinction between yellow and gold. Yellow was a common color for Christ's robe and gold was used often as though it were a paint. This period also saw a heavy use of opposing or complementary colors. Yellow and blue or red and green were applied next to each other to impart a vibrant look. Color symbolism was apparent in representations of the holy triad as either red, yellow, and blue or red, blue, and white. Violet was often used as a symbolic color for angels and royalty. But in many works throughout this time period, violet was dropped and reintroduced. Such an occurence is not unusual when one considers that not every manuscript was done by one artist. This is obvious in many works which may show an abrupt change in technique or two different styles within the same piece. A 13th century work entitled Christ Rising from Tomb showed the first evidence of getting away from the use of flat unmodulated colors by featuring three values of red in Christ's robe and the border modulated in three shades of green. The 13th century also saw the first artistic representation of a gray scale. In the 14th century book Advice to Kings, no violet was used whatsoever and all the reds were orange reds and not violet reds. A true red was difficult to achieve. Late in the 14th century the first signs of color theory began to appear in artwork. It was common to find pictorial representations of a color spectrum going from red to yellow to orange to green to blue to violet. These works also implied the mixing of colors to produce the spectrum. In fact 1402 marked the earliest picture of an artist's palette, or a "mixing machine" as Charles Parkhurst called it.

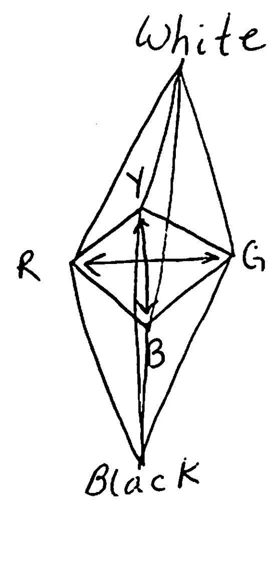
Discussion of the color theories behind the 12th through 15th century artwork began with Robert Grossteste's beliefs. His theory deviated from Aristotle's horizontal linear photometric scale by rotating white and black 90 degrees until they formed a vertical axis with white at the top and black at the bottom. As Aristotle, Grossteste proposed seven colors, which he never explicitly named, to fall in a circular arrangement midway between radiating light and dark.



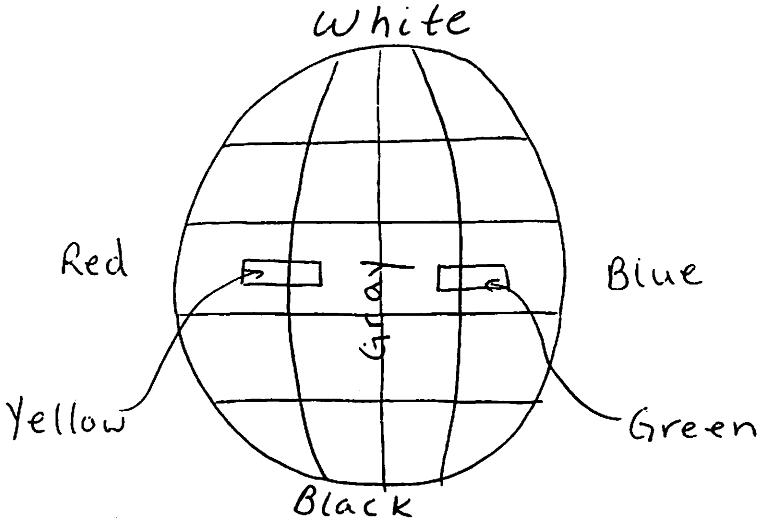
This appeared in Grossteste's text of about 1230, De colore, as the first evidence of a color circle. Its design represented "intension" up from black and "remission" down from white. Thus it may have been Grossteste's theory that was responsible for the modulation of colors that appeared in the artwork of this time. Grossteste was a neoplatonic thinker who believed that lightness was the embodiment of spirit and darkness was embodiment of matter.

Roger Bacon was a protege of Grossteste. His color theory, as reported in Opus Majus (1266-1267) and a recently identified manuscript of about 1252, distinguished between rainbow or imaginary (apparent) colors and real (true) colors. Bacon named blue, red, and green as generic colors intermediate between and equally distant from the white and black extremes. All other colors are diverse species formed by mixing the three middle colors with each other or with white or black. Bacon was the first to propose a geometrical color mixing diagram using the middle red as an example. Bacon's five specific color genera were identified by name and subdivided into 24 named species hierarchically ordered according to lightness or darkness. Bacon was so strongly influenced by Grossteste that his theory also featured many tints and tones as lighter and darker species of the main generic hues. But Bacon's theory distinguished itself from that of Grossteste because it actually named the colors.

The talk ended with a brief discussion of color theory in Renaissance times. The four color (red, green, blue, and yellow) theory became prevalent and used to symbolize the Four Elements: fire, water, air, and earth. Alberti showed the opposing arrangement of these four hues in an intermediary position from which colors, in terms of artists' paints, could be modeled up to white or down to balck.



Finally in 1611, Forsius, a physicist, proposed the following circular color theory, in the earliest preserved color circle.



Charles Parkhurst did an excellent job of using artwork to present the practical application of color theories throughout late medieval times. Even when he reached the end of his excursion through time, some Aristotelian influence was still evident. This fact reinforced the point he made at the beginning of the presentation. Color theories moved so slowly through the centuries that change was almost undetectable.

Faber Birren gave a fascinating presentation on color in religious mythology and symbolism. He began by emphasizing that color symbolism has been a part of human culture since the beginning of recorded history. Going back as far as the seventh century B.C., he explained how the ancient scripture, Hindu Upanishads, associated colors with the vital elements. To the Hindus, red was the color for the sun or burning fire, white was for water and black was for earth. All other unknown entities were thought of as combinations of those three elements. As centuries unfolded, the use of four elements (air, fire, water, and earth) was adopted in various forms by Chinese, Greek and Roman cultures well into the 16th century. For Leonardo da Vinci, blue was symbolic for air, red for fire, green for water ant yellow for earth.

Even the ancient concepts of the world formulated by different civilizations had color connotations associated with them. To the central Asian people of Tibet, the world was a high mountain shaped like a pyramid with the top chopped off. To the north was a continent pictured as yellow with people of square faces, to the south was blue with oval-faced people, to the east was white with crescent-faced people, and to the west was red with round-faced people.

Races were characterized by color even in ancient times. The Egyptians and then the Aryans described four races of mankind. They were proud to be the red race, as evidenced by heavy use of red in their artwork. The Asiatic people were yellow. The Negroes to the south were black. White symbolized the people to the north, across the Mediterranean, and in Asia Minor. India defined four castes in a similar manner. The Arabs believed that all of mankind fell into one of two racial colors; red or black.

Ancient temples were constructed with symbolic use of color. The Birs Nimroud temple of Nebuchadnezzar, which dates back to the 7th century B.C., was built in seven stages, each dedicated to a planet or other heavenly body. The lower richly panelled stage was black to symbolize Saturn; the next orange for Jupiter; the third red for Mars; the fourth yellow for the Sun; the fifth green for Venus; the sixth blue for Mercury; and the seventh upper stage white for the Moon. A tower dating back to 2500 B.C. was unearthed by Dr. C. Leonard Woolly and called "The Mountain of God." It too was built in stages. Black was used for the lower stage and red for the upper stage. Blue glazed tile covered the shrine and gilded metal the rood. Woolly speculated on the mystical significance of these colored stages as emblematic of "the dark underworld, the habitable earth, the heavens and the sun." This mystical use of color was a sign that the ancient peoples believed that the heavenly and earthly kingdoms could be united. Common solar hues were blue, red, and yellow. Consciousness was represented by blue. Intelligence was represented by the vitalizing yellow hue. Force was represented by the heat-giving hue of red. This trinity plus the four supplementary hues resulted in the seven hues commonly used for the rainbow, planets and the days of the week. The twelve signs of the xodiac each had their own symbolic hue also.

Next we saw an Egyptian palette which dated back to 1450 B.C. Its eight compartments contained a terra cotta red, a light and medium yellow ocher, a turquoise blue, a green, white and black. The one empty compartment could have contained an ultramarine blue or purple. In ancient times, all color applications were symbolic in nature and were dictated by mystics. This explains why the palettes had few colors. Each color was applied one at a time in a limited flat manner and mixing of colors was not done. Amazingly enough, the same basic color selections were used among many different civilizations.

For primitive as well as highly developed civilizations, man has always believed his destiny was controlled by the powers in the sky. The sun was the master of heaven and earth. Gold, which is a precious metal, was crystallized sunlight used for ornamental and sacred applications. Colors were used to symbolize the ancient Egyptian gods. For example, Ra was pictured in gold because he, as the chief deity, was as powerful as the sun.

The legendary writings of Homer were presented by the Greeks in a very colorful manner. In the Odyssey they wore purple to represent the sea-wanderings of Ulysses. In the Illiad they wore red to symbolize the bloody war.

The next topic was the influence of color in the three divisions of the Druidic Order of England and Ireland. The Ovates were members of the lowest division. They wore green as the hue of learning and were well trained in medicine and astrology. The second division was the Bards who wore blue for harmony and truth. The Bards memorized the sacred Druidic poetry and were teachers. The third division consisted of the chief Druids who wore white and were the ministers of religion.

India was the first stop in our journey to the east and far east. Brahma was the first all powerful Indian god. He was pictured either red or gold in hue with four heads, four arms and four legs facing the four directions of the world. Yellow was the sacred color for the Brahmans. The color blue was symbolic of the gods origin within the sea. Next came Buddha as the most powerful being. Buddha was depicted most often as yellow or gold to symbolize his radiance. Whenever he fasted, Buddha's golden hue turned to black. Buddha associated evil and sin with a red color. He would often wear red to meditate about mankind's evil ways.

Next we moved on to a discussion of the more practical and less mystical Confucius. Color did not play a dominant role except in the garments Confucius wore. The book, Heang Tang, says he wore "black over lamb's fur, white over fawn's fur and yellow over fox fur." Because fasting represented the highest spiritual purity attainable, Confucius wore white for such an occasion.

Color symbolism was most prevalent in Chinese culture. Examples include the custom of hanging red cloth from a new home as a sign of happiness or placing green pine in the scaffolding to keep the evil spirits away by making them think it is a forest. Each Chinese Dynasty had its own royal color. It was brown for the Sung Dynasty, green for the Ming Dynasty and yellow for the Ch'ing Dynasty. The Chinese believed in four heavenly kings who guarded the four compass points. The black-faced Mo-li Shou guarded the north. He had a creature that devoured men. The red-faced Mo-li Hung guarded the south with an umbrella of chaos that could bring darkness, thunder or earthquakes. The green-faced Mo-li Ch'ing guarded the east with a magic sword. The white-faced Mo-li Hai guarded the west with a guitar that made the world listen.

Moving forward in time brought the discussion to Mohammed, Allah, and the Moslem faith, which was prevalent in Asia Minor, India, and Africa. White was the primary color of dress for Mohammed. The Moslems believed green to be the most sacred hue, which explains why they wore green turbans on their pilgrimages to Mecca. The Keblah is a black stone found at the Caaba sacred shrine in Mecca. There is an interesting history behind this black stone. Gabriel brought it from heaven to Abraham for use on the shrine he was building. It was a sparkling white with emanating rays to symbolize the omnipresence of Allah. However the evil wrong-doings of mankind blackened the stone. Even today Moslems are still praying that the stone return to its original lustrous white. The Koran, the Moslem holy book, contains some references to color. One color that was rarely mentioned in connection with the Moslems is red. The reason for this is unknown.

Next we entered the Judeo-Christian era. Here many Biblical references relied heavily on the use of color to describe appearances. The sacred tablets containing the ten commandments were said to be of divine sapphire. Noah's ark contained a red carbuncle. A colorful rainbow was shown to Noah as a sign of peace. The most frequently used colors in the Old Testament were red, blue, purple, and white. Blue, the color of a divine sapphire, was taken as the hue of the Lord. In the New Testament the references to color are less eloquent. The Holy Trinity was comprised of God the Father, who was always shown in blue, God the Son in yellow, and God the Holy Ghost in red. Man's essence was also symbolized by these three colors. His body was red, his mind yellow and his spirit blue. Extending these color symbols one step further. Heaven was thought of as blue, earth as yellow, and hell as red. The hue of Christ in the New Testament was probably green because many references to Christ associate him with an emerald.

Faber's talk would not have been complete without discussion of the American Indian color lore. Their lower world was black while their upper world was of many colors. Their use of color was purely symbolic as evidenced by their tattoos, face masks, and huts. The religious mystics were responsible for the heavy use of color. The religious ritual was to place yellow, the color of the north first, then blue or green for the west, then red for the south, and finally white for the east.

Faber Birren should be congratulated for giving us a very complete historical tour of color symbolism in worldwide religious beliefs. His slides provided a delightful embellishment to the descriptive colorful words.

Continuing our journey through color history brought us to the 17th century and Sir Isaac Newton who was responsible for the next milestone in color theory. Dr. Alan E. Shapiro was our Newton expert. His presentation took a new approach in that he described Newton as having fathered the study of color mixture, but he also elaborated on much of Newton's confusion with the concepts of three primaries and additive and subtractive color mixture. Presenting the information in this way was important because, as Dr. Shapiro put it, "confusion is the essence of the history of color theory."

The basic foundation of Newton's theory was that sunlight consisted of rays of light of different refrangibility. His experimental set-up involved sunlight being incident through a small hole onto a prism and the colors passing from that prism onto a screen. He saw the spectrum in an oblong rather than a circular shape. An infinite number of colors were produced because of unequal indices of refraction for the rays. Newton named only five spectral colors. They were red, yellow, green blue, and purple. Later he added orange between red and yellow and indigo between blue and purple. Eventually he adopted the name violet instead of purple. Newton felt that the colors were innumerable, but that they were all variations of these seven basic spectral colors.

Out of the above basic concepts, Newton formulated his definitions for simple and compound colors. He defined simple spectral colors as primitive ones that exhibited uniform rays. This definition was very vague because Newton, himself, was at this time still confused. He referred to these simple colors as the seven primary colors, red, orange, yellow, green, blue, indigo and violet, and their intermediate gradations. Compound colors were compounded of these. Newton endorsed the painters three primaries of red, yellow, and blue. Here is where the confusion begins for he used terms associated with pigment mixing, such as primary, simple and compound colors. Yet he really defined these terms according to their refrangibility, which is a physical property of light, and not according to their sensible appearance.

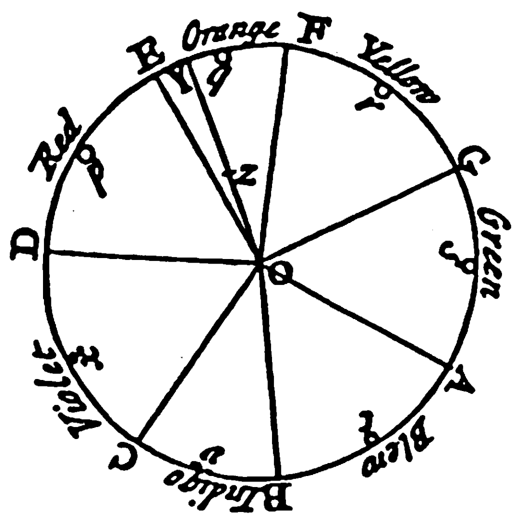
Newton discovered two ways that the same sensible spectral color could be produced. The first was by a monochromatic ray of a single refrangibility and the second was by a mixture of these. This led him to formulate his general rule for color mixing which said that any spectral color can be produced from a mixture of neighboring colors. A compound color results when the sensations and not the rays mix. Newton's ideas, such as his definition of white and the color resulting from a mixture of yellow and blue, were challenged by others such as Hooke and Huygens.

Most of what Newton's contemporaries called color mixing we know today as subtractive color mixture. Actually Newton was the first to explain the difference between additive and subtractive color mixture because of his understanding of selective absorption. Many of Newton's pigment mixing experiments resulted in very dark colors, such as gray or black. He observed a great loss of reflected light from these dark mixtures. One of his basic conclusions from his pigment mixing work was that white, gray, and black are just different levels of the same species of color. Newton was bold in drawing such a conclusion because it was so different from all the earlier beliefs which revolved around white and black being separate entities, one sacred and one evil, as we had just heard from Charles Parkhurst and Faber Birren.

The largest source of confusion for Newton, as well as for others at the time, was the belief that the same color mixture rules held for pigments and lights. Newton explained away evidence to the contrary as due to impurities in the colors and loss of intensity.

Newton's experiments with moving a comb at different rates in front of a light beam led him to assume that color mixture takes place in the eye. He talked about vibrations which were sent through the optic nerve to the sensorium. This was the first hint at the importance of the eye and brain in color mixture phenomena.

In his 1704 Opticks, Newton proposed a color mixing circle which was one of the most important aspects of his theory. Its importance and historical impact was emphasized in its use as the logo for this Williamsburg conference.



This color mixing circle could be used to find the hue and saturation of any mixture of colors, not just neighboring ones. The circumference, which represented the pure hues, was divided in harmonic proportion. White was located at the center of the cricle. Again sources for confusion between his theory and the pigment-mixing tradition were evident. This circle implied that white was a mixture of all colors, yet Newton said white could result from mixing as few as three colors. Nevertheless this circle laid the foundation for the trichromatic theory of Helmholtz, Maxwell and Grassmann. It was just a matter of time before those who followed in Newton's footsteps could develop a more thorough understanding of color to clarify the confusion.

Janis Bell's talk dealt with ideas discussed in 17th century color theory and art criticism on the nature of apparent colors and their effects. Foremost among the writings discussed were two volumes of Matteo Zaccolini's newly discovered treatises on color, De Colori and Prospettiva del Colore, dating from the end of the first quarter of the 17th century. Since Zaccolini was an artist writing without the benefit of a university education, his ideas were compared to those of scientific writers dealing with color, such as Aquilonius, DeDominici, and Grimaldi. She discussed two different sources of information for Zaccolini. The first was the standard medieval writers on optics, such as Peckham, Witelo and Alhazen; Aristotle and the Aristotelian De Coloribus; Leonardo da Vinci's Treatise on Painting and notebooks. The second was passages on color from the art literature citing Alberti, Vasari, Lomazzo, and some perspective treatises. Occasionally modern ideas on color interaction were introduced for clarification or contrast.

After defining the distinction between real and apparent colors, Janis Bell summarized Zaccolini's ideas on the causes of apparent colors, which included illumination, angle of vision, shadow, mixture, overlay and juxtaposition. The importance of each of these to the practice of painting was investigated, sometimes demonstrating a relationship between theory and practice, but more often raising questions needing further investigation.

Three areas were examined in greater depth – the color of the sky, the color of shadows, and the effect of juxtaposition of color perception. This last area was most intersting because Zaccolini anticipated the ideas of Chevreul and Albers, examining the way that juxtaposed colors affect each other in brightness and hue. Since Zaccolini's primary goal (and that of most of his contemporaries) was to create paintings with depth and plasticity, he advised artists to void the kinds of color juxtapositions that Albers would explore in his works. Yet his sensitivity to these issues alerts us to their importance in 17th century art, as was demonstrated with some examples by Poussin, Rubens, and Bernini.

Robert Gerhardt, a painter teaching color theory at the University of North Carolina at Greensboro, gave us a presentation on color theory from his artistic point of view. He began by showing the works of many contemporary painters and tried to link their techniques with color theory concepts of the time.

First we saw Seurat's famous Sunday Afternoon on the Grande Jatte. Herhardt described the use of pointillism as a scientific manner of painting. Color is definitely the main issue in this work. Specifically the five points of color involvement in this painting are the local color of the object, the color of the surround, the color of the light reflected by the object, the color of the light reflected from neighboring objects, and the complementary color to that of the object.

The next artist was Mondrian. His work was of a more theoretical nature with an emphasis on form and color. His colors moved closer to achieving pure hues. Purity was obtained by abstracting everything that was unnecessary. Hence his work moved towards use of pure primary colors, black and white.

Itten's work showed various contrast effects. Among the examples were the different visual effects created by complementary hues, light and dark colors, and simultaneous contrast. Itten is also well known for his color wheel.

Paul Clay was a teacher as well as an artist. Many of his paintings look like color charts, which was most likely his way of emphasizing the importance of color theory. Many of his works show that he preferred gradations in color. Since his abstract paintings were often difficult to interpret, he used very descriptive titles to aid the observer in understanding what his artwork was trying to convey.

Josef Albers applied color to his paintings directly from the tube. He created ambiguity in his paintings. Another way of saying this is that his paintings implied relationships that weren't there. He introduced metaphysics into his paintings. He used color in such a way that it would stand on its own. Another technique he used to create the illusion of transparency was to overlap two colors. His paintings also illustrated the difference between arithmetic perception, which gave the appearance of an unequal transition and geometric perception, which gave the appearance of an equal transition. He also used different techniques to show the interaction of color. The same color presented in different proportional amounts can change the appearance of that color. In this respect, Albers' paintings showed a certain amount of confusion. An example is one of his paintings which emphasized so many different reds that one is left wondering which is the reddest red.

Ad Reinhardt was another contemporary painter who had a very metaphysical style. His paintings showed that the contrast of a color was more important than its value. Although simultaneous contrast was not commonly found in contemporary paintings, Reinhardt did have some examples which emphasized the concept. Another technique he used was the inclusion of warm and cool illustrations in the same painting. Eventually he worked his way to emphasizing black in his paintings. These paintings all had color, but they appeared black.

The basic question that Robert Gerhardt was trying to answer in his presentation was: are these references to color theory found in contemporary paintings intentional? He quoted from different artists to try to get an answer. Many contemporary painters felt that color theory interfered rather than enhanced a work. Yet it was obvious for other painters that there was some connection between what their artwork conveyed and color theory.

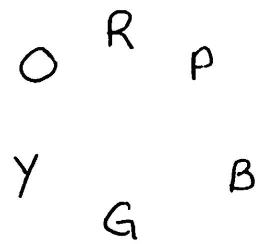
Gerhardt closed his presentation by showing delightful paintings done by his students in his color theory classes. It was amazing and enjoyable to see how imaginative and original the students could be when trying to create a piece that would illustrate a color principle. It was obvious that the students were doing more than just mimicking the color charts and concepts. They were using their creativity and initiative to capture the theories in a unique way on canvas.

Marching up through the centuries led us to the 19th, where Heinwig Lang shared with us the color vision theories that were prevalent in Germany. More importantly, he described how the concepts of physiological optics developed from the general philosophy and social conditions of 19th century Germany.

Wilhelm von Humboldt was responsible for reviving the scientific life at universities in Prussia. He promoted the concept of uniting research and teaching. Freedom of teaching on any scientific subject was encouraged. He also insisted on freedom of learning at any university from any teacher. The direct consequence of Humboldt's philosophy was a reorganization of the educational system with a major impact on the universities in Berlin and Bonn.

Schelling's "Naturphilosophie" discussed the whole world as a living organism and the human mind as part of that organism. This philosophy revolved around the unity of subject and object or spirit and matter. It inspired scientists of the time to see nature and its general principle of polarity in a new light.

Goethe's "Farbenlehre", published in 1810, introduced a new approach to color theory. He emphasized the eye as playing an active role in color vision. The concept of physiological colors was the basis for his whole doctrine. He also defined required colors as complementary colors appearing in afterimages. His array for colors was a circular one with complementary colors on opposite sides of the circumference.



He believed that white could not be mixed from other colors. He also demonstrated how colored shadows could be produced without trying to prove how.

Most of what Goethe proposed was in opposition to Newton's color theory. Goethe was the first to introduce many general rules about color vision. Most important of all was that trichromacy is a consequence of the physiology of the retina. Throughout the first half of the 19th century, Goethe's general scientific ideas were the major influencing factors in color theory for all of Germany.

In 1860 A. Schopenhauer published his work on color and it was obvious that he, as Goethe, rejected Newton's theory. Schopenhauer extended Goethe's theory of physiological colors, but two major differences made his theory unique. First he believed that white could be mixed, but only from pairs of complementary colors. Second Schopenhauer's theory defined a three-fold division of retinal activity. The intensive division was responsible for brightness perception. The extensive division was responsible for space perception. The qualitative division was responsible for color perception, and it worked according to the following photometric scale which illustrates how the complementary colors could be mixed to form white.

Black	V	B	G	R	O	Y	White
0	1/4	1/3	1/2	1/2	2/3	3/4	1

This was the first evidence of additive color mixing among the German scientists. One requirement specified by Schopenhauer for color mixing was that the two colors must be united on the same spot of the retina. Schopenhauer's model worked well for mixing complementary colors, but it did not apply to the mixing of all other colors.

J. D. Purkyne was a physiologist who specialized primarily in subjective visual phenomenon and was greatly influenced by Goethe's color theory. Specifically he defined primary and secondary visual patterns resulting when the closed eye was stimulated by light, electricity, or even after the use of drugs. Most of his extensive visual observations were accomplished by self-observation. Purkyne believed that black is a positive image and that complementary colors are afterimages created by the eye.

J. Mueller was another physiologist who often lectured at German universities. As Purkyne, he believed that the best method for acquiring knowledge was through self-observation. He defined the "law of specific sense energies" as our visual sense reacting with visual perception which results from pressure. His definition of afterimages was broken down into two different terms. Physical afterimages resulted from eye fatigue for one color. Physiological afterimages resulted after the eye stared at one color so long that it produced the complementary color to relieve the strain. These definitions make it apparent that Mueller was also influenced by Goethe.

G. T. Fechner, in 1838, defined subjective complementary colors and in 1840, subjective afterimages. He believed that colored shadows were objective in nature resulting from a physiological change in the retina. He had a difficult time explaining why he saw no color in the shadows through Rumford's black tube. To him, afterimages and color contrast were interrelated and thus should come together in the same theory. Fechner was most famous for his 1860 publication of "Psychophysik" where he defined psychophysics as the science of the relationship between body and soul. He viewed temporal and spatial contrast effects as one and the same. He also believed that color phenomena are supported by a psychophysical process.

Perhaps the most famous 19th century German scientist in the area of color was Helmholtz. He was a physicist who studied under J. Mueller. His most well-known accomplishment was the Young-Helmholtz theory of color vision. He believed that only physical and chemical principles should be used to explain organic processes. Unlike Mueller, his teacher, he emphasized the use of optical instruments and other measurement techniques to study color rather than the more crude techniques such as cutting holes in paper. His theory of compound colors dealt with color mixing. Specifically he described pairs of spectral colors that would produce white when mixed. Helmholtz didn't notice that white could be mixed from two complements because his experimental set-up was imperfect. It was impossible for him to avoid successive and simultaneous contrast when viewing the mixtures. His Handbook of Physiological Optics was published in 1856-1867. He discussed afterimages as a fatigue of three colors from the retina. He had no explanation for simultaneous contrast, other than to say it was an unconsious inference, colored shadows or Rumford's black tube. Unlike Fechner, he felt that the color sensation of the shadow remained if the effect of the surround was taken out.

The final German expert in the area of color vision was E. Hering. He was a student of Weber and Fechner and hence also believed in psychophysical phenomenon. His theory of the sense of light assumed that the psychophysical process occurs in the brain. From 1872 to 1874 he developed his Opponent Color Theory which revolved around the concept that every color sensation is composed of two out of the four colors of red, green, yellow and blue. More specifically, black-white, red-green and yellow-blue were the three antagonistic processes responsible for the perception of complementary colors. He assumed that neutrals come from a balance of assimilation and dissimulation. This was the first 19th century German color vision theory that emphasized the existence of some physiological basis for afterimages and simultaneous contrast. It contained some fundamental differences from Helmholtz's color theory. First it assumed that visual sensations are the starting point and not just physical phenomena. Second it defined visual sensations as real and not as delusions. Finally, it explained that the visual stimulus is not connected to a passive response system, but to a very active one.

Dr. Kurt Nassau of Bell Laboratories should be congratulated for giving us a fascinating presentation on the fifteen causes of color in a record time of just less than one hour. It was a brief, but information-packed, capsulized summary of the contents of his book entitled, "The Physics and Chemistry of Color, The Fifteen Causes of Color."

He began by stating that his interest in color came from his work on crystals and gems. He then outlined three ways to use light to make color. They were emission, absorption and refraction. This naturally led him to a discussion of the electromagnetic spectrum where he emphasized that the low energy end was too weak for the human eye to see. The high energy end was too strong for us to see, but this uv end was often responsible for the fading of paintings. He emphasized how narrow the visible range was in terms of energy.

The first cause of color is dispersive refraction. He described it very simply as a single ray of light going in and many colored rays coming out. A rainbow is a prime example. He made us aware of not only the primary rainbow, but also the secondary rainbow which is separated from the primary one by a dark band. Using the full dispersion curve of a colorless crown glass as an illustration, he emphasized that blue light is bent more than red light because of its higher refractive index.

The second cause of color is vibrations and rotations in atoms. Water is a perfect example. It consists of hydrogen which is the lightest atom capable of forming the strongest bond. The absorption spectrum of water has many narrow bands in the infrared region which become weaker towards the visible region. However there is just enough absorption in the red end of the visible region to account for the pale blue color of pure water. When water looks green, that color is due to the presence of algae.

The third cause of color is gas excitations. Sodium and mercury vapor lamps operate on this principle. High voltage excites one of the atom's outermost electrons to a higher energy state orbital. When this electron jumps back down to the lower energy ground state, light is emitted. The color of the emitted light depends on the energy difference between the excited and ground states. Auroras are thought of as "nature's neon tubes" because they result from excitations of gas atoms and molecules high in the earth's atmosphere.

The fourth cause of color is incandescence which refers to light given off by an object because of its temperature. The color of the light depends on the energy level attained at each temperature. As the temperature increases so does the energy in the object emitting the light which explains why the color goes sequentially from black to red to orange to yellow to white and finally to bluish white. Black body radiators represent the ideal case of incandescence because they completely absorb light at any energy with no reflection or transmission.

The fifth and most common cause of color is transition metal compounds which have unpaired electrons in their outer shells. Dr. Nassau wittingly reminded us that unpaired electrons, like humans, prefer to be paired. Some rearrangement occurs and the result is the formation of colored ions. Examples of such transition metal compounds with unpaired electrons in a ligand field are pigments such as chrome green and gemstones such as turquoise.

The sixth cause of color is transition metal impurities which is closely related to the fifth cause. If these impurities contain unpaired electrons which have been excited to higher energy levels, they will impart color to colorless substances. An example of this is an aluminum oxide crystal white contains 1% of chromium sesquioxide and is more commonly known to us as a ruby. The three unpaired electrons of chromium in its +3 ionic state can be excited to different orbitals. It is the absorption and emission mechanisms occurring within the ligand field that are responsible for the red color and fluorescence of a ruby. Chromium can also form other colors depending upon the bonding strength and crystal field strength. An emerald is an example. Chromium present in its +3 ionic state as an impurity in beryllium aluminum silicate imparts the green color to an emerald. The overall bonding in an emerald is weaker than in a ruby because there are more oxides present besides aluminum oxide which contribute to weakening the ligand field. Another way of viewing the weaker bonding is that the oxygens wind up with lower effective electric charge on them resulting in a weaker crystal field. Thus the unpaired electrons are excited to different energy levels and the absorption band shape has changed from yellow-green in a ruby to yellow-red in an emerald. Hence the transmission characteristics are lower in the red region and higher in the blue-green region for an emerald than for the ruby. The result is its green color. An emerald, like a ruby, fluoresces red when illuminated with ultraviolet light. It is possible to heat a ruby and change its red color to green because the lattice has expanded to reduce the ligand field and weaken the bonding. Likewise it is also possible to change the color of an emerald from green to red by applying pressure to shorten the bond length and strengthen the bonding.

The seventh cause of color is organic molecules which contain unpaired electrons in molecular orbitals. The carbon-carbon double bonds in these organic molecules contain electrons which travel over the whole molecule in these molecular orbitals. Excitation of these molecules leads to energy transitions in the visible region. Organic compounds which fall into this category are dyes, pigments, and nature's flora and fauna.

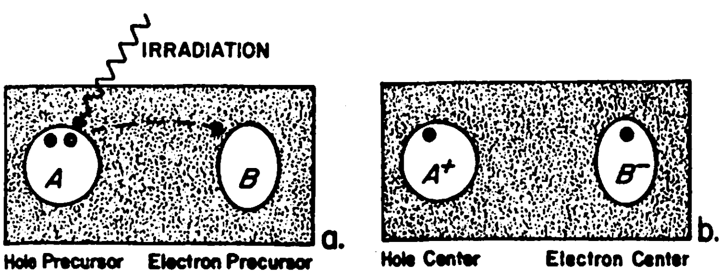
The eighth cause of color is charge transfer. Here light energy absorption produces electron motion from one transition metal ion to another one of a different valence located close by in the same molecule. The result is a temporary change in the valence state for both ions. An example is iron and titanium ions which are responsible for the deep blue color of a sapphire. A similar phenomenon produces the color of such pigments as Prussian blue, ultramarine, and chrome yellow.

The ninth cause of color involves energy bands of electrons in metals. A typical metal can contain as many as 10^{23}atoms with 10^{23} molecular orbitals comprising the energy band. All of the electrons are tightly packed in terms of energy and all are shared by the individual atoms making up the metal. The delocalized nature of the valence electrons and their ability to move freely throughout the band give metals their luster appearance and low electrical resistivity properties. More specifically, metals have high reflectivity because they reflect electromagnetic radiation as soon as it is absorbed, which in turn leads to their conduction of electricity. Different shapes of bands create different metals with different colors. Examples are gold, silver, copper, and brass. Ruby glass, resulting from grinding gold into very fine particles, is another example.

The tenth cause of color applies to semiconductors and is also explained by band theory. Here there is a gap in energy between the valence band and the conduction band. Electron excitation resulting from light absorption causes electrons to move across the gap from the valence band to the conduction band. The size of the band gap in terms of energy determines the color of the semiconductor. If the size of the band gap is large enough, no light in the visible spectrum will be absorbed. The result is a colorless substance such as a diamond. As the size of the band gap decreases, the semiconductor color goes from yellow (cadmium yellow) to orange (cadmium orange) to red (vermillion and cinnabar) and finally to black (galena).

The eleventh cause of color comes about from impurities in semiconductors. Such impurities have energy levels that lie within the band gap. These impurities can be present in as little as one atom per million, but even at such small levels, they impart color. A nitrogen impurity in the band gap of a diamond can donate electrons to the conduction band and a yellow color results. A blue colored diamond, such as the Hope diamond, results from a boron impurity. This phenomenon also provides the mechanism for the color of light emitting diodes.

The twelvth cause of color is energetic radiation which unpairs electrons and creates a color center in crystals and glasses. These color centers are either electron centers or hole centers.



Either the hole or the electron center or both are capable of producing color. Irradiating quartz containing iron in the +3 ionic state, results in an amethyst. Other examples of color centers are smoky quartz, topaz, and amethyst "desert" glass.

The thirteenth cause is interference of light beams. This results when two light beams of the same wavelength travel along parallel paths. If they interact with each other, as is possible in thin films, iridescent color fringes result. Examples are soap bubbles, oils slicks, and animal colorations, such as the eyes of cats.

The fourteenth cause of color is diffraction which is a kind of interference. It is defined as the spreading of light at the edges of an obstacle. Grimaldi was the first to coin the word after seeing thin fringes of colored light coming through the small opening of a window shutter. A diffraction grating is a regular array of slits to diffuse light. Color results from the interference of the diffracted light beams. Other examples of objects colored by diffraction are opals, the aureole around the sun, and the glory around our shadow.

The fifteenth and final cause of color is light scattering by small particles. The intensity of scattered light is stronger at the violet end of the visible spectrum than at the red end. This scattering phenomenon is responsible for the blue color of the sky, the red color of sunrise and sunset, blue eyes and pink skin.

Rolf Kuehni began his talk on the scientific aesthetic of Charles Henry by taking us back to Plato, who believed that forms provide reality. Plato considered beauty as one form which caused an aesthetic experience. He believed in the connection between science and aesthetics.

As time marched on and the 17th century was reached, science and aesthetics went their separate ways. Charles Henry strove to prevent such a separation. In 1881 he was a librarian at the Sorbonne. For the next 20 years he began to publish extensively. In 1910 he earned his PhD on the topics of sensation and energy as well as memory and habit. Although his interests were very broad, he laid a great deal of ground work in the areas of color, light, and form. His goal was to develop the mathematics of the unconscious. He also tried to establish "psychobiophysics" because he was a strong believer in the ability to trace everything to biological activity. Many considered him as a "psychobiophysicist." He established two psychophysiological principles. One, known as dynamogeny, was an increasing function with lines to the right and movement from low to high. It was associated with gaiety and pleasure. The second was inhibition, which was a decreasing function with lines to the left and movement from high to low. This was more like a nervous irritation associated with pain and sadness. In 1888, he applied these psychophysiological principles to a color circle. The circle contained white in the center, black on its circumference and the pure spectrum colors inbetween. Its chromatic circular portion went from red to violet with the complementary colors positioned opposite each other. The warm colors symbolized the gay principle of dynamogeny and the cool colors symbolized the sad principle of inhibition. He also designed an aesthetic protractor, the purpose of which was to merge line and color in a harmonic relationship. This aesthetic protractor provided a mathematical basis to illustrate harmony.

This aesthetic founded by Henry and based on sound scientific principles was a source of inspiration for contemporary artists, such as George Seurat. Again we saw one of Seurat's most famous masterpieces, Sunday Afternoon on the Grande Jatte. Rolf pointed out his highly stylized form and the way pointillism produced color stimulus mixture in our eyes as viewers. Seurat applied Henry's theory of color and harmony to his pointillistic paintings to turn dark sad colors into bright gay colors. Seurat's work, entitled The Circus, employed Henry's gay color theory to the fullest. It showed angles and movements in a dynamogenous way. It was also the first abstract representation of laughter. Signac was another contemporary pointillist who was influenced by Henry.

A sense of lament was present in Rolf's voice when he mentioned that today Charles Henry's theories are forgotten. Rolf speculated as to reasons why. One was that Henry's theories were perhaps too simple. Just as Gustav Fechner, father of psychophysics, defined a scientific link between man and nature, Charles Henry was trying to do the same for art and science. Rolf closed by naming Charles Henry as the last example of a thinker trying to bridge the gap between physics and metaphysics. This topic was particularly appropriate for this Williamsburg audience because there was an equal mix of artists and scientists who did feel a communication gap between their two disciplines. Perhaps both groups could have learned something from the forgotten Charles Henry.

Dorothea Jameson or Dottie, as Bonnie Swenholt affectionately called her, gave a very eloquent presentation on color vision theory in 1985. She was quick to point out that color vision in 1985 is no different than it was in 1385, however our theories about color vision have changed. Today there has been a stronger emphasis on conceptual formalization due to the appearance of computers.

Dottie began by showing the absorption curves for the three cone photopigments in the retina. She emphasized that these are not very different curves from the ones Helmholtz used to describe the Young theory, but their interpretation has changed. Young hypothesized that these were the characteristics of the three particles or fibers responsible for three fundamental hue sensations. Today we merely say they represent the cone receptor absorptions, and they are not hue coded.

Next she went into a discussion of color constancy or approximate color constancy as it should more accurately be called. She discussed what happens to our perception of colored objects as they are taken from natural daylight into incandescent room light. Despite chromaticity changes which suggest that yellow in daylight would be equivalent to blue in incandescent light, as our visual mechanism adapts to the incandescent illumination, the objects are perceived to have approximately the same color as when they were seen in daylight.

Next came a discussion of the Helson-Judd effect, which is a systematic departure from constancy. One of the most important points she made here was that perceived contrast increases with level of illumination. Such a statement is true for color as well as black and white. Then we saw a delightful series of Monet's cathedral paintings illustrating this perceived contrast change as the time of day (type and level of illumination) and season changed.

The complexities of the human visual system were made apparent in a magnified cross-section of the retina. A detailed discussion was not given but it was emphasized that by the time a signal gets out of the retina, there has been much crosstalk, interaction and processing. This led her on to a description of the opponent-process theory of color vision.

Dottie dealt with the topic of blackness. Its impact can be magnified by increasing the amount of light in a white surround. Artists have a similar way of dealing with blackness as Albers has shown. Seurat depicted a black silhouette of a woman by surrounding her with a white halo. The reverse also holds, namely the impression of whiteness can be enhanced by surrounding white by black. Matisse on the other hand used black as a color and not merely to shade.

Next Dottie illustrated how the butting of ordered gray steps adjacent to each other can produce light to dark modeling within each step without having to shade. A computational model was then used to show the above phenomenon, which is really a brightness contrast effect, and to predict the way it depends on viewing distance.

Albers was again used for illustrative purposes. A green lattice was shown on a yellow background, and, next to it, on a blue background. Simultaneous contrast effects were responsible for the appearance of the green changing depending on the color of the background. Computations based on the opponent-process color theory were used to predict the visual result.

Amazingly enough Dottie was the third and final speaker to recognize Seurat's accomplishments in his pointillist painting entitled Sunday Afternoon on the Grande Jatte. She pointed out that spatial mixing is not just a failure of resolution, but involves the same neural "receptive fields" that account for contrast phenomenon as well. To show that the degree of mixing or assimilation depends on the viewing distance, Dottie moved from the full painting to various close-ups where our level of assimilation changed dramatically with each close-up approaching finer detail. Examination of such a painting up close makes it look a lot more vibrant because the appearance changes as the center of the eye is focused on different parts of the painting. Farther away the grain of the painting imaged on the retina becomes small relative to the neural "receptive fields" and the painting looks flat, just as it does at a close distance in the retinal periphery. It was emphasized that computational models based on opponent-process receptive fields account for the various contrast and assimilation effects that were illustrated, whereas ratio computations, such as Land's retinex model, fail to do so.

I would like to personally thank Dottie for an outstanding presentation of color vision theory. It was enhanced by artwork and quantitative computational models to illustrate her most important points in a very clear and eloquent manner.

The similarities between Rothko's colorfield abstractions and ancient murals was remarkable because it had to have been accidental. Vincent Bruno from the University of Texas at Arlington shared the details of Rothko's artistic career with us to prove that no historical connection was responsible for the coincidence.

Going back as far as the 1930's, Rothko's work did show some classical suggestions. In the next decade Rothko painted many styles as if he were searching for his own way. As the late 1940's approached, the abstract expressionist side of Rothko dominated as evidenced by his emphasis on bright colors. At this time the similarity with ancient art began. The Acropolis had different colored marbles and many Roman paintings of the time derived their styles from such a structure. Other early paintings showed a heavy emphasis on replicating the structures found at Pompeii. The Second Style rooms of the Villa of the Mysteries at Pompeii were a perfect example. One common scene was a picture of a wall that retained a central idea. When Rothko reached his classical stage, the forms he used hardly changed in essence. Everything was broken down into zones. A lower zone appeared to act as a support. An upper zone appeared to continue farther upward. These zones suggested a golden harmony of parts. Deep yellow was also a common color in the early structures at Pompeii. Both zones were divided by black much as black marble was used in the Parthenon. Brilliant reds were often used for one of the zones which coincidentally was also a common color found on the early walls of the rooms at Pompeii. An essential element to the Rothko formula was that the walls remain an intact part of the space. Rothko's technique was to suspend large areas of colors almost as if we, as observers, could see past or even transcend them. Rothko's colors moved, meaning that they were not flat, which distinguished them from the Pompeii colors. Many ancient paintings showed a use of intense blue to represent an association with the heavens. This is not surprising since it was believed that magical powers came from the sky. Rothko used blue as a border for his rectangles. This use of blue was also powerful since it represented a boundary that we, as observers, could penetrate or even go beyond. Rothko arranged the elements of his paintings not as a frieze but as a total environment which was similar to the openings and other characteristics of classical Second Style walls. Rothko's painting suggested that even though we are real people, we could penetrate into the surreal world of the gods. When Rothko stood in the rooms of the Villa of Mystery of Pompeii, he realized how similar his colorfield abstractions were not only in terms of colors, shape, scale and proportion but also in terms of the transcendental illusion created just by being in the rooms.

Once Rothko saw the Second Style and realized how much it reminded him of his own work, he changed his color and form. He grew tired of the classical style because it was too sophisticated. He turned to a more primeval style which was much more simplistic. This made him begin to use more muted colors. His forms began to follow ancient symbols. Some of them remind us of such ancient structures as Stonehenge. These works created a feeling of disorientation or a loss of place. As time went on, Rothko used black heavily with an underlying deep bloody red. In contrast to his earlier work, black had become a decorative expressive color.

This presentation featured many visual examples of Rothko's work. Vincent Bruno nicely illustrated the expressive power of color and its ability, as depicted by Rothko and ancient artists, to evoke the consciousness of spiritual life and myth.

Roy Berns of the Rochester Institute of Technology gave us a refreshing presentation on the importance of selecting the right irradiating source for displaying artwork. His interest in the topic was aroused when he attended an exhibit in California of French impressionist landscapes. He was immediately struck by the fact that all the walls were painted in high chroma colors. The reason why was not obvious to him so he began investigating the general topic of displaying artwork.

First Roy clarified his use of the term irradiating rather than illuminating light source. The irradiating source is the correct term because more than just the visible portion of the electromagnetic spectrum must be taken into consideration. The proper selection of an irradiating source must center around three major concerns. The first is the geometrical distribution of the irradiating source. Roy showed two excellent examples of how a collimated source and a diffuse source can lead to dramatically different appearances for the object they are irradiating. One example was a classic from Ralph Evans' collection and another was a simple but very illustrative stack of paper toweling. The second concern is the spectral irradiance distribution of the object being irradiated. It is important to remember that the color of the object depends on the source irradiating it. Fortunately, our ability to chromatically adapt minimizes these effects. As an example he shows a series of slides depicting a lovely country scene of a gray barn. Each successive slide was changed slightly in color balance but, because of chromatic adaptation and color constancy, our impression of the barn color was always gray. At the end he simultaneously projected the first and last slides showing that the series had gradually shifted to a barn of a very cyan balance. The third concern is the level of irradiation or illuminance. Typical levels can cover a range as broad as from 50 to 100,000 lux. The light source position can also have a significant impact on an object's appearance. An example of the same object irradiated by a light source in the front of it and also by one in the back of it showed that the lightness of the object changed significantly with position of the light source while the brightness remained the same. The object, when shown alone, appeared white. However when a white object with greater luminous reflectance was added to the scene the original object looked gray. This illustration was to emphasize that the perceived appearance of an object depends on its relationship to whatever else is in the scene.

The two factors of equal importance to a conservator in choosing a source to display artwork are the source's illuminance and its spectral irradiance distribution. Due to reciprocity law failure, image degradation does depend on these two factors. Thus a conservator would like to find a source which emits a minimum amount of ultraviolet radiation and one where the illuminance can be readily adjusted. For these reasons, the most commonly chosen sources are incandescent flood lights.

Conservators would also benefit from being concerned about the color-rendering properties of the irradiating source. More specifically, they may also want to consider how the selected source will change the appearance of the artwork relative to the original source used by the artist.

It is often times difficult to find irradiating sources that are free of all these concerns. Computer colorant formulation techniques and chromatic adaptation theory have been used to quantify the appearance change for artist materials caused by variations in typical irradiating conditions. The appearance changes were quantified in Munsell color space. Excellent visual demonstrations were shown to illustrate the impact of these appearance changes.

This work should provide beneficial assistance to three groups of art-oriented people. First it should aid conservators and exhibitors in the selection of the proper irradiating source for a particular piece of artwork. Second it should make art historians cautious in drawing conclusions about artwork based solely on their observations of that artwork in a museum environment. Finally this work should aid the artist in choosing materials more carefully so that the appearance they intend to convey to the observer will indeed hold when the work is displayed in an environment different from where it was originally created. This means that the artist should try to avoid use of colorants that seem most sensitive to changes in illumination. Roy suggested that wherever possible, the artist should try to produce the artwork under the illuminant that is intended for final viewing. One might say that it is virtually impossible to predict what the irradiating light source might be. However some generalizations about light source usage are known. There may soon be three fluorescent sources promulgated internationally as standard illuminants and most industrial and commercial environments have resorted to use of metal halide lamps.

Finally Roy cautioned us that he is not trying to reduce the topic of irradiating artwork to a set of numbers. He is merely trying to illustrate general trends. Care should be taken in deciding when the numbers indicate that one colorant should be used over another.

Before the discussion began, Heinwig Lang demonstrated the colored shadow experiment that he referred to in his talk. He had two light sources. One was simulated daylight and the other was a colored light. When the light sources were combined, a colored shadow resulted.

Rumford's tube was coated with black velvet and when he looked at the shadow through the tube, he saw no color in the shadow. We did not have a black tube, but we did have a black piece of paper with a hole in the center. We tried to verify what Rumford saw.

When Fechner used Rumford's tube to look at a colored shadow as the surround was changed, he saw no color change in the shadow. When Helmholtz tried a similar experiment, he looked at the border between the light and the shadow. Then the color of the surround remained as he looked at the shadow through the black tube. He concluded that what he saw must have been an unconscious response. Hering felt that seeing color in shadows must be due to successive contrast effects that the eye picks up as it moves around the visual field. Thus Hering disagreed with Helmholtz's theory of unconscious interference as the cause of colored shadows.

Heinwig Lang closed by emphasizing that the 19th century theories tried to convince scientists that a physiological explanation for color phenomenon was needed. This became evident in the evolutionary history that led to the understanding of what created color in shadows.

Mark Gottsegen, one of the general chairmen of the conference, acted as the moderator of the discussion period. He stimulated the group by commenting on the divergence of art and science that began at the end of the 19th century and is still with us today. He wanted participants to speculate as to why. The first cause that came to mind was that our academic world is structured in such a way that art and science are taught as separate entities from grammar school on up to higher education levels. Robert Gerhardt commented that it may be logical to teach them separately because there is no scientific method in art. Nancy Jo Howard strongly disagreed. She felt that when an artist composes a work, he is applying some type of scientific method.

Dottie Jameson voiced her opinion by saying that the value of a work of art is always there. The value of a scientific work is there only until a new theory comes along to replace it. In 1984, a Rembrandt is just as important as it was many years earlier. In 1984, if you are seeking some scientific information, you want to make sure you have the most recent state-of-the-art work upon which to call.

Dr. Nassau bridged the gap by saying that art is science and science is art. Whether it is painting, sculpture, music or literature, it will communicate something to some observer, just as a scientific theory will communicate something to the person who studies it.

Rolf Kuehni felt that to blame education for the split between art and science is to put the cart before the horse. Science involves induction, logic and reason, whereas art involves emotion. This difference is the basic problem.

Next we heard from Gracia Melanson of the Rhode Island School of Design. She felt that the educational system wipes out the visual semantics that infants have instinctively from birth. The only solution she sees is to try to bridge the gap by educating scientific students to refamiliarize them with the visual semantics that came so naturally to them in their earlier years.

Anna Campbell Bliss discussed the existence of degrees of visual literacy. Scientists can't hope to understand art as well as artists and vice versa. Therefore communication between artists and scientists is difficult because their vocabulary is different.

At this point Mark polled the audience to see what the split was in terms of the numbers of artists and scientists. The split was about even with slightly more scientists (55%) than artists (45%).

Heinwig Lang was the next to voice his opinion. As his and other speakers' talks emphasized, it was difficult for science to develop the aesthetic and emotional aspects of color. One reason is that science must go beyond the sensual experience. Art often times stops at the sensual experience.

Again Rolf Kuehni spoke to define the purpose of science as to answer how the world works. He asked, what is the purpose of art?

Anna Campbell Bliss found it difficult to answer Rolf's question because today art is so fragmented. Years ago it would have been an easier question to answer because art was not found in so many different forms. She feels that art is not purely a sensory experience as Heinwig Lang alluded. Art can be very intellectual.

Dottie wondered whether we were really talking more about specialization than what leads to the split between art and science. Today our degree of specialization is so great that communication between a specialized scientist, such as a biochemist, and an artist is difficult because their terminology is likely to be very different.

Mark expanded upon Dottie's statement by commenting that there is probably less of a communication problem between a sculptor and a painter, because they are each artists in their own way, than between a chemist and a painter.

Bev Damko spoke of an artist's ability to take an aesthetic idea and put it into some medium that we all can understand. Nature has also accomplished the same goal.

Dottie responded again on behalf of the scientist. She said that a piece of scientific work, if done well, can also give an aesthetic experience.

Jim King proposed a definition to distinguish art from science. Art is subjective and science is objective.

Faber Birren made a similar attempt. Art is universal. Science is transitory. Most people were happy with this distinction. After having spent so much time on this discussion and having come to one point that we agreed upon, new topics were entertained.

Charles Parkhurst, as an art historian, asked a linguistic question of the scientists in the audience. He wanted to know why it took so long for the hue name blue to evolve. For the longest time, black, white, and red were the only hues mentioned. Many historical literature pieces mentioned "the dark wine sea." They must have seen water as blue yet they did not name it as such. Why?

Dottie reassured him that ancient people should have seen color as we do today because they must have had the same visual discrimination capabilities as we do.

Rolf Kuehni mentioned that black and white arose from drak and light or night and day. Red was the next hue name to evolve because it was the color of blood.

Again the discussion slipped back to the art-science issue. Someone mentioned that industrial design bridges the gap between art and science because it contains concepts from both disciplines. Industrial design has an objective goal but the means for accomplishing that end involve retaining some aesthetic beauty.

Anna Campbell Bliss felt that the audience had raised too narrow a view of artists by restricting them to such groups as painters and sculptors. Artists are into all kinds of technologies such as lasers, computers, and photocopies.

Nancy Jo Howard then put forward a challenge to the group. She proposed that at some future meeting the artists and scientists of the ISCC should put together a cooperative effort to demonstrate how their work can bridge the gap between art and science. Jim King mentioned the Color Marketing Group has done this very successfully in the past at an event called the creative fest.

The discussion ended after a two hour period of stimulating conversation among all participants.

In closing I would like to applaud Rolf Kuehni and Mark Gottsegen for putting together a superb Williamsburg conference. It was extremely valuable to broaden our knowledge with this historical perspective on the evolution of color theory from early B.C. times to the present. The speakers were a well chosen mix of artists, historians and scientists, each with a uniquely interesting and most often colorful presentation.

Paula Alessi

DECORATORS PREDICT TREND TO MUSHROOM, BEIGE COLORS FOR HOMES

Reprinted from The Sun, Sunday, January 27, 1985

Mushrooms may loom in your life in 1985, and not only in your salad.

Mushroom is going to be one of the trendy colors in home furnishings and building products this year, according to Color Marketing Group. The nationwide association of architects; designers, manufacturers and retailers meets twice a year to determine color trends.

Jacqueline Cabana, president of J&R Design Associates in Oldsmar, Fla., is a member of the group.

Mushroom, she explained, is "a mid-gray [color] with a suede look on the mocha side."

But the color won't have the obvious name of the fungi it resembles. Instead, a little color subterfuge is planned. The color has been designated "Kennett Square, Pa.," which bills itself as the mushroom capital of the world.

Overall, colors this year will be sophisticated, Ms. Cabana says.

Smoky pastels, a winter green, terra cotta, khaki, and clean and creamy beiges top the list compiled by the color forecasters.

Beiges will lean toward dark and dusty tints; dusty peach and mauve will become more important; interior grays will be on the platinum side; browns are becoming warmer and lighter; bottle green and other greens are getting stronger, as are the blue-greens.

So, who cares?

Color choices have an important influence on consumers. If colors weren't developed and coordinated in advance, "there would be chaos in the marketplace," said Miami interior designer Jacquelyn Yde.

Coordinating colors between linen manufacturers and producers of china means your dining table looks pretty. Because carpet manufacturers and makers of automotive paints cooperate, your new car sports the perfect shade of carpet and upholstery to complement the exterior.

In short, there is nothing accidental about the colors we live with at home, in the office or even on the road.

"Color affects us every second of our lives," said Ms. Yde, a partner in the firm of Swedro Yde Design Associates. "It affects us emotionally and psychologically. We perceive color immediately and it affects the way we live and work."

Ms. Yde predicts a trend toward "more softness in our interiors. Because of our high-tech society, we have a need for nostalgia. Woods, soft colors and jewel tones will be more important in this decade."

Ms. Yde, who is a member of the American Society of Interior Designers and the Institute of Business Designers, also sees employers becoming more aware of the importance of light and color in the working place. "Businesses will increase profits, there is less absenteeism, and people produce better when their surroundings are comfortable and the colors pleasing."

Even the color of a desk top is important. Bright colors and shiny whites that reflect light can cause fatigue. "A desk top should be neutral; there's nothing wrong with beige," Ms. Yde said.

Color affects every aspect of life, Ms. Yde told colleagues during a recent lecture before the national ASID meeting in Chicago.

"In the planning and design of food-service facilities, it has been found that bright and warm colors stimulate the nervous system while cool colors have a tendency to retard it. Reddish orange and orange seem to arouse the most agreeable sensations. Yellowish green and purple are not well received where food is served. Bluish greens are well liked and are an ideal background for the display of food. White suggests cleanliness," Ms. Yde said.

Store merchandisers "have found that effective color and light will sell in profitable volume, while the wrong color and light will cause costly inventories to lie dormant and unsold," the designer said. "Good color invites traffic into the store ... In working with store environments, do not overlook customer appearance, particularly where personal products are sold, such as fashion and cosmetics. Good fluorescent lighting, which always creates a flat, shadowless look, is flattering. Customers will not buy if they do not feel góod about the way they look."

In health-care facilities, color is a vital element in promoting feelings of well-being and to help patients get well, Ms. Yde said.

"Soft warm colors should normally be used, with the exception of chronic patients who should be reconciled to a longer stay. Cool tones, warm blues and greens then become appropriate. In surgery, walls and dressing gowns are green or bluish green to reduce glare and to ... neutralize the red hue of blood and tissue ..."

Ms. Yde says only recently have we been able to produce and use color freely. "Before the Nineteenth Century, a very limited number of dyes and pigments were available and these were of organic origin. Certain colors such as purple were available only to royalty and the very wealthy. [The color came from a sea creature and vast numbers were required to dye a king's robe purple.]

"Between 1910-1915, we became aware of the potential of new synthetic dyestuffs. We are now able to produce literally unlimited gradations of colors ..."

If there seems to be a small range of colors available in a manufacturer's product, she says, "the reason is probably economic. Color is costly ... and color cycles last just two to three years."

So, if mushroom doesn't appeal to you as a color, stick around. Color forecasters will find new ones for you every year.

CAR'S COLOR CONTRIBUTES TO VEHICLE VISIBILITY ON THE ROAD

"You can have any color you want as long as it is black," is a quotation attributed to the first Henry Ford regarding the color selection a customer had when buying a new automobile. Fortunately, attitudes changed and the auto manufacturers now make a rainbow of colors available for you to choose from.

Because of their color, certain vehicles are usually recognized more easily by other drivers and pedestrians. The most noticeable colors, listed in order of visibility, are shown below:

1. Luminous orange
2. White
3. Light yellow
4. Light orange
5. Dark yellow
6. Light grey
7. Light blue
8. Light red
9. Light brown
10. Light green
11. Dark grey
12. Dark red
13. Dark blue
14. Dark brown
15. Black
16. Dark green

In recent years, much attention has been focused on underride accidents. In an underride accident, a truck or passenger car drives under another truck or trailer on the highway. A study by the University of Michigan's Highway Safety Research Institute found that most fatal car-truck crashes occur at night. Inclement weather is a minor contributor to these accidents, but low visibility at night is a major factor. The collisions studied were almost always surprise events in that the passenger car driver did not expect to find a truck or trailer in his or her path, and had little time to react.

Although the majority of the underride accidents involved the rear of the vehicle, a significant number involved the side of the vehicle. While experts believe that many of these accidents would have been less severe if the vehicle had had better rear underride guards, they do not believe that side impact results would have been greatly changed.

Increased vehicle visibility appears to be an important measure in helping to prevent both types of accidents. If used, light colors would reflect more light and contrasting colors and graphics, used on both sides and the rear of the vehicle, would make it much more visible. Reflective material would also increase visibility and the safety advantages would really begin to add up with relatively little cost and no weight penalty.

From
"Accident Prevention News, 35, #1
Jan.-Feb., 1985 Western Pa. Safety Council

CALENDAR

AIC
International Congress Colour 85, June 16-22, 1985, Monte Carlo

AIC
Interim Meeting, June 19-20, 1986, Ryerson Polytechnic Institute, June 19-20, 1986

AMERICAN SOCIETY OF INTERIOR DESIGNERS
National Conference, July 24-28, 1985, Dallas, TX

CANADIAN SOCIETY FOR COLOR
Annual Conference, May 23-24, 1985, Niagara-on-the-Lake, Ontario

DRY COLOR MANUFACTURERS' ASSOCIATION
Annual Meeting, June 16-19, 1985, Greenbrier

FEDERATION OF SOCIETIES FOR COATINGS TECHNOLOGY
Annual Meering, October 7-9, 1985, St. Louis, MO

ISCC-CSC 1986 ANNUAL MEETING
June 16-18, 1986, Ryerson Polytechnic Institute, Toronto

ILLUMINATING ENGINEERING SOCIETY OF NORTH AMERICA
Annual Conference, July 21-25, 1985, Detroit, MI

OPTICAL SOCIETY OF AMERICA
Annual Meeting, October 14-18, 1985, Washington, DC

SOCIETY OF PHOTOGRAPHIC SCIENTISTS AND ENGINEERS
Second International Congress on Advances in Non-Impact Printing Technologies, November 4-8, 1985, Arlington, VA

PANTONE, INC. COLORS NEWSLETTER

A very generous donation of paper and color printing from Pantone, Inc. has restored the color spectrum to the front page of the NewsLetter. The ISCC Board of Directors wishes to express its thanks to Pantone, Inc. for this tangible expression of support and help.

1. Any person interested in color and desirous of participating in the activities of the Council for the furtherance of its aims and pusposes . . . . shall be eligible for individual membership (By-Laws, Article I, Section 2). Application forms for individual membership may be obtained from the Secretary (address given above).

2. The Council promotes color education by its association with the Cooper-Hewitt Museum. It recommends that intended gifts of historical significance, past or present, related to the artistic or scientific usage of color be brought to the attention of Cooper-Hewitt Museum, 9 East 90th Street, New York 10028.

Deadlines for submitting items to be included in the Newsletter are: February 15, April 15, June 15, August 15, October 15, and December 15; in other words, the fifteenth of the even-numbered months.

Send newsletter items to:
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