INTER-SOCIETY COLOR COUNCIL
NEWS LETTER

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News Letter Committee:

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Deane B. Judd Dorothy Nickerson
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CANDIDATES FOR 1958-1959 OFFICERS AND DIRECTORS

In a letter dated July 11, 1957, Waldron Faulkner, chairman of the Nomination Committee sent a slate of candidates for officers and directors for the term 1958-1959. Other members of the nominating committee are Miss Dorothy Nickerson and Dr. Deane B. Judd. All of these candidates have agreed to run for office. Other names may be presented in accordance with the by-laws of the Inter-Society Color Council.

President	Walter C. Granville, IDI, IES, PI
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*According to the by-laws, Article 6, Section 1, the retiring president (in this instance, Waldron Faulkner) automatically becomes a member of the board for a period of two years.

NEW MEMBERS The following applications for individual membership were accepted at the last Board of Directors' meeting held in Washington, D. C. on June 24 and 25, 1957.

Associate Individual Members	Particular Interests:
Mr. Sven Alfort Box 3112 Stockholm 3, Sweden	Methods for measuring the shades of pigments used in the paint industry and ready-made paints manufactured by the paint industry. These methods must be easy and speedy to use as well as accurate.
Mr. Calvin S. Hathaway The Cooper Union Museum Cooper Square New York 3, New York	Color determination and color designation as involved in the study and description of objects in museum collections, creation of explanatory museum displays illustrating color theory and its applications in the arts of design and decoration.
Mr. S. J. Huey The Sherwin-Williams Company 601 Canal Road Cleveland 13, Ohio	The use of color systems and color measuring instruments as an aid in paint formulation and production control.
Miss Kaye A. Leighton Large Lamp Division General Electric Company Nela Park Cleveland 12, Ohio	The response of various color mixtures and mediums to quantity, quality and color temperature of artificial light sources. (i.e. Incandescent-Fluorescent (all electric discharge sources) and color tinted sources of all types.)
Mr. Alexander F. Styne 80 St. Paul's Road North Hempstead, New York	Color trend, forecast, consumer acceptance. Color as a design element in interior and architectural design.
Mrs. Ouida M. Wessman Scott Paper Company Chester, Pennsylvania	Stability of dyes in pulp-beater-dying operation - ratio of change during storage periods. Receptivity of dyes in pulp for tissue-type paper. Data on color trends for mass market appeal.

Affiliate Individual Members	Particular Interests:
Mr. Kenneth A. Ervin Division of Art Education State University Teachers College New Paltz, New York	Instruction of prospective teachers of art in elementary and secondary schools; instruction of prospective industrial designers. Use of color in exhibition preparation, information and communication.

Affiliate Individual Members	Particular Interests:
Mr. Arthur D. Sylvester c/o L. E. Carpenter and Company Wharton, New Jersey	I am interested in every one of the five listed in (1) above but at just this time I happen to be concerned with certain stability matters. In general, however, I would say that the psychological and psychophysical discussions touch my work.
Mr. Walter F. Zysk, Color Consultant Binney and Smith, Inc. Post Office Box 431 Easton, Pennsylvania	Development of more permanent and brilliant pigment collors for art supplies.
Dr. Linda van Norden 312 E Street Davis, California	Anything to do with black and blackness - also with dark as distinct from black.

PHYSICAL SOCIETY COLOR GROUP MEETINGS

At the Ninety-ninth Science Meeting Mr. J. W. Perry (Group Chairman) was in the chair. Over 70 members were present. The group loudly acclaimed Dr. Stiles' election to the Fellowship of the Royal Society.

Then Mr. R. G. Horner presented the retiring Chairman's address entitled: "Colour Systems and C.I.E. Transformations." Emphasising the difference and connection between subjective and objective variables, Mr. Horner said that any three independent variables sufficed to match a given color. This made it possible to classify colors in terms of a solid, as exemplified by the Munsell and Ostwald systems. The latter was of little use for representing color discrimination. Surface colors could, but spectrum colors could not, be represented in three-dimensional space. Color systems could be based on appearance, on mixture, or on colorants: each group had a function to fulfill. Various other contemporary color atlases were produced and described. Mr. Horner concluded with a discussion of the Hesselgren and DIN systems, followed by a description, and incidentally, a round condemnation of elaborate formal transformation, which met with the murmuring approval of the audience. He thought that a transformation such as that of Evans (Adams? Ed.), which could be used equally in physical colorimetry, and as a basis for a color solid, would have much to recommend it.

Mr. Perry was again in the Chair for the 100th Science Meeting, Wednesday, May 1st. The Chairman said that, as this was the 100th Science Meeting, a review of the past and pre-view of the future were indicated. He described how the early meetings had centred round color measurement. Taking the period as a whole, papers on color vision and industrial color problems bulked most largely, but we had ranged from wave-mechanics to the colorimetry of kippers, and variety in the menu had come to stay. Professor Wright, afraid lest he be caught wallowing in sentiment, described how the blitz had delayed the inaugural meeting. But the baptism of fire (the color temperature of which Professor Wright omitted to mention) had led the Group from strength to strength. He modestly added that no single individual had "run" the Group, the friendly atmosphere ensuring that it did not have to be "run." Future historians were advised to study Dr. Walsh's accounts of the Group's activities in "Light and Lighting."

After the conclusion of the celebration, Mr. M. Gadsden (Imperial College) described experiments involving "Colorimetry and Colour Photography as applied to Natural Phenomena." A portable colorimeter had been used very successfully in the study of the twilight sky, leading to a distinction between Rayleigh and ozone blue respectively. Colored transparencies illustrated the value of colorimetry in the study of aurorae, and its superiority to spectrophotography (particularly when the lens cover is left on the camera).

Mr. F. J. J. Clarke (Imperial College) described studies of the "Properties of Extra-foveal Vision." Peripherally imaged objects faded in the near periphery, parafovea and fovea after a latent period, when the eye was dark-adapted for 15 seconds. The latent period decreased with retinal eccentricity. The fading was ascribed to an adaptational component intermediate in its rate of change to the a (alpha) and B (Beta) mechanisms respectively.

Mr. K. J. McCree (Imperial College), discussing the "Effects of Steady Fixation on Colour Matching" showed that wavelength discrimination curves, characteristic of small-field tritanopia were obtained under a variety of conditions if rigid fixation was maintained. He emphasised the danger of fixation to colorimetry, and revealed the difference between small-field and fixation tritanopia respectively.

The discussions of the papers were vivid. A correlation was established between the excellence of Professor Wright's performance at the N.P.L. and his abject failure at Imperial College. A remark of Mr. Holmes' about knots in the strings of the Wright monochromator was appreciated by nearly everybody.

About thirty persons were invited to visit the Research Laboratories of the General Electric Company Ltd., Wembley, on June 19th. The party arrived at 2:15 p.m., visited the Laboratories for two and one-half hours and had tea in the Senior Luncheon Room.

A notice sent out by the Physical Society draws attention to a Symposium on Visual Problems of Colour, which will be held at the National Physical Laboratory, Teddington, Middlesex, on 23rd, 24th and 25th September, 1957. The aspects of the subject to be covered include Visual Pigments, Brightness and Colour Matching, Normal and Defective Colour Vision, Subjective Colour Measurement, Electrophysiological Aspects of Vision and Colour Theories. About 35 papers will be presented.

The Colour Group and the Optical Group also announced the Eighteenth Thomas Young Oration delivered May 15th in the Lecture Theatre of the Science Museum. Mr. J. Guild spoke on "Observations on the Behaviour of Diffraction Gratings."

THE COLOR ASSOCIATION

From Estelle Tennis comes an announcement of the 1957 Fall and Winter Hosiery Colors. They are: Beige Glaze, Blushgleam, Clovetone, Sungem, French Cafe, Paris Taupe, Rose Magic. Carried over from previous hosiery cards are: Solar Glow, Frosted Caramel, Blush Dawn, and Burnished Sun.

INDUSTRIAL DESIGNER'S INSTITUTE 7TH ANNUAL IDI DESIGN AWARDS

Three design teams were recipients of the 7th Annual IDI Design Awards. These awards of equal merit, in the form of a medal, constitute a token of unbiased recognition given by professional designers to their fellow designers for outstanding creative work for industry. Presentation of the awards was made by Walter C. Granville, Chairman of the Committee, at a luncheon in the Ambassador East on June 20th.

The three design teams honored this year were:

ARTHUR N. BECVAR, ASID and ROBERT W. BLEE, for their design of the General Electric Kitchen Center, a coordinated assembly of kitchen appliances, prewired and pre-plumbed for minimum installation time.

VIRGIL M. EXNER, IDI, HENRY T. KING, H. T. BANNISTER, C. C. VOSS, CARL REYNOLDS, IDI, and ROBERT BINGMAN, for their establishment of a continuity of design which reflects with distinction the spirit of the 1957 Chrysler Corporation cars, while maintaining a separate design identity for each of the individual car divisions.

CARL W. SUNDBERG, IDI, MONTGOMERY FERAR, IDI, R. W. FIGGINS, U. J. PEPIN, IDI, H. F. WEBER, and ELIOT NOYES, ASID, for the design of the IBM Ramac and for imparting an architectural quality which will integrate well with contemporary office design.

Departing from the tradition of formal speech-making, the leaders of the three design teams, Arthur N. Becvar, Virgil M. Exner, and Carl W. Sundberg each outlined his design philosophy at the luncheon.

The Jury of Awards, all officers of the Industrial Designers' Institute, was headed by Walter C. Granville, Chairman. The Jury consisted of George Beck, National President of IDI and head of the design staff of the General Electric Ithaca Plant; Carl Bjorncrantz, Sears Roebuck & Co.; Franklin Q. Hershey, Kaiser Aluminum and Chemical Sales, Inc.; Paul R. MacAlister; James Shipley of the University of Illinois and Gerald Thurston of New York.

ROLAND E. DERBY'S LECTURE TO THE PHILADELPHIA-WILMINGTON COLOR GROUP

Many of the problems in color are peculiar to the industry in which they occur. Occasionally however, a problem is presented which has application in many fields. Mr. Roland E. Derby, Jr. presented such a topic to the Philadelphia-Wilmington Color Group last February. I am sure the solutions for the textile industry cited by Mr. Derby can be used to solve similar problems which arise in the graphic arts, appliance, building, and food industries as well as many others. With his permission, I have undertaken the job of summarizing this significant paper. According to Mr. Derby, it is to be published in its entirety in an English journal fairly soon.

WLR

PROBLEMS IN COLORIMETRY FOR COLOR CONTROL

For many products it is sufficient to specify physical and chemical properties such as weight, size, ductility, etc. Disagreements concerning whether or not the product meets the specification can be resolved by referring to easily understood and widely accepted international standards. Disagreements involving color are not so simply resolved. The difficulty is due to the fact that color is appearance. Surrounding color, adaptation, fatigue and plain "wishful thinking" have a strong influence on appearance.

The C.I.E. system is one of the various systems available for the measurement and specification of color. In view of the numerous problems confronting the scientist attempting to measure color, the success of the C.I.E. system has been remarkable. In some cases it is sufficient to specify color coordinates, x and y, and lightness, Y.

Sometimes, however, the eye's lack of analytical ability leads to metamerism; i.e., matches which exhibit instability when the light source is varied. It should be pointed out that the C.I.E. observer and illuminant C result in a case of "seeing towards artificial (tungsten) light." In any case of metamerism the C.I.E. results will indicate a match if it is closer in tungsten light than in daylight. If one realizes this situation, practically all discrepancies between visual and instrumental results can be resolved. Since metameric matches are a source of difficulty, it is advisable to avoid them if possible.

The problem of color measurement and specification is further complicated by the fact that the eye is a marvelous instrument; it has good sensitivity over a phenomenal range; and it is capable of making rapid and sensitive comparisons of two colored samples in a matter of seconds. The use of the eye in any industrial color problem is not to be ridiculed and may actually be the best solution. Instrumental methods aid the eye by relieving it of routine tasks and ones which it cannot readily perform, namely the quantitative variation within a group of samples. Instruments relieve the eye of tedious accept-reject decisions wherein fatigue may play a decisive role, and since they are unintelligent, they do not try to use their "knowledge" to influence results. At present there are no instrumental methods which can be used on cloth having a pattern or which can examine several thousand samples a day.

For visual color control it is not possible to utilize a written specification. It is always necessary to have a sample representing the standard, and all comparisons must be made in pairs. Moreover, instrumental methods are useful in plotting information graphically, in using statistical methods to evaluate variation from lot to lot, in utilizing statistical "decision" functions in quality control problems, and in adjusting batch color so that the product will meet specifications.

TEXTILE COLOR CONTROL

The quantity of textile material (10 billion linear yards of cotton last year), the variations of the dyeing process, the competitive atmosphere, and the sensitivity of the eye make it necessary to employ color control in most textile processes.

Simply stated, the problem is as follows:

1. A customer desires a certain shade.
2. This is formulated with dyestuffs appropriate to the end use of the material.
3. A satisfactory match is agreed upon by the customer.
4. Production commences and slight (!) variations about this standard arise due to random fluctuations in the dyeing processes.
5. The resulting pieces are submitted to the customer, who accepts or rejects all or part of them.
6. The rejected pieces are returned to the supplier, who attempts to correct these deficiencies by one means or another. If this cannot be done, they are sold as "seconds" or dyed black.
7. In the latter stages of this process differences of opinion may well arise concerning the nature of acceptability.

While in principle this is a straight-forward procedure, it is complicated by the difficulty of establishing tolerances which are a basis for acceptance or rejection of material. Since color is three dimensional, all possible combinations and interactions may have to be considered. For example, when a sample is too red, how thin can it be? Can it be equally thin when it is too blue? In practice it is common to have thin-dark, blue-yellow and red-green tolerances.

MacAdam and his co-workers at Eastman Kodak have established the statistical theory of random matches. They carried out thousands of experiments to determine the geometry of the color space concerned. Hemmendinger, Davidson, Hanlon, O'Neil, Derby, Gould and Flister have demonstrated that the results, although determined using colored lights in a binocular colorimeter, apply in a general way to surface colors of the type commonly found in textiles.

In the C.I.E. system it is possible to use tristimulus values (X, Y, Z) in a color difference equation to determine if the sample is acceptable. Although the problem of developing a color difference formula for all cases has occupied the attention of some of the world's best color scientists for many years, no such formula exists today. Davidson, however, showed some time ago that for very small differences most color difference formulas gave good results. A survey of various formulas has been given by Nickerson. For textile problems involving a large number of samples our experience indicates that graphical evaluation of the relative importance of color differences by means of MacAdam's data is most suitable.

It has been demonstrated that color difference due to fading can be represented by a scale of grays. The Society of Dyers and Colourists "grey scale" and other similar ones have been developed for fastness evaluation. I have made judgments using this scale and feel that it is adequate. If such a scale is effective then a good color difference formula should be possible.

The color difference formula used for this work was the well-known Adams-Nickerson formula. It was chosen because of its ease of application and demonstrated reliability for the small differences involved. At our laboratory several nomograms have been constructed to aid in solving this equation. Recently we have constructed one which permits direct transition from X, Y, Z to E, without recourse to any mathematical operations or tables.

To put the system into effect it is necessary to obtain tristimulus coordinates (x and y) and lightness (Y) of the standard agreed upon by the supplier and customer. The data should be obtained using a spectrophotometer calibrated according to procedures recommended by the Bureau of Standards. Several measurements (at least two!) should be made on the standard in order to specify the precision of measurement. If sufficient material is available it is cut in half to obtain a working standard and a master standard. From this data, a chart (Figure 1) is prepared. The ordinate and the abscissa represent Δx and Δy respectively. The standard is represented by the origin.

Points P1, P2, and P3 represent production samples. ΔY (difference in lightness) is shown in the parentheses. The construction of the ellipse is based on MacAdam's data. The distance from the origin to the perimeter represents a visually equal chromaticity distance. The actual size of the ellipse representing tolerance is usually determined empirically, but if data are lacking, multiplication of MacAdam's axis by 2.5 at a lightness equivalent to Munsell Value 3-4 will often be found adequate. At lower and higher values, larger and smaller ellipses will be required. The factor for multiplication may be determined roughly by reference to Munsell renotation charts or to Davidson and Hanlon cited in the bibliography.

Any sample outside the ellipse is unacceptable. Samples inside the ellipse are unacceptable if it exceeds the light or dark limits. Figure 2 shows the lightness acceptability contour. Tolerances on the dark side should be less than those on the light side due to the logarithmic nature of visual sensitivity. For very small differences this may be ignored. The lightness tolerance (ΔY) for zero chromaticity difference is approximately 0.04Y for each unit of MacAdam's ellipse. (i.e., 0.1Y for a 2.5x ellipse) In addition to representing tolerance or specification limits, the C.I.E. diagram can be used in solving the problem of dyeing stock to a standard shade. Figure 4 shows the steps required to adjust the color of the batch so that it met the specifications. By judicious manipulation of process steps (finishing) and the initial point, it is possible to adjust the "average change" vector so that it terminates in the vicinity of the standard. The vector must be determined experimentally.

In the case of stock dyeing one may have as many as 25 or 30 batches to work with. It is possible to correct various batches towards the desired point by making the next dyeing "off" by an equal amount in the opposite direction.

FIG. 3 PRINCIPLE OF AVERAGE CHANGE

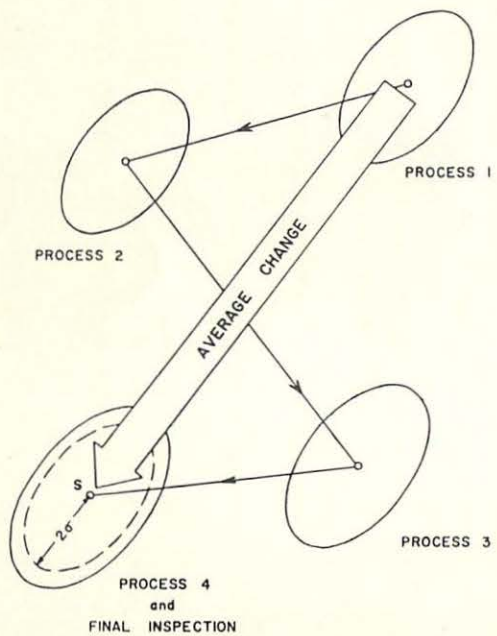


FIG. 2 CONTOUR MAP OF LIGHTNESS ACCEPTABILITY AS A FUNCTION OF CHROMATICITY

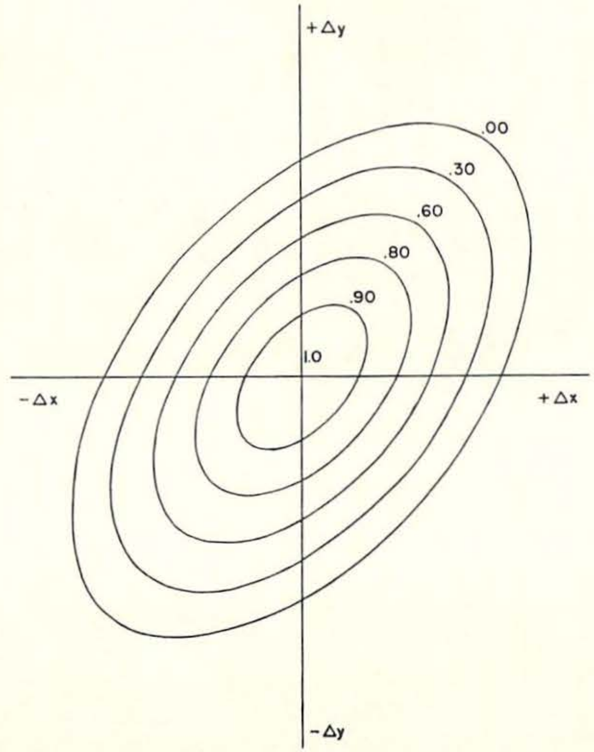
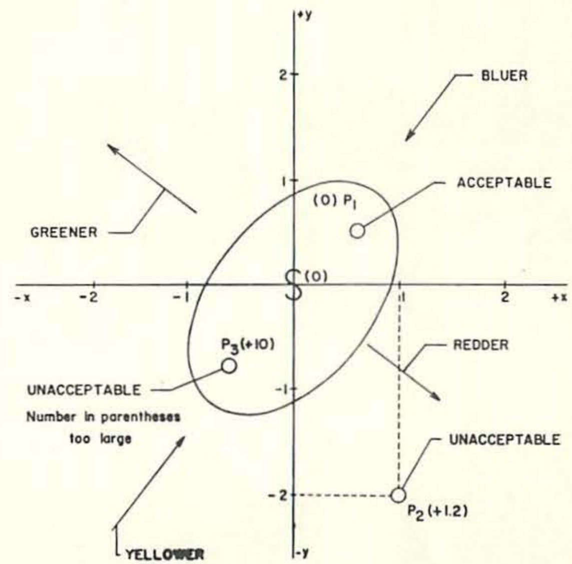


FIG. 1 METHOD OF PLOTTING COLOR COORDINATES AND DETERMINING COLOR TOLERANCE



NUMBER IN PARENTHESES REFERS TO LIGHTNESS:

(+) LIGHTER, (-) DARKER.

When variations in process control result in excessive color gradient being established in a textile material, it is called "shady." Local color gradient is referred to as "cloudy." Shadiness is evaluated under conditions which are ideal for visual evaluation. The eye is adapted to the color of the cloth, and the sample is large. This is an important application of instrumental evaluation since rejection is of considerable economic consequence. In general any sample having less than 0.5 color difference units variation between areas is not called "shady", while any having a difference greater than 1.0 units is always called "shady." The area in between exhibits varying degrees of statistical incidence but are not in general rejected. These tolerances and methods are discussed in reference 7.

One of the big advantages in obtaining numerical color data is that it can be treated statistically. The ellipses in Figure 3 represent the random process variation. By comparing these ellipses with the color tolerance ellipses it is possible to predict the approximate percent of acceptability. By observing trends it is often possible to correct mistakes before control is actually lost and rejects occur.

Since the time requirement of two days does not seem detrimental to operations and since future results can be predicted from early production, it is possible to exercise quality control in several mills from a central control laboratory.

As in most quality control work, proper sampling and preparation of the samples are important considerations. Actually, as many as ten repeated measurements should be taken, but due to a combination of factors (mostly economic) four to six seems to be most common. A single measurement is not useless, but it is not far from it. Two samples from the same lot are more useful than two measurements on one sample.

By sampling from a batch (usually four samples) it is possible to determine how close the batch is to the standard and what is the probability that a shipment from that batch will differ from the standard by an allowable amount. It is also possible to detect inadequate blending and other problems. (See references 8 and 9.) In other words, by making measurements and applying statistics we can arrive at appreciable better decisions than had previously been the case.

We have made considerable progress in color measurement. In the early days it was an accomplishment merely to measure a reflectance curve. Today this is commonplace. Still more progress is needed. We need cheaper, faster instruments which can compete successfully with the eye. We need better methods of sampling and sample preparation. We need quick graphical methods of handling multivariate statistics of the problem. We need better color difference formulas. When these things are available to us, we shall be able to say that the color control problem is nearly laid to rest. I expect these developments will take a few years, however.

Roland E. Derby, Jr.
The Derby Company, Inc.
49 Blanchard Street
Lawrence, Massachusetts

CHARLES R. CONQUERGOOD RECEIVES THE AULT AWARD

Dr. J. S. Long, Professor of the University of Louisville presented the L. A. Ault Award to Charles R. Conquergood on behalf of the National Association of Printing Ink Makers at the Annual Banquet at the Broadmoor Hotel, Colorado Springs, Colorado on May 3rd, 1957.

In addition to the long list of accomplishments, the citation pointed out that Mr. Conquergood has achieved fame in and beyond his native Canada. He has addressed conventions of the International Graphic Arts Education Association. He is a founder of the Advisory Council on Graphic Arts Education and of the new Education Council.

In 1935 Mr. Conquergood became president of the Canada Printing Ink Company, which he joined in 1902 after graduation from the Toronto Business College. He was made Chairman of the Board in 1956.

He has been President of the Canadian Printing Ink Manufacturers' Association and of the National Association of Printing Ink Makers; member, Canadian Manufacturers' Association;-one-time chairman of the Toronto Branch and of the Ontario Division; representative of the National Association of Printing Ink Makers to the Graphic Arts Educational Council of the Printing Industry of America; also member of the Twenty-one Man Royal Commission on Education, Toronto; was one-time President of the Toronto Club of Printing House Craftsmen. For eighteen years, Mr. Conquergood served as a member of the Toronto Board of Education; he was appointed by the Canadian Manufacturers' Association to the Advisory Vocational Committee of the Board for six years. He formed, while on the Toronto School Board, the Toronto and District Urban School Trustees Association.

Mr. Conquergood is one who made the organization of the Ryerson Institute of Technology possible through the efforts necessary for its founding; it is he who, as a member of its Advisory Board, contributes wholeheartedly to its guidance and influence and to its educational prestige.

DR. DEANE B. JUDD NAMED ASSISTANT DIVISION CHIEF AT THE NATIONAL BUREAU OF STANDARDS

Dr. Deane B. Judd has been named Assistant Chief of the Optics and Metrology Division at the National Bureau of Standards. Since 1933 Dr. Judd has been in charge of the Bureau's colorimetric work, initiating and conducting research, developing test methods and instruments. It is in the field of color vision, however, that he has made his most outstanding contributions. Dr. Judd's work in color research is reflected in his many articles and publications, which were listed in the News Letter, many of which have received national and international recognition.

In 1936 he was the recipient of the Journal Award of the Society of Motion Picture Engineers for his investigations of color-blindness and other anomalies of vision. In 1950 he received the Commerce Exceptional Service Award for outstanding scientific accomplishment in the fields of colorimetry and color vision. In March, 1957 he received from the Inter-Society Color Council the first Godlove Award for contributions to the knowledge of color.

Dr. Judd was a representative of the Optical Society of America at the Jubilee Celebration of the Royal Society of Physics and Chemistry in Madrid, 1953. At the invitation of the Institute of Optics of Spain, he recently spent four months as guest research worker and lecturer.

Dr. Judd received his A.B. degree from Ohio State University in 1922 and his M.A. in 1923. He was awarded his Ph.D. in mathematics and physics from Cornell University in 1926. Dr. Judd joined the Bureau staff in 1927. Previously he was a research associate at the Munsell Research Laboratory. During 1923 and 1924 he was instructor in physics at Ohio State University and instructor in psychology at Ohio Wesleyan University.

He is a member of the Optical Society of America (President 1953-1955), the American Society for Testing Materials, the Washington Academy of Sciences and the Washington Philosophical Society. He served as President of the Inter-Society Color Council from 1940 to 1943. For many years he has been an American representative at the International Commission on Illumination. He is a member of Phi Beta Kappa, Sigma Xi and Pi Mu Epsilon.

COURSE ON SPECTRO-PHOTOMETRY AND COLOR MEASUREMENT

Davidson and Hemmendinger announce a sequence of courses on spectrophotometry and color measurements to be given at their laboratory at 76 North Fourth Street, Easton, Pennsylvania. The first such course was held in April, 1957; two others will follow this fall. Each course is one week in length, and is limited to a maximum of ten participants.

The next course, to be held in September, 1957, is designed for those with no prior experience in color specification. Subject matter will include the definition of color-order systems, description and characteristics of spectrophotometers and other color-measuring instruments, and the meaning and use of color-difference measurements. The second course, in October or November, 1957, will treat additional topics of the foregoing subjects, and will consider detailed working methods for the use of either spectrophotometry or color measurements in the control of production of colored materials. Both courses will consist of lectures and laboratory exercises, under the direction of Hugh R. Davidson and Henry Hemmendinger.

RAHR HELPS SOLVE PROBLEMS OF READY MADE DRAPERIES

The HOME FURNISHINGS DAILY of April 25 carried a success story on ready made draperies in which the Frederick H. Rahr Customer Preference Clinics played a part. As the article said, the growth of ready-made draperies presented manufacturers with some thorny problems, for it practically forced unit packaging on an industry which heretofore had been somewhat loathe to adopt modern packaging methods. What multiple units should be bought, stocked, and sold? What widths, sizes, and colors should be available? The Cameo people, in developing its multiple width plan for its Trianon fabric, retained the services of the Rahr Customer Preference Clinics to determine the most wanted textures and colors of ready-made draperies, as well as the most asked for lengths and widths. With the information obtained they decided to run the drapery in nine colors and 18 sizes. Following the first season they ran a results survey to determine how actual sales, in color and size, compared with the basic Rahr predictions. They report that results at the retail level were found to coincide very closely with the Rahr estimates. White, sand, nutmeg, and green came out on top as predicted, and gold far outsold the predictions. A consumer demand predicted for blue and gray, which the firm's stylists doubted, were proved correct. A spokesman for Cameo reported that the careful planning done in this program has helped to push their Trianon to being one of the most widely distributed ready-made draperies in the industry.

ISCC PRESIDENT'S FIRM WINS ARCHITECTURAL AWARD

The Washington Board of Trade honored Waldron Faulkner's firm, Faulkner, Kingsbury and Stenhouse, and Maurice S. May, Associated Architects for the design of Providence Hospital. The hospital was built by the Charles H. Tompkins Company.

EDITOR'S CORRECTION

The last News Letter announced that Walter C. Granville left Container Corporation to join Design Dynamics. I have since learned that this was not correct. Walter had established an <u>independent practice</u> as a color consultant and Design Dynamics was his first client.

MISS FURRY APPOINTED TO SUBCOMMITTEE 18

The appointment of Miss Margaret S. Furry to Subcommittee 18 (Colorimetry of Fluorescent Materials) was approved by the Board at the meeting in Washington, June 24th and 25th. Miss Furry is employed in the Clothing and Housing Research Division, Institute of Home Economics, Agricultural Research Service, U. S. Department of Agriculture, Beltsville, Maryland. She is chairman of Task Group 5 (Evaluation of Fluorescent Brightness) of ASTM D-12 Subcommittee 5 (Soaps and Other Detergents).

"THIS IS COLOR" GOES TO EUROPE

The IPI film, <u>This is Color</u>, which is so successful in the United States, is now being shown in many parts of Europe. I had the pleasure of showing it to the International Conference of Printing Research Institutes at Rottach-Egern, Germany (near Munich). The film was taken to Europe by Donald Macaulay of Chappaqua, New York, who is lecturing on quality control in graphic arts. Mr. Macaulay has shown the film in France, Italy and Switzerland. I am sure he got as good a response to the film as I did.

WLR

NOMOGRAPH FOR CONVERTING COLORMASTER DATA TO ADAMS COORDINATES

Emery C. Swanson and Ernest Hoschka, Pillsbury Mills, Inc., have developed a nomograph for converting Colormaster Colorimeter data to Adams Coordinates. Gustav Bergson, President of Manufacturers Engineering Equipment Corporation, printed the nomographs, which are based on the work of L. G. Glasser and D. J. Troy, published in J.O.S.A., Vol. 42, p. 652 (1952). The charts are priced at $5 per hundred with a minimum order of $5. The company's address is York and Sunset Lane, Hatboro, Pennsylvania.

GLENN COLORULE AGAIN AVAILABLE

A few months ago, Warren Reese told me that the Glenn Colorule was again available. This was the first I knew about the device, so I bought one. It is a slide-rule like pair of strips composed of patches of dyed cloth, which can be used to point up variations in color vision and to illustrate the effect of light sources and metameric matches. At first I thought it was just a curious and interesting gadget, but several color people expressed a keen interest in the applications; and they were delighted that it was "available again." After such enthusiasm and interest, I guess all News Letter readers should know about the Glenn Colorule. The price is $5 and is available from: Sidney Blumenthal & Co., Inc, 1 Park Avenue, New York, New York.

WLR

WANT A DIFFERENTIAL COLOR MIXER?

In a letter to the Council, Ralph Gerbrands said he understood that very few people realized that differential color mixers were available in this country. He has manufactured several for the Naval Submarine Base, New London, Connecticut. Mr. Gerbrands says he manufactures one which will mix two colors through an angle of 340 degrees while the disks are rotating at approximately 3000 to 4000 R.P.M. The disks can be cut from ordinary colored paper. Mr. Gerbrands address is: 96 Ronald Road, Arlington 74, Massachusetts.

LOF OFFERS NEW SPANDREL GLASS TO DESIGNERS AND BUILDERS

"Vitrolux" manufactured by Libby-Owens-Ford is quarter-inch polished glass with an opaque ceramic color fused onto the back at high furnace temperatures. The glass will be made in black, white, fawn, buff, golden olive, brick red, colonial blue, jade green, charcoal, sage green, ice green, spruce, hunter green, turquoise, silver gray, gunmetal, cinnamon, and chocolate. All of the LOF colors will conform to those established in the third edition of the Color Harmony Manual published by the Container Corporation of America.

POPULAR ARTICLES ON COLOR SCIENCE

Two excellent popular articles on color were brought to my attention. Both appear in the list of articles. "The Art of Color Matching" by John C. Holle is a beautifully illustrated article which concerns itself largely with the physics of color, especially absorption by surface coatings. The author deals with homogenous layers as well as pigment mixtures. He describes spectrophotometry and discusses spectrophotometric curves. He deals briefly with the physiology and psychology of color. His treatment of the subject strongly resembles the IPI film "This is Color."

A good followup to Interchemical's article is one by H. M. Cartwright of England, "Subjective Aspects of Color." Cartwright is interested in the things to consider when assessing color printing. Some of his illustrations of psychophysical effects are the best I've seen, especially one red, green, and gray simultaneous contrast example. He talks about illuminants, subjective white, surface effects and ends on a note which should be obvious but which is usually overlooked. "In . . . the reproduction . . . it may be quite wrong to attempt to match each color in a literal way. . . . "should be looked at as a whole . . . to form a subjective impression such as the artist would wish to convey."

WLR

AMERICAN CERAMIC SOCIETY SESSION ON COLOR

Just before the deadline, I received the following letter. WLR

"I just wrote to Tyler Pett and asked him to give you a report on the Session on Color which was held at the A.C.S. Design Division meeting in Dallas, May 8th. This was a panel discussion by members of the American Ceramic Society delegation to the Inter-Society Color Council. Tyler Pett was the moderator, and the participants were: Isay Balinkin, P. W. French, R. L. Gibson, Theodore Lenchner, K. C. McCartt, R. F. Patrick, J. C. Richmond and F. J. Von Tury. The session gave an insight into the Inter-Society Color Council and the manner in which the American Ceramic Society and the ceramic industries may benefit from it. The organization and its method of operation was described. The meeting was well attended and the audience participated in the discussion period which followed."

F. J. Von Tury

A CHALLENGE TO COLORIMETRY BY DR. W. D. WRIGHT

With this issue of the News Letter is a reprint of Dr. Wright's resume of the Physical Society Colour Group symposium on "Colorimetry: Its Errors and Accuracy." The article first appeared in NATURE, January 26, 1957. Arrangements to reprint the article were made by Dorothy Nickerson. The reprinting was done by the Rochester Institute of Technology.

LIST OF ARTICLES ON COLOR RECEIVED BY NEWS LETTER

"Apparent Intensities of Colored Signal Lights" W.E.K. Middleton, and H.S.T. Cotterfield, Illum. Eng. 52:192-196, No. 4, April 1957.

"A Challenge to Colorimetry", W. D. Wright, Nature, 179:179-180, Jan. 26, 57.

"Analytical Approximations for Color Metric Coefficients", D. L. MacAdam, Journal of the Optical Society of America, 47, No. 4, pp. 268-74, April, 1957

"An Evaluation of Some Statistical Techniques Used in the Analysis of Paired Comparison Data", J. E. Jackson, and M. Fleckenstein, Biometrics, The Biometric Society, 13:51-60, No. 1, March, 1957

"Aspects of Colorimetry Applied to the Colour Gamut of Pigments", E. Atherton and D. Tough, Oil & Colour Chemists' Assoc J. pp. 115-128, February, 1957

"Color Difference Specifications" (Munsell and CIE coordinates), Henry Hemmendinger and Hugh R. Davidson, Plating, pp. 274-8, March, 1957

"Color Discrimination of Twelve Observers", by W. R. J. Brown, Journal of the Optical Society of America, 47, No. 2, pp. 137-143, February 1957

"Correlate for Lightness in Terms of CIE-Tristimulus Values, Part I", C. L. Sanders and G. Wyszecki, Journal of the Optical Society of America, 47, No. 5, pp. 398-404, May, 1957

"Colorimetry in the Paint Industry", A. J. Seavell, Oil & Colour Chemists' Assoc J., pp. 87-114, February, 1957

"Colorimetry of Shiny Biological Specimens", W. E. K. Middleton and G. W. Wyszecki, The Canadian Entomologist, 88-pp. 683-685, No. 12, December, 1956

"Constant Brightness Check", D. Noel Obenshain, Instrumentation, 10, No. 3, pp. 8-10, May-June, 1957

"Diagnostic Tests for Colour Vision", W. D. Wright, Annals of the Royal College of Surgeons of England, 20, pp. 177-191, March, 1957

"Hickethier Colour System (review of English version of Alfred Hickethier book)", Printing World, pp. 312, March 27, 1957

"Measurement of the Light Adaptation of the Rods", Stanley W. Smith and Forrest L. Dimmick, Journal of the Optical Society of America, 47, No. 5, pp. 391-393, May, 1957

"On the Functional Relation Between Luminous Energy, Target Size, and Duration for Foveal Stimuli", George F. Nolan, 47, No. 5, pp. 394-397, May, 1957

"Simple Absolute Method for Measuring Diffuse Reflectance Spectra", Kazuo Shibata, 47, No. 2, pp. 172-175, February, 1957

"Subjective Aspects of Colour", H. M. Cartwright, FRPS, Process, pp. 184-189, May, 1957

"The Art of Color Matching", John C. Holle, Interchemical Review, 15, No. 3, pp. 59-73, Autumn, 1956

A CHALLENGE TO COLORIMETRY

THE Small Physics Theatre at the Imperial College of Science and Technology was filled to capacity on December 12, 1956, when the Physical Society Colour Group held a symposium on "Colorimetry: its Errors and Accuracy". An assessment of the reliability of colour measurements was manifestly of great interest, and many industries were represented in the audience.

The problem basically is this: On the trichromatic system of colour measurement established in 1931 by the International Commission on Illumination (C.I.E.), a surface colour can be specified by its chromaticity co-ordinates, x and y, and its luminance factor β. Direct measurement of these quantities by three-colour matching is too inaccurate for most commercial applications, since the matching of lights of markedly different spectral composition brings out individual differences of colour vision. Other methods have therefore been developed, including (*a*) a six-stimulus visual colorimeter in which an approximate spectral energy match is established and the effect of observer differences therefore reduced; (*b*) photoelectric colorimeters employing a photo-cell in conjunction with selected colour filters to give spectral sensitivity curves approximating to the three spectral distribution curves of the C.I.E. standard observer; and (*c*) photoelectric spectrophotometers in which the spectral reflexion curve is measured through the visible spectrum, and the colour specification calculated using the colour mixture data of the standard observer as tabulated by the International Commission on Illumination. Yet none of these methods is at present capable of specifying a colour to a limit of accuracy that cannot be exceeded by the remarkable capacity of the eye to discriminate between two colours of nominally the same specification, when compared side by side in a good light.

In principle, the spectrophotometric method gives the most absolute specification, since the determination of the reflexion factor at each wave-length is unaffected by the spectral sensitivity of the observer or photo-cell. Nevertheless, the accuracy of the result may be limited by the rather small amount of light that is sometimes available for measurement, and if an integrating sphere is used for increasing this amount, then a new uncertainty is introduced because the integrated reflexion may differ from the more directional reflexion employed in visual examination of the specimen. Other possible sources of error in spectrophotometry include stray light, finite slit-width, limited accuracy of photometric control or linearity of photoelectric response, and uncertainty in the specification of the white reference standard.

The magnitude of these inaccuracies was studied by circulating six coloured tiles, supplied by the British Ceramic Research Association, to a number of research laboratories where reflexion spectrophotometry is practised, and Prof. W. D. Wright (Imperial College) presented a comparison of the results to the meeting. In all, ten different instruments had been used, including five General Electric (Hardy) recording spectrophotometers and five non-recording instruments. Two of the latter employed double monochromators and three single monochromators. The tiles chosen for the test were of various colours and, more important, various surface characteristics, described as glossy, semi-matt and matt, although the polar reflexion curve of the matt tile showed a fairly broad specular component. One of the tiles had a very low reflexion (of the order of 1 per cent) in the green part of the spectrum and it was a tribute to the sensitivity of modern photoelectric devices that in this case the differences in the results from one instrument to another were generally less than 0·1 per cent in reflexion. For the other tiles, the reflexion of which ranged from about 20 to 80 per cent, the spread was of the order of 1 or 2 per cent.

It was noted that for five of the tiles, the average readings with General Electric recording spectrophotometers were 0·5–1 per cent lower than the average of the non-recording instruments, and this difference was attributed to the inclusion in the integrating spheres of the light diffusely reflected at large angles to the normal, whereas the non-recording instruments collected the light within a fairly narrow cone centred around the normal to the surface or, in the case of a Beckman spectrophotometer, in an annular cone at 45° to the normal. On the other hand, in the case of the so-called matt tile, the General Electric spectrophotometer readings were some 2 per cent higher, apparently due to the inclusion of some of the broad specular component mentioned above, in spite of the insertion in the integrating sphere of the black cap intended to absorb the specular reflexion. Some of the other differences could be traced to errors in the values for the reference white against which the tiles were compared. The ultimate standard is, by definition, a white magnesium oxide surface, but the discussion revealed some divergence of practice in the preparation of such a surface exactly to specification

On the assumption that the average values from the five non-recording instruments were the most nearly correct, the measurements made at the National Physical Laboratory using a Müller–Hilger 'Uvisir' double monochromator were the most accurate, with the results from the Paint Research Station using a Beckman spectrophotometer a close second. While the agreement among the different instruments was regarded by the instrumentalists at the meeting as quite gratifying, the practical colour men made it clear that they needed something a good deal better.

The requirements in industry were discussed in a paper by Miss D. L. Tilleard, who described experiments carried out at the Paint Research Station on a set of nearly identical panels prepared by the progressive addition to a standard paint of small amounts of tinting paints of different colours. The panels were measured on the Beckman spectrophotometer and were also compared by experienced observers, under good conditions of daylight illumination, with the panels touching on a long contact line. Under these good viewing conditions, chromaticity differences of 0·0003 or even less could be distinguished in a light biscuit series of panels and differences of less than 0·01 in luminance factor. Commercial tolerances for close matching are larger than this, but may still be as small as 0·001 in chromaticity. This compares with a precision of measurement of the order of 0·0004 in x or y as given by the standard deviation of a number of repeat measurements with the Beckman spectrophotometer, which thus has a differential sensitivity comparable with the closest commercial tolerances.

(Reprinted from Nature, Vol. 179, *pp.* 179–180, *January* 26, 1957)

The same theme was developed further in a paper by Mr. P. S. Williams (Imperial Chemical Industries Paints Division), who compared results on the General Electric recording spectrophotometer and Librascope computer, the Donaldson six-filter colorimeter and the 'Colormaster' differential colorimeter developed by Glasser at the Dupont Company in the United States. When tested on various specimens, the two latter gave results in close agreement to each other, but differing slightly from the former on account of the special illuminating and viewing arrangements, to which reference has already been made. Changes in the spectral transmission of the filters with temperature were found to be one source of error in the Donaldson instrument, while the highest precision with the differential colorimeter (possibly as high as the smallest detectable difference by eye) is only achieved when comparison is made between samples of fairly similar spectral reflexion. This instrument uses a split beam to illuminate a standard and comparison surface, with two photo-cells (plus filters) to form a null balance bridge. Mr. J. W. Perry (Hilger and Watts, Ltd.) discussed the factors which must limit the accuracy of a colorimeter employing filter-screened photo-cells, with particular reference to the Hilger photoelectric tristimulus colorimeter. The fundamental difficulty is, of course, to obtain the correct sensitivity curves, but except for surface colours with irregular spectral reflexion curves, Perry considered that an accuracy of $\pm 0{\cdot}005$ could be achieved for a very large range of chromaticities with the Hilger colorimeter. Used as a differential instrument, the precision would be very much higher than this.

As the discussion on all four papers developed, one of the questions asked was, "Where do we go from here?" The chairman, Mr. R. G. Horner, promised that a future meeting would be held on colour tolerances, to provide an opportunity for the colour industries to define in more detail the limits to which they need to work and to consider the best form in which tolerances should be expressed. One particular point which requires clarification is whether the high discrimination which can be achieved in differential colorimetry needs to be matched by a corresponding precision and accuracy in absolute colour measurements. Evidently if the components of some product are manufactured at different parts of a works or at different times, the manufacturer must control the colour of each component to such an accuracy that they will appear to match when assembled together. Whereas the customer will be able to make a differential and highly critical judgment, the manufacturer may be denied this advantage during the actual production process. In principle, colorimetry is just the tool the manufacturer needs to assist him in this task. In practice, it looks as if the tool still requires some sharpening.

W. D. WRIGHT

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