M. Balcom

INTER-SOCIETY COLOR COUNCIL

NEWS LETTER

NUMBER 121 NOVEMBER, 1955

News Letter Committee:

Eugene Allen, Chairman
Deane B. Judd Dorothy Nickerson
Albert H. King Ralph E. Pike

Address correspondence regarding subscriptions and missing copies to the Secretary.
Annual subscription to non-members: $4.00

Editor: Eugene Allen
American Cyanamid Company
Bound Brook, New Jersey

Secretary: Ralph M. Evans
Color Technology Division, Bldg. 65,
Eastman Kodak Company
Rochester 4, New York

NEW MEMBERS The Board of Directors of the Inter-Society Color Council met October 5, 1955 at the Hotel William Penn, Pittsburgh, Pennsylvania. The following applications for individual membership were accepted:

Associate Individual Members	Particular Interest
Mr. Theodore G. Clement Eastman Kodak Company 343 State Street Rochester 4, New York	Color trends, influence of color on buying; Psychology, color in packaging and merchandizing of products; Control of color in factory finishing departments.
Mr. Norman R. Pugh Department 817 Sears Roebuck and Company 3301 West Arthington Street Chicago 7, Illinois	Color tolerance systems, color instrumentation, consumer color preference information, store lighting and architectural design, color harmony theory.

Affiliate Individual Members	Particular Interest
Mr. Stig Bergman AB Wilh. Becker Postfack, Stockholm 1, Sweden	No particular interest mentioned.
Mr. Benjamin H. Danziger Climax Molybdenum Company 500 Fifth Avenue New York 36, New York	Comparative visibility and eye appeal of different colors; Increasing applications of color.
Mr. Kenneth Gale The Mosaic Tile Company Zanesville, Ohio	Color coordination in building products.

Mrs. Charles Grover 9302 Glenville Road Silver Spring, Maryland	Learning to describe color so others will understand. Learn to use color imaginatively and competently. Know the principles behind the use of color.
Mr. Frank S. Wilbar 1074 Chantilly Road Los Angeles 24, California	The reproduction of color photographically.

NEWS FROM CALIFORNIA

On June 25, the California Color Society held a meeting of its members at which Mr. E. Taylor Duncan presented a paper on "An Investigation of Muddy Color." Mr. Duncan is an individual member of ISCC, and had for several months been attending the University of Southern California where he was doing research relevant to "muddy color" pigment and dye mixtures. The presentation, which included excerpts from, and analyses of, pertinent literature, was followed by a lively and informal discussion period with most of the members present participating.

On July 20, at the Art Center School, the CCS program, "How and Why We See Color," was presented by Dr. George Bentley, president of the Instrument Development Labs., Needham, Mass. Included was a discussion on the physiology of color vision and the limits that human vision places upon the development and practical application of industrial color measurement. Also, the tristimulus meter developed by Dr. Bentley, together with Mr. A. R. Macdonald, was demonstrated. This is a comparator permitting percentage deviation readings of two samples. The interest of the audience in this program was demonstrated by the fact that many were still examining the meter and asking questions when the time came to close the auditorium for the evening.

On October 20, a group of CCS members met at a French restaurant for dinner. Following dinner a short business meeting was held, at which plans were made for future meetings and programs. Then a color film, designed by Eames and titled "Communications," was shown. This film, available through the Museum of Modern Art, proved to be most interesting, having to do with color as well as sound, light, motion, etc. used as mediums for human communication. Arrangements for its showing were made by Miss Elizabeth Franklin, former chairman and present counsellor of CCS.

Albert King, individual member of ISCC and counsellor for CCS, has been elected Chairman of the Design Division of the Southern California Section of the American Ceramic Society. Plans are being made for a joint meeting of this group with the California Color Society next spring.

The University of California (Los Angeles) Engineering Extension, in cooperation with SMPTE, is conducting two courses pertaining to color. They are "Illumination Optics" conducted by Mr. Ernest W. Silvertooth, Engineer, Librascope, Inc., and "Duplication of Color Motion Pictures" conducted by Mr. Roderick T. Ryan, Quality Control Engineer, Eastman Kodak Company. The courses, each of which consist of 18 meetings, began in September and are held at the John Burroughs Junior High School, 600 South McCadden Place, Los Angeles.

Louisa E. King,
CCS Secretary

PHYSICAL SOCIETY - COLOUR GROUP

We have received notice of two meetings of this active British Group. The first, held on September 28, featured an address by Dr. W. D. Wright, who reported on the Heidelberg, FATIPEC, and CIE meetings. In his talk, Dr. Wright summarized the main achievements of these conferences, with particular reference to the CIE meeting. At the November 9 meeting, two papers were presented: "Structure of the Retina and Colour Vision," by E. H. Leach; and "The Physical Measurement of Human Cone Pigments in the Normal and the Colour Blind," by Dr. W. A. H. Rushton.

THE PROBLEM FACED BY THE CIE At the CIE meeting in Zurich this June, Technical Committee 1.3.1, Colorimetry, under the chairmanship of Deane B. Judd, passed six resolutions. Resolution (3) reads as follows: "It is recommended that any new color-mixture functions to be adopted shall be based in principle on the results of procedures yielding in every case a complete match of the two fields being compared."

The implications of this harmless-seeming sentence may not be apparent at first reading. Dr. Judd, in an article which has just appeared in the October issue of the Journal of the Optical Society of America, 45, 897 (1955), says that this resolution foreshadows "radical changes in photometry and colorimetry," and then goes on to tell why. Dr. D. L. MacAdam, in an address entitled "A New Look at Colorimetry," delivered before the SMPTE Convention on October 6, also discusses the implications of Resolution (3), especially as they affect the lighting, photographic and television industries. Since the changes to come will affect everyone who has anything to do with colorimetry, we think it worth while to discuss these two important papers in some detail. A good way to start may be to review what color-mixture functions are, and to explain why the present set needs changing.

Dr. MacAdam's address contains a lucid explanation of color-mixture functions in only a few words: "To specify a color only three quantities are needed: the amounts of red, green, and blue light that have to be mixed to match the color. These amounts are called color-mixture values." In 1931, the CIE set out to define a particular set of color-mixture values - the amounts of standardized red, green, and blue primaries needed to match each of the pure spectrum colors. But since each pure spectrum radiation may vary in intensity (i.e. in energy), it was necessary to specify just what the relative energies of the spectral radiations being matched should be. [Accordingly, the matches were to be made on spectral colors all having equal energy.] - Not actually or measured in experimental conditions - see ¶ after next.

The color-mixture values finally adopted, on which all modern colorimetry is based, were determined by the classic experiments of Wright and Guild (who worked independently, but whose results showed very good agreement.) Both investigators used a colorimeter with a divided field. Pure spectral radiation of, let us say, 400 millimicrons was directed into one-half of this field, and a mixture of three primary colors was directed into the other half. The observer varied the amounts of the primaries until a match was obtained. The same thing was then done for 410-millimicron spectrum radiation, and repeated for the entire visible spectrum at intervals of 10 millimicrons. However, and this is the cornerstone of the problem which faces the CIE today, in neither Wright's nor Guild's investigation were the relative energies of the spectrum radiations being matched known. These investigators both determined only the relative amounts of the three primaries necessary to match each spectrum color of arbitrary energy, but did not directly determine the absolute amounts of these primaries needed to match a spectrum of equal energy. The investigators were, of course, not to blame, for it did not seem necessary at the time to determine the energy distribution of the spectrum colors being matched. This would have been a rather difficult task and it seemed that the problem could be solved in another more simple manner.

What the original investigators did was to use luminance measurements, which were easier than energy measurements. First, they measured the luminosities of their three primaries. They then invoked a law known as Abney's law, which states that the luminance of any mixture of components is equal to the sum of the individual luminances of these components. Therefore, the luminance of each of the spectral colors being matched was equal to the sum of the luminances of the primaries, each multiplied by the relative amount of that primary in the mixture. Now the luminances of the spectral colors were of course arbitrary, since their energies were arbitrary. However, by the application of a suitable factor to the color-mixture ratios at each wavelength, the spectral color luminance could be made to agree with the luminance of that spectral color in the standard luminous-efficiency function. This latter function had been set up provisionally by the CIE in 1924, and expressed the relative luminance of each spectral color <u>at equal energy</u>. Thus, determination of luminance and application of the standard luminous-efficiency function was used as a link to convert the relative amounts of the three primaries to absolute amounts on an equal energy basis. This seemed more accurate than the more elaborate method of determining the relative energy of each of the spectral colors being matched.

To avoid any misconception on the part of the reader at this point, we would like to mention that in our foregoing reference to primaries we do not mean the X, Y and Z primaries finally adopted by the CIE for use in computational work. These latter primaries have luminances of 0, 1 and 0 respectively, and do not correspond to real lights. Imaginary lights were chosen in such a way that, for convenience in computation, the Y tristimulus value would be equal to the luminance of any color. Our discussion here has nothing to do with this final choice of primaries; rather it deals with the original, physically-real primaries used by Wright and Guild in their determination of the color-mixture values.

The reader will have noted that two assumptions were made in this method of converting the relative amounts of the primaries to absolute amounts needed to match a spectrum of equal energy. The first assumption is that Abney's law is valid; the second assumption is that the standard luminous efficiency function is correct. Dr. Judd in his paper points out that "rather sizable deviations from Abney's law (25-30%) have been found in the last 40 years," and gives a list of nine references. Many of these papers are rather recent, and show that luminance, as determined by instrumental measurement and the application of the CIE luminosity function, is not always an adequate measure of brightness as seen by the eye. The luminance of any color is determined by its Y value, and the calculation of this value involves a summation of the luminances of the spectral constituents of that color. Fundamentally, Abney's law provides the authority for making such a summation (in fact, as Dr. Judd mentions, Abney's law is specifically written into the definition of luminous flux). This non-equality of luminance and perceived brightness, then, implies that Abney's law is not valid. One of the references cited by Dr. Judd is to a paper by Dr. MacAdam in the Journal of the Optical Society of America, <u>40</u>, 589 (1950) in which these discrepancies are explored. In this paper Dr. MacAdam describes one very striking experiment which brings out clearly the difference between luminance and brightness: "When a white mixture was kept unchanged in the comparison half of the field, and the red component of an equally bright white mixture was reduced in intensity, the resulting color was a bluish-green, very obviously <u>brighter</u> than the white. By merely removing red light from a white mixture, a brighter color was produced. The luminance as well as the energy content was obviously decreased, because the luminous red component was removed without any compensating increase of the other components. This anomaly...cannot be attributed to a confusion of saturation with brightness. The observers tried without success to convince themselves that the bluish-green was darker than the white. They found that interpretation of their sensations quite unacceptable, and after keeping their attention directed to the saturation, they still judged the bluish-green to be brighter than the white from which it was derived by elimination of the red component."

From the doubts thrown on the validity of Abney's law, one might expect that difficulties with the CIE color-mixture values would arise. These difficulties would not be confined to the luminance values alone, but to color measurement in general, since Abney's law was used as a tool for calculating the entire set of color-mixture values. This turned out in fact to be the case. In 1948, A. E. Jacobsen, working at the National Lead Company, found that color differences of near-white paints containing titanium pigments as calculated from spectrophotometry by means of the CIE color-mixture values did not agree with those found by visual estimation. Dr. Judd, realizing the importance of these findings, undertook an extensive check of Jacobsen's work, and substantiated his conclusion that the color-mixture values do not properly weight the region of the spectrum below 460 millimicrons. Since that time, other instances of inadequacy of the CIE functions were found; some of these are mentioned in Dr. MacAdam's address before the SMPTE. At the 1951 CIE meeting, some consideration was given to the idea that these difficulties might be caused by failure of the second assumption mentioned earlier, namely, the correctness of the 1924 luminous-efficiency function, and it was proposed to correct the color-mixture values in accordance with certain minor corrections of the luminosity data. However, the British Committee suggested that action be postponed, and that a complete new determination of the color-mixture values be undertaken by direct match of an equal-energy spectrum rather than by the use of luminosity as a bridge.

At the 1955 CIE meeting, the preliminary results of this work by Dr. H. G. Sperling of the U. S. Naval Medical Research Laboratory and by Dr. W. S. Stiles of the National Physical Laboratory of England were reported. The results of both of these investigators showed that the original method of setting up the CIE functions by the use of the luminosity data was invalid, because if the luminosities of the primaries which they used (to match a <u>true</u> equal-energy spectrum this time) were summed at each wavelength, the resulting luminosity function did not agree with the standard luminosity function adopted provisionally in 1924. In fact, Sperling checked the color matches for three subjects with the luminosity functions for those same subjects, which was a very direct check, and found the same sort of disagreement. In the words of Dr. Judd's paper, "Such a sum [of the luminosities of the primaries] gave a wavelength function significantly broader than the subject's luminous-efficiency function determined by equality-of-brightness settings with the spectrum at 520 mμ ..." Dr. Judd then goes on to explain that "Resolution (3) expresses the view that any revision of the 1931 CIE Standard Observer for Colorimetry should result from an average of directly determined color-mixture functions uncontaminated by any adjustments to make a weighted sum of the color-mixture functions conform to any data obtained by flicker photometry or equality-of-brightness settings in the presence of a noticeable chromaticity difference."

The implications of all this are profund, and result in a dilemma (in the original sense of the word). The nature of this dilemma may best be understood by reference to Dr. MacAdam's SMPTE address. Dr. MacAdam explains that we are faced with two alternatives: "(1) we must abandon the connection between luminosity and color-mixture data and accept the possibility of contradictions between the results of photometry and colorimetry, or (2) we must adopt a revised luminosity curve significantly different from the present standard. According to this second alternative, the luminosity curve would be defined as a linear combination of directly determined color-mixture curves and would take into account only indirectly the great mass of experimental data on which the luminosity curve has been based in the past. Such data would be used only to determine the coefficients of the linear combination of color-mixture data which best fit the average luminosity data." Dr. MacAdam then goes on to show the implications of each of these alternatives. If the second alternative is chosen, namely, to adopt a revised luminosity curve, there would be serious repercussions in the lamp industries. The luminosity curve is used for rating the intensities of nearly all commercial lamps. As a result of such a change in the luminosity curve, the ratings of incandescent tungsten lamps would be expected to be increased only 1 or 2%, but the ratings of daylight fluorescent lamps, projection arcs and kinescope tubes would be increased as much as 10%; also, highly chromatic light sources such as railway, automobile and aircraft signal lights might be increased 100% or more.

Dr. MacAdam then explains that adoption of the first alternative would be even more irksome: "If the luminosity curve is not a linear combination of the revised standard color-mixture curves ($\bar{x}$, $\bar{y}$, $\bar{z}$), then colorimetric specifications might indicate that two physically different colors are alike in all respects and yet, according to the standard luminosity data, they would have to be reported as having different luminances. Since all reproductions in color motion pictures and color television result in colors physically different from the original colors, such contradictions and dilemmas would be potentially frequent and serious."

This would be an impossible situation, and both Dr. Judd and Dr. MacAdam agreee that the second alternative with all its inconveniences is by far to be preferred. A standard luminosity curve must be adopted which can be derived from the directly-determined color mixture data, even though it differ considerably from the standard luminosity curve now in use. However, let us remember that in setting up such a modified luminosity function we do not necessarily have to do this in the strict manner by addition of the luminosities of the primaries independently determined, as was indicated previously under the discussion of the Sperling and Stiles data. Actually we can use any weighted combination of the color-mixture data, or in Dr. MacAdam's terminology, any linear combination of the color-mixture data, so as to get a luminosity curve which best agrees with the one we have now. (Since the weights used should theoretically be the luminosities of the primaries, this would mean that we have to assume different luminosities of the primaries than those actually found experimentally.) This departure from rigor will offend only the purist; actually, it will make possible the use of the best approximation to the present luminosity function which can be <u>calculated</u> from the color-mixture data. In this way, the connection between photometry and colorimetry will not have to be abandoned.

Dr. MacAdam's address to the SMPTE concludes with an exhortation to all organizations "concerned with the advancement of color television, color photography, and color reproductions in general to participate aggressively in the current activities and deliberations which will shortly lead to a decision by the CIE on this important matter .... In its own interest, as well as in the best long-term interest of all the color industries, the weighty and respected council of the SMPTE might appropriately be brought to bear favoring the redefinition of the luminosity data as a linear combination of directly-determined color-mixture data."

Dr. Judd's paper also discusses Resolution (1) of the CIE, which reads: "It is recommended that further studies of color-mixture functions made for the use of the

CIE Technical Committee on Colorimetry give chief attention to fields whose diameters subtend 10°." Dr. Judd explains that the 1931 Standard Observer was determined by use of a 2° field, but almost universal practice in the color producing and consuming industries is to use specimens for color examination which are large enough to subtend considerably more than 2°. "Since the annular retinal area corresponding to 10° field with a 2° central spot taken out differs from the central spot certainly by having less macular pigmentation and possibly by having receptors of different spectral character, it is to be expected that a revision of the 1931 Standard Observer for Colorimetry based on the 10° field will involve more than minor changes."

Whatever the outcome of all these studies will be, it is certain that we are faced with the prospect of considerable changes both in photometry and colorimetry. As Dr. MacAdam states in his address, "Nearly a quarter of a century has elapsed since the (1931) adoption of the present CIE resolutions concerning colorimetry.... All of the delegates to the CIE are determined that this time the job shall be done so well that no further revisions will be necessary in the next quarter of a century."

E.A.

REPORT ON ISCC PROBLEM 2 IS PUBLISHED

Each delegate and individual member of ISCC should have received in the past few weeks a copy of NBS Circular 553, "The ISCC-NBS Method of Designating Colors and Dictionary of Color Terms," by K. L. Kelly and D. B. Judd. This is a revision of the 1939 report of Subcommittee on Problem 2, Color Names, of which Dr. Judd was chairman. The 1939 report was published under the title "Method of Designating Colors," by D. B. Judd and K. L. Kelly, and appeared in the NBS Journal of Research 23, 355 (RP 1239). Many thousands of copies of this report were sold, which established something of a record for research papers at the National Bureau of Standards! The present revised report is published in book form, and additional copies are available from the Government Printing Office at $2.00 each.

We are fortunate indeed that there has been such close cooperation with the interests of the National Bureau of Standards that we are able to have this ISCC-NBS method published in such a useful form. Since this publication serves as a final report of the subcommittee, the Board of Directors of ISCC has authorized the purchase of sufficient copies to supply one to each delegate and member of the Council. The News Letter Editor will be glad to receive comments concerning this report from News Letter readers that he can use in a later issue.

* * * * * * * * * * *

LIST OF PARTICIPANTS IN HEIDELBERG MEETINGS ON COLOR METRICS

Our ISCC membership roster is a useful list of those chiefly in our own country interested in color problems. There is no international roster, and it was suggested therefore by our President that many who were unable to attend the June meetings on color metrics in Heidelberg might like to have available for reference a list of the participants, with identification where possible to show their professional or business interest and home city. Dr. Richter, who expects to publish the papers of these meetings in Die Farbe (the quarterly journal of which he is editor), was kind enough to provide us with the list of names and addresses presented here. The 128 persons in attendance came from 12 countries, over one-third of them outside of Germany

LIST OF PARTICIPANTS AT INTERNATIONAL DISCUSSION OF PROBLEMS IN COLOR METRICS HELD AT HEIDELBERG

BELGIUM

Gochet, M., 203 Avenue de Mai, Woluwe St. Lambert, Brussels
Thiels, A., Dr., Phys. Labor. d. Geveart Photo-Producten N.V., Mortsel

CANADA

Middleton, W.E.K., National Research Council, Ottawa

EGYPT

Ishak, I.G.H., Dr., Faculty of Science, Cairo

ENGLAND

Boshoff, M.C., Techn. Optics Sec., Imperial College, London
Crawford, B.H., Dr., Light Div., Natl. Phys. Laboratory, Teddington
Gloag, H.L. (ARIBA), Manor Farm Cottage, School Lane, Welwyn, Herts
Hopkinson, R.G., Dr., Bldg. Research Station, Garston Watford, Herts
Horner, R.G., 65 Headley Chase, Brentwood, Essex
Medd, D.L. (ARIBA), Architects Branch, Ministry of Educ., London
Moreland, J.D., Techn. Optics Sec., Imperial College, London
Musgrove, J. (ARIBA), Div. for Architectural Studies, Nuffield Foundation, London
Padgham, C.A., Dr., 14 Woodside Close, Amersham, Bucks
Perry, J.W., Hilger & Watts, London
Rushton, W.A.H., Dr., R.F.S., Physiol. Lab., Cambridge
Sanders, C.L., Dr., Techn. Optics Sec., Imperial College, London
Stiles, W.S., Natl. Phys. Laboratory, Teddington
Thomson, L.C., Inst. of Ophth., London
Weale, R.A., Dr., Inst. of Ophth., London
Wilson, M.H., Goethean Science Foundation, Stourbridge, Worc.
Winch, G.T., Dr., Res. Labs. GE Co., Ltd., Wembley
Wright, W.D., Dr., Techn. Optics Sec., Imperial College, London

FRANCE

Baumgardt, Ernest, Dr., 1, Avenue A. Briand, Cachan (Seine)
Déribéré, M., Dr., Cie des Lampes, Paris

Kellershohn, C., Prof. Dr., Faculté de Médicine, Nancy (M & M)
Leblanc, Georges, Cie Clémançon, Paris
Le Grand, Yves, Prof. Dr., Phys. Lab. Museum Natl. d'Histoire, Naturelle, Paris
Merlier, Robert, Compagnie Française des Matieres Colorantes, 9, Avenue Saint Georges, Paris
Roy-Pochon, Cécile, Mme., 15 Rue Jacques - Boyceau, Versailles
Tarnay, Fernand, Dr., 22 Rue Saint Saëns, Paris

GERMANY

Adam, Manfred, Wilhelm-Ostwald-Archiv, Grossbothen
Ahlenstiel, H., Dr. med., Hamburg-Altona, Altonaer Bahnhofsplatz 4
von Beckerath, Kurt, Dr. phil., Schroers & Co., Krefeld
von Beckerath, Kurt, Jr., St. Tönis b. Krefeld
Berger, Anni, Dipl.-Ing., Optisches Institut der TU Berlin
Berthold, W., Dipl.-Ing., i.H. C. Lorenz A.G., Stuttgart-Zuffenhausen
van Beuningen, Ernst, Dr. med., Univ. Augenklinik Tübingen
Born, Fritz, Dr. phil., Osram, Berlin
Breitlander, Dirk, Optisches Institut der TU Berlin
Budde, Wolfgang, Bundesanstalt für Materialprüfung, Berlin
Conradi, E., i.H. Berger & Wirth, Berlin
Dietzel, Karl, Justus-Liebig-Hochschule, Giessen
Dirbach, W., Dipl.-Ing., Ulm, Donau, Blücherstr. 19
Dolland, Claus, Inst. f. theoret. Phys., Univ. Freiburg
Dotzel, Walter, Dr., i.H. Gebr. Hartmann, Frankfurt/Main
Engelking, Ernst, Prof. Dr. med., Univ.-Augenklinik Heidelberg
Fesefeldt, Hans, Dr., i.H. Gossen & Co., Erlangen
Franzke, Paul, Radebeul 2, Dresden
Frieser, Hellmuth, Prof. Dr.-Ing., Afga, Leverkusen-Bayerwerk
Frühling, Hans-Georg, Dr.-Ing., Osram, Berlin
Gott, Otto, Dr., Deutsche Spiegelglas AG., Grünenplan/Alfeld-Leine
Haacke, Haat, Dipl.-Ing., i.H. Bernhard Halle Nachf., Berlin
Hansen-Schmidt, Hans, i.H. "Musterschmidt" K.-G., Göttingen
Harms, Heinr., Prof. Dr. med., Univ. Augenklinik Tübingen
Hartmann, Joh., Optisches Institut der TU Berlin
Haxel, Otto, Prof. Dr., Physikal. Inst. d. Univ. Heidelberg
Hellmig, Ehrhard, Dr. phil., Agfa, Leverkusen-Bayerwerk
Helwig, Hans-Joachim, Prof. Dr., Berlin-Schöneberg, Leberstr. 11
Hennicke, Irmgard, Dipl.-Ing., Optische Werke G. Rodenstock, München
Hennig, Dr., Deutsche Spiegelglas AG, Mitterteich
Hertel, Joachim, Optisches Institut der TU Berlin
Heynacher, Erich, Optisches Institut der TU Berlin
Hickethier, Alfred, Verlag H. Osterwald, Hannover
Hönl, H., Prof. Dr., Inst. f. theoret. Phys. d. Univ. Freiburg

Hoffmann, Konrad, Dr., Farbwerke Hoechst AG, Frankfurt/Main
Iriart, Pierre, Dipl.-Ing., Optisches Institut der TU Berlin
Jaeckel, Georg, Optisches Institut der TU Berlin
Jaeger, Wolfgang, Dr. med., Univ. Augenklinik Heidelberg
Jaensch, P.A., Prof. Dr. med., Essen, Hufelandstr. 55
Kammerer, Joachim, Optisches Institut der TU Berlin
Kaps, Eleonore, Optisches Institut der TU Berlin
Keilich, Dr., i.H. "Musterschmidt" K.-G., Göttingen
von Keller, Heinr., Dipl.-Phys., Optisches Institut der TU Berlin
Kirchhof, Günther, Dipl.-Ing., Optisches Institut der TU Berlin
Koch, Otto, Dr. rer. nat., Farbenfabriken Bayer AG, Leverkusen-Bayerwerk
Köhler, Walter, Dr. phil., Berlin-Wilmersdorf, Nikolsburger Platz 2
Krempel, Fritz, Dipl.-Ing., Osram, Berlin
Kundt, H.E., Dr. phil., Osram, Berlin
Larché, Kurt, Dr. phil., Osram, Berlin
Lompe, Arved, Dr., Osram, Berlin
Maleska, Waltraud, Bundesanstalt für Materialprüfung, Berlin
Monjé, Manfred, Prof. Dr., Physiol. Inst. d. Neuen Univ. Kiel
Münch, Wolfram, Dipl.-Ing., Osram, München
Quack, Friedr., Dr., i.H. "Musterschmidt" K.-G., Göttingen
Redondo Mena, Victoria, Dipl.-Mathem., Optisches Institut der TU Berlin
Remberg, H., Dr. med., Frohnhausen Dillkreis
Rennilson, Justin James, Optisches Institut der TU Berlin
Reuther, Rudolf, Prof. Dr.-Ing., Dresden, Erlweinstr. 10
Richter, Manfred, Prof. Dr.-Ing., Bundesanstalt für Materialprüfung, Berlin
Schaefer, Hans, Prof. Dr., Physiol. Inst. d. Univ. Heidelberg
Schirmer, K.-H., Dipl.-Ing., Inst. d. Deutschen Ges. f. Forsch. im Graph. Gewerbe, München
Schultz, Ursula, Optisches Institut der TU Berlin
Schultze, Werner, Dr.-Ing., Badische Anilin- & Sodafabrik AG., Ludwigshafen
Singhof, Walter, Dipl.-Chem., i.H. Chr. Lechler & Sohn Nachf., Lackfabrik, Stuttgart
Steinmeyer, Heinr., Dr., Badische Anilin- & Sodafabrik AG., Ludwigshafen
Tanner, F., Dipl.-Ing., i.H. Deutsche Philips Gmbh., Hamburg
Waubke, Dr. med., Univ.-Augenklinik Heidelberg
Wehlte, Kurt, Prof., Staatl. Akademie d. Bild. Künste, Stuttgart
Weise, Herbert, Bundesanstalt für Materialprüfung, Berlin
Wiedbrauck, Günther, i.H. Hostmann-Steinberg'sche Farbenfabriken, Celle
Willms, Dipl.-Phys., i.H. "Musterschmidt" K.-G., Göttingen
Wolf, Karl, Dr., Badische Anilin- & Sodafabrik AG., Ludwigshafen
Wyszecki, Günther, Dr.-Ing., Bundesanstalt für Materialprüfung, Berlin
Zimmermann, Wilhelm, D ., i.H. Sunlicht Gesellschaft AG, Mannheim

NETHERLANDS

Bouman, M.A., Dr., Kampweg 3, Soesterberg, Research Unit for Perception NDRC
Friele, L.C.F., Drs., Vezelinstituut T.N.O., Delft
Kruithof, A.A., Dr., Philips' Eindhoven, Roosendaal
Rutgers, G.A.W., Utrechtsweg 210, Arnhem
Walraven, P.L., Dr., Kampweg 3, Soesterberg, Research Unit for Perception NDRC

SOUTH AFRICA

Einhorn, H.D., Dr.-Ing., Univ. Kapstadt

SPAIN

Plaza, Lorenzo, Dr., Inst. de Optica "Daza de Valdes", Madrid

SWEDEN

Hesselgren, Sven, Dozent Dr., Regeringsgatan 40, Stockholm
Johansson, Tryggve, Försvarets forskninganstalt, avd. 2, Stockholm
Tonnquist, Gunnar, Försvarets forskninganstalt, avd. 2, Stockholm

SWITZERLAND

Eggert, John, Prof. Dr., Eidg. Techn. Hochschule Zürich
Ganz, E., Dr., Ciba, Basel
Mäder, F., Dr., Eidg. Amt. f. Mass u. Gewicht, Bern
Miescher, K., Dir. Dr., Ciba, Basel
Rometsch, Rudolf, Dr., Ciba, Basel
Rust, Ernst, Prof. Dr., Eleonorenstr. 18, Zürich

UNITED STATES

Balcom, Margaret M., NBS, Washington, D.C.
Balinkin, Isay, Dr., Univ. of Cincinnati, Cincinnati, Ohio
Breckenridge, F. C., NBS, Washington, D.C.
Farnsworth, Dean, Commander, New London, Connecticut
Fry, Glenn A., Dr., School of Optometry, Ohio State Univ., Columbus, Ohio
Judd, Deane B., Dr., NBS, Washington, D. C.
MacAdam, David L., Dr., Eastman Kodak Company, Rochester, New York
Nickerson, Dorothy, U.S. Dept. Agr., Washington, D. C.

TCCA MILLINERY AND GLOVE COLORS

New releases from the Textile Color Card Association describe the 1956 Spring and Summer Millinery Color Card and the 1956 Spring and Summer Glove Color Card. As explained by Estelle M. Tennis, executive director of the Association, the millinery colors were chosen after an intensive survey of advance spring trends in textiles and accessories to harmonize with or accent all the important costume colors, being especially linked with gloves in coordinated promotions. The pastel group, inspired by the colorful Riviera, include Petal Yellow, Jasmine White, Heavenblu, Pink Crystal, Italian Turquoise, French Helio, Monaco Pink, Dulcet Green, and Wheat. The town group includes Dawnbeige, Wild Honey, Glazed Chestnut, Santos Coffee, Relish Green, Wild Cherry, and Spring Gray. The third group strikes a dramatic note and has an oriental aspect: Tropic Peacock, Burma Green, Indies Blue, Aloha Gold, Tahiti Purple, Carib Orange, and Afghan Red. White, navy and black continue as classics. There are 23 colors in all. The glove colors, numbering 20, include 15 of the colors enumerated above, which points up the close correlation between the millinery and glove colors. Also present on the glove card are Cream Jasmine and India Ivory in the pastel range; Parisian Navy in the town group; Oriental Red in the oriental group.

DR. WYSZECKI'S NEW POSITION

We hear that Dr. Günter Wyszecki has accepted an appointment to the staff of the National Research Council of Canada, where he will be associated with Mr. W. E. K. Middleton's laboratory. Dr. Wyszecki has been visiting at the Institut d'Optique in Paris through November, and intends to return to Berlin for a short period before starting his association with the National Research Council on approximately January 1. A considerable fraction of Dr. Wyszecki's time in his new position will be spent on research in color. Those of us who are familiar with Dr. Wyszecki's work know that the National Research Council has made a valuable acquisition. We wish Dr. Wyszecki every success in his new endeavor.

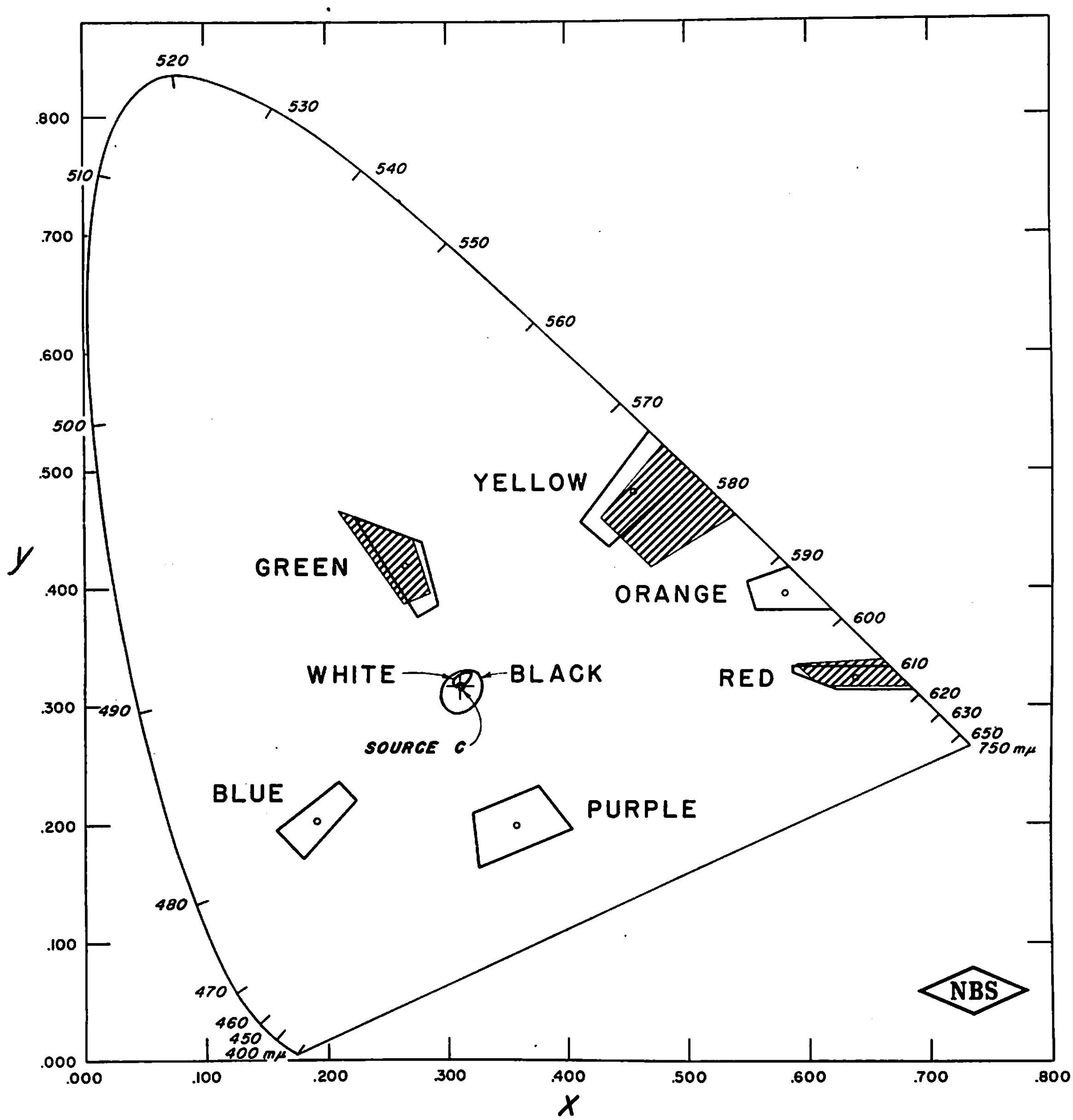
UNTIMELY DEATH OF L. C. THOMSON

We were deeply sorry to learn of the untimely death on October 10 of Dr. L. C. Thomson, director of the M.R.C. Group for Research in the Physiology of Vision, Institute of Ophthalmology, London. Professor Glenn A. Fry of the Ohio State University has visited Dr. Thomson's laboratory and is familiar with his work. Dr. Fry has kindly consented to write a brief obituary of Dr. Thomson, which will appear in the January issue of the News Letter.

ASA AND ISO SAFETY COLOR CODES

Ed. Note: We are indebted to Harry J. Keegan, ISCC Representative to the ASA Safety Color Code Committee, for the following article which gives the new ISO recommendations for safety colors and shows the relationship of these to the corresponding ASA colors.

A "Proposal for a draft recommendation Safety Colours" has been received through Mr. Henry G. Lamb of the American Standards Association from Dr. F. van Teutem, Secretary of the Hoofdcommissie voor de Normalisatie in Nederland. This document was prepared by the International Organization for Standardization, Technical Committee ISO/TC 80 - Safety Colours. It contains CIE specifications of the lines of limiting hues and saturation and tolerances of luminous factor, β, for the three colors recommended; namely, Safety green, Stop red, and Danger orange-yellow. These specifications resulted from a meeting at The Hague in May 1955 of a special ISO subcommittee on "Definitions of Safety Colours," at which Dr. Deane B. Judd, National Bureau of Standards, was the representative from the United States of America. The parts of the text on color are as follows: "No. 6387, Enclosure 44, ISO/TC 80 (Secretariat - 15) PROPOSAL FOR A DRAFT RECOMMENDATION SAFETY COLOURS.



CIE CHROMATICITY DIAGRAM SHOWING THE SAFETY COLOR CODES OF ASA (OPEN AREAS) AND ISO (CROSS-HATCHED AREAS)

---

1. PURPOSE AND USE

Recommendations are given with regard to the meaning and the application of a number of colours that are to be used for the purpose of preventing accidents and to meet certain emergencies which may arise in industry and public life.

SAFETY COLOURS ARE NOT INTENDED TO BE SUBSTITUTES FOR PROPER ACCIDENT-PREVENTION MEASURES.

DANGERS SHOULD BE REMOVED AND ACCIDENTS PREVENTED BY APPROPRIATE MEASURES OF PROTECTION. THE USE OF SAFETY COLOURS IS ALLOWABLE ONLY IN CASES IN WHICH IT IS IMPOSSIBLE TO APPLY APPROPRIATE SAFEGUARDS.

2. SAFETY COLOURS AND THEIR GENERAL MEANING

Colour	Meaning
Green	Freedom from Danger Free exit First-aid stations and materials
Red	Stop Fire fighting equipment
Orange-yellow	Warning of danger

3. DEFINITION OF THE SAFETY COLOURS

This definition is restricted to colours of surfaces which diffuse and reflect light.

The safety colours are defined by means of the CIE system of colour specification, as accepted in the resolution of the 8th session 1931 of the 'Commission Internationale de l'Eclairage' Cambridge, U.K.

The specifications are expressed in CIE chromaticity co-ordinates x and y, and the luminance factor β, determined under CIE conditions of illuminating at 45° with CIE Source C and viewing along the perpendicular to the surface.

The three safety-colours are defined as follows:

Colour Name	CIE chromaticity co-ordinates x and y, luminance factor β.
Safety green	$x > 0.526 - 0.683y$ $x < 0.410 - 0.317y$ $y > 0.282 + 0.396x$ $y < 0.547 - 0.394x$ $0.15 < \beta < 0.30$
Stop red	$y < 0.290 + 0.080x$ $y > 0.920 - x$ $y > 0.559 - 0.394x$ $y > 0.316$ $0.07 < \beta < 0.15$
Danger orange-yellow	$x > 0.048 + 0.827y$ $y > 0.120 + 0.632x$ $y > 0.887 - x$ $\beta > 0.45$

4. DIRECTIONS FOR THE APPLICATION OF SAFETY COLOURS

Safety colours should be applied in a very visible manner and generally on small surfaces so as not to interfere with colour schemes in which colours are applied to relatively large surfaces.

Black and white are recommended to be used as contrasting colours.

In general safety colours are used in the form of safety signs."

It is interesting to note that the three chromatic colors and their uses in the ISO document are essentially the same as those stated in the original ASA American War Standard, Safety Color Code for marking physical hazards and the identification of certain equipment (ASA Z53.1-1945). The present ASA American Standard Safety Color Code for marking physical hazards and the identification of certain equipment (ASA Z53-1953) recommends the use of six chromatic colors, red, orange, yellow, green, blue, and purple. However, the color definitions for the colors red, yellow, and green are the same in both the ASA War Standard and the ASA American Standard. From the Figure on page 11, it may be noted that the ISO and the ASA definitions for the colors red, green, and yellow (or orange-yellow) are essentially the same.

Harry J. Keegan

WHAT IS A COLOR CLINIC? Your editor, probably in common with many people, has always been curious as to what makes people want certain products in some colors and not in others. For example, women's suits may be highly salable in Color A, but may stay on the racks in Color B; on the other hand, electric blankets may be highly sought after in Color B, but shunned in Color A. Your editor was therefore very much interested in reading a paper by ISCC member Frederick H. Rahr and Elbridge B. Foskett which appeared in Journal of Retailing, Vol. XXI, Summer, 1955, No. 2, page 3. But even more important, from the point of view of satisfying our curiosity, we were very glad to have the opportunity to visit Mr. Rahr at his New York Offices and find out something about what his organization, the Rahr Color Clinic, is doing. After having read the paper and talked with Mr. Rahr we were left with the distinct impression that the question posed at the beginning of this article is a rather academic one from the point of view of large-scale marketing; of much greater practical importance is finding out in great detail just what these color preferences are. This is a new and important development in marketing; in fact, many of our ISCC members are engaged in this kind of work.

Mr. Rahr, your editor learned, is a well-known color consultant, whose services have been used by some of the largest retailers and manufacturers of colored merchandise of any description. His organization is built on the idea that Mrs. Consumer has a mind of her own, and knows what she wants, when it comes to color. Her color appetite, a product of many complex factors, is not something which changes with each passing fancy. On the contrary, it is clearly defined, and concentrated on certain definite and objective colors. These may be different for different commodities, even for different types of each commodity and from season to season. Those retailers and manufacturers who know in advance what these appetites are, will be in a better position to satisfy them, and will come out way ahead. It is information of this type which Mr. Rahr's organization and others like it supply.

Mr. Rahr, a cultured individual with an excellent command of the English language, has a great deal of respect for the taste of the consumer. "Too many retailers and manufacturers subscribe to the principle of 'Color by Command Decision,' and try to force colors of their own choice on the buying public," he said. "This is complete disregard for the desires of the people - a form of Fascism. Others claim that Mrs. Consumer's tastes are mercurial - she doesn't know what she wants. This is nonsense, and the facts prove it is."

Three years ago a new research group, "Customer Preference Clinics," was formed by Mr. Rahr and Elbridge B. Foskett, associate research director of New York University's School of Retailing. This organization has done a good deal of work in large department stores. An interviewing table and large color chart are set up, and customers are stopped and addressed with the following, carefully worded, message: "The...Company is very much interested in knowing your preferences in (name of item) regarding the color, size, fabric, style you want, and price you want to pay. Only in this way can we have the kind of merchandise you want to buy in the store and when you want to buy it. Would you mind answering a few questions?" The response is good, and customers are glad to answer the questions.

Data so obtained at the rate of about 1000 interviews a week per store are processed with the help of IBM equipment and statistical techniques to give a complete picture of the shoppers' wants with detailed reference to price, size, style, type of material and color for each product line. All major apparel, home furnishings, and appliance lines are reported. Mr. Rahr states that the individual store results are reliable on the 95% probability level and a composite of all store results on the 99.5% level, and can therefore be used with complete confidence as a guide to what the store should have on hand. This type of service is claimed to be quite valuable; for example, "lost sales," returns of merchandise and markdowns of prices are dramatically reduced. Manufacturers, too, profit by this type of information, according to Mr. Rahr. To come back to the lead paragraph, a large company which produces electric blankets, among other things, completely restyled its blankets one year to appear in six colors indicated by the Color Clinic to be the most desired for this product. A dramatic increase in sales resulted, 100% in two years.

Mr. Rahr numbers among his clients General Electric, The Ford Motor Company, The J. L. Hudson Company of Detroit, B. Altman & Company of New York, and many others in the United States and Canada. This would indicate that the kind of market research described is quite valuable, and already well established. We shall be glad to hear more of the Rahr Color Clinic and the Customer Preference Clinics and their progress in the future.

E. A.

THE FEDERATION OF PAINT AND VARNISH PRODUCTION CLUBS

Ed. Note: The following article, one of a series on our Member-Bodies, was written by a member of our News Letter Committee, Dr. Ralph E. Pike. We all know about the splendid job the FPVPC did in promoting the ISCC Color Aptitude Test - a good example of how both the ISCC and each of our Member-Bodies stand to gain by this type of cooperative effort. Dr. Pike's article presents an over-all look at the Federation and gives us in clear and interesting phraseology some idea as to the structure and aims of this important organization representing a major American industry.

In July, 1922 fifteen delegates, representing seven previously unaffiliated sectional Paint and Varnish clubs, founded The Federation of Paint and Varnish Production Clubs. At that time the objectives of the Federation were to promote the investigation and interchange of ideas among its members and to encourage research and application of the sciences in the manufacture and use of paints, varnishes, lacquers, related protective coatings, and printing inks. The Federation has grown through the years to a present membership of over 3,500 in twenty-four constituent clubs, twenty-one of which are in this country, two in Canada, and one in England.

Membership in a constituent club automatically provides for active membership in the Federation and requires that the individual be specifically engaged in production or technical work in the industry. Various classes of affiliated memberships are also provided for students and others engaged in related but definitely technical activities.

Federation activities are administered by the President and a Board of Directors, who are elected from the active membership. Policies are guided by a Council representing the national officers and duly elected delegates from the constituent clubs. Routine functions of the Federation are carried out by the office of the Executive Secretary, C. Homer Flynn, presently located at 121 South Broad Street, Philadelphia 7, Pennsylvania.

The present objectives of the Federation are:

1. To develop or provide practical and technical facts, data, and standards fundamental to the manufacture and use of paints, varnishes, lacquers, related protective coatings, and printing inks.

2. To promote the investigation and interchange of ideas among its members and to promote research and application of the sciences in the manufacture and use of these products.

3. To arrange for the collection and dissemination of information pertinent to the industries served by the Federation and for the presentation, discussion, and publication of papers and other contributions.

4. To encourage the establishment of constituent clubs and to coordinate their activities with those of the Federation.

5. To perform a public service by the constant improvement of products and elimination of wasteful methods in manufacture.

The official organ of the Federation is the "Official Digest", which is published monthly. In addition to its normal function of reporting on the various activities of the Federation and the constituent clubs, the "Official Digest" also serves as an important technical reference source for the industry. During 1955 the use of color printing in the "Official Digest" was effectively used for the first time to illustrate an article on "New Trends in Colored House Paints".

An annual meeting is held in conjunction with an elaborate paint industries show. The national meeting, always well attended, provides a stimulating three-day program which includes several outstanding speakers, reports on technical problems completed by the constituent clubs, and symposiums. A symposium on color and the use of color measuring instruments is presently planned for the 1956 annual meeting to be held in Cincinnati.

Joint committee activities are carried out by the Federation with many groups in fields of common interest. In addition to the Inter-Society Color Council, close liaison with ASTM; the National Paint, Varnish, and Lacquer Association; the Inter-Society Corrosion Council; and the Steel Structures Painting Council is maintained. The better known committees of the Federation, or what we call our "service committees", cover such fields as corrosion, education, research, standards and methods of tests, and technical advisory. Today, the principal interests of the Federation, however, are in the fields of research and technical education.

> Research is encouraged by support of projects of broad interest to the industry by individuals, industrial laboratories, research organizations, universities, or constituent clubs. There are about 45 constituent club projects presently active and about ten percent of these are related to the field of color and appearance specification.

> In the field of education, the Federation is directly concerned with a continuous and adequate supply of trained technical personnel for the laboratories and plants of our industry. To this end it assists educational institutions to establish and maintain paint technology courses. In addition, the dissemination of information and support of educational projects of interest to the industry are encouraged.

The Federation is closely affiliated through what is known as the "Tri-Alliance", with the Oil and Colour Chemists Association of the British Commonwealth, and FATIPEC of continental Europe. These organizations are closely patterned after the Federation in both organisation and objectives. This form of liaison provides for effective international exchange of ideas, technical resources, and fellowship. A report on the recent FATIPEC Congress on "Theoretical and Practical Aspects of Color Matching" was included in the July issue of the News Letter.

The advantages to the Federation of its affiliation with the Inter-Society Color Council were recognized in a general way early in the life of the Council. Full use of the potential benefits were not realized until 1948 or 1949. At that time the Federation was becoming vitally interested in color and particularly in means for identifying color aptitude. Advised of the earlier work of the ISCC Committee on Problem No. 10, a plan was formulated that resulted in Federation sponsorship of the present Color Aptitude Test. To date, about 175 of these test sets have been placed in useful service and considerable validation data assembled. This successful completion of the project through the cooperative efforts of the two organizations is a clear example to the membership of the advantages to be gained by the affiliation. The splendid personal cooperation so evident in this project sets an excellent example for other joint committee activities. The Federation is looking forward to future cooperative efforts to utilize more effectively the science of color in the development of more efficient methods of manufacture as well as better use of color in the protective coatings field.

R. E. P.

NEW YORK UNIVERSITY COLOR SEMINAR

A Color Seminar, currently being presented in a series of weekly meetings at New York University, has been arranged in three phases: The Nature of Color, Color to Sell Wtih, and Color to Live With. Each week features a new guest speaker, and we note among them ISCC members Faber Birren speaking on "Psychological Aspects of Color Symbolism," Frederic H. Rahr speaking on "Color Trend Forecasting," and O. C. Holland whose topic is "Color in the Graphic Arts." The Seminar director is Robert I. Goldberg, formerly Vice Chairman of the New York Chapter of the Industrial Designers Institute. This is the first of a series of color seminars which will be held every year, and further information may be obtained by writing to the Division of General Education of New York University.