Nole: 2.16 [illegible]

[illegible] 7/31/51 [illegible] 7-27 MHB 7-27 [illegible] 7-27 MAB 7-30 [illegible] 7-31

INTER-SOCIETY COLOR COUNCIL

NEWS LETTER NO. 93

MARCH, 1951

News Letter Committee:

Faber Birren
I. H. Godlove
Deane B. Judd
Dorothy Nickerson

I. H. Godlove, Editor
127 Spring Garden Street
Easton, Pennsylvania

Dorothy Nickerson, Circulation Manager
Box 155, Benjamin Franklin Station
Washington 4, District of Columbia

For matters of business
Address the Circulation Manager

Subscription price to non-members
$4.00 annually

NEW MEMBER BODY ELECTED

We are very happy to welcome the Technical Association of the Lithographic Industry as our 21st Member Body.

President of the association is Dr. Marvin C. Rogers of R. R. Donnelley & Sons; and George W. Wilhelm, 814 North East Avenue, Oak Park, Illinois, is secretary-treasurer. W. P. Greenwood of Forbes Lithograph Mfg. Co., Boston, an individual member and formerly active in the Boston Color Group, will be chairman of TALI's delegates to the ISCC. Mr. Greenwood reports that within a very few months the name of the organization will be changed to Technical Association for the Graphic Arts, in order to be more nearly descriptive of their group. We hope and fully expect that the association of this 21st Member Body with the ISCC will prove of mutual benefit.

NEW INDIVIDUAL MEMBERS

We are glad also to welcome as individual members the following persons whose applications were approved on February 27 by the Executive Committee:

George P. Bentley, Instrument Development Laboratories, Needham Heights, Mass., particularly interested in instruments, sample presentation, and conditions of illumination and viewing (makers of the Color-Eye); member of Instrument Soc. of America and Institute of Aero. Sciences;

Irene R. Eno, with the Veterans Administration, Washington, D. C., interested in color as an element of design in relation to environment; and in teaching;

Bernard Fread, M. D., New York City, ophthalmologist interested in all problems relating to the eye and vision; member of O.S.A.;

Dorothy M. Gleason, Sioux City, Iowa, interested particularly in mural designing and interior decorating, formerly with the Container Corporation, Chicago;

Alex. E. Javitz, New York City, Associate Editor, Electrical Manufacturing, particularly interested in application of color in product design, both for appearance and functional purpose; member American Chemical Soc., Soc. of Plastics Engineers, Inst. of Radio Engineers;

Miss Evelyn Julesgaard, with Faber Birren & Company, New York City, interested in the promotional and merchandising aspects of color;

Boris Kompaneysky, Color Laboratory in the Physics Department of the University of La Plata, Buenos Aires, Argentina, has published for many years on color in the Bechtereff Institute for Beain Research (Leningrad), in the Russian Academy of Arts, also the University of Vienna. A list of his scientific papers and inventions accompanied his application;

Elsie Murray, Ithaca, N. Y., a psychologist well known in the field of color vision tests and testing; member A.P.A.

Marie Nichols, of Marie Nichols Fabrics, New York City, works chiefly with upholstering fabrics;

Warren B. Reese, with the Macbeth Corporation in Newburgh, N. Y., interested in electronic devices for measurement of color, formerly with Ansco, member IES, OSA, SMPTE;

Manfred Richter, Berlin, for many years well known in the science of colorimetry, having published from the Textile Research Institute at Dresden, then the Illuminating Engineering Laboratory, since 1938 Chief of the Color Research Laboratory, Office for Testing Materials Berlin-Dahlem, and since 1941 Docent at the Berlin Technical University. A list of Dr. Richter's publications accompanied his application.

Technicolor Motion Picture Corporation, Research Library, Attn. L. M. Dearing, formerly with Eastman Kodak, during the war years with U. S. Navy Photographic Center, member O.S.A., S.M.P.T.E.

PHILADELPHIA-WILMINGTON COLOR GROUP — This group met for its Eleventh Meeting at 8:00 P.M. in the Philadelphia Textile Institute, Henry Ave. and School House Lane, Germantown, Philadelphia, following an informal dinner at the Alden Park Manor. The speakers of the evening were Mr. Walter A. Kaiser and Philip E. Tobias, Research Engineers of Edward Stern & Co., Inc., who discussed Color Problems in Multi-Color Printing. Mr. Kaiser has been associated with the graphic arts for over thirty years, much of it with the offset process, and he was instrumental in development of the aquatone- now called Optack-process. He writes extensively for trade papers and has been active as President and Director of the Philadelphia Litho Club. Mr. Tobias is a professional Chemical Engineer with over five years experience in the graphic arts. His master's degree was obtained at Brooklyn Polytechnic Institute. He also did research at the National Bureau of Standards before joining Edward Stern & Co. He is a member of Sigma Xi, ACS, AIChE, AAAS, TALI and TAPPI.

The twelfth Meeting also followed dinner and dinner and meeting were held at the same two places. The date was March 15 and the speaker was Dr. Peter C. Goldmark, Vice-president, Engineering Research & Development Dept., Columbia Broadcasting System, whose subject was Color Television, a subject of very timely interest. Dr. Goldmark is known throughout the country for his pioneering work in this field. He is a member of the ISCC and has given lectures on this subject at their meetings. The Group was fortunate to secure such an outstanding speaker and we are sure his talk was very much appreciated by the membership.

CALIFORNIA COLOR SOCIETY

This Society met on January 31, after our January issue had gone to press, at the Art Center School Auditorium, Los Angeles. They were addressed by Rex Brandt, distinguished California watercolorist. His subject was: Part I, Demonstrations of the root concept of color from pre-Renaissance through history to post-expressionism; Part II, Applications made by the artist and color consultant, and the relation of light to color. Mr. Brandt has exhibited in leading cities, and is the winner of more than twenty awards. His work appears in Fortune, Colliers, and the Post. He is now free-lancing, and conducts a summer painting school in Corona del Mar with Phil Dyke.

The February meeting was held at the same place on February 28 at 8:00 P.M. The subject of the evening was The Theory of Subtractive Color Reproduction. The topics included: (1) A brief discussion and demonstration of subtractive theory; (2) brief surveys of subtractive methods in (a) photographic color reproduction, and (b) graphic-arts color reproduction; (3) theoretical limitations of color reproduction in (a) color photography, and (b) the graphic arts. The speakers were: Mr. Frank Wilbar, medical photographer at the Huntington Memorial Hospital, Pasadena and Instructor of Photography at the Fred Archer School of Photography; Mr. Art Widmer of Warner Bros. Studio, recently with the Research Laboratories and Motion Picture Sales Department of Eastman Kodak Company; and Mr. Morris Marsh of Jeffries-Banknote Company, dealing with Lithography and Printing.

COLOR GROUP OF THE PHYSICAL SOCIETY

The Fifty-Seventh Science Meeting of the Group was held on January 11 in the Lecture Theater of the Institute of Ophthalmology, Judd Street London W.C.I. The paper of the evening was on Colour Vision Characteristics of Egyptian Trichromats, by Dr. I. G. H. Ishak, of Ibrohim Pasha University, Cairo, and Imperial College, London. Dr. Ishak dealt with experimental determinations of the response functions of nine observers with normal color vision, using Wright's colorimeter, with an analysis of present data, with the adequacy of the present C.I.E. (I.C.I.) standards, and with the problem of yellow pigmentation.

The Fifty-Eighth Science Meeting of the Group was held on January 31 in the Physics Department, Imperial College, Imperial Institute Road, London S.W.7. Professor H. Moore, of the Department of Glass Technology, University of Sheffield, read a paper on the Analysis of the Colours of Glasses Containing Iron. Spectrophotometric transmission curves of glasses containing iron have been analyzed by means of similar curves given by "fully ferrous" and "fully ferric" glasses. To account for the color it is necessary to add a "grey" absorption attributed to ferrosoferric oxide, and the results also indicate that, in most glasses, a considerable proportion of iron does not contribute to the color.

COLOR FOR THE BLIND

Recently we had from Helen Taylor a very interesting article from the Philadelphia Inquirer Magazine of February 12, 1950, on color for the blind. The article was by Constance Myers and reported a recent book by two Philadelphians, Jeannette Freed and Henry Singer, both employees at the Free Library who have prepared "A Picture Book in Color for the Blind." Their purpose was to introduce pictures to the blind and to convey some suggestion of the glory of the beautiful world of color. Miss Freed herself is blind.

The key to the method is an opening page in which there are patches representing nine colors, each patch being labeled in Braille. Red is a gritty, rough surface;

green is more pleasant to the touch; violet is a gritty surface; blue is a soft, felt-like surface. There are also patches for orange, brown, yellow, black and white. The article includes one of the illustrations - two colorful birds against a green background. We agree with others who have seen the article that this is an unusual application.

GRAY FINISHES FOR INDUSTRIAL APPARATUS AND EQUIPMENT

Gray Finishes for Industrial Apparatus and Equipment, sponsored by the Mechanical Standards Committee of the American Standards Association. Published as ASA Z55.1-1950 by ASA, 70 East 47th Street, New York 17, N.Y.; eight pages 8½ x 11 inches; plus four standard color chips; price, 35¢ per copy for pamphlet alone, $2.50 complete with color chips.

Representing several years of work on the part of organizations and groups representing all classes of manufacturers and users, this American Standards specification represents an important forward step in the unified effort of industry to reduce the number of colors for industrial apparatus machines and equipment. General acceptance of this new standard by individual manufacturers and purchasers of industrial equipment is expected to reduce considerably the cost of finishes and finishing. Purchasers of equipment will benefit by greater ease and accuracy in specifying colors, and in securing matching colors on equipment from different manufacturers.

Each of the four grays may be specified by a name or a number given below. The numbers indicate the approximate degree of lightness and darkness of grays. Munsell Renotations for hue, value, and chroma accurately identifies each color.

Name	Number	Munsell Renotation
Light Gray	#61 Gray	8.3 G 6.10/0.54
Med. Light Gray*	#49 Gray	10 BG 4.90/0.60
Med. Dark Gray	#33 Gray	7.8 B 3.30/0.94
Dark Gray	#24 Gray	10 B 2.40/1.18

*Closely approximates Machine Tool Gray (7B) a standard of the National Machine Tool Builders' Association.

Contrary to the popular conception of grays, they are not necessarily variations in proportions of black and white. They may be light or dark colora with low or weak chroma (less than 1.5). Actually the present Light Gray is a "green"; Medium Gray is a "blue green", and Medium Dark and Dark Grays are "blues" under the more discerning "eye" of a spectrophotometer. (From Illum. Engin. 45, Sept. 1950, pp 26A-27A.)

THREE COLOR MEETINGS

Three color meetings have passed into history; and we wish we had space to picture and record all the interesting details of these coordinated events. Unfortunately, we do not. We refer, of course to the five days from Feb. 27 through March 3, with color especially featured on the first three days and color vision on the fourth. The first meeting, that of Committee E-12 of our member-body, the ASTM, under the able chairmanship of Mr. M. Rea Paul, moved rapidly. Morning speakers included R. S. Hunter, S. M. Newhall, D. B. Judd, J. W. McNair, K. S. Gibson and E. I. Stearns, all effective speakers, well known in their respective fields. No less interesting were the talks, related to types of materials, such as paper, ceramics, and textiles, by M. Kantrowitz, R. F. Geller and W. M. Scott, for these materials; and for other materials, J. C. Richmond, L. A. Melsheimer, H. F. Clemmer, H. B. Trost, W. A. Kirklin and G. W. Ingle.

The 20th Annual Meeting of the ISCC, on the next day, began with a Discussion Session pushed along ahead of schedule by the Problems Committee, Chairman M. J. Zigler, the discussion leaders on seven problems being D. B. Judd, W. C. Granville, F. L. Dimmick and C. E. Foss, R. H. Osborn, R. S. Hunter and J. L. Barach. At the Business Session, under the chairmanship of I. A. Balinkin, along with reports by representatives of most of our 20 member-bodies, were three on two American Standards Association projects (H. J. Keegan, C. E. Foss and N. F. Barnes). ?

Color in Government

The first day (March 1) of the session of the Optical Society of America was said to be the most interesting from a color standpoint, of any of its meetings of recent years. Following the three invited papers of a symposium on Polarization and two contributed papers, there were five papers relating to colorimetry in the morning (by R. S. Hunter, H. J. Keegan and H. T. O'Neill, I. H. Godlove, H. Hemmendinger & N. B. Libhart, and G. H. Conant, Jr.) In the afternoon, papers of special interest to color workers were contributed by R. H. Peckham; R. T. Mitchell, A. Morris and F. L. Dimmick; L. L. Sloan, H. R. Davidson and H. Luttringhaus, R. W. Burnham; H. K. Hammond, III and I. Nimeroff; S. Q. Duntley; W. E. K. Middleton & C. L. Sanders; and by F. Scofield. In the evening there was also an interesting invited lecture: "The First Half Hour of Creation." On March 2 came the Ives Medal address by the well merited recipient of the medal Dr. Brian O'Brien, on "Vision and Resolution in the Retina." Following this came one of the best Symposia on the present state of visual theory it has ever been the Editor's good fortune to hear, with papers by S. A. Talbot, H. K. Hartline, J. M. Otero (a guest from Spain) and George Wald, all very well known workers in this field. Of the March 3 papers, those of most interest to color workers were ones by M. R. Nagel, R. Stair and M. H. Sweet.

On the evening of the 28th, following the I.S.C.C. dinner in the cafeteria of the National Bureau of Standards, whose 50th Anniversary was being celebrated, Open House was held at the Bureau under the auspices of the Photometry and Colorimetry Section of the Bureau (K. S. Gibson, head); and for the Optical Society on March 2 an afternoon trip through the Bureau was arranged to exhibit the optical research work and facilities of the Bureau. These events and the informal dinner that evening, when Dr. K. S. Gibson, Director, and Dr. E. C. Crittenden, retiring Associate Director, spoke briefly but entertainingly, all combined with the many papers to make the combined meetings a very memorable event.

I.H.G.

KODAK COLOR HANDBOOK From the February 1951 issue of the Journal of the Optical Society of America we pass along the information that the Eastman Color Handbook, a publication by the Eastman Kodak Company, Rochester, New York is available at most photographic dealers ($4.00), and as a manufacturer's guide is unusually complete and useful, not only in the use of their own manufactured products but in the broader aspects of the characteristics of color, general theory of color photography, illumination, color harmony, and the application of these principles in outdoors and studio color photography. A separate section has been included on the available types of Eastman color films, including their storage, handling, processing, and characteristics. The combination of four separate publications, amounting to some 240 pages, is well and attractively bound in a loose-leaf ring binder. The entire edition is illustrated with many good and some poor color illustrations.

These "poor" illustrations have been intentionally included to show effects of improper exposure, illumination and film type. Such illustrations are in general more satisfactory for technical study than lengthy verbal explanations, especially for those who have a general knowledge of color mechanics.

PROF. KOMPANEYSKY AND DR. RICHTER Two new Individual members of the ISCC submitted, with their applications for membership, lists of their publications. One of the new members is Prof. Univ. Dr. Boris Kompaneysky, formerly Director of Laboratories for Color Research in the Bechtereff Institute for Brain Research, in the Russian Academy of Arts, (both in Leningrad), and in the Physiological Institute of the University of Vienna; now head of a Color Laboratory in the Physics Department of the University of La Plata in Argentina. The other new member is Dr. Manfred Richter, also well known to workers in colorimetry for his publications (see the list of new members). We take this opportunity of welcoming both these scientists to our numbers. Professor Kompaneysky's list includes 27 bibliographical references and 21 patents. Dr. Richter's list includes over sixty books and articles. We hope some time, when our News Letter material is less than we now have on hand for this issue, to insert copies of these lists for interested persons. If anyone feels he cannot wait for this publication, perhaps our Secretary will be willing to arrange for photostatic copies for him, as she did for us. Her address may be found on page 1 of this issue.

COLOR BECOMES A SCIENCE The following item telling about work of an associate editor of the News Letter was received from Miss Evelyn Julesgaard on January 23, just too late for our January issue. Under the heading "Color Becomes a Science", she says:

Color becomes a science in the United States. In telling the world about it, the Voice of America program has made two recordings with Faber Birren, color consultant as guest, and Roger Lyons, program director. These programs will be broadcast abroad on the Crossroads America and University America radio series.

How does color affect the American way of life? The average person in the U. S. and abroad is little aware of the fact that a group of pioneers in America have made research studies of the scientific aspects of color in relation to human welfare. These men, known as color consultants, have made seeing easier and minimized eyestrain in the factory, office and school with the correct application of color.

Faber Birren has gone so far as to institute a color safety code that is specifically responsible for reducing accidents in hazardous occupations in industrial plants. These men are making an important contribution to the welfare of the working man and woman as well as the school child. Their efforts are made possible, in large part, by business and industry which have granted large sums of money for research in color. Thus a realm of activity which heretofore has been reserved for the artist and esthetic enjoyment, now goes hand in hand with our way of life in creating more liveable and workable surroundings for Mr. and Mrs. Average American.

Specifications which counteract adverse seeing conditions, lessen fatigue and safeguard against accidents call for the use of green and blue-greens to reduce nervous and muscular tension, and to provide an ideal environment for sedentary tasks, concentration and meditation. Traditional white walls may cause the pupil of the eye to close and may set up annoying distractions.

These same specifications may be applied to many fields to take the place of the monotonous "institutional tan." However, a peach tone is also suggested to prevent glare and give a uniform adequate brightness that is psychologically warm.

Much can be said about human reactions to the colors of the spectrum, and may be found in Mr. Birren's latest book, "Color Psychology and Color Therapy."

Mr. L. van der Plas, of Sikkens Paint Company, Holland, is presently in the U. S. to study the results of Mr. Birren's research which has led to unique achievements in personnel relations, product development, merchandising and industry. In these days when efficiency is vital, when human energies must be conserved, when economic waste must be avoided, both the American and European businessman is attaching much importance to the right specifications of color. The discovery that color can be put to effective use in security and national defense, and can add psychological comfort and pleasure to our way of life has been recognized only in the last few years.

YOUR DAD AND MY DOG The preceding item mentioning a book by our associate editor, Faber Birren, which we reviewed in our July 1950 issue, reminds us of a story. One or two people told us that our review was not as favorable as we intended it to be; and this was a surprise to us. And thus the story. The little boy was brought up shortly by the big bully of the neighborhood. "What's this I hear", he barked, "about your saying that my dad hasn't any more brains than your dog?"

"Oh no," quickly replied the smaller boy. "I didn't say that. What it said was that my dog has as much brains as your dad." "Okeh," said the bully, "that's different." And there is a difference.

We did not say the Birren's last book was worse than his "Selling With Color", which we liked so much. What we meant to say was that his "Selling With Color," was even better than his "Color Psychology and Color Therapy." And in case any one wants to see what others think of the book, there is a review of it in the October 1950 American Journal of Opthalmology by Irving Puntenney.

METAMERIC COLORS The following draft of the A. A. T. C. C. REPORT ON METAMERIC TEXTILE SAMPLES was submitted for the A. A. T. C. C. COLOR COMMITTEE by its chairman, Frederick T. Simon.

Metameric matches are well known to most of the textile industry since these represent a large portion of the color matches obtained. The effect of metamerism will be even more pronounced in the future with the advent of important usage of a great variety of synthetic fibers. There is no recourse from extreme examples of metamerism on different fibers, since dyes of different chemical constitutions must be used on different fibers. Even when it is possible for the same dyes to be used, the results will be metameric to the extent that the optical properties of the fibers differ.

Three near neutral samples were chosen on the basis of the I. C. I. data to represent equal color differences on three fibers; nylon, wool and rayon. The color of the nylon sample was indicated to be roughly intermediate between the rayon and the wool. When these are examined visually with Macbeth 7500°K. daylight there is no agreement with the I. C. I. data in that the wool and nylon sample appear to be not too far from a match, whereas the relation of the wool with the rayon seems to be correctly represented by the I. C. I. data. A number of facts are known about these samples which may explain this phenomena.

1. The spectral reflectance of the wool is relatively higher from 400 - 450 millimicrons compared to the wool and rayon.

2. The spectral reflectance of the wool is relatively higher from 620 - 680 millimicrons compared to the nylon and rayon.

3. Colorimetric data which agrees with visual observation (Macbeth 7500°K.) are obtained if the energy distribution of a special illuminant is substituted for I. C. I. illuminant "C" in the integrations. The special illuminant is a combination of a photoflood lamp with a Macbeth filter and has an equivalent color temperature of 13,200°K.

4. Apparent visual agreement with normal I. C. I. data (using illuminant "C") is obtained by several observers suspected of having heavy ocular pigmentation. Ages of all these latter observers in their 50's and 60's.

5. Apparent visual agreement with normal I. C. I. data (using illuminant "C") is obtained by several observers if the angle of sample subtence is reduced from 6-8° to 1-2°. These observers are younger than those described in "4." above, and are presumed also to have rather normal ocular pigmentation.

6. The device of substituting, as in point "3.", a different illuminant in place of illuminant "C" is not merely a change in red-blue ratio but also of spectral distribution. This is based on the fact that when integrations are performed using other distributions (e.g. Planckian, Taylor-Kerr) with approximately the same equivalent color temperature, the results are not favorable. The point of difference seems to be between 620 and 680 millimicrons; if the $\bar{x}$ function were reduced in this region by a maximum factor of 0.75 at 650, better agreement could be obtained.

7. Evidently agreement with visual data would be obtained if the $\bar{x}$ function were made larger, more particularly 400 to 460 millimicrons.

8. Approximate Munsell data on the samples are as follows:

	WOOL	NYLON	RAYON
Illuminant "A" (computed)	9.3P 4.10/0.95	4.0P 4.18/0.45	8.4PB 4.12/0.55
Illuminant "C" (computed)	6.8P 4.08/0.83	3.6P 4.17/0.59	8.5PB 4.12/0.49
Illuminant "D" (computed)	5.4P 4.07/0.80	4.3P 4.17/0.64	10.0P 4.13/0.59
Macbeth 13,200°K. (estimated)	5.0P 4.07/0.80	5.5P 4.17/0.79	2.2P 4.13/0.53
Visual Estimate (Macbeth 7500°K.)	5.0P 4.1/0.80	5.5P 4.2/0.80	1.0P 4.0/0.60

THEY HAVE GONE PHOTOMETRIC Our good Baltimore friends have apparently so strongly impressed the city that it has gone scientific. K. Katz & Co. advertised recently in the Baltimore Sun that it has "Now for the first time Photometric custom suits for Ladies starting at $85." We suppose it's the suits which start there. Below we learn that their method "photographically records your posture and contours as well as your measurements."

TWO NEW BOOKS We have received announcement of another book by Louis Cheskin: "Color for Profit"; Color Research Institute of America, 176 Adams St., Chicago 3. The prospectus indicates that the book is designed for use by business men, advertising executives, designers, artists and creative salesmen to increase sales by the use of test-rated designs and color combinations on packages and advertising pages; and that it is based on case histories in the Institute files. Price $3.50.

Another book is the new Second Edition of Maerz and Paul's "Dictionary of Color"; McGraw Hill Book Co., 330 West 42nd St., New York 18. As is well known, this work shows 7000 printed colors with the corresponding color names for about half of them. It is the standard work in this field. The price is $25.

COLOUR We have just received an interesting 120-page book of this title published by the Dyestuffs Division of Imperial Chemical Industries Ltd. It is a collection of nine papers describing "Investigations in the Fields of Colour Physics and Colour Psychology Carried out in the Laboratories of the Dyehouse Department of I.C.I. Dyestuffs Division at Blackley, Manchester, during the period 1940-1948." It contains a foreword by G.S.J. White, Chief Colourist of the division, who correctly remarks that the first (and introductory) paper, by him and Dr. T. Vickerstaff, though "not quite up to date" is still a useful survey of the literature. The collection is, as Dr. White calls it, a "mixed bag," ranging in content from papers on the "Estimation of Dyestuffs in Solution and on the Fiber" to "Colour Harmony." If, therefore, in this collection we feel a lack of the completeness and unity of a textbook on color or colorimetry in the dyestuffs industry, we must remember that this is an assemblage of isolated papers honestly sailing under no false colors. Perhaps in part because the book comes from a technical research laboratory rather than from a center of academic research, it is marked by a realistic common-sense approach to the various problems dealt with.

The arrangement of papers is not chronological; instead, it groups them by type of subject matter contained; for example bringing together a paper on the legibility and esthetic value of colored inks on colored papers and the paper on color harmony. The first paper, on Colour (White and Vickerstaff) largely follows orthodox lines, beginning with light sources. No explicit definition of color, physical, psychophysical or psychological in nature, is given. But there is nothing in conflict with recent trends toward a psychophysical definition in this country. Among illuminants, Miss Nickerson's use of an "even bluer light than Illuminant C" is mentioned and there follows the prediction that the use of B "is doomed." The use of Spectrophotometry is regarded as "ideal from the dyer's point of view;" and it is explained why no great use of the method has been resorted to. It is "almost impossible" to predict from color measurements that amount of dye required to match a sample. Formulas relating to reflectance to concentration are considered. The Snow duplex spectro reflectometer is mentioned as a step toward an electronic device into which are fed curves representing properties of three component dyes, and which would represent the resulting mixture in the form of a graph, ultimately arriving at the required proportions of the three components.

Under the "observer," the Willmer theory and the criticisms to which it has given rise, is followed by the Young-Helmholtz theory and work of Granit and Hartridge. Under "afterimages," it is stated that the work of Craik (1940) shows afterimages to be due to retinal processes, not to effects occurring in the brain. Hecht's work, on the quantum relations of random emission from sources is mentioned. Under "colour blindness," work of Ishihara, Garnes and Farnsworth is mentioned.

On page 19, it is stated that the Ostwald and Munsell color systems are "very similar in their fundamental arrangements." This seems rather a stretch, for the former analyzes colors in terms of the black content, white content, and content of full color, while the latter analyzes in terms of the three color attributes hue, value and chroma. In the Ostwald triangles, the full colors are all put at the same (middle) value level, while the typical Munsell full yellows are light and the full blues dark, and so on, thus in practice only (not in theory) giving triangles, variously shaped. The authors believe that, of the multiplicity of systems, only the I.C.I., Munsell and possibly the "monochromatic" systems, will endure. The Silberstein-MacAdam ideas on the inadequacies of plane mixture diagrams are mentioned; but it is stated (with Wright) that color differences can probably be sufficiently accurately represented by present uniform chromaticity diagrams.

Moon and Spencer's work on color harmony, and Spencer's formula for adaptation effects are criticized; and the binocular matching device of Wright for studying adaptation is mentioned. The paper ends with the remark that "in the application of colorimetry to practical problems, the Americans are pre-eminent." But the rest of the book illustrates that in dyehouse color problems, the British, especially the I.C.I. workers, may be setting the pace for us.

In "The Physical Significance of the Dyers' System of Colour Matching," by White, Vickerstaff and E. Waters, 154 different color combinations (11 papers each with each of 14 inks) were studied on printed leaflets. Here in ingenious experiments with 38 observers, were determined the effects on visual judgments of strength, of dyeings on increasing grayness, when the dye strength was objectively constant, 12 non-colorists judged a lighter dyeing as being weaker (apparently basing their assay primarily upon lightness), while 26 experienced colorists judged the dyeings primarily on the basis of excitation purity. The maximum effect was a 9% "error." Both groups probably combined reflectance with purity as the bases of judgments. The Editor's work agrees with these conclusions, except that with yellows and some oranges, the rate of change of strength with reflectance is too low for any safe judgments; and the change of purity (or saturation) alone at high strength may be misleading; for there may be two very different values of strength having the same purity (or especially, saturation).

The paper by Vickerstaff on "The Brightness of Present-Day Dyes" is probably too well known here to need further comment. We have reviewed it before in these pages. The actual chromas obtained with commercial dyes were compared with MacAdam limiting possible chromas, after "correction" of the color solid for surface reflection. The result shows that in certain yellows, we have gone much of the way, while in greens and blue-greens (where the absorption band is carried from the ultraviolet most of the way across the spectrum), great improvement in brightness is still possible.

The "Brightness and Hue of Present-Day Dyes in Relation to Colour Photography" is by Vickerstaff with M. E. Clarkson. In a figure, the range of chromas obtained with present dyes is compared with the Munsell range and the theoretical limits (lying between them) at 10%, 20% and 40% "brightness" levels. Of several "rectangular" primaries, it appears that ones with "cut-off" at 490 and 580 mμ, are to be preferred; but the precise point of spectrum division is not critical. Sloping (overlapping) cut-offs are better than "vertical-sided" primaries at low lightness levels, while at higher lightness this is only slightly true or reversed; at 80%, there is little difference between different sets of primaries. The range of the Kodachrome and Technicolor processes are examined. It is predicted that the future will show an advance even beyond the range of the latter.

In an "Investigation of the Legibility and Aesthetic Value of Coloured Printing Inks on Coloured Papers," by Vickerstaff and C. S. Woolvin, 154 different color combinations (11 papers each with each of 14 inks) were studied on printed leaflets. The 12 observers cast "votes" for most and least legible, and most and least pleasing combinations. With paper constant, the most legible ink was black, followed by dull greenish blue, phthalocyanine blue, purple and navy blue. With constant ink, the most legible papers were white, yellow, blue, and pale yellow and orange (with yellow ahead of white for black ink). Least legible were pale mauve and light blue inks, and green, orange and pink papers. With constant paper, most pleasing were purple, chocolate, (and less so) blue, dull greenish blue and navy blue inks; with constant ink, blue, yellow and white and yellow paper, in that order. Least pleasing were pale mauve, light blue and green inks and pink, orange and pale pink inks. In agreement with Luckiesh, brightness contrast was found of major importance in legibility. For the blues, pleasantness followed "brightness" in the dyer's sense, a composite of lightness and saturation.

"Colour Harmony," a previously unpublished paper, is by Clarkson, O. L. Davies and Vickerstaff. There is a good critical review of previous work. The views of Ostwald and Moon and Spencer were criticized as lacking adequate experimental basis. The precision of statement of Guilford's work was regarded as "surprising but may arise partly from the small number of colours used." Experimental data were obtained by the method of paired comparisons of 2-color combinations presented to 45 observers as a circle with a pleasing sigmoid dividing line between the two colors. A short-cut method was used to abbreviate the necessary number of comparisons. Although complementary red and blue-green were good, some (as blues with yellows) were least pleasant. For the saturated colors used, a minimum ratio of the two lightnesses was much preferred to maximum ratio. Harmony increased with increasing purity (saturation) difference. A color-harmony equation for pleasantness as a function of hue was set up. Its predictions were by no means perfect, but were very suggestive. The "popularity" function for color pairs, converted to Munsell terms, was HC/V^4. Hue-contrast H was found of primary importance. Near-complementaries were as good as complementaries. There was no evidence for a "harmony of similarity." The Editor wonders whether adjustment of visual scale-factors in the popularity function would improve the fit to experimental data. Also whether use of equal areas of the paired colors might largely vitiate the results of this excellent study. In his own unpublished work, all observers were agreed as to the important effect of area and preferred in all cases a large ratio of areas (say 15% to 85% of the total), as in a narrow dado on a large wall.

"The Estimation of Dyestuffs in Solution and on the Fibre," by E. Waters, is an excellent survey of experimental methods, mentioning even a recent development, the use of dimethyl formamide as solvent for acid and direct dyes. We can add that it is very good too for "naphthols." The final papers too are primarily of experimental interest. They are: "The Accuracy of Colorimetric Instruments in Dye Strength Determinations," by Davies, C. H. Giles and Vickerstaff; and "A

Photoelectric Device for Recording Variation in the Concentration of a Coloured Solution," by T. B. Davenport. The Editor feels very fortunate in receiving this fine group of papers from Imperial Chemical Industries, and congratulates those who have made this color information available in such a satisfactory manner.

I.H.G.

SMALL-DIFFERENCE COLOR FORMULAS

Recently questions have been raised by the Fastness-Test Co-ordinating Committee of the Society of Dyers and Colourists concerning an article by I. H. Godlove on Uniformity of Grading of American, British and German Lightfastness Standards (Am. Dyestuff Reptr. 39, P215, 1950, see I.S.C.C. News Letter No. 88, pp 3-4, for review). This is answered in some detail in the February 19, 1951 American Dyestuff Reporter by Godlove. The reply raises a number of important and interesting points that are not too clearly understood by all color workers. It is a paper that should interest many News Letter readers. Dr. Godlove made use of the small-color-difference formula based on Adams' Chromatic Value space. The British reply questioned its use, and Godlove replied in detail on the question of its validity.

This question of small color-difference formulas is one that practical colorists are only beginning to study, though work has been published since 1936 on the subject. In 1944 the I.S.C.C., jointly with the AATCC and the Federation of Paint and Varnish Production Clubs, held a Symposium on Small Color Differences. At that time summary presentations were made of available formulas, relating them to the concepts of color space upon which each of the available formulas were based. That same year a very complete study for the Engineer Board at Fort Belvoir, applying these several formulas to several series of camouflage colors, was published in the Journal of the Optical Society of America by Nickerson and Stultz. (Reprints available.) Statistical analyses showed that any one of the several formulas gave results that were of the same general order of significance (correlation coefficients ranged from an average of 0.60 for formulas based on Munsell space to 0.53 for those based on Judd's UCS space and on two forms of Adams' space). Thus the most sensible choice of formula would be the one that would accord best with the form of the color data one has available. If one's data are in Munsell notation, the formulas based on Munsell color space are easy to apply; if the data are in terms of Hunter's instruments, use the formulas based on UCS space; if they are in I.C.I. terms, the formula based on Adams' Chromatic Value space is extremely simple and easy to apply.

The general philosophy on which the various formulas are based is discussed briefly in a recent paper by Nickerson in the American Dyestuff Reporter, Tables for Use in Computing Small Color Differences (Aug. 21, 1950). Since much of the colorimetric data in the textile field are in I.C.I. terms, this report was published to make it easy to apply the small difference formula based on Adams' Chromatic Value space. Any one who is interested can write for a reprint, either to the author or to the Munsell Color Company, Inc., 10 E. Franklin Street, Baltimore 2, Md. It might help to make clear some of the background thinking.

D.N.

COLOR DIFFERENCE FORMULAS

Since the preceding item was written by Miss Nickerson, there have been some minor developments in the formulas used by the Editor which may be worth reporting. First he wished to second Miss Nickerson's suggestions, and emphasize reference to the paper she mentions in the last paragraph as well as others by her. In the work requested by the AATCC Lightfastness Committee, the Editor used the Adams-type formula in exactly the form applied by Miss Nickerson, except for a final arbitrary constant which established a unit of smaller magnitude. (On this the Editor has no special conviction, and is glad to accept our Secretary's suggestion of a unit four times as large as his. More of this below.)

The Editor recently resuscitated a formula derived in 1945 for calculation of color differences based on Munsell Renotations. It was previously unpublished because it was believed that there were already enough equations for the purpose on the market. But previously published formulas based on Munsell data failed somewhat badly to give certain results obtained in the Editor's study of "on-tone fading." The new formula apparently gave the correct result, and also gave improved handling of some partially published experimental work by H. R. Davidson. It was reported at the recent OSA meeting in Washington. But even since then, further interesting experimental verification has been obtained, besides, it has been found (since the meeting) that the derivation and the assumptions on which the equation was based could be still further simplified with some further slight improvement. The only assumption which is now made is that color differences can be represented along a straight line in Euclidean space. The rest is rigid geometry applied to the Munsell cylindrical coordinate system. The formula for color-difference I so derived, is: $I = \sqrt{2 C_1 C_2 \phi(H) + (\Delta C)^2 + (n\Delta V)}$ where $\phi(H)$ is an abbreviation for $(1-\cos 3.6 \Delta H)$, and ΔH, ΔC and ΔV are the differences in hue, chroma and value, respectively, between sample and standard, whose chromas are C_2 and C_1. There is still one uncertain factor; this is the relative visual magnitudes of the Munsell units of hue, chroma and value, which experience shows vary considerably with experimental conditions. The Munsell geometry assumed fixes the relation of the hue unit to the chroma unit. It happens to come out (when one uses the average of the arc and the chord to measure the hue angle) almost exactly what Bellamy and Newhall got experimentally for small differences; namely 8 chroma steps = 22 hue steps (at chroma 6). The Editor with ten observers for certain conditions got 1 value step = 4.36 chroma steps. This he rounded off to 1:4, giving "n" in his usual form as 4, and the color difference I_4. The value $\phi(H)$ may be read off directly from a simple table prepared by the Editor for all small values of ΔH.

The Editor gives this formula here, not to advertise his product, but rather to ask readers who may happen to have experimental data by which color-difference equations may be tested, to try this formula. He is especially anxious to find the best value of "n" for specified conditions. Our Secretary uses n = 2, and ISCC Chairman Balinkin's formula uses a value of n near unity. This fits data on some tiles of his better than the above formula with n = 4, but no better than the formula with n = 1. The Editor wonders whether some gloss was included in the Balinkin study; also whether the "ratio method" he used would not have been improved by using a standard color-difference not his smallest difference, but some difference in the middle of the range. Then it would have been necessary to say that a given color difference was only 2 or 3 times as large as the standard difference (not up to 6 or 7 times).

Quite different results were obtained experimentally by Mr. H. R. Davidson, and by the Editor independently. The former dealt with 30 colors (10 reds, 10 greens and 10 blues) judged visually by five observers by the ratio method and by the formulas. The average deviations between visual results and formulas were: Balinkin formula, 0.56; Nickerson index, 0.42; Davidson's empirical method 0.30; new formula (IHG), 0.27. Davidson, in an OSA paper now in galley proof, gives the hue, chroma and "value" limens obtained from his data. Putting these into the new formula gives a constant total difference within ± 6% (from the mean of the three) for the red, the greens and the blues. For the reds, which he thought his best data (because of the difference magnitudes) the average hue, chroma and value components of I_4 were constant within $\pm$ 9%.

The Editor's data were obtained in a study of "on-tone fading." This is the color change due to loss of concentration only, as when some dye is merely washed off the cloth. When ten observers were shown six 2% blue dyeings alongside the corresponding 0.5% blue dyeings, these differences were said by all observers to be "at least twice" the corresponding difference in yellows (changing from 2% to 0.5%); two observers said "2 or 3 times" as great. The Balinkin formula the reverse of this relation; that is, the ratio of blue difference to yellow difference was 0.67:1 instead of 2:1. The Nickerson index was slightly better, yielding 0.83:1. The new formula gave somewhat less than 2:1.

Another of the Editor's reasons for this item is involved in the data just quoted. Balinkin uses n = 1.06, Nickerson uses n = 2 and the new formula in preferred form uses n = 4. This is the order of approximation to "correctness" in assaying all the quoted data on textiles. On the other hand, the order is very different with the Balinkin tiles; and here the Balinkin and Nickerson formulas appear to much better advantage. We are thus left with an unsolved question. What is the proper relation between the visual magnitudes of a Munsell value step and a chroma step; and how does it vary with texture, experimental conditions and position in the color solid?

Miss Nickerson has discussed above the "philosophy" of the formulas; and in the following we add a bit more. The Nickerson-Stultz camouflage colors have not been brought into this discussion for the following reason. In the Balinkin tile experiment, the same question is asked of the observer as the formulas ask; namely, how much larger is the given color-difference than the standard color difference (?). In the Nickerson-Stultz work, the colors were merely ranked on a 6-step scale from excellent match to very poor match. We do not know the relative sizes of the steps, nor whether they can be legitimately averaged to compare with data from formulas. The Editor, out of curiosity, calculated a scale ranking correlation coefficient for 18 of the camouflage colors, between a Nickerson-Stultz average visual ranking and the new formula ranking. This correlation coefficient turned out to be 0.72, perhaps fairly good in view of the questions just stated.

Does anyone have anything to add to this discussion?

I.H.G.

HOW FAR HAVE WE GONE? The recently reported completion by Mr. H. R. Davidson of a collection of dyed colors arranged according to the Munsell system marks an appropriate time to ask the following question: What proportion of the way have we gone toward the colors of theoretical maximum possible saturation (chroma) for surface colors in every given hue and lightness level?

As it is possible to calculate the limiting theoretical efficiencies of gas engines from the Carnot cycle, and compare actual efficiencies with these, so is it possible to compare the best actual brightnesses (composite saturations and lightnesses) of dyeings and pigmented surfaces with the ideal limiting brightnesses. The Davidson colors have gained chroma considerably over the Munsell Book of Color samples in dark levels, but have lost in highest levels and in the blue to purple region; but the net gain is over 200 colors above the Munsell thousand odd. Where there is a loss, more colors could be used by letting down the bars somewhat in fastness or "levelness" or increasing costs. However, we have computed ratios of actual to maximum theoretical brightnesses by using for the actual surface either the dyeings or the Munsell pigmented surfaces, whichever is greater in saturation (chroma). Unlike the Munsell system, the dyer (and John Q. Public) are interested in brightness, a composite of saturation and lightness. But Munsell chroma may be substituted for brightness when considering a constant lightness (Munsell "value") level.

We shall state presently reasons why the following figures are only approximate. They are, however, close enough to be very illuminating. Calculating the ratio of the maximum actual Munsell chroma to the maximum possible chroma at each of 40 hues and 8 Munsell "values", one to eight (dark to light), we find that the maximum ratio is 89%, reached in the oranges (Munsell 5R) at "value" level 6. The minimum is 8%, reached in Munsell 2.5P at value level 1. Among other oranges, there are "efficiencies" of 85-86% at Munsell 10R, values 4 and 5; and over 80% at some value level from 10R to 5GY. The highest figure among Munsell greens (2.5G through 10G) is 38% and the lowest figure there is 10%.

The reasons why these figures are not exact are three: (1) Both the Munsell book and the GAF colors made to match the corrected Munsell colors (the "Re-notations") included only the <u>even</u> chroma steps, not the odd ones, so that when chroma 13 could be obtained only 12 may have been used in the calculations; (2) the "maximum possible" data were not corrected for surface scattering; and (3) the Munsell chromas used in obtaining the ratios were nominal notations, not the corrected re-notations. The data on maximum chromas were obtained to nearest half steps by D. Nickerson & S. M. Newhall (J. Opt. Soc. Amer. <u>33</u>, 419; 1943) from original calculations by D. MacAdam. In spite of these errors the quoted approximate figures give a fairly good picture. Among the oranges, the chemist has gone most of the way in securing the brightest possible colors; among the greens, he has gone only a small part of the way. Colors of other hues lie in between.

BIBLIOGRAPHY

J. Dana to General Electric; U. S. Patent 2,465,068 (1949); Daylight filter for flash lamps

J. Eggert; Sci. indus. photog. <u>20</u>, 205-6 (June 1949); Brilliance of the surround and its influence on correct subjective representation

R. M. Evans; Illum. Eng. <u>44</u>, 47-54; (Jan. 1949); Light sources and colored objects

K. V. Flerov & B. V. Ozimov; Zhur Obshchei Khim. (J. Genl. Chem.) <u>20</u>, 789-93 (1950); Absorption spectra of solutions of organic dyes and of inorganic salts in the red region

General Aniline & Film Corp.; Rev. Sci. Instr. <u>20</u>, 326-7 (April 1949); Color-computing device (GAF-Librascope Tristimulus Computer)

K. S. Gibson & M. A. Belknap; J. Research Natl. Bur. Stand. <u>44</u>, 463-73 (May 1950); J. Opt. Soc. Amer. <u>40</u>, 435-7 (July 1950); Data shows that glass standards in files for 16 years have not changed. Similar standards exposed to south skylight, including sunlight, for 3 years have changed.

P. C. Goldmark to Columbia Broadcasting System, Inc., U. S. Patent 2,528,510; Color television

A. N. Goldsmith to Radio Corp. of Amer., U. S. Patent 2,531,508; Color television system

W. F. Grether, U. S. Patent 2,528,513; Self-administering color vision test

Alan M. Gundelfinger; J. SMPE 54, 74-86, (January 1950); Cinecolor three-color process

H. K. Hammond III & I. Nimeroff; J. Research Natl. Bur. Stand. 44, 585 (1950), RP 2105; Measurement of 60° specular gloss. (Glossmeter error effects on gloss readings investigated; standards required to check instrumental conformance to specifications shown; gloss and related terms defined)

H. G. W. Harding; J. Sci. Instr. 27, 132-4 (May 1950); Three-component glass filter to correct the spectral sensitivity curves of selenium rectifier photo-electric cells to that of the eye for photopic vision

R. E. Harrington & F. T. Bowditch; J. SMPE 54, 63-73, (January 1950); Color measurement of motion picture screen illumination

V. G. W. Harrison; J. Sci. Instr. 26, 84-90 (March 1949); Gloss measurement of papers; a comparative study

E. Hellmig; Z. wiss. Photog. 43, 237-46 (1948); Graphical aids for the numerical correlation between RUCS and ICI coordinates

E. Hellmig; Z. wiss. Photog. 43, 68-112 (1948); Mathematical treatment of subtractive color processes

A. L. Hetherington; Nature 1949, 163, 900 (June 11); Chinese ceramic glazes, with special reference to those derived from copper

H. H. Hodgson; J. Soc. Dyers Col. 65, 14-7 (January 1949); Colour and constitution; XI, amino-coumarins

D. Hubbard & G. F. Rynders; J. Research Nat. Bur. Stand. 41, (1948) RP 1933; Chemical durability, specular gloss, and transmittance of optical glasses

C. E. Huffman to Allen B. duMont Laboratories, Inc. U. S. Patent 2,530,431; Color device for utilizing control signals

C. W. Jerome; Illum. Engin. 45, 225-32 (April 1950); Determination of the color parameters of fluorescent lamps

L. C. Jesty; Nature 163, 960 (June 18, 1949); The resolution/brightness/contrast sensitivity of the eye in certain forms of picture reproduction

J. H. Jones; J. Assoc. Offic. Agr. Chemists 33, 401-5 (1950); Spectrophotometric testing of coal-tar colors

D. B. Judd; J. Research Natl. Bur. Stand. 41, (1948) RP 1922; Color perceptions of deuteranopic and protanopic observers

D. B. Judd; J. Research Natl. Bur. Stand. 44, 1-8 (Jan. 1950); The 1949 scale of color-temperature (RP 2053)