D. B Judd
IV-3c, note 129
Judd
HJK
DBH
Hilmes
MMB
KM.

INTER-SOCIETY COLOR COUNCIL

NEWS LETTER No. 41

MAY 1942

I. H. Godlove, Editor-in-chief
Box 386, Wilmington, Delaware

Charles Bittinger, Editor for Art
C. E. Foss, Editor for Industry
D. B. Judd, Editor for Science

CONFERENCE ON COLOR AND DYES

We received, just too late for inclusion in the March issue of the News Letter, notice of a Conference on "Color, Constitution and Reactions of Dyes," which was held at the American Museum of Natural History, New York, on March 27 and 28 by the Section of Physics and Chemistry of the New York Academy of Sciences. The program included an informal subscription dinner. A notice of the meeting appeared in Science, vol. 95, no. 2464, March 20, 1942.

LOCAL COLOR GROUPS

Washington and Baltimore. On April 6 the Colorists held a dinner meeting at the Arts Club in Washington. Dr. Michael J. Zigler of the Psychology Department of Wellesley College, an APA delegate to the ISCC and a member of the Executive Committee, was guest speaker. Professor Zigler is one of the few psychologists who has made a study of theories of color vision, a subject that several of the colorists wished to hear discussed authoritatively. Dr. Zigler stressed particularly the fact that no theory of color vision can be entirely satisfactory unless it explains what happens behind the retina; brain processes are involved, and must be taken into account. There was considerable discussion following the talk. On May 8 the Colorists met in Baltimore where they first visited the beautiful and extremely colorful Sherwood Gardens which reach their full beauty during the first week in May. Dinner was served to 43 of the group at the Johns Hopkins Faculty Club. Guest speaker was Dr. G. F. A. Stutz of the New Jersey Zinc Company who gave a talk and demonstration of fluorescent and phosphorescent paints and their newer applications. It was a real show!

Chicago. The Association for Color Research, Chicago held a dinner meeting on April 1. Dinner was as usual at the Normandy House, 800 N. Michigan Avenue, from when at 8:00 p. m. the group adjourned to the nearby Art Center Chicago. The subject for the evening was: "Color: Industrial, Photographic and Chemical." Three speakers discussed these three aspects of the general subject. Mr. R. L. Harding, Research Engineer, National Cylinder Gas Company, discussed the many interesting and profitable applications of color made by industrial organizations. Exhibits illustrating equipment and methods were on display. Mr. Fidelis Harrer, well known Color Photographer, discussed some of the unusual problems that confront the color photographer, and exhibited some of the famous Harrer photographs. The last speaker, Mr. G. W. Wilhelm, Chief Chemist, Rand McNally Company, completed the story by discussing the chemical and physical problems encountered in modern color reproduction. His talk was also illustrated by many fine examples of color reproduction.

Boston. The April meeting of the Boston Color Group was held on April 7 in the Emma Rogers Room at the M. I. T. The speaker of the evening was Mr. George L. Stout,

Head of the Department of Conservation, and Lecturer on Design at the Fogg Art Museum of Harvard University. Mr. Stout's subject was: "Artists' Pigments in Relation to Color."

MUNSELL FOUNDATION LETTER BALLOT

On May 18 the I.S.C.C. Executive Committee held a special meeting to ascertain results of a letter ballot sent to voting delegates on April 18 in accordance with action authorized at the 1942 annual meeting. Out of a possible 42 ballots, 33 were received, all in the affirmative. In accordance with this vote, the Executive Committee of the Inter-Society Color Council is empowered to appoint a Trustee to the Board of Trustees of the Munsell Color Foundation, to be established in accordance with the copy of a proposed Certificate of Incorporation transmitted to voting delegates under date of April 18, 1942.

ARMY AND NAVY REPRESENTATIVES ON COLOR-BLINDNESS-TEST COMMITTEE

The subcommittee for the development of a color-blindness test whose formation was announced in the March issue has been filled out by representatives of the Medical Division of the Army Air Corps, the Research Division of the Navy Bureau of Medicine and Surgery, and the Aviation Medical Division of the Civil Aeronautics Administration. The personnel of the subcommittee is: Dr. Le Grand Hardy (Ch), Prof. F. L. Dimmick, Mr. Carl E. Foss, Lt. Col. L. E. Griffis, M. C., Comdr. Eric Liljencrantz, U. S. N. R., and Dr. A. J. Herbolsheimer, Chief of the Physical Standards Section, CAA Aviation Medical Division. The subcommittee is at work on a stream-lined form of the test based on the principle of single judgments. The projected test can be given in less than 5 minutes. It is expected to be largely self-administering in character, the subject making his own permanent record.

LATITUDE AND LONGITUDE OF COLOR

The following letter came recently to your Editors' attention. It was written by Dean Farnsworth in answer to an inquiry; and we believe that it presents such a concise picture of the real usefulness of a color notation for approximate solution of practical color problems that we reproduce it here for our readers:

My dear Miss _____:

You ask very important questions concerning the practice of color in painting and in the theater. Yes, the Munsell "theory" works. I have taught it for 14 years, and many hundreds of people who have been students at Northwestern and N. Y. U. now plan color in terms of it.

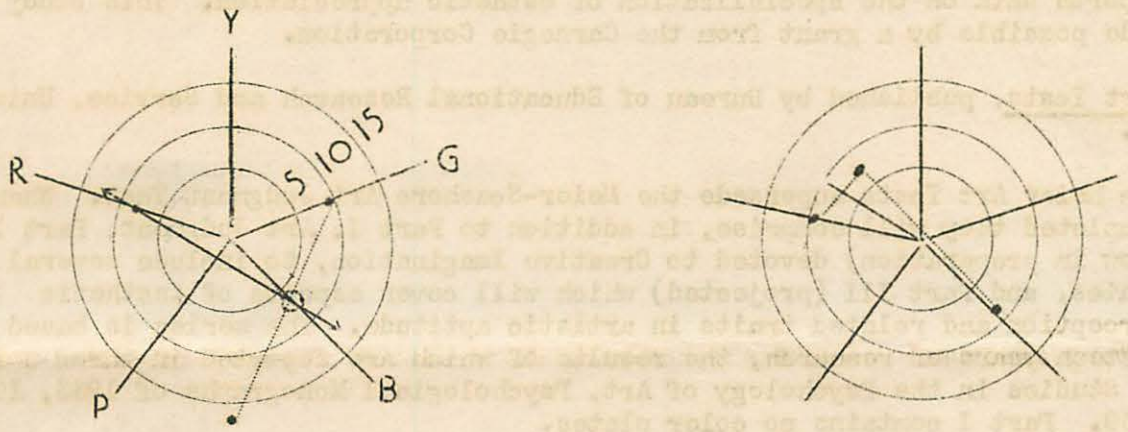
But you must not think of it as a theory in the sense that the schemes which are based on certain primaries are theories. These latter are the primaries of convenience depending upon the kind of work one is doing. They can all be embraced within or described in terms of the Munsell system of nomenclature. You must look on the Munsell as equivalent to the latitude and longitude and distance-from-sea-level system which can place any earthly object. It is simply the systematization of color -- color in the sense of what is seen, not color as a pigment or colorant.

Now you will see why it is the only system of thinking that will correlate all the complex relationships that we have on stage. Here at the University we estimate our grease paint and powder, our glass filters, scene paint, gelatins and costume color, in Munsell H V/C, and then, without even experimenting, can predict the approximate

mixture, or effect of lights on lights, lights on colorants, and pigment mixture. We say approximate, for there are a number of small physical effects in every media which somewhat influence the result; such as, index of refraction of the vehicle, size and shape of pigment particle, specific absorption characteristics due to molecular structure, and so on. These vary for every color in every field (i.e., each color in a series of printing inks, in oil paints, in gelatin, in stained glass, in a given brand of water colors, and so on). These are far too complex to examine in each instance in practice, and usually exercise so small an influence in any given case that they can be generally disregarded in use (though they are extremely important to the manufacturer). "Additive and subtractive" are very silly terms -- disregard them. All color mixture is additive. Subtractive effects are what we have just discussed in the previous paragraph as peculiarities of media.

I'm afraid this is moving pretty fast into unfamiliar territory. Book-writers don't seem to have time to study, and research people don't have time to write books for the public.

But let us briefly try this in practice. Let us, for example, dye a scarf with ultramarine about PB 4/16 and splash it with chrome green scenic paint, G 6/8. At audience distance the scarf will appear about B 5/7. If we use a Stein's flesh base and powder of about R 8/2 and wear the scarf, we can be sure the scarf will appear a little greener and the face will seem a little more yellowish-red (more "peach" and less "pink") by simultaneous contrast. Under a spotlight and amber gelatin with a transmission which match YR 5/7 the scarf would appear exactly gray, the face R - YR. It can all be determined beforehand if we use Munsell designation of the original materials. Try it!



Now you see you can't "have trouble" with Munsell colors -- except as you have trouble with a map in geography. It's just a means of finding things, and they can be located just as accurately as you have need for. But the mixing diagram method is reliable only to the extent that the original designation was accurate.

More questions? Write us again.

Sincerely yours,

(S) Dean Farnsworth

ART JUDGMENT TESTS Our recent color-in-art-education meeting brought to your editors' attention the fact that several art judgment tests have been developed for use in testing art ability, particularly in schools. The following four seem to be those that are best known. We have seen the McAdory and Meier Tests, and find them very interesting.

Lewerenz Tests of Fundamental Abilities in Visual Art, Research Service Company (now Southern California School Book Depository, Los Angeles).

These tests contain a large chart of "primary, secondary, and tertiary" colors made up of patches about two inches square, with the "primaries" in large patches about five inches square -- mounted on a cloth backing.

McAdory Art Test, Bureau of Publications, Teachers College, Columbia University

The McAdory Art Test was first reported upon in The Construction and Validation of An Art Test, by Margaret McAdory, Teachers College, Columbia University Contributions to Education, No. 383, 1929. The test itself comprises 72 plates, 24 in color, 48 in half-tone and line cut. Each plate consists of 4 illustrations (for multiple choice) printed on heavy paper and placed in portfolio. Recent Work: Validation and Standardization of the McAdory Art Test, 1933, by Margaret McAdory Siceloff and Ella Woodyard and the staff of the Division of Psychology Institute of Educational Research Teachers College. This is a report of the Validity of the scoring scheme and the separate tasks at three grade levels, it gives the grade norms (3 to 12), the age norms (8 to 21), reports the reliability of the test scores, and reports data on the specialization of esthetic appreciation. This study was made possible by a grant from the Carnegie Corporation.

Meier Art Tests, published by Bureau of Educational Research and Service, University of Iowa.

The Meier Art Tests supersede the Meier-Seashore Art Judgment Test. When completed they will comprise, in addition to Part I, Art Judgment, Part II (now in preparation) devoted to Creative Imagination, to include several color plates, and Part III (projected) which will cover aspects of Aesthetic Perception and related traits in artistic aptitude. The series is based on fifteen years of research, the results of which are reported in three volumes of Studies in the Psychology of Art, Psychological Monographs of 1933, 1936, 1939. Part I contains no color plates.

Varnum Selective Aptitude Test, International Correspondence Schools of Scranton, Pa.

The Varnum Test is a recent product, put up in a spiral binding on two edges so that the plates fold from each side into a middle section. The color tests consist of a color-recognition test for tints and a color-memory test in which the person is required to recognize from 20 color patches certain colors seen in a crazy-work pattern of colors on a preceding plate.

SYMPOSIUM ON PHYSICS OF PIGMENTS AND GLASSES In a letter, dated April 17, 1942, from Mr. R. S. Hunter, Member, ACS Delegation to the ISCC, we received notice of this symposium; and though you will receive this issue too late for advance notice of the event, we give the speakers and titles of their papers, which Mr. Hunter listed in his

letter. The symposium was scheduled for May 15 and 16, at Houston Hall, University of Pennsylvania, 34th and Spruce Streets, Philadelphia, Pa., under the sponsorship of the Department of Physics of the University of Pennsylvania and the Philadelphia District Committee of the American Society for Testing Materials.

Introduction by G. P. Harnwell, Director, Physics Laboratory, University of Pennsylvania.

(1) "Basic Principles Involved in the Preparation of Pigments" by R. H. Sawyer, Krebs Pigment and Color Corp., Baltimore, Md.

(2) "Basic Principles Involved in the Preparation of Glasses" by B. E. Warren, Massachusetts Institute of Technology, Cambridge, Mass.

(3) "The Electron Microscope and the Determination of Particle Size" by R. B. Barnes American Cyanamid Co., Stamford, Conn.

(4) "Physics of Pigments in Dispersed Systems" by H. Green, Interchemical Corp., New York, N. Y.

(5) "Mechanical Properties of Glasses" by F. W. Preston, Preston Laboratories, Butler, Pa.

(6) "Combined Glass-Pigment Systems" by Campbell Robertson, E. I. du Pont de Nemours & Co., Inc., Perth Amboy, N. J.

(7) "Deterioration of Materials by Light" by F. Seitz, Randal Morgan Laboratory, University of Pennsylvania, Philadelphia, Pa.

ACRIDINE COMPOUNDS IN PEACE AND WAR — This is the title of a lecture by A. Albert to the Sydney section of the Society of Chemical Industry on Nov. 20, 1940; see Chem. & Indus. 60, 253 (1941). The speaker noted the fact that acridine derivatives are frequent among compounds used as fluorescence indicators. The fluorescence colors of certain hydrochloric acid salts of amino acridones, when excited by ultra-violet light, were given as: 5-amino-, intense violet-blue; 2-amino-, golden color; and 2,8-diamino-acridine hydrochloride, apple green. The lecturer concluded with an experiment on "cold light." Adding a little alkaline hydrogen peroxide to a 1:1000 solution of "luzigenin" (bis-N-methyl acridyl) results in a brilliant green glow (chemiluminescence). It is bright enough for reading fine print and lasts an hour at somewhat diminished intensity.

ISCC-NBS COLOR NAMES — K. L. Kelly; Bull. Natl. Formulary Comm. 9, No. 10, 302-11 (Sept.-Oct. 1941); success of the ISCC-NBS system of color names in the chemical monographs. This study undertook to determine, from the results of several years' experience, whether the ISCC-NBS color names used in the monographs of the National Formulary and the United States Pharmacopoeia were understandable and usable, and whether certain tests gave the same color names when used in different monographs or when repeated by different workers. The workers independently performed the color tests of N. F. VI in the section on the Ingredients Used in the Chapter on Materials and Preparations for Diagnostic Use and in the U.S.P. XI to page 219. The observer agreement in most of the tests was good; and there was also good agreement with data submitted by members of the Color Names Committee. The tests were limited to those resulting in chromatic solutions or

precipitates and specific for a given substance. In the paper, 89 tests are listed, with the ISCC-NBS names; for 55 of these, the number of individual tests was more than one (up to 27 for the "pink to red-purple" color obtained from phenolphthalein and alkalis). While there has been considerable use of the system for surface colors, the results of this study constitute the first detailed examination of the success of the ISCC-NBS system applied to specification of the colors of transparent and translucent media. The procedures used were those given in "Method of Designating Colors," by D. B. Judd and K. L. Kelly, J. Research Natl. Bur. Stand. 23, 355 (1939); and "Instructions for Determining the Color Names for Drugs and Chemicals," K. L. Kelly, Bull. Natl. Formulary Comm. 8, 359 (1939-40). The agreements noted serve as a proof of the efficacy of the system of color names and the procedures adopted for their practical determination.

CADMIUM PAINTS. National Bureau of Standards Report on the Trilinear Coordinates and the Munsell Hue and Chroma of 70 Painted Panels prepared by the Paint Testing and Research Laboratory, Massachusetts Art Project, WPA (NBS Test No. 43C-11/41, dated Sept. 16, 1941; by D. B. Judd). The 70 painted panels in sets of 2 to 6, each set showing a number of paints marked under the same name by different manufacturers, were prepared by the Massachusetts laboratory to assist in the selection of tinting-strength standards for the Recommended Commercial Standard TS-3116 for Artists' Oil Paints. On May 16, 1941, a Special Committee appointed at the General Conference, Feb. 9, 1940, selected tinting strength standards for 15 paints and made a judgment as to whether each other panel was within the hue range satisfactory for the paint. The colors were the Cadmium and Cadmium-Barium Reds (Deep, Medium and Light), Oranges and Yellows (Deep, Medium and Light), as well as the Mars Violets. Each paint was extended in a 20:1 volume ratio with standard zinc-oxide reduction paste. The purpose of the test was to supply a color specification of the 15 tinting-strength standards, and to evaluate tentative hue tolerances for each paint as indicated by the special committee. Munsell notations were determined by direct visual comparison in daylight with the Munsell Book of Color, with both interpolation and extrapolation. The Munsell designation of the 15 standards, and 15 of the most critical hue-tolerance panels were also determined in artificial daylight by obtaining trilinear coordinates with Judd's subtractive colorimeter (Text. Research 9, 252; 1939) and use of the Glenn-Killian data and Newhall report (J. Opt. Soc. Amer. 30, 640-2; 1940). The hue ranges tentatively chosen were:

	Cadmium	Cadmium-Barium
Red, Deep	6.5 RP - 0.5 R	7.0 RP - 1.0 R
" , Medium	0.5 R - 4.5 R	1.0 R - 5.0 R
" , Light	4.5 R - 9.5 R	5.0 R - 10.0 R
Orange	10.0 R - 5.0 YR	2.0 YR - 7.0 YR
Yellow, Deep	7.5 YR - 2.5 Y	7.5 YR - 2.5 Y
" , Medium	2.5 Y - 7.5 Y	2.5 Y - 7.5 Y
" , Light	7.5 Y - 2.5 GY	7.5 Y - 2.5 GY

The Munsell hue notation of the Mars Violet standard was 3.6 RP.

REFLECTANCE FROM TRANSMISSIONS H. F. Launer; J. Opt. Soc. Amer. 32, 84-93 (Feb. 1942); reflection-transmission relationships in sheet materials. The theoretical relation for computing the reflectance of a sheet from the transmissions of one and two sheets of a material was confirmed experimentally. The method is an absolute one, since it requires the use of no reflectance standard.

PURPLE-RING ILLUSION R. L. Ives; J. Opt. Soc. Amer. 32, 119-20 (Feb. 1942); the "purple-ring" illusion. A bright purple ring, concentrically surrounding a rapidly receding bright red light, first noticed by the author around the port wing-tip light when witnessing a number of rapid night take-offs of commercial aircraft, is attributed to afterimage effects. The factors influencing this spectacular and transitory illusion are briefly outlined. It is concluded that the illusion will be noted only by an observer whose eyes are on night vision; when there is great contrast between skylight and the light observed; when the apparent image of the observed light is very much larger than its true image, due to irradiation; when the loss of intensity of the light, due to recession, exceeds 30 percent per second; and when this loss of intensity continues probably more than one-third second.

OPTICS OF DIFFUSION S. Q. Duntley; J. Opt. Soc. Amer. 32, 61-70 (Feb. 1942); optical properties of diffusing materials. The author treats of the general case which occurs when dealing with pigmented films, such as paints, lacquers, printing inks, and other industrial finishes, as well as plastics, paper, rubber and textiles. The theory treats the most general possible case represented by colored particles dispersed in a colored vehicle of different refractive index and bounded by reflecting surfaces. It is a development of concepts embodied in the general theory of diffusing materials gradually taking shape since the work of Schuster (1905); and includes contributions from Lord Rayleigh (1914); Channon, Renwick and Storr (1918); Silberstein (1927); Ryde (1931); Kubelka and Munk (1931), and Steele (1935). It is pointed out that Schuster described the internal optical properties of diffusing materials in terms of two constants, an absorption coefficient and a scattering coefficient. Silberstein increased the number of constants to three, Ryde to four; and the author increases it to six (two absorption and four scattering). Two more constants are added because of boundary reflections. Thus in general eight measurements are required; and this experimental situation is further complicated by the transcendental nature of the equations of the theory and the occurrence of high powers of the parameters. But simplification and elimination of two constants is accomplished by measurement in such a way as to allow no surface reflections to occur. To do this, two attachments to the Hardy (1935) spectrophotometer, and simplifying photometric procedures, were devised. The relations of the present theory to the two-constant treatments of Kubelka and Munk, Gurevich (1930), Smith (1932), Neugebauer (1937) and Amy (1938), are also shown.

COTTON COLOR CHANGE Dorothy Nickerson; Report on Color Stability in Raw Cotton, II, Storage Tests; Agricultural Marketing Service (now Agr. Marketing Administration), Washington, D.C., Oct. 1941. This is a continuation of studies reported in 1933 under the same general title by D. Nickerson and L. D. Milstead, Bur. Agr. Econ. Twelve samples representing six commercial varieties of cottons, 1st and 2nd pickings, graded white or light spotted, were put up in boxes in triplicate and stored in 15 locations from New Bedford, Mass. to San Pedro, Calif. After 2 years' storage, one box of each group was recalled; the remaining two boxes were recalled after 5 years. Each sample was then measured for color, and all spots were counted and compared with marked photographs of the original samples. At the end of the test, visual comparisons of all samples were made against the box that had changed the least.

Results are shown in a series of charts. The outstanding color difference, according to varieties stored, was an increase of saturation (Munsell chroma, a measure of the general increase in "depth of yellowness") for all varieties. Except for the Acala cotton, this increase was not so great for the first 2 years of storage, but it was significant for all varieties after 5 years. The direction of change was the same in

all cases; but on the whole the 2nd picking, except for Acala, did not change quite as much as the 1st picking. Cottons stored 5 years at Houston, Galveston and Mobile not only showed a real color change but much more change than samples stored at such cooler and/or drier points as New Bedford, New York, Washington, El Paso and San Pedro. There was a noticeable change even for 2 years' storage at Houston, Galveston and Austin. All cottons studied lost a high percentage of their spots within 2 years; they regained some, but by no means all, in the next 3 years. The change in general background color seems dependent chiefly on place of storage; the change with respect to spots depends more on variety than it does on the location of storage.

MULTIPLE-VARIABLE ANALYSIS — H. Helson; Amer. J. Psychol. 55, 46-57 (Jan. 1942); multiple-variable analysis of factors affecting lightness and saturation. Investigations of hue, lightness and saturation have been made usually by means of small patches of spectrally homogeneous light in such fashion that the influence of only one factor at a time was studied. When experimental procedures are properly designed, it is possible to study the effect of several factors operating jointly and to isolate each statistically by means of analysis of variance. In the present study, the relative importance of the effects of composition (C) and amount (A) of illumination and reflectance (R) of background on lightness (L) and saturation (S) of reflecting surfa ces are evaluated by this method; and its application to a problem in color vision involving triple classification into groups (of A), columns (C) and rows (R), are illustrated and explained. The whole retina was subjected to chromatic light and several variables were allowed to operate simultaneously; 5 observers estimated, on 11-point scales, the L and S of 18 Munsell samples (selective and non-selective) on white, gray and black backgrounds under yellowish red, reddish yellow, yellowish green and reddish blue illuminations, each illumination being used in four different amounts. All stimuli within the field were compared without equating or matching as usual.

By the indicated method of analysis it was found that C, A and especially R, have highly significant effects on S, the variance test being 2.5 to 9.0 times the significant values. These effects refer to the data as a whole and not to individual differences between averages for each condition, which are examined by a second test. The first test, however, shows that interaction between C and R, and possibly between A and R, is significant; so that saturation S is affected not only by C, A and R directly, but also at least by the interaction of C and R. The second test is used in place of the classical standard error. By this test it was found that the differences in S between all six paired C's, except the red-green difference (especially the yellow-blue difference), are highly significant. It also indicates that the R differences exert important effects on S; but of the six A differences, only the three differences between the two higher A's as against the two lower A's are highly significant.

Turning to the analysis of the effects on lightness L, the effects of R, A and especially of C are highly significant. Interaction effects are absent. All differences between the C's are significant, and all but the red-blue difference highly significant. Of the effects on L of the A differences, all but the difference between the two higher A's are significant. Throughout the paper, indirect confirmation of the results by independent means, when possible, is discussed.

COLOR TERMS — J. H. Archibald; Text Colorist 63, 285-8 (1941); color criticism and terminology. The author refers to the "high cost of dissonance between dyers and color stylists," because of ambiguity in the color languages.

Criticism should revolve around 3 attributes (or questions): value, hue and chroma. For example, directions may indicate that a "rust" should be redder; a "medium tan" should be grayer; and (more subtle) a "rich red gold" should be made "richer and greener." The author discusses loose terminology: "a hair," "a fraction," "a trifle," "a taste," "a step," "a little," and "slightly." A scheme of dyeings to illustrate steps of value, hue and chroma is suggested; also a tag on which is shown the color, pattern, value ("make 10% lighter"), hue ("O. K.") and chroma ("make 5% richer" or "5% flatter").

FLUORESCENT FLOOR COVERINGS — Alexander Smith and Sons Carpet Company; Text. World 90, No. 7, 46 (1940); application of fluorescent carpets. An example is given of a carpet dyed with fluorescent dyes for use with ultra-violet mercury lamps in darkened theaters. The extra cost is about 75 cents per square yard, and the fluorescence is said not to be appreciably impaired by dirt or wear.

FLUORESCENCE WHITENING — H. Meyer; British Patent 522,672 of 24/6/1940; application of methyl umbelliferone for "blueing" (whitening yellowish whites). Materials having a yellowish or off-white color, especially textile fabrics, paper, etc., are treated during manufacture or subsequently with a solution of a compound of the cumarin group, preferably methyl umbelliferone, or of any other compound which, when dissolved, produces a blue fluorescence, for the purpose of eliminating the yellowish or off-white tinge and thus obtaining a "pure white" appearance. The Editor may say that he had some yellowish white paper sheets treated with beta-methyl umbelliferone and was astonished at the degree of improvement of the color.

CHIMPANZEE COLOR VISION — In a number of papers (J. com. Psychol. 29, 167-92; 1940; J. exp. Psychol 26, 394-403; 1940) W. F. Grether has reported the results of an extensive analysis of chimpanzee color vision. The primary aim of these studies was to discover any differences between man and chimpanzee that might throw light on the evolutionary development of color vision. Spectral colors were projected upon two diffusing surfaces behind windows that could be pushed back to uncover food rewards. By rewarding one and not other colors it was possible to train chimpanzees in making extremely fine discriminations. In a determination of spectral hue discrimination thresholds it was found that the apes could distinguish as small wave-length differences as some human subjects with normal color vision. Furthermore, the curve of hue discrimination as a function of wave-length had the same general form as for human beings, with best discrimination in the blue and yellow spectral regions. The only noticeable inferiority of chimpanzee as compared with human hue discrimination was in the long-wave end of the spectrum. In a complementary mixture of red and blue-green, and a yellow-appearing mixture of red and green stimuli, the required stimulus proportions differed insignificantly from those of human subjects. Another type of experiment showed that the chimpanzees can see at least as far into either spectral extreme as can human beings. By measurements of minimum perceptible colorimetric purity, plotted as a function of wave-length, it was shown that chimpanzees have very nearly the same spectral saturation distribution as human beings. The point of minimum saturation, however, which normally appears at 570 mu for human subjects, was found to be displaced 5 mu toward the shorter wave-lengths in chimpanzees. In still another experiment (private communication not yet published) it was shown that chimpanzees experience simultaneous chromatic contrast of the same magnitude as that experienced by man.

Taken in their entirety the results indicate that the color vision function is extremely similar in chimpanzee and man. Whatever slight deviations were found for

chimpanzees, namely, inferior hue discrimination at the long-wave end of the spectrum and displacement of the point of minimum saturation toward the short-wave end, are in the same direction as the much more severe deficiencies found in human color blindness. In the evolution of its color vision, therefore, the chimpanzee would appear to have closely approached, though not quite reached, the human stage of development.

MORE ON CAMOUFLAGE

The following three papers on this live subject run along sufficiently similar lines, so that the Editor found it possible to abstract and condense them into one fairly homogeneous account of methods and colors used; the articles are: G. Palmer, J. Soc. Dyers Col. 56, 510-1 (Dec. 1940); industrial camouflage; Camouflage Section, Engineer Board, Fort Belvoir, Va., Amer. Paint J. Convention Daily, Oct. 29, 1941, pp. 21-2, notes on camouflage; Editor, Fortune 25, No. 3, 78-83 (March 1942), camouflage ("it has come a long way since the dazzle paint of world war I"; 14 illustrations, 10 chromatic).

Camouflage is defined as the science of confusing the identity of an object for the purpose of deceiving the observer (especially the air bomber). In the United States, we are assumed to be concerned not with general blitzkrieg bombing, but with precision bombing. Concealment against aerial photography, which may be done at heights of 3 to 4 miles with telescopic lenses and a triple camera using ordinary, color and infrared-sensitive plates, is not the primary object of camouflage. Even if the target is recognized on the photograph, the bombardier must actually see it in his bombsight for precision bombing. At 10,000-foot elevation (it may be up to 35,000) the bomb will take 25 seconds to reach the ground. If the speed is 250 miles per hour (up to 400), the bomb will travel nearly 2 miles. That is, it is released 2 miles from its target. Time is required after recognition of target, also for laying the sights and tracking the target in the line of flight. Hence a minute (at least 30-45 seconds) elapses between recognition of target and arrival of the bomb. In this interval, the plane will travel 4 miles (up to 6 or even 8); so the target must be recognized at this distance. Any partial aid in confusing the bomber is therefore worth while. The angle will be 25° from horizontal (sometimes 15°-50°). Under these conditions only 6-foot (to 12-foot) areas can be resolved. The main targets are armament factories, arsenals, aviation plants, hangars, oil and gas tanks, chemical-storage tanks and fire hazards, and water plants. Landmarks which assist in placing the target include easily identifiable coast-line inflections, rivers, canals, Boulder Dam and the Washington Monument, mountains, railways, highway intersections (especially clover-leaves), racetracks, stadiums, very large buildings, towers and monuments, gas and oil tanks, smokestacks and smoke. These are to be avoided in new construction, camouflaged when possible if already present.

What may be called accessory give-aways include: (1) Angular and curved shadows. These are broken up at the source with nets to simulate grass or foliage, altered with superstructures of projecting, serpentine, slabs of fiberboard, or with jagged-edge structures (see below). (2) Straight lines and right angles (there are none in nature): straight roof lines, roads, canals, bridges, tall chimneys. These are destroyed, or used to simulate urban patterns; or similar decoy patterns are set up. (3) Smooth textures (none in nature) or reflectors (nature has smooth water): windows, flat roofs, saw-tooth roofs, skylights, vents, aluminum paint, glass-brick construction, car-park areas, water pools, etc. Smoothness and reflections are destroyed with garnished (hanging) nets, wood shavings, chips, excelsior, slate-roofing granules, ground rubber, etc.; or dull matt finishes or dust and sand thrown on painted surfaces before drying are used. In car-park areas, wire ropes strung on poles and loaded with colored steel wool, etc., are used. (4) True circles and other regularities (none in nature): oil and gas tanks, water towers, silos, parallel lines of

windows, railroad sidings. See below, (5) Light surfaces: white cement roads and walls, sheet-metal roofing, parking fields. These may be darkened by spraying with residual oil. Factories are recognized by uniformities in lightnesses, especially if with such roofs as asbestos-cement sheeting. Such areas are too light. (6) Mere bulk alone. When possible, areas are broken up by methods discussed herein. (7) Smoke. In new construction, forced-draft systems may be used; with old construction, other decoy smokes may be used. (8) Color (one of the least important elements if limited to chromaticness only): red-brick buildings, heaps of red-iron ore or sulfur, large flower gardens. At a distance, all colors in areas less than perhaps 6-12 feet in diameter blend together and become bluer and duller, with indistinct boundaries. Patterns of purposeful confusion of colors, serpentine and curved strips, never straight or regular, are used. The old green and brown alone will not do; by some, yellows, greens and grays are recommended. One portion at least will always blend out sufficiently with the surroundings. Contrasts in lightness are more important than hues.

The methods, grouped broadly, include: (1) Painting. Painted color alone, such as the old green and brown "dazzle," will not disguise cast shadows nor hard outlines. Shadow-breaking superstructures of painted fiberboard, textiles or paper are used (see below). (2) Structural: such as wire or cord nets woven with colored weather-proofed textile materials and strung at different levels (uneven overhang). Three degrees of camouflage have been distinguished; these are: (1) Toning down (reduction of visibility); the most common job, done mainly with paint. (2) The average job (confusion of identity): includes false shadows, false forms, etc., to destroy out-lines; simple construction (salvaged lumber, chicken wire, nets, steel wire and wool, cheap textiles), planting of trees, quick-growing weeds, rubble; on canals, floating of oil, cork, soot, black sawdust, plywood floats to resemble roofs. (3) The all-out job (complete concealment). This includes (a) complete duplication of the lightnesses, patterns and textures of the countryside, complex or underground construction (false roofs, trees on roofs, etc., this completeness being limited to important installa-tions. (b) Decoy (false, dummy or deflection) targets, of two sorts: harmless features are made to look dangerous or important, while armaments factories, etc. are made to look non-military. Technically, in the terms previously used in reviews in the News Letter, the methods are classifiable as follows. (1) Disruptive pattern, including "dazzle" (zigzag) and parti-coloring, especially for large buildings. (2) Counter-shading (compensative or obliterative shading and "gradation" to remove out-lines and contrasts); especially important for cylindrical objects (snakes and cater-pillars in nature). This is used for gas and oil tanks, guns, torpedo-tubes, aircraft and also buildings. (3) Mimicry (coincident pattern and imitative coloring); like "protective coloration" of animals in nature, including (a) general resemblance, blend-ing into the background (in the field, especially for mobile objects), and (b) special resemblance: similitude to grass, woods, sand, loam, etc. (4) Decoy (false, dummy or deflection targets): ten false gun emplacements along with one real one; several rising smokes near a powerhouse smokestack, etc.

It is necessary to distinguish rural and urban patterns. In urban patterns we find rectangular areas, straight lines, dark values of slate, red roofs and brick, green grass, gray and brown streets, roads, earth and black shadows. Factories are con-spicuous expanses of white-ridged roofs with regular shadows and glass reflecting at low angles. Roads of concrete are light and should be darkened. Glass roof lights should be treated to scatter light by colored particles of powdered brick, slate, granite chipp ings, or sand, using hardened wool-fat varnish, oil varnish or oil-emulsion binders. Other up-facing surfaces should also be made matte. Disrupt the surface of extensive roofs by bold markings. Vertical surfaces should be made actually

lighter, especially if facing north, in order to appear of the same value. The rural patterns are chameleon-like, with the greens of "bronze" type, yellowish rather than bluish, and with many variations in value; but seasonal changes should be kept in mind. Shadows are distorted and there are dark shadows on the ground. Use green and brown (or according to one camoufleur, green, yellow and gray) for factories; elsewhere simulate houses and gardens. For decoys, simulate highways with cement spray (but darken actual highways with sprayed residual oil); use other smokes to decoy from powerhouse smokestacks; use faked trees and similar objects but do not put trees on hangars in such a way that the shadows are a give-away. For new construction, use many decentralized buildings, irregularly spaced (like a powder works); use forced-draft power systems (no smoke); locate the buildings in hilly or wooded areas; use mechanical shutters, auxiliary power and water systems, buried storage tanks; and avoid the "accessory give-aways" listed above. In the study of camouflage jobs, use cardboard models on a 1/200 scale; view them from a roof in the open, or in a "sun laboratory" (dark room with turntable and artificial sun) using vision through sand-blasted glass to simulate haze, blurring of outlines and reduction of saturation. Simulate all seasons, hours of the day and conditions of illumination and viewing, and "strike an average."

Resorting to some interpretation of published data, we may say that the Munsell notations of the greens are in the range near 5 GY; the "earth" colors from 5 YR to 9 YR, especially near the latter; the drabs of low saturation from 8 YR to about 7 Y, and sand and loam from 10 YR to about 5 Y. The reflectances for daylight are in the range about 10 to 20 percent, except for wet dirt or loam, which may run as low as 5 percent and some sands, which may have reflectances as high as 40 percent. As to spectral character, the greens should have high reflectance in the green-yellow (550 mu), low reflectance in the extreme red (680 mu) and very high reflectance in the near infrared (800 mu) in order to simulate the effect of the chlorophyll of foliage. The browns should slope gradually upward in reflectance from the short-wave to the long-wave visible regions and continue thus into the infrared, in order to simulate sand, dirt and loam. For decoy purposes, low instead of high infrared reflectance may be necessary.

SPECTRO-PHOTELO-METER — C. Sheard and M. N. States; J. Opt. Soc. Amer. 31, 64-9 (1941); concave-grating photoelectric spectrophotometer. A detailed description is given of the "spectrophotelometer" or photoelectric spectrophotometer which consists of a concave grating monochromator with suitable exit slit, an absorption cell holder and a barrier-layer photocell directly connected to a box-type galvanometer. A linear response between light intensity and galvanometer deflection obtains over the range of wavelengths 3250 and 7500 A. The spectral region isolated, precautions against stray light, the calibration of the instrument and the barrier-layer photocell are discussed.

LIGHT SIGNALS — J. G. Holmes; Nature 147, 423-4 (Apr. 5, 1941); recognition of coloured light signals. For the author's experiments, an apparatus similar to the Donaldson colorimeter, but with 11 primary stimuli, was used under conditions comparable to night signalling; the mixed lights were gathered in an integrator. The "spectrum" was covered from extreme red to "emerald green" (550 mu); also "turquoise, royal blue and purple," and especially yellow and white. The results "gave 256 points on the colour chart, all being of the same luminous intensity and brightness and each having a closely similar energy distribution to that which would be given by the corresponding colour filter; and would be used in practice." It was concluded that red is the ideal signalling color, being easily produced and yet recognized down to the lowest illumination, even when not fully

saturated. Green is satisfactory under usual conditions, but its use is restricted if blue is also employed. Blue and purple are not satisfactory, the former requiring very high intensity, and the latter depending "on the dichromatic aberrations of the eye." Yellow and white are satisfactory if used separately, but not together unless the white approximates daylight. Really, the fact is whites are unsatisfactory if too yellow. Presbyopic vision and light adaptation both assisted the recognition of blue and purple signals. Fifty observers at one illumination and six (average) ones at three intensity levels were used; and there were 43,000 observations in all.

BIBLIOGRAPHY R. Granit, T. Holmbert & M. Zewi; Nature 142, 397- (1938); through Psychol. Abstr. 15, No. 11, Nov. 1941; mode of action of visual purple

H. D. Griffith & A. M. Fraser; J. Sci. Instr. 18, 9-10 (1941); flourescent medium for use on surface (smoothness) plates

M. M. Gurevich; Uspekhi Fiz. Nauk 22, 129-67 (1939); through Chem. Abstr. 36, 303 (1942); general foundations of colorimetry

M. M. Haring & H. A. Heller; J. Amer. Chem. Soc. 63, 1024-7 (1941); spectrophotometric study of the characteristics of halogen-substituted sulphonephthalein indicators

N. B. Harman; Brit. med. J. 1941, part 2, 347-9; through Psychol. Abstr. 16, No. 1, Jan. 1942; testing night vision

L. Harris, J. A. Kyger & C. N. Sjogren; J. Opt. Soc. Amer. 31, 263-7 (1941); prism and sector photoelectric photometers for determination of concentrations in gaseous or liquid systems

V. G. W. Harrison; J. Sci. Instr. 18, 103-9 (1941); physics of paper and ink (includes measurement of color, opacity and gloss)

Heberlein & Co.; Brit. Pat. 539,165 (1941); production of flock-print effects on fabrics, wherein in addition to figured effects produced by parchmentizing or swelling-agent treatments, flock-print effects are produced

L. G. Heglo; Vestn. Oftal. 17, 824 ff. (1940); through Psychol. Abstr. 16, No. 1, Jan. 1942; evaluation of the Rabkin, Stilling and Ishihara plates used in artificial light

P. A. E. Hellige; U. S. Pat. 2,244,839 (1941); colorimeter suitable for use with various liquids

H. J. Henk; Deut. Wollen Gewerbe 72, 831-2 (1940); through Chem. Abstr. 35, 2331 (1941); cellulosic fibers: identification by fluorescence

M. Héros; Compt. rend. 211, 203-5 (1940); fluorescence of mixtures of fluorescent substances

Adam Hilger & Co., Ltd.; Amer. Ink Maker 19, No. 1, 43 (Jan. 1941); photometric color comparator and amplifier for measuring spectral characteristics of colors

H. H. Hodgson & E. Leigh; J. Soc. Dyers. Col. 57, 82-6 (1941); positional influence of chlorine and of the nitro-group on the colours of certain azo dyes; colorimetric evidence for the mesomeric and inductive effects

L. W. J. Hollerman & L. De Vos; De Ingenieur in Ned.-Ind. 8, 33-48 (1941); through Analyst 66, 395 (1941); tapioca flour: color and brightness measurements

J. G. Holmes; Nature 147, 423-4 (1941); recognition of colored light signals (see abstract, ISCC News Letter, this issue)

Holophane Ltd.; J. Sci. Instr. 18, 171 (1941); low-intensity illumination gauge

I. Honjo; Mem. Coll. Sci. Eng. Kyoto 15, 207-35 (1939); through Psychol. Abstr. 16, No. 2, Feb. 1942; color sense of salamander larvae

R. G. Hopkinson, W. R. Stevens & J. M. Waldram; Trans. Ill. Eng. Soc. (London) 6, 37-48 (1941); lighting systems: effects of brightness and contrast

E. O. Hulburt; J. Opt. Soc. Amer. 31, 467-76 (1941); optics of atmospheric haze

R. S. Hunter; Paper Trade J. 113, TAPPI Sect. 275-80 (1941); Amer. Dyestuff Rptr. 30, 525-30, 542-5 (1941); Paint Var. Prod. Mgr. 21, 207-8, 210, 212-6, 218-20 (1941); multipurpose photoelectric reflectometer

R. S. Hunter; J. Opt. Soc. Amer. 31, 463 (1941); color differences: photoelectric tristimulus measurement

C. L. Huyck; Amer. J. Pharm. 113, 149-56 (1941); effect of ultraviolet light and sunlight on solutions of some coloring agents

J. F. Hyde to Owens-Corning Fiberglas Corp.; U. S. Pat. 2,245,783 (1941); method of coloring glass fibers which consists in forming and incorporating a pigment within the fibers

I. G. Farbenind. A.-G.; French Pat. 846,980 (1939); Brit. Pat. 522,028 (1940); measuring the color of light (using 2 photocells and 2 region filters)

Ingranic Electric Co., Ltd.; Brit. Pat. 527,333 (1940); colorimetric apparatus

H. M. Irwin, Jr. & S. S. Irwin; Photo Technique, June 1941, pp. 56-9; specular and diffuse (photographic) densities

E. Jacobson; Paint, Oil Chem. Rev. 103, No. 3, 16, 18-24 (1941); color instead of paint (proposal of 680-color system with 24-step hue scale and equal perceptual intervals)

A. H. Jay; J. Sci. Instr. 18, 128-30 (1941); simple photometer for the examination of X-ray films

G. W. Jennings; U. S. Pat. 2,261,473 (1941); color-changing temperature-indicating compositions

C. R. Johnson & E. A. Garcia; Refiner Natural Gasoline Manuf. 20, 520-1 (1941); spectrophotometric characterization of lubricating oils

R. P. Johnson; Amer. J. Phys. 8, 143-53 (1940); solid fluorescent materials (review)

L. A. Jones & H. R. Condit; J. Opt. Soc. Amer. 31, 651-78 (1941); brightness scale of exterior scenes and the computation of correct photographic exposure