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NEWSLETTER

INTER-SOCIETY COLOR COUNCIL NEWSLETTER

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MAXWELL COLO(U)R CENTENARY

According to the Secretary of the Centenary Committee, R. W. G. Hunt, the dates of the conference have been changed to May 16, 17, and 18. This joint Physical Society - Inter-Society Color Council meeting will be held at the Imperial College of Science and Technology, London. Each session will be opened by a short review of the current position of the subject concerned, followed by papers by one or two well known workers in the field; time will then be allowed for contributions by other conference members and for discussion.

The following provisional programme has been drawn up:

Tuesday, May 16 — "Trichromatic Principles"

Morning "Colorimetric Aspects"

Afternoon "Physiological Aspects"

Evening Centenary Discourse by Dr. D. A. Spencer, "A Hundred Years of Colo(u)r Photography"

Wednesday, May 17 — "Colo(u)r Reproduction"

Morning "Photography and Television"

Afternoon "Printing and Pigments"

Evening Conference Dinner

Thursday, May 18 — "Colo(u)r Appearance"

Morning "Relevant Factors"

Afternoon "Its Specifications"

Among those who have already signified their intentions to be present and deliver a paper are the following: Dr. D. B. Judd, Dr. W. S. Stiles, Dr. G. Wyszecki, Dr. W. A. H. Rushton, Professor Y. Legrand, Dr. D. R. Duncan, Mr. M. H. Wilson, Mr. W. C. Granville, Professor W. D. Wright, Miss D. Nickerson, Mr. B. H. Crawford, and Mr. W. L. Rhodes.

ITALIAN CONGRESS ON COLOR

(In the last issue of the Newsletter reference was made to two international meetings on color. Deane Judd translated a summary of the Italian meeting. He also translated titles and summaries of the French meeting which were published in Couleurs magazine. Both are to be reproduced in the N.L.)

The 4th National Italian Congress on Color was held in Padua, 2-4 June 1960, on the theme: Color in Publicity. This Congress has marked a new step in the series of annual manifestations of the Istituto Nazionale del Colore. The quality of the discussions, the importance of the participants, the care in its organizing, all were outstanding, and this year a large international participation was assured with about one hundred participants coming from Austria, Germany, Jugoslavia, Holland, Brazil, and an important French delegation from the Centre d'Information de la Couleur, who established excellent contacts with the Istituto del Colore. The program consisted of three parts.

Part I: Color in Printing Chairman, Professor Vasco Ronchi, Director of the Institute of Optics, Florence

Mr. René Viguier (France) presented the problem of color in periodicals, and, most especially, in the daily press, showing the economic difficulties, then that the technical problems are solved, presenting actual French accomplishments (sheets taken from a newspaper).

A German delegate from the firm, Pelikan, then showed a very carefully studied principle of standardization of primary inks.

Professor Boganelli insisted on the psycho-physiological bases of the use of colors in publicity and showed statistical results of a study on color preferences.

Mr. C. C. Smits (Netherlands) spoke of color symbolism in its practical applications.

Mr. Levy (National Institute of Safety, France) presented the signs issued by the Institute and the practical results indicated by the frequency of requests by their users.

Professor Petrini, finally, reviewed the use of colors in books.

Part 2: Color in Presentations Chairman, Mr. Déribéré, General Secretary of the CIC, Paris

Dott. Pia Albertazzi Bossi, in a very concise and concrete communication, presented a questionnaire of a very direct use for a scholarly investigation of the directed choice of a color.

Professor Ernest Lother Reich (Austria) made a psychological explanation of color in publicity, packaging and sales, which was completed by Professor Elisabeth Lothar Reich.

Mr. Marzano spoke of the affective stability and chromatic preferences on the basis of statistics obtained on the Italian railroads.

Mr. Déribéré presented some practical results obtained in France on the coordinated and rational use of light and color: luminous and illuminated signs, choice of coloration as a function of the nature of the illuminant.

Part 3: Color in the Salesroom Chairman, Professor A. Terstenjak, Jugoslavia

The architect, Carlo Pagani presented the general theme of the ambient color of sales places.

Professor Anton Terstenjak took up this theme on the physiological plane, and Engineer Giorgi Paini on the descriptive and physical aspect.

Mlle. Suzanne Dumarest dealt with research on color harmony in a very positive manner and on the adaptation of a psychological and artistic value with utilitarian purposes.

Dr. Cusimano, finally, treated the subject referring most specially to the case of free service.

Before dispersing, a banquet was held to reunite the chairmen, the organisers, and the authors of communications and to permit them to strengthen the bonds of friendship and collaboration between the groups from the different countries notably between the Istituto Nazional del Colore of Padua and the Centre d' Information de la Couleur of Paris. (Padua written here probably by mistake, DBJ).

FOURTH JOURNÉES INTERNATIONALES DE LA COULEUR (The meeting was held in Rouen, 28-30 April 1960 and reported in Revue Officielle du Centre d'Information de la Couleur (CIC), No. 36, 3rd Quarter of 1960.)

Editor's note: The summaries are too extensive to be published in a single issue of the Newsletter. The remainder will be published in Newsletter Number 151, January-February 1961.

Section 1, Colorimetry

W. D. Wright (London), "A New Visual Differential Colorimeter"

The instrument described in this note was conceived for the measurement of very small differences with the greatest possible precision.

The specimens to be compared are illuminated to different levels, and the ratio of the luminance factors, B_1/B_2, is given by the ratio of the illuminance levels, E_2/E_1, required to obtain a photometric match. This ratio also corresponds to that of the stimuli, Y_1/Y_2. The ratios of the other stimuli, X_1/X_2 and Z_1/Z_2, are determined by repeating the observations with orange and blue filters introduced into the system. The optics of observation include a biprism and a group of lenses so that the observer sees a 10° bi-partite field whose two halves are separated by a very fine line.

The construction of the instrument described constitutes one part of a program of researches on high precision in colorimetry and spectrophotometry that have been undertaken by Imperial College, and the instrument itself is still being perfected. On this account, the description of its present actual state is more a kind of report on its possibilities than a final note, and it is not possible to communicate any detailed reports of its actual performance.

(Instruments based on this principle, called photometric ternary analysis, were built and studied by I. G. Priest from 1926 to 1930. Because each match is by heterochromatic photometry, the precision attained was inferior to that by methods taking advantage of the chromatic sensitivity of the eye directly. Substitution of a photocell for the human observer, changes this instrument into a more or less conventional photoelectric tristimulus colorimeter. Priest's experience suggests that Wright may find that the instrument does not conform to its purpose of "measuring very small differences with the highest possible precision." DBJ)

G. Bertrand (Paris), "Can the Accuracy of Photoelectric Tristimulus Colorimeters Be Improved?"

Most colorimeters in industry are tristimulus instruments. The radiant energy emitted by the source and the spectral sensitivity of the cell are generally imposed. Only the spectral transmittances of the three filters can be modified to make the combination source-filter-receptor realize approximately the three distribution functions corresponding to one of the standard sources A, B, or C. Since it is hard to construct a combination of filters giving directly the X-function, two different filters are employed for the two distinct parts of the curve, the filter used for the part between 0.38 and 0.50 μ serving as a measure of Z.

The tristimulus values of a material given for the measuring conditions corresponding to a particular type of instrument are given by equations of the form:

$$X = a_1x_1 + a_2x_2, \qquad Y = b_1y_1, \qquad Z = c_1z_1,$$

where the a, b, c, are experimental coefficients, and the x_1, x_2, y_1, z_1 are readings made by means of the instrument.

The use of these equations leads to non-negligible systematic errors in the chromaticity coordinates and luminance factors which can amount to the following values:

$$\Delta x = \Delta y = \pm 0.02, \qquad \Delta Y/Y = \pm 10\%$$

Various methods have been proposed to reduce these uncertainties. The fundamental relations giving the tristimulus values of a colored material for a specified source can be expressed in the form of a limited development of terms of the form:

$$X = \sum_i a_ix_i, \qquad Y = \sum_i b_iy_i, \qquad Z = \sum_i c_iz_i, \qquad i = 1, 2, \ldots n$$

the a_i, b_i, c_i, being experimental coefficients, the x_i, y_i, z_i, corresponding to readings made on the measuring instrument with filter, i, inserted. On this principle, König has constructed a colorimeter with 10 filters. (1)

(1) H. König, Kolorimetric mittelot Vakuumsel und Kombinations-filter, Helv. Phys. Acta. 17, 571 (1944).

By this idea, it is proposed to determine, for an upper fixed limit of uncertainty: $|\Delta x| = |\Delta y| \leqslant e$, $\Delta Y \leqslant r$,

1) the choice and number n of filters to use, and

2) the method permitting the best definition of the coefficients a_i, b_i, c_i.

Certain industrial problems require the determination of x, y, Y with an exactitude which only the most highly perfected spectrophotometers can give. The purpose of this study is the construction of a colorimeter simple to use, with more than three filters, capable in certain cases of reducing the uncertainties to the limits of those of spectrophotometers. (This method has been known in the USA as abridged spectrophotometry. DBJ)

G. de Schrevel (Eindhoven), "Results of Measurements of Spectral Reflection Factors by Means of Commercial Spectrophotometers"

The study group on color tolerances of l'Association Néerlandaise pour l'Étude des Couleurs has set up a measuring program for spectral reflectances obtained by means of the spectrophotometers at its disposal in order to have an idea of:

the precision for each instrument

the correlation between instruments

the accuracy of the results of the measurement.

The group hopes that these results, which will be confronted with the results of analogous examinations made in other countries, can serve as a basis for the study of color tolerances.

Fr. Braun (Louvain), "Contribution to the Study of the Idea of Vivacity of Color"

The idea of vivacity of color does not appear to correspond to any physiological idea, but presents more a technological character requiring its definition by a physical relation.

This physical relation already studied and presented by Edelmann is discussed here in the light of Luther's theory of moments.

F. Driancourt (Imprimerie Georges Lang), "Some Details of Colorimetric Measurement on Printed Specimens"

Most theoretical studies on the colorimetry of printed specimens are based on the simple hypothesis that the ink layer deposited on the surface of the paper acts essentially like a colored filter. It is admitted that the combination:

paper support plus filter, examined by reflection, can be directly deduced from the reflection properties of the support on the one hand and the transmission properties of the filter on the other.

It is proposed to show that this approximation is insufficient and that it is necessary to take into account among other things phenomena such as the specular reflection and reflex ("mordoré") of the ink layer.

These phenomena seem to be the source of the discrepancies found among measurements made on colorimeters of geometrically unlike dispositions. The study undertaken on this subject has furthermore permitted to place in evidence the influence of fluorescence effects which are another cause of discrepancies between measurements on instruments of different type.

P. Mouchel (Vincennes), "Improvement in Color Reproduction by Means of Interimage Effects"

The procedures of color reproduction are generally based on equations of reproduction established for chromatic sensitivities and the colorants used. These equations, in their most usual form, relate the densities of colorants formed to the densities of the photographed subject.

The determination of these equations is very difficult in particular because of the subjective character of the word "perfect" in the expression "perfect color reproduction". However, an appraisal method based on colored objects judiciously chosen among the most familiar can facilitate this determination.

The reproduction equations contain correction terms relating the densities of each colorant to the exposure densities corresponding to two other colorants. Photographic technique introduces these corrective terms under the form of masks.

Different procedures permit their introduction in an automatic way. This is the case of the "interimage effects", susceptible of being produced to different degrees in films and papers with multiple emulsion layers. Such effects can be beneficial if they approach the procedure which puts them into play from their equations of reproduction. In the favorable case they can contribute to an improvement of color reproduction.

R. Seve (Kodak-Pathé), "Test to Determine the Whiteness of Papers Containing Fluorescent Products"

After having recalled modern work on the determination of whiteness by a single number, it was shown that the extension of this work to products containing fluorescent colorants is necessary. It was explained how this work was accomplished thanks to a Zeiss precision colorimeter. The measurements were made on a series of papers dyed with an extended series of known quantities of the same fluorescent product. Visual estimations were compared with the curves of spectral reflectance and with the whiteness determinations calculated by the various usual methods: luminance factor, TAPPI brightness, Stephansen whiteness, Hunter diagram, Judd-Selling whiteness.

It was shown that the illuminating source used was too rich in ultra-violet rays. It was also shown that the only hope of solution is in the Hunter methods or in the Judd-Selling formulas. Encouraging perspectives finally were detailed.

M. Jacquemart (Institut Textile de France), "Photometric Evaluation of Whites in the Textile Industry"

The impact of color on the textile world masks at times the importance that must be accorded to white; but very complex problems are posed for its realization in the domain of fibers both traditional and synthetic. There is a need to set up reproducible methods to control dyeings. The colorimetric problems of textiles are common to those of other activities: paints, papers, ceramics, but difficulties which are admittedly considerable inherent in this type of measurement are aggravated on account of the influence of the support on the diffused flux. These difficulties follow from the nature of the fibers and construction of the fabric.

The working group, Colorimetry, of l'Institut Textile de France, has undertaken studies to find a solution for each of the colorimetric problems posed to this industry, in collaboration with other existing groups. A method of evaluating white applicable to all types of instruments used has been adopted permitting the achievement of a convenient, comparative classification of specimens. This method permits the rejection of the use of certain instruments and improvements for others. The analysis of the numerous measurements made has brought out the diversity of performance of the instruments used. Colorimetry is the only way to eliminate difficulties inherent in subjective judgments by insufficiently informed observers. Progress is needed in order to develop definitive tests which are convenient and susceptible to definite practical applications. Collaboration is recommended between researchers and users.

P. Kowaliski (Kodak-Pathé, Vincennes), "Some Remarks on the Geometry of Color Space"

The increasing use of the CIE triangle as the practical image of the domain of real colors is little compatible with its particular constitution which is destined only to supply a convenient plot for colorimetric calculations. The definition of its position relative to a cartesian, orthogonal system having for axes the real primaries R, G, and B of the CIE permits better relating its virtual primaries, X, Y, and Z, whose concept is abstract, to the space of real colors. The discussion of the precise meaning of points of that space, outside the domain of realizable colors, is facilitated by relating them to three basic elements having an unambiguous physical meaning: the neutral axis, the cone of spectral colors, and the alychne plane.

Section 2, Psychology, Esthetics of Light and Color

R. Kherumian and C. Ropartz (France), "Some Genetic and Anthropological Problems of Color Blindness"

Color-vision abnormalities pose numerous genetic problems (discordance on the part of monozygote twins, dominance variation on the part of heterozygotes, correlation with diseases, and so forth), and anthropological problems (ethnic and regional variations of incidence, incidence of tritanopia, and so forth). For the solution of these problems it is necessary to proceed according to the national plan for detection of color-vision abnormalities. Furthermore this detection has a great practical importance in avoiding that color-abnormals orient themselves toward activities contra-indicated by their anomaly.

R. Blin, "The Operational Concept of Color"

A theory of colors in the cadre of the evolution of modern technique - Fundamental and dominant colors - Psychophysiology and purity of colors - Preferential colors - The operational concept of color: study of harmony.

M. Déribéré, "The Nuance of Light in the Presentation of Metallic Objects"

Manfred Adam (Berlin), "Aemilius Miller and the Ostwald Color Science"

COLOUR GROUP OF
THE INSTITUTE OF PHYSICS AND
THE PHYSICAL SOCIETY

(The following is taken from a program sent to the Newsletter by A. W. S. Tarrant, Honorary Secretary.)

<u>Extra-Foveal Colour Metrics</u>

An investigation of colour matching properties of the initially dark adapted eye at 10° eccentricity confirms interesting phenomena noted by previous workers and establishes some new effects. Additivity has been examined in terms of both extra-foveal and foveal comparison RGB systems, and marked failures of both photometric and chromatic additivity have been found in spite of the fact that local adaptation and the level of stimulation have been controlled throughout. This suggests interaction between the physiological responses in mesopic vision. A theoretical treatment in terms of cone-rod inhibition successfully explains the form of the additivity failures.

Dr. F. J. J. Clarke
National Physical Laboratory

<u>Some Photo-Chemical Properties of Extra-Foveal Regions of the Living Human Retina</u>

While the existence of at least two light-sensitive substances in the rod-free area of the human retina is demonstrated easily, visual purple contained in the rods impedes the study of extra-foveal regions. It is none the less possible to reveal outside the fovea the presence of light-sensitive material other than visual purple. A tentative scheme describes how the cones may perhaps utilize light, and qualitatively accounts for the difference between the data on foveal and extra-foveal cones respectively.

Dr. R. A. Weale
Institute of Ophthalmology

Notice to Members

Another science meeting will be held on 9th November, when Mr. L. B. Happé (Technicolor Ltd.) will speak on the visual assessment of coloured ciné films and Mr. J. Vickers (John Vickers Studios) will speak on the visual assessment of colour prints.

There is to be a joint meeting of the Photoelectric Spectrometry Group and the Optical Group on 21st October, on the subject of recording spectrophotometers; members of the Colour Group who would like to attend are invited to contact Mr. K. A. Macdonald (Unicam Instruments Ltd., Arbury Works, Cambridge), who is the P. S. G. Secretary. Papers will be read by Dr. G. H. Beaven and Mr. A. W. S. Tarrant and there will be a series of demonstrations of commercial instruments.

FEDERATION OF SOCIETIES FOR PAINT TECHNOLOGY

The Federation held its 38th Annual Meeting in the Sherman Hotel, Chicago, October 29, 30 and 31, and November 1 and 2, 1960. The program and abstracts of the papers were published in Official Digest, Volume 32, Number 429, October 1960. Two of the sessions were devoted to color subjects: "Status of Color and Gloss Measurements in Industry," Mark Morse, E. I. du Pont de Nemours & Co., and "Paint Problem Clinic and Color Headaches," conducted by Colonel Billy Hood.

The following is the published abstract of Mr. Morse's paper:

> "Current practices and problems of color matching and gloss rating by visual and instrumental measurements are described and discussed. Studies by Federation and A.S.T.M. groups to establish standardized conditions for rating color and gloss are described and problems encountered in preparing and maintaining permanent color and gloss standards are outlined. Types of color and gloss measuring instruments used in industry are briefly described and some methods of translating measurement data to visual appearance are given. Results of an A.S.T.M. study of color difference measurements by commonly used spectrophotometers and colorimeters are evaluated. Comments are made on the advantages and disadvantages of instrumental color and gloss measurements as compared to visual ratings."

FORTY-FIFTH ANNUAL MEETING OF OPTICAL SOCIETY

The Optical Society of America held its 45th Annual Meeting October 12, 13, and 14, 1960, at the Somerset Hotel, Boston. Deane B. Judd and David L. MacAdam were chairmen of two of the afternoon sessions.

The following is a list of papers concerning color:

"Color of Electroluminescent Phosphors," Lester W. Strock, Sylvania Lighting Products, Inc., Salem, Massachusetts.

"New Recording Spectral Scanning Color Analyzer," Monroe H. Sweet, Quantametric Devices, Inc., Binghamton, New York, and Frank J. Rizzo and Alvin O. Ramsley, HQ QM R&E Command, Natick, Massachusetts.

"Physical Approximation of Color-Mixture Functions," W. E. R. Davies and G. Wyszecki, Division of Applied Physics, National Research Council of Canada, Ottawa, Ontario, Canada.

"Color Order System Predicting Constant Hue," F. W. Billmeyer, Jr., J. K. Beasley, and J. A. Sheldon, Polychemicals Department, E. I. du Pont de Nemours and Company, Wilmington, Delaware.

"On the Bezold-Brücke Phenomenon," P. L. Walraven, Institute for Perception, RVO-TNO, Soesterberg, The Netherlands.

SOCIETY OF PHOTOGRAPHIC SCIENTISTS AND ENGINEERS

The 1961 National Conference of the SPSE will be held in Binghamton, New York May 22 - May 26. The main theme of this conference will be Color Photography in all of its scientific and engineering aspects. The SPSE is planning a program that will include papers pertaining to the following specific areas:

1) Color Perception and Color Photography
2) Color Photographic Systems and Processes
3) The Structure of the Gold Image
4) Color Sensitometry and Densitometry
5) Color Cameras, Printers and Processing Equipment
6) Color Photography for Recording Purposes in Science and Engineering

SECOND COLOR CONTROL SEMINAR

A second three-day seminar on the topic "Color Control" will be presented by Rochester Institute of Technology, December 14, 15, and 16, 1960. The seminar director is F. L. Wurzburg, Interchemical Corporation. The staff consists of Dr. Henry Knoll, Bausch and Lomb Optical Company; Warren Reese, Macbeth Corporation; S. A. Philpot, Coca Cola; Dr. Robert Meltzer, Bausch and Lomb; and Warren Rhodes, Rochester Institute of Technology.

Topics covered in the seminar are Physics, Vision, Illumination, Purchasing, Color Control, Color Measurement, and Instrumentation.

DICTIONARY OF VISUAL SCIENCE

The editors are Max Schapero, David Cline, and H. W. Hofstetter. The Chilton Company recently published this unique dictionary (1960) containing 785 pages illustrated.

The unique objective was to provide a comprehensive dictionary covering all the fields relating to visual science, and so far as this was feasible it appears to have been well accomplished. Of the over 13,000 definitions or characterizations, 170 are under color (colorimeter, chromas, chrom-, etc.), 30 on illusions, 15 on adaptation, 250 on lenses, 60 symptoms (subjective evidence) of anomaly or disease, 110 signs (objective evidence) of disease, 35 varieties of scleritis, and so on. Naturally the interests of the authors and the 61 collaborators are reflected in the emphases of content. Optometrists predominate but there is also expert representation in physiological optics, orthoptics, geometrical optics, pathology, ophthalmology, and more specialized branches.

Sidney M. Newhall

Reprinted from "The New Scientist" Vol. 6, pp. 447, 448 and 449, 1959

Colour vision: a field of unsolved problems

How does the brain distinguish between an object that is red and one that is blue? The answer must depend on the nature of the messages transmitted from the retina of the eye, but the problem of what goes on there has still to be solved

by Professor W. D. WRIGHT
Technical Optics Section, Imperial College of Science and Technology

CAN any subject claim a more diverse body of investigators than colour vision? Psychologist, photographer, physicist, dyer, physiologist, lighting engineer, artist, philosopher, chemist, printer, ophthalmologist, paint manufacturer, geneticist, television engineer—a babel of many tongues, perhaps, but all have an interest and all have contributed to the wealth of information which now exists. Yet mystery still surrounds even the initial light reaction in the colour receptors (the so-called cones) of the retina, let alone the final emergence of a colour sensation in consciousness.

There are many reasons for this state of affairs. The cones in the centre of the retina, the fovea, where colour vision is at its best, are only some 0.0015 mm. in diameter, so that the most refined techniques of the microscopist have to be used if any internal structure is to be seen. Extraction and examination of the light-sensitive chemical from the cones has proved a baffling exercise in microbiology and biochemistry and one moreover that has to be conducted in the dark. Attempts to record nerve impulses from individual neurones in the retina or single nerve fibres in the optic nerve strain the techniques of the neurophysiologist to the uttermost. And none of these methods of investigation can be employed *in situ* in the living human eye.

Nevertheless, from comparative studies of human and animal retinas, some idea of the extremely complex biological activity in the retina and optic nerve has emerged. In particular, it appears that the retinal response is of a dynamic nature, changing rapidly with the duration and intensity of the stimulus, and that there are innumerable opportunities for interaction between neighbouring areas of the retina and along the neural pathways to the brain. Yet in all this there is hardly a single clue as to how the message that is transmitted to the brain distinguishes, say, an object that is red from one that is blue.

The ignorance about the nature of the sensation itself is even more complete. Electro-magnetic waves of wavelength 0.65 microns are described as red light, but this is not a description of redness, which is something entirely different. The best we can do is to attempt an introspective description, although we rarely stop to think that the redness of a pillar box is not an intrinsic part of the pillar box but is subjective within us. The constancy of the colour of things around us is in fact a remarkable tribute to the manner in which our visual sensations are mentally projected into the objective world, and give little hint of the subtle processes by which this result is achieved.

They soon begin to emerge, however, when we come to examine problems of colour vision in the research laboratory. The physicist inevitably starts with the spectrum, since he can check the radiation which produces the sensation of vision in the simplest possible terms of wavelength (or frequency) and energy. When he looks at the spectrum he is aware of the familiar sequence of colours from red through orange and yellow, yellow-green, blue-green, blue and violet. He notices, too, that the brightest part of the spectrum is in the yellow-green. In some way the eye responds differently to each wavelength in the spectrum and this discrimination must exist from the moment the light strikes the retina.

Our understanding of what happens at this first stage must therefore be regarded as Problem No. 1. Until this has been solved an element of uncertainty must exist in our interpretation of all the events which occur at later stages in the visual process between retina and brain.

It is generally accepted that the millions of cones in the retina are divided into different types, some being more sensitive to one part of the spectrum and some to another. In some way light falling upon these cones is converted into impulses which can be transmitted by the optic nerve. It seems likely that the different cones contain chemicals sensitive to light of different frequencies. It has also been suggested that the cones may behave like resonators tuned to the different frequencies of light, depending on the size and geometry of their internal structure. Whichever explanation is accepted, the idea of different cones having different spectral sensitivity provides a simple and straightforward basis for wavelength discrimination.

The main argument is concentrated on the number of different types of cones which are required. Colour mixture experiments, which date back to the work of Sir Isaac Newton, suggest that there must be at least three types, each with different spectral sensitivity: and that three would be sufficient. These conclusions arise from the fact that colours can be matched by adding together red, green and blue light; this principle is applied in three-colour printing processes, colour photography and colour television. Notice that in physical terms the mixture of red, green and blue lights must be very different from the physical composition in terms of wavelength and intensity of the light that is being matched; but the sensation is the same. It is easy to demonstrate that a two-colour process in general reproduces an incomplete range of colour sensations. In printing, it is true, four or more colours are often used, but this is largely due to the shortcomings of the pigments.

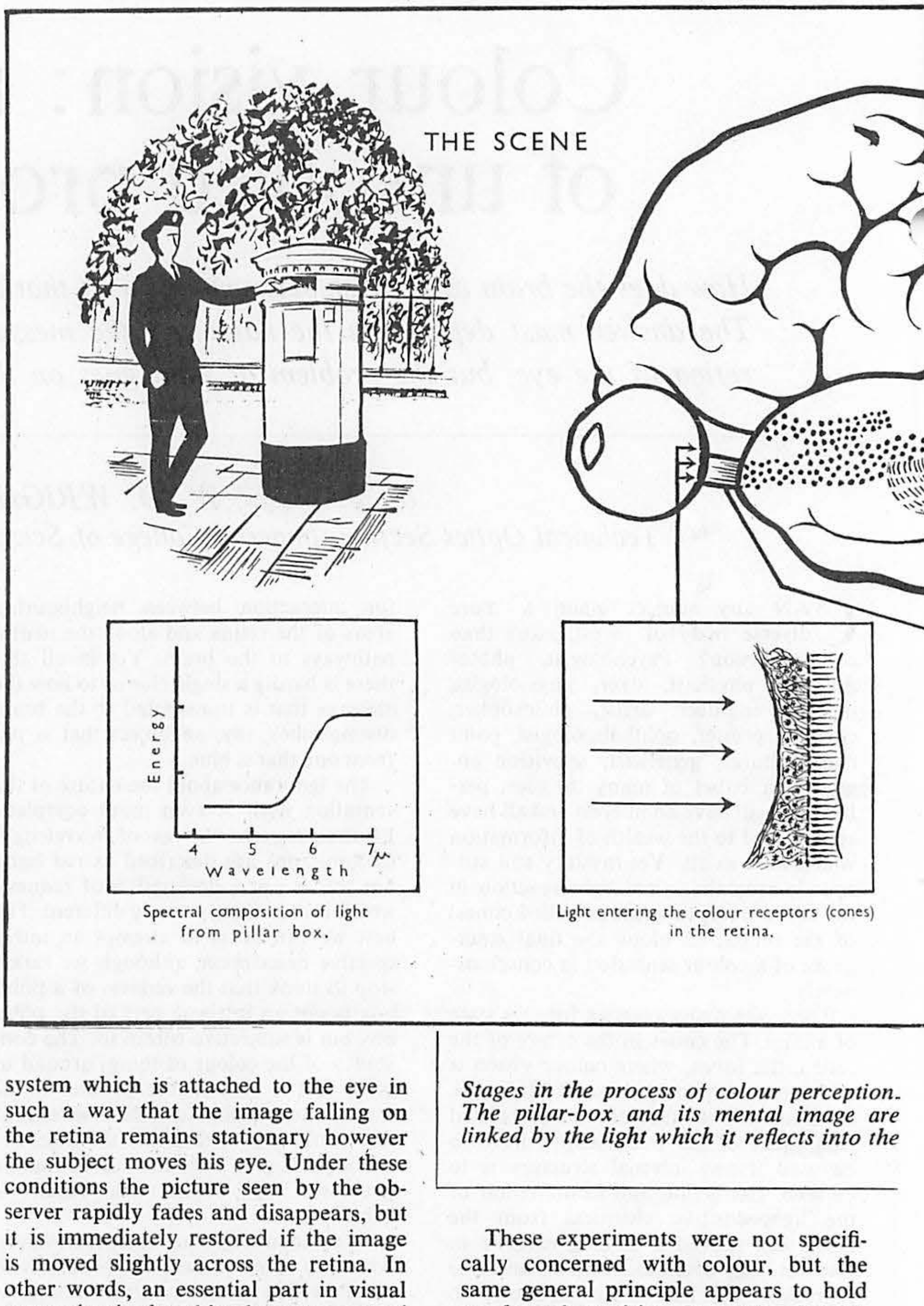
It is one thing to note that a mixture of light of three different wavelengths will produce a sensation of colour, but quite another to relate this to what is going on in the retina. However, it is possible, by matching the colours through the spectrum, to work out what the spectral sensitivity of each of the three types of cone may be. This is very different, though, from measuring directly the colour absorption of lights of different wavelengths by the cones themselves.

Recently W. A. H. Rushton, of Cambridge University, and R. A. Weale, of the Institute of Ophthalmology in London, have devised very clever experiments for measuring the absorption of light in the cones of a living eye. Their method depends on reflecting light from the back surface of the retina. The manner in which this surface absorbs light of different wavelengths can be discovered by "bleaching" the visual pigment in the cones. When the retina is exposed to a very bright white or coloured light the visual pigments are temporarily bleached, and light which returns from the back surface of the eye is hardly affected by passing through the cones. If the experiment is repeated with the cones unbleached, then the reflected light passes through the pigment twice. Thus the amount of light absorbed by the pigment can be calculated. Light of different wavelengths is used for the absorption measurements to build up the complete spectral absorption curve of the cones. The results which have been obtained show a suggestive similarity to those derived from colour matching experiments, although as yet there is little direct evidence from this technique to suggest the existence of a blue pigment.

We thus have some objective confirmation from studies of the living human eye that different colour-sensitive processes do exist, although they have still to be identified with biological processes.

Another important line of investigation has been developed by Professor R. W. Ditchburn and his colleagues at the University of Reading, whose work has made clear the dynamic nature of vision. They have designed an optical system which is attached to the eye in such a way that the image falling on the retina remains stationary however the subject moves his eye. Under these conditions the picture seen by the observer rapidly fades and disappears, but it is immediately restored if the image is moved slightly across the retina. In other words, an essential part in visual perception is played by the movement of the image across the rods and cones of the retina.

Experiments going on in our own laboratory, where F. J. J. Clarke is studying the fading of images located on fixed areas of the periphery of the retina, support the view that eye movements are an essential part of vision. The eye is in no sense a counterpart of a physical light detector like a photoelectric cell, which maintains a constant relationship between the input of light and the output of an electric current.



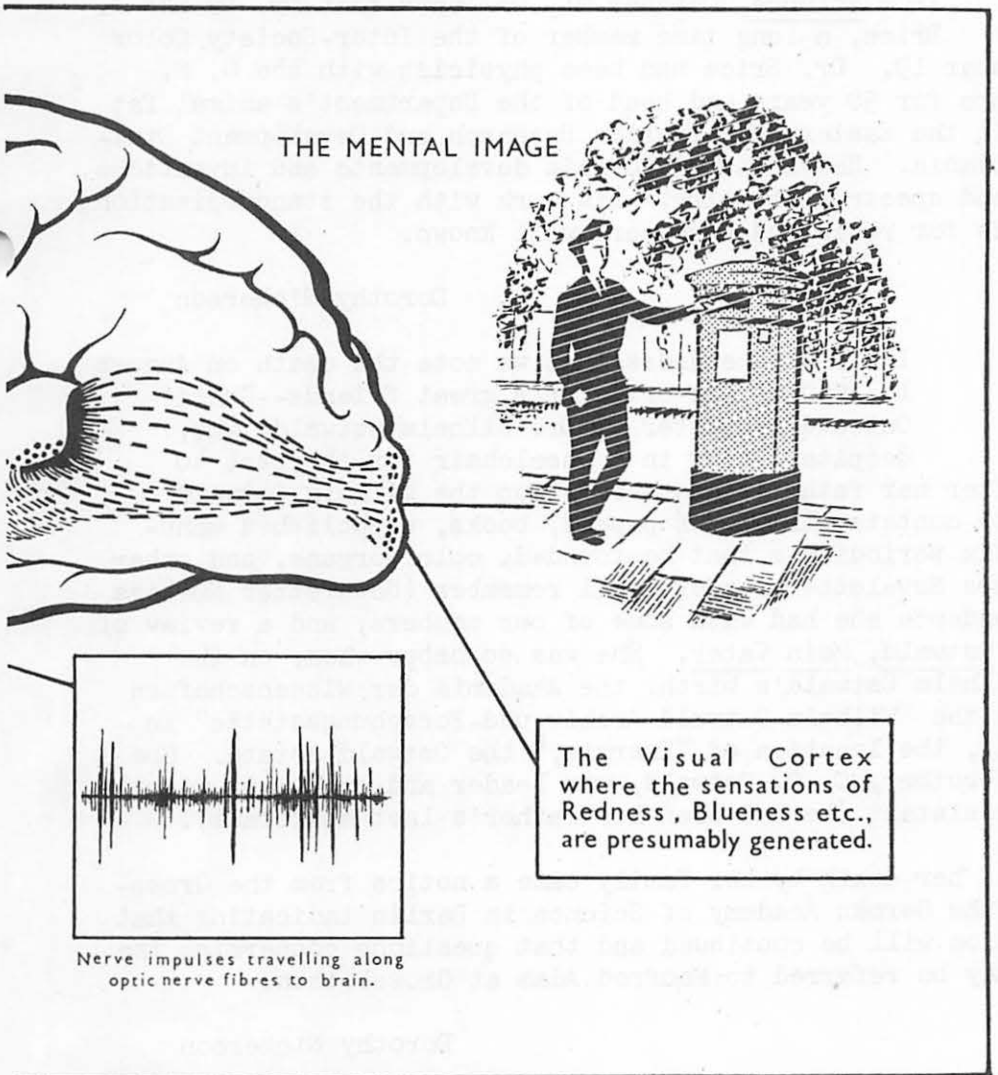
Spectral composition of light from pillar box.

Light entering the colour receptors (cones) in the retina.

Stages in the process of colour perception. The pillar-box and its mental image are linked by the light which it reflects into the

These experiments were not specifically concerned with colour, but the same general principle appears to hold too for colour vision. In another investigation K. J. McCree has shown that some observers, principally those capable of maintaining very steady fixation, find that quite large differences in colour rapidly disappear when viewed steadily. What is not clear is how to interpret these results; whether they should be attributed to some property of the cones or the optic nerve or whether they result from some more remote process in the brain.

In fact the more that one investigates the eye the more strikingly different does



eye, by the colour response of the retinal receptors and by the nerve currents transmitted from the retina to the visual cortex.

its behaviour appear to be from that of a physical instrument. For example, remarkable changes in colour appearances can be produced by adaptation and contrast. Light of a wavelength which the physicist describes as yellow, can be made to look either red or green by giving the eye a period during which it becomes accustomed to green or red light. This "change in values" is, of course, common for most sensations. If the left hand is placed in hot water and the right hand in cold water, and then both hands are plunged into a bowl of tepid water the left hand feels the tepid water as cold, while the right hand feels it as hot. The experiment with the yellow light is exactly comparable. The eye which has become accustomed to green light sees yellow as orange and even red.

Another fact of importance to colour designers can be seen if small coloured squares are mounted on a pattern of alternate yellow and blue stripes. The appearance of the coloured squares undergoes striking change as the distance from which the pattern is viewed is increased. S. J. Belcher is studying this fact quantitatively at Imperial College. It probably arises partly because of the interaction between neighbouring areas of the retina or that part of the brain involved in colour vision, and partly because of scattered light in the eye. The realism of these effects was strikingly illustrated in the construction of the Stalingrad Sword, which had a hilt bound with alternate stripes of blue and gold wire. The juxtaposition of the blue with the gold changed the gold colour to a brilliant pink. Attempts were made to restore the hue of the gold, but it quickly became obvious that this was a visual and not a metallurgical problem.

Similar striking colour effects were observed by Goethe, who experimented with coloured shadows. If a white screen is illuminated with white light from one lantern and red light from another, an interposed object will throw two partial shadows. In one shadow the screen will be illuminated only with white light and the other only with red. Yet although one shadow appears red, the other (which physically speaking should be white) looks blue-green.

We cannot explain this phenomenon in detail, since we do not know whether it occurs in the eye or in the brain. Certainly photochemical and neural processes of adaptation in the retina tend to compensate for excess of one type of radiation over another, but there may well be equivalent processes in the brain about which we know very little. These phenomena and their relationship to the problems of colour reproduction have been brilliantly illustrated in a series of lectures by R. M. Evans of the United States.

More recently Edwin H. Land has shown that a surprising range of colours can be reproduced using two-colour projection. Land has exposed negatives through colour filters, transmitting at the long and short-wave side of the yellow point in the spectrum, and has projected the two images in, for example, red and white light on to a single screen. This appears, in essence, to be an elaborate form of Goethe's coloured shadows experiment. In this kind of research, however, the end result is too often described in qualitative terms only, and effective progress is unlikely to be achieved until we find some way of actually measuring the colour appearance.

There is scope here for employing what is known as the binocular matching technique: one eye, say the right, is used as the test eye, and is subject to a variety of conditions and colour stimuli, while the other eye, the left, is maintained in a constant state of adaptation and is used as the reference eye. This kind of observation is of particular interest because it deals with colours as we see them and not merely in the physical terms of wavelength and intensity; but the major problem of colour vision is still the unsolved one of what goes on in the retina. Until that is solved we can only speculate on these other fascinating questions.

B. A. BRICE DIES

From Science, October 21, we learn that Dr. Brooks A. Brice, a long time member of the Inter-Society Color Council, died on September 19. Dr. Brice had been physicist with the U. S. Department of Agriculture for 30 years and head of the Department's animal fat properties laboratory in the Eastern Utilization Research and Development Division, Wyndmoor, Pennsylvania. He was noted for his developments and inventions in the field of color and spectrophotometry. His work with the standardization of glass color standards for rosin and honey are well known.

Dorothy Nickerson

GRETE OSTWALD DIES
FEBRUARY 13, 1882
AUGUST 1, 1960

It is with sadness that we note the death on August 1, 1960 of one of Color's great friends--Grete Ostwald, daughter of Dr. Wilhelm Ostwald, who, despite living in a wheelchair for the past 40 years, nevertheless, after her father's death built up the Wilhelm Ostwald Archiv at Grossbothen to contain all of his papers, books, unpublished manuscripts, letters, the six periodicals that he founded, color-organs, and other color apparatus. Perhaps Newsletter readers will remember (Newsletter Numbers 106, 122, 124) correspondence she had with some of our members, and a review of her 1953 book, Wilhelm Ostwald, Mein Vater. She was so happy when, on the 100th anniversary of Wilhelm Ostwald's birth, the Akademie der Wissenschaften of East Germany founded the "Wilhelm Ostwald-Archiv und-Forschungsstätte" in Grossbothen near Leipzig, the location of "Energie," the Ostwald estate. She wrote that her younger brother, C. O. Ostwald, was leader and organizer with Manfred Adam as first assistant (he had been her father's last assistant).

With the announcement of her death by her family came a notice from the Grossbothener Foundation of the German Academy of Science in Berlin indicating that the work of the Foundation will be continued and that questions concerning the Ostwald color studies may be referred to Manfred Adam at Grossbothen.

Dorothy Nickerson

FRED BILLMEYER RECEIVES
APPOINTMENT TO M. I. T.

Dr. Billmeyer received his appointment as Visiting Professor of Chemical Engineering to assist in revising the curriculum with respect to polymer chemistry, to teach new courses and to revise his book, Textbook of Polymer Chemistry. In a letter to the Newsletter, Dr. Billmeyer said, "As you see, these objectives refer to the other half of my 'split personality' and have little to do with color. However, my interest remains high, and I plan to keep abreast of the field and the committee work for the year."

The "split personality" refers to previous work which Dr. Billmeyer has done in the field of polymer chemistry. He received his B. S. degree in chemistry from the California Institute of Technology in 1941, and his Ph.D. in physical chemistry from Cornell University in 1945. Since 1945 he has been associated with the du Pont Company. He is author of 30 papers in the fields of polymer chemistry and optics, and his book is widely used in classrooms. Since 1951 he has held the position of Lecturer in High Polymers at the University of Delaware.

DR. BALINKIN AND ASSOCIATE INVENT FILTERGRAPH

(From the Cincinnati Enquirer) Dr. Isay Balinkin and Dr. C. Harrison Dwight are co-inventors of the "Filtergraph," a device for demonstrating additive and subtractive color mixture. The device is approximately 11 inches long and consists of stationary and sliding frames, one holding four different blue filters, the other four different yellow filters. By moving the frames so that filters and their spectral curves overlay, users can see quickly the composition of the transmitted light and the resulting colors.

By the use of the "Filtergraph" it is easy for a teacher to demonstrate that blue and yellow do not necessarily make green. According to the article, blue and yellow can be combined to make any hue in the spectrum. It can be ordered from:

Central Scientific Company
1700 Irving Park Road
Chicago 13, Illinois
Attention: Mr. H. Schindler
Catalogue Number 87416 ($10.95)

D. NOEL OBENSHAIN MODERATES TAPPI PROGRAM

D. Noel Obenshain, Project Leader, Research Engineering and Design, West Virginia Pulp and Paper Company, (ISCC Board, 1958-60) was the moderator of a TAPPI technical symposium on "Relative Humidity and Paper Test Methods". The symposium was held in Grand Rapids, Michigan during the 11th Annual Testing Conference, September 27 through 29, sponsored by the Technical Association of the Pulp and Paper Industry.

NOTE FROM HELEN TAYLOR

Although her permanent address is Bermuda, Helen Taylor still remains active in ISCC. She continues as chairman of delegation from the Tanner's Council of America, and she is still an active member of the Newsletter Committee.

Mrs. Taylor writes, "We have a lovely old house here, built in about 1690, with a charming garden on the water. The flowers and the flowering trees are wonderful, and every day something new bursts into bloom. We can swim off of our own dock, and almost everything is in walking distance. All ISCC members will be very welcome here and our telephone number is 11241.

Her address is: Queen of the East
Broadway
Hamilton, Bermuda

ARTISTS' PIGMENT-COLOR SYSTEMS

In proposing, in the January 1960 issue, to open the pages of the ISCC Newsletter to a discussion of the kind of color system artists want, Dr. Judd writes (Page 20) of the "communications barrier between artists and scientists."

I suspect that the chief problem here is access to a selective bibliography. The scientist and the artist, will, of course, be familiar with standard works within his own field, and with monographs on his own specialty; but when he seeks to learn more about his "opposite number" he is in a difficulty.

As a young boy I was familiar with the Munsell color system, and was a pupil of Arthur Pope, yet it was only years later, when I acquired a first edition of "A Color Notation," that I appreciated the history of color systems in America as it is expressed in Milton Bradley's "Color in the Kindergarten," (Springfield, Mass. 1893); Albert Munsell's "A Color Notation" (Boston, 1905), and the two books now combined in Arthur Pope's "The Language of Drawing and Painting," (Harvard University Press, Cambridge, Mass. 1949.)

In a more recent edition of "A Color Notation," (Baltimore, Md. 1954) Miss Nickerson writes: "A great many people have the idea that the Munsell system and 'The Book of Color' are Mr. A. H. Munsell's primary contribution to color. I do not believe this is so. His contribution lies in a much more fundamental matter. A color notation was on his mind, and 'A Color Notation' was the result."

I had the privilege, as a boy of sixteen, of entering a course in the use of Munsell color standards, as they applied to two-dimensional design. The course was devised by Albert Munsell and Professor Dow of Columbia University, and given in the years 1922-23 at Teachers' College. Looking back on this experience, I think it likely that the remarkable personality of Mr. Munsell (who died in 1918) illumined the course; for the atmosphere was electric, the students enthusiastic and the work turned out remarkable.

This early exposure to the Munsell system of colors determined the whole course of my life; I will not pretend, however, that my youthful interest would have survived intact until the present day, without the training I received during the next four years at Harvard College; where the department of drawing and painting was headed by Arthur Pope, since Professor of Fine Arts.

In the Preface to "The Language of Drawing and Painting," Mr. Pope writes: "I like to think of what I have written not as the expression of a purely personal point of view but rather as the product of studies concerning the art of drawing and painting which have been carried on during the last fifty or sixty years by a succession of teachers and students in the Department of Fine Arts in Harvard University. It has been the aim of these studies to build up a body of knowledge to form the basis for a genuine theory of the Fine Arts comparable to theory in music, understanding of which is taken for granted for the intelligent listener as well as for the composer and performer. In the visual arts there has been history on one hand and practice on the other, with theory (partly on account of the complications of the general subject of vision) largely neglected." (page ix.)

The kind of painting Prof. Pope has in mind is clarified in the following paragraph: "The principal difficulty with the more or less abstract painting that has been produced in recent years is that when enclosed within the limits of a frame like an independent picture without function as an enrichment of a particular surface, it is, however perfect, often meager in interest - in manifestation of order - as compared with the richness of organization we find in what we think of as fine examples of either representation or of pure pattern." (page 138).

During the fifties, when I lived in Connecticut, I on several occasions gave an illustrated lecture which I called "Introduction to Modern Art." In it I attempted to trace some of the tendencies of the painting of today (there are said to be 46 different schools of contemporary art) from the bold experiments of the impressionists, whose fame dates from the Independent Exhibition of 1874, in Paris. My real purpose in explaining the scientific color theories of the impressionists was to see how far the "listener" could go in understanding the "performer", to quote Pope's musical analogy.

The purpose of the impressionists is thus expressed by Robsjohn-Gibbings ("Mona Lisa's Mustache," N. Y. 1947.): "The impressionists, with their solid bourgeois backgrounds, did base many of their discoveries in painting on the scientific analyses of color and visual phenomena. They were in complete sympathy with science and were anxious to advance painting into the rationale of the scientific world. In many ways they succeeded in doing this. But this very preoccupation with science makes the impressionists an isolated phenomenon in the over-all history of modern art." (page 7.)

Mr. Ted Sprague, in an exchange of letters with Dr. Judd (in the issue of the ISCC Newsletter referred to above) says (page 21): "The problems that an artist deals with are, I believe from years of observation, given more concentrated attention than most people give to their business." This leads us to another source book, by a practicing artist, Hilaire Hiler ("Some Associative Aspects of Color: The Journal of Aesthetics and Art Criticism, Vol. IV, No. 4, June 1946.) Mr. Hiler began his painting as an impressionist, and later made a change to abstraction, so that his sympathies cover a wide range of territory.

In discussing the possibilities of an artist pigment-color system, Mr. Hiler makes the following suggestions:

1. Minimum size of standards, 4 square inches, for grading and matching; play-card size for average operators.

2. A flexible format.

3. Execution in standardized oil colors, soil resistant and washable.

4. Information on reverse sides: number & symbol of color, name of color in several languages, including Latin, mixing directions, wavelength, and other physical registration data, reference to other systems.

"These recommendations," (continues Hiler) "form a minimum of qualities for a practical color system. The establishment of such a system would of course involve considerable labor, and it could be better carried out by an institution than by an individual. There should be collaboration between chemists, psychologists, artists, semanticists or epistemologists."

Henderson Wolfe

MANUAL OF SKIN COLOR

There has been received from Dr. Sanzo Wada, Director of the Japan Color Research Institute (1 Akasaka-Fukuyoshicho, Minato-ku, Tokyo) an exemplar of the Manual of Skin Color recently completed by that Institute representing the culmination of ten years of research on this subject. This manual includes 679 colors within the Munsell chroma range, 1 to 7. Each color is shown as a 7/8-inch square of vinyl chloride plastic chosen for its similarity to the appearance of human skin, which facilitates color matching. These chips are mounted in seven systematic square arrays, ranging from light to dark, and are freely detachable, which makes for convenient color comparison; and the size of the color differences between neighboring steps (13 hues with a spacing averaging about 2 Munsell steps, 7 values averaging about 0.5 of a Munsell value step apart and 8 chromas averaging about one Munsell Chroma step apart) are as small as could be desired. Even small areas of normal human skin exhibit rather large color variations. The chips are each identified by a three-number notation; the first number indicating value; the second, hue, and the third, chroma, on scales analogous to the Munsell scales. The Munsell notation intended for the color of each chip is also given in a conversion table.

The Manual of Skin Color is intended primarily as a guide to make-up in the fields of color photography and color television, but it finds important applications also in the cosmetic business, in anthropology, and in dermatology. An unique property of the Manual of Skin Color is that the color chips have been formulated from colorants of spectral characteristics very similar to those of the pigments by which human skin derives its color. The matches made are thus relatively stable regardless of the spectral character of the light used. By virtue of this unique property the Manual of Skin Color has been patented.

D. B. Judd

MORE ABOUT SKIN COLOR

In connection with work on the CIE Committee on Color Rendering of Light Sources, the color of skin is important. From Japan's expert, Dr. Takashi Azuma, this committee has recently received spectrophotometric data on skin color that have to do with make-up especially made to follow actual complexion colors. A full and recent report of this work, including 18 figures and 11 references, has been published in the June 1960 Journal of the Society of Motion Pictures and Television Engineers, "New Type of Make-up Material for Color Motion Pictures and Color Television" by Hidemitsu Seki and Akira Kodama. This contribution comes from the Japan Color Research Institute, (Sanzo Wada, Director), Akasaka Fukuyoshi-cho, Minato-ku, Tokyo, Japan. The paper is a translation of an article published in Japan, August 1958. It will be interesting to many ISCC members that in it, reference is made to curves of skin color that appear in our secretary's 1948 excellent book, An Introduction to Color.

Dorothy Nickerson

SEARS SEEKS COLOR MAN

Sears Color Laboratory has an opening for an experienced physicist. In addition to extensive training in physical science it would be desirable for applicants to have experience in production and liaison. Problems will include application of physics, color, sound and other sciences to consumer products. It is a challenging opportunity for a man possessing a technical background who is interested in dealing with people.

MISCELLANY

New Color TV Uses Two Black-White Tubes

A basically different color TV receiver was demonstrated and explained by its inventor, Dr. Frank G. Back, at a recent meeting of the New York Area Chapter of the Society of Photographic Scientists and Engineers.

"This new color television set," he explained, "completely departs from previous methods of color reception, and is based on experiments which indicate that the human eye is basically a two-color mechanism and not three-color, as was previously believed. Because of this, the new set requires fewer and less intricate parts than present color television sets.

"The new set receives both black and white and color programs, but does not require a special color picture tube. Instead, two ordinary black and white tubes, working simultaneously through a new optical arrangement, produce unusually sharp black and white pictures as well as realistic color. The sharpness of all pictures is due to the fact that by using black and white tubes it is not necessary to project color pictures through a colored phosphorus 'screen'."

Dr. Back contends the new set is far simpler than those now in use, and is less sensitive to external "interference" such as the earth's magnetic field. It is as simple to service as black and white sets and will probably cost much less than present color TV sets.

* * * * * *

New Colors for Hearses

America's funeral directors are turning from traditional black to two and even three-tone funeral coaches.

The old folk superstition about black is changing with a resulting new status symbol in the funeral business in many parts of the nation.

In 1940, more than 95% of all hearses were black. Today, fully half of the coaches produced are colored. Three-tone tan coaches are popular as well as combinations of white and blue. Peacock blue with aqua and gray has been accepted.

Funeral directors, in defending the trend toward multi-colored coaches, remind critics that flowers have been an accepted burial tradition for centuries. "Why not color in coaches, too?" they ask.

* * * * * *

Make our Spans More Spic

(The following is an excerpt from the <u>Family Magazine</u> of the Pittsburgh Press by Mary O'Hara)

What's wrong with our bridge work? Here we have in our county more beautiful bridges than the Maharajah of Baroda has rubies and what do we do with them? Paint them all the same neutral color....

Why don't we study each one -- particularly the 27 major bridges and paint it to match its personality and the particular spanning job it performs?

For example, the Liberty Bridge is crying for red, white and blue to match its name. The graceful swirls of the Smithfield Street Bridge could be done in bright Tyrolean green and red because it leads into that minor league Alp, Mt. Washington.

A gay yellow would certainly be easier to look at than a soot-shot gray the color of squid ink.

Our paint goes all over the world soothing patients in hospitals, resting the eyes of the book-weary, stimulating gastric juices, livening up jaded old houses, cooling stuffy little attics, warming up coldly forbidding rooms with northern exposure.

Why not apply this color psychology to our bridges? (We have 571 of them in Allegheny County.) Make our town the city of glorious bridges (which it is, only nobody knows it).

Who would look at the Taj Mahal if it were battleship gray -- or olive drab?

* * * * * *

Peachy Penicillin

A new form of penicillin which was introduced to the market came out simultaneously under at least six different brand names and in five colors -- pink, green, two shades of yellow and peach!

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Adding Color to Food May be Undesirable

Excerpts from an article by Bill McPherson in the September 5 edition of the Washington Post:

Color influences nutrition, and whether for good or bad is largely up to the food processor, a Canadian scientist reported to the Fifth International Congress on Nutrition.

Ross a Chapman of the Food and Drug Directorate, Ottawa, Canada, described experiments in color conducted in a large supermarket. Women were asked to wear colored glasses while doing their shopping, then to remove the glasses and examine what they had purchased.

"Every woman involved," Chapman said, "was surprised at some of her selections and many wished to return some of the goods. They experienced most difficulty with meats, cheeses, fruits and vegetables."

In another experiment, a number of foods -- meat, potatoes, peas, shrimp and mint jelly -- were served in pairs to a taste panel, members of which were asked to indicate their preference.

The foods were identical except that they had been colored with different amounts of vegetable dyes of no nutritive value. One of the foods in each pair was colored to resemble the natural, normal or expected color of the food, while the other was an intensification of the normal hue.

"The panel members preferred the food with the natural color," Chapman said, "but for the wrong reasons. Without exception they reported that the off-color foods had decided off-flavors."

Synthetic food colors added to foods are obviously a potent weapon which can strongly influence the choice of foods. 1.6 million pounds are used each year in the United States and 150,000 pounds in Canada.

"The use of color," Mr. Chapman said, "could have either a good or bad influence on nutrition. Certainly the situation demands that processors use food colors with discretion."

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