Inter-Society Color Council *Newsletter*

NUMBER 215
November-December 1971

41ST ANNUAL MEETING

The 41st Annual Meeting of the Inter-Society Color Council will be held at the Statler-Hilton, New York, N.Y., on Monday and Tuesday, March 20 and 21, 1972.

On Monday, March 20, open meetings of the ISCC Problems Subcommittees will be held. As in the past, members and friends of the Council are encouraged to attend this Monday session. Both morning and afternoon meetings will be held.

Mr. John T. Smith, Jr., of the U.S. Coast and Geodetic Survey has arranged two programs, under the auspices of the American Society of Photogrammetry, dealing with photogrammetry and color aerial, space and underwater photography. These topics will be treated in illustrated talks and discussions on Monday, March 20, at 2:30 P.M. and on Tuesday, March 21, at 1:30 P.M.

The reception and banquet of the Council will be held on Monday evening, March 20, in contrast to the usual Tuesday time for this event. The program will highlight the first presentation of the Council's Macbeth Award. The banquet speaker will be Mr. William A. Radlinski, Associate Director of the U.S. Geological Survey and Past President of the American Society of Photogrammetry. His topic will be "What is Photogrammetry?"

The annual business meeting will be held on Tuesday morning, March 21, and will include the presentation of reports by Chairmen of Member-Body delegations as well as by Officers and Standing Committee Chairmen.

A final program and registration form will be sent to the membership in February. Because of the change in banquet time to Monday, advance registration and purchase of banquet tickets is strongly urged.

EDITOR'S NOTE

The initials on the map of the Geographical Distribution of ISCC members, in the last issue (No. 214) should have been F.W.B. (not RWB) for Fred Billmeyer who was responsible for assembling the drawing. My apologies to him.

R.W.B.

A NOTE TO THE PRESIDENT FROM THE CHAIRMAN OF THE 41ST ANNUAL MEETING

The tentative program for the forthcoming ISCC meeting in New York on March 20 and 21 is as follows:

For the forum on Monday afternoon, March 20, from 2:30 to approximately 5 o'clock -- Dr. Frank J. Wobber will present "Earth Orbital Photography -- Application to Environmental Protection," touching on the subjects of pollution, ecology, agricultural resources, forestry, etc. He will be followed by Dr. Edward Yost, on "Low and Medium Altitude Multiband and Multispectral Photography as a Tool for Photogrammetrists." The final presentation will be by Mr. Sheldon Phillips, who will discuss "Oceanographic Efforts of Research Submersibles using Color for Photogrammetric Interpretations."

With regard to the Tuesday afternoon (March 21) symposium from 1:30 to approximately 4:30, the following is planned:

Dr. Harold Rib will speak on "The Necessity for Accuracy in Color Measurements in Photogrammetry;" Mr. Anthony Salerno will speak on "Laboratory Techniques for Processing and Rectification of Color." Mr. Salerno will also use color orthophoto maps for illustration of the new techniques. Mr. Gerald Norman will present "Agriculture and Forestry Blight Determinations by the Use of Color." Colonel J. Robert Quick will wind up the program with a discussion of "The Acquisition of Photography from Aircraft." At the end of the program, there will be approximately 30 minutes for open discussion and for questions pertaining to the topics discussed.

The American Society of Photogrammetry is preparing approximately 250 packets for distribution to registrants. These will include papers on color aerial photography, a copy of our publication, Photogrammetric Engineering, and other items we feel will be of interest to non-technical people attending the sessions.

The program I have laid out is not intended to be technical in nature, but is designed more to familiarize people with photogrammetry and to illustrate its uses.

John T. Smith, Jr.

DR. GUTH ELECTED VICE PRESIDENT COMMISSION INTERNATIONAL DE L'ECLAIRAGE

Dr. Sylvester K. Guth, manager of Applied Research in General Electric's Lamp Marketing Department at Nela Park, Cleveland, Ohio has been elected a Vice President of the Commission International de L'Eclairage (CIE) and named Chairman of the Action Committee. His election came during CIE's Plenary meeting Sept. 8-15 in Barcelona, Spain.

Dr. Sylvester K. Guth

As chairman of the seven-member Action Committee, he will be responsible for assigning personnel to and directing and coordinating the work of 27 technical committees working in all areas of lighting. In addition, Guth and his committee will review each committee's work plans and results as well as organizing the technical program of the next Plenary meeting scheduled to be held in London in 1975.

Guth has been a member of the Action Committee for 12 years as well as serving as chairman of one of the Technical Committees, the International Committee on Discomfort Glare. He has presented papers to the Plenary meeting of CIE on four occasions and has authored more than 50 scientific and technical papers on light, vision and seeing.

A fellow of the Illuminating Engineering Society, Dr. Guth was chosen for the Society's Gold Medal Award in 1967 in recognition of outstanding contributions in the field of lighting, vision and seeing.

During his 41-year lighting research career, Dr. Guth has developed many criteria and techniques used in evaluating visibility, contrast sensitivity, visual acuity, glare and ease of seeing.

A native of Milwaukee, Wisconsin, Dr. Guth received his Bachelor of Science Degree in Electrical Engineering in 1930 and a Professional degree of Electrical Engineer in 1950, both from the University of Wisconsin, and the degree of Doctor of Ocular Science from the Northern Illinois College of Optometry in 1953. Dr. Guth is a Fellow of the American Academy of Optometry and the American Association for the Advancement of Science. He is a member of the Optical Society of America, the Association for Research in Ophthalmology, Inter-Society Color Council, the Illuminating Engineering Society (London) and the Armed Forces' National Research Council Committee on Vision.

In his capacity with the General Electric Company, Dr. Guth directs research on the physiological, psychological and psychophysical effects of radiant energy on man, animals and plants.

STYLE IMPORTANT IN LIGHTING

The big breakthrough in home lighting this year, it appears, is a revolutionary process for bonding 24-karat gold to glass -- making possible a durable bare-bulb look the size of a fish bowl that gives a golden hue that will last as long as the glass.

That the lamp doesn't give enough light to read, work or even talk with appears to be unimportant. For some reason beyond comprehension, illumination is one of the last considerations in home lighting research and development these days.

The real effort seems to be poured into styling instead. And finding the secret path beyond styling to good lighting is a very hard job for most consumers. In fact, says an executive with Lightolier, Inc.:

"People today are not lighting their homes any better than people lighted them 30 years ago. It's too easy these days to mistake seeing a light for being well-illuminated. These bare-bulb lamps show you a lot of light, but it isn't comfortable light."

Adds a spokesman for Westinghouse: "People don't know if their lighting is comfortable unless they've been exposed to good lighting. And that information for the average consumer is very hard to come by, although some public utilities here and there are beginning to try public education programs."

Looking for advice on good illumination in a lamp store or department is frequently a waste of time, according to an executive engineer with a lamp-socket manufacturing firm.

"Lamp stores are in business to sell fixtures," he explained. "Selling light is secondary. They're not expected to know anything about light. That's the job of a lighting consultant. So if you have the money to hire one, you should have no problem."

Now this is not to say that poor illumination is a conspiracy by lamp makers and designers. In the words of designer Robert Sonneman:

"Light is the last thing women think about when they are furnishing a room. The rule seems to be that first you have to have a sofa, then a rug, then draperies, then end tables -- and finally you have to have something to see it all with. So last of all you think about buying a couple of lamps."

That priorities list with its accent on styling is helped along by many house-and-home magazines, according to one lamp manufacturer. In his words:

"The magazines often use our lamps in their photos. But they use their photographic lights to take the pictures. In fact, one magazine recently did a whole story on lighting with full-page color pictures. But you couldn't tell what the room lighting did at all because all the illumination for the photos came from the photographer's lights.

"When I said that to the editor, she replied that the photo was 'prettier' that way."

How long the bare-bulb look will remain in style is anybody's guess. Much of the industry is surprised that it has lasted this long, and is waiting nervously for the next lighting style to arrive.

But the more basic question remains unasked by most manufacturers, namely, how long will illumination be of secondary importance in the lighting industry?

There is one small sign of change on the horizon. The electric utility companies, having seen the great profits to be made from air-conditioner users, would like to keep summertime revenues coming in all year long. But it's a hard job to convince customers to keep their air-conditioners on in the winter, or to buy a second refrigerator or hi-fi complex.

The only way to sell more wattage, it seems, is to sell more illumination. If better lighting comes, it will be an act of sheer desperation.

Elaine Cannel
Rochester, N.Y. Democrat and Chronicle
December 19, 1971

REPORT FROM SUB-COMMITTEE FOR PROBLEM NO. 18: COLORIMETRY OF FLUORESCENT MATERIALS. NOVEMBER, 1971 MEETING

Report of Task Force I

Dr. Per Stensby (CIBA-GEIGY) reviewed the activities of Task Force I, Visual Appraisal of Fluorescent Materials. This is a visual evaluation of white samples of paper, textiles and plastics. The evaluation is being done in four laboratories with five observers in each laboratory. Instrumental measurements were also made on the samples in each laboratory.

Dr. Stensby stated the inability to obtain the data collected during the previous chairmanship of the task force, and that he and Franc Grum would continue working on obtaining this information. Only two laboratories' data (Proctor and Gamble and Kodak) were available although four laboratories have completed the analysis. Information is available on the instrumental measurements as well as the visual analysis from the two reporting laboratories.

It was felt that inasmuch as the instrumental measurements have shown very little change during the year and a half over which the measurements have been made that the samples were quite stable. It was pointed out that the spectral power distribution of the viewing lamp and the measuring lamp should be known, and that they should be as closely matched as possible when comparison is made between visual analysis and instrument measurement. A suggestion was made that it would be valuable to have a paper and perhaps a textile manufacturer involved in the analysis. For those wishing to undergo the analysis the task force furnishes the viewing light sources, samples, and instructions for viewing geometry, surround conditions, etc.

Status of Task Force II

Task Force II, Analysis of SRF (Spectral Reflectance Factor) in terms of true reflectance and true fluorescence, was reported on by Mr. Fred Simon. The problem, as Mr. Simon pointed out, is one of correct measurement of the sample. He made reference to a paper presented at CIE in Barcelona by Franc Grum. This paper describes the result of work done at Kodak in regards to SRF, true reflectance, and true fluorescence. Copies of this paper are available through Franc Grum or CIE (CIE P71.22). A previous paper by Franc Grum dealing with the instrumentation involved with this analysis was cited as most useful (Applied Optics 8, p. 1149).

Dr. Eugene Allen stated that he had discovered a method for determining true reflectance by using spectrophotometric data obtained by an instrument having white light illumination and monochromatic pickup. Such data is valid for true reflectance up to the wavelengths where fluorescent emission begins. A measurement is then made at some wavelength beyond the excitation region using a filter over the light source which cuts out all exciting energy. With this information it is possible, according to Dr. Allen, to calculate the true reflectance curve of the sample in question. Dr. Allen also stated that true reflectance curves could be obtained above the long wavelength end of the excitation curve by normal spectrophotometry, i.e. monochromatic illumination and total pickup.

Fred Simon suggested that with instruments having both normal and reverse geometry (monochromatic illumination and total pickup or white light illumination and monochromatic pickup) information obtained by a combination of both methods can be used in determining true spectral reflectance. An analysis of the two curves leaves an area of uncertainty only where the excitation curve and the fluorescent emission curves overlap. This region of uncertainty can be approximated reasonably well by appropriate methods of curval linear interpolation. In addition Mr. Simon stated that it is essential that the energy distribution of the source be known for the reverse geometry spectrophotometric measurement. Dr. Allen believed this approach to be less accurate than the one he is suggesting. Dr. Allen is preparing a paper on his approach which should be available soon.

Report on the New Interlaboratory Test

Franc Grum discussed the results of the last round-robin for spectrophotometric measurements of fluorescent samples. Results indicated that the color temperature of the D_{65} simulator must be standardized as well as the spectral power distribution of the source. Some samples were temperature dependent in that the SRF changes as a function of temperature. In summary the results for the mean range in x and y (chromaticity coordinates) for good samples was as small as 0.001 and in FMC-1 Delta E a range of from 0.11 to 0.42 in the best case but normally did not exceed much over unity. Franc felt this indicated that under controlled conditions measurements having good agreement between laboratories could be made.

The Next Subcommittee Meeting

The next meeting will be held on March 20, 1972 at the regular meeting of the ISCC in the Statler Hilton Hotel in New York City.

Milton Pearson
Committee Secretary

THINK PINK!

A lady engineer at General Telephone Company of California started something when she happened to use a pink pencil to indicate manhole covers on some blueprints.

Based on her drawings, someone ordered paint for the covers in the same color.

Now, telephone men working near the painted manholes tend to blush a matching shade as they receive some gentle kidding from passers-by.

HENRY W. LEVISON CITATION

Henry W. Levison, FAIC, has retired as president of Permanent Pigments, Inc., leading manufacturer of artists' colors. For retirement activity he has started a new firm, COLORLAB, to do research and development in decorative and protective coatings with locations in Cincinnati, Ohio, and Hallandale, Florida. The greater part of available time has already been contracted for.

At this year's National Art Material Trade Association annual meeting Levison was elected to the association's Hall of Fame and cited as "having favorably affected the art materials industry more than any other living individual." Among the activities referred to were the initiating of "truth in packaging" and restriction of manufacture to only lightfast artists' colors when he founded his firm in 1933. He also played a major role in the establishment and continuation of Artists' Oil Paints, Commercial Standard, CS98-42.

Having the advantage of steady activity as a paint chemist since graduation from the University of Cincinnati (MA:28) Levison was constantly in contact with the latest developments in protective coatings. This resulted in many new developments in the archaic artists' color field. The most far reaching of these was his development of a full line of acrylic emulsion artists' colors, the first new kind of artist's paint in four hundred years. "Acrylic" paints now are surpassing oil paints as the most used medium.

Levison is also busy writing extensive sections on artists' materials for several series of technical treatises on the paint industry. He has long been a member of and is involved in committee work in the Federation of Societies for Paint Technology and the Inter-Society Color Council.

MAKE YOUR OWN LIGHT SCULPTURE

Have you noticed a popular trend in contempory art called light sculptures? These are combinations of glass or plexiglas and a light source using bulbs of different sizes or color or intensities. They may not look like much to begin with, but once you plug one in, wow!

There are two kinds of light sculptures. One is designed by gifted artists and will be beautiful, unique and costly. The other kind is the "multiple" -- which means an original design with many copies, and though usually less expensive than an original, still costs more than I like to pay.

But don't turn off yet! There is another way -- the light sculpture you make yourself. And there are so many possibilities that as soon as I begin to describe a few, you will think of a hundred variations on each theme.

Begin simply, think first in terms of using readily available materials. Take styrofoam, for example. Many cameras, radios, television sets and other valuable equipment comes from the store packed in styrofoam specially made to fit the product you've bought, often in two or four sections that come apart for easy unpacking. I used to throw these away -- with reluctance, because they are often beautiful forms.

But now, I put the pieces back together, leaving a small space between them for ventilation, mount them on a block of wood or a single pedestal with Elmer's glue and set a bulb and wired socket into the space formerly occupied by a projector radio. Turn it on: the styrofoam has a gorgeous, luminous texture

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when lighted from within -- like a floodlight in a snow palace. It's mysterious and inexpensive; besides styrofoam is non-biodegradable, so you're helping to keep pollution down and saving a buck at the same time.

Other visual delights are equally inexpensive. Plain fluorescent ceiling fixtures, for example, can be hung on a wall to make a geometric shape of different colors; simply change the tube -- from white to green or pink or yellow -- in a 12 inch by 12 inch fixture -- or a 2 foot by 2 foot fixture, or a 1 foot by 4 foot fixture if you like stripes, and allow the translucent diffuser -- cover of the fixture -- to do the rest. Hang these on a big wall, and for even more glow, connect the cords to a dimmer. This can be especially effective for the end of a long corridor that needs light anyway.

Or take strings of the tiniest Christmas tree lights you can find and drop each in canisters or jars made of brightly colored glass. I like the lights that twinkle best because they seem to bring a whole life style to any room, sparkling away happily in their rosy-hued homes.

But light sculptures can also be simple materials merely altered or activated by daylight or by a spotlight on the floor or table. I like to use fishing tackle boxes of clear plexiglas and fill the compartments with bits of sea-glass, marbles, or plastic jewelry parts you can buy in craft or plastics stores. Set this box in a small window for a real daytime delight; you can change the insides when you get bored.

In a room I designed recently I combined several homemade light sculptures with modern furnishings. I made a many-sided divider by pasting mirrored squares, or mylar squares, together on either side of nylon fishing cord set at regular intervals on the ceiling. These hang freely, to the floor, and separate the dining from the seating area with a shimmering, invisible veil that is in constant motion from any slight draft of air. You can add to this visual excitement by placing a floor-floodlight behind the sofa, making a soft light for dining from the reflection of a hundred tiny mirrors.

Another light sculpture you can buy are those gorgeous yellow warning lights you see fastened to saw-horses at construction sites in any city. A word of warning to free-loaders; these cannot be unbolted -- take it from one who has tried! But you can buy them at a modest cost -- the used ones are less expensive -- from your local transit company. Buy three and use them in a group on a shelf. They last for years and they blink in a cheerful amber pattern, in or out of traffic.

Or make lighting accents of your windows. One of my very favorite ideas is to use eight-foot fluorescent tubes on either side of a window hung with white or the new mirrored venetian mini-slats. You can do the same thing if you have a deep window with a simple floor flood lamp behind the blinds; both lighting treatments will be equally effective with matchstick bamboo or a rich textured fabric.

Almost anything you light can become a sculpture. The combination of ideas and light can make any room live. And you're the artist, so use your own imagination to make the idea work.

Emily Malino
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AIC HELMHOLTZ MEMORIAL SYMPOSIUM ON COLOR METRICS HELD IN DRIEBERGEN, NETHERLANDS, SEPTEMBER 1-3, 1971

At the 1969 Congress of the AIC (Association Internationale de Couleur) the Dutch National Committee proposed an invitational symposium on Color Difference Measurement to be held in 1971 in Holland. The Executive Committee of AIC agreed to sponsor such a symposium. Accordingly, an Organizing Committee comprising Dr. P. L. Walraven as Chairman, Dr. L. F. C. Friele, Dr. J. L. Ouweltjes, and Dr. J. J. Vos was constituted to arrange for the symposium. Each national organization of the AIC was asked to submit names of persons, without regard to nationality, whom they felt should be invited to take part in the symposium. Accordingly, a total of 67 people were invited to attend the symposium and 65 actually participated.

The Organizing Committee provided each of the attendees with pre-printed copies of the papers before the meeting took place. Accordingly, each paper was allotted only approximately 15 minutes for summary presentation. The rest of the time was devoted to discussion of the papers. In addition, there were formal discussion periods set aside in afternoon and evening sessions. There was also considerable informal discussion among the participants.

The subject of the papers and discussions may be generally categorized into five areas of color metrics. These are:

1. Considerations of theoretical line elements.

2. Theoretical metric analysis.

3. Experimental perceptibility data.

4. Experimental acceptability data.

5. Evaluation of color difference formulae.

Both line elements and color-difference formulae provide methods for assessing color differences. Color-difference formulae generally assume a Euclidean color perception space. Line elements, on the other hand, need not restrict the assumptions to Euclidean space and generally describe color differences according to a definite positive quadratic equation for a just noticeable color difference or some constant fraction of it. The coefficients of this quadratic equation are called the "metric coefficients" and usually are determined, for line element approaches, on the basis of theoretical considerations of the operation of the visual mechanism postulated by a theory of color perception, or are derived by statistical and mathematical techniques from empirical or experimental data in such a manner as to best describe the experimental data. Color-difference formulae, implying Euclidean spacing, generally are based on color order systems or uniform chromaticity spacings. The Munsell System is an example of such a color order system.

Since many of the line elements and all of the color-difference formulae rely in one way or another upon quantitative expression in some color metric, the mathematical restrictions and practical implications of metric systems for colorimetric specification are of interest in any consideration of expressing color differences. Accordingly, after an excellent one-hour historical review of line elements in color theory by Dr. W. S. Stiles, a number of papers and much of the discussion was addressed to analyses of color metric systems. In particular, there were papers which concerned the influence of fundamental primaries on chromatic adaptation and color difference evaluation; on non-parametric multi-dimensional mapping of color order systems; on the limitations of 1960 and 1964 CIE Uniform Chromaticity Scales and Uniform Color Difference Scales. In general, it was shown that while the colorimetric specifications are both valid and important for specifying the physical characteristics necessary for identity of color match under limited viewing conditions, the attempt to extend such metrics to the description of small and large color differences has yielded less than completely satisfactory results.

Part of the problem involved in attempting to extrapolate such metric systems to the description of color differences appears to lie with the fact that much of the data upon which expressions of color difference are based relate to sub-threshold data. That is, the standard deviations of color matching are typically some fraction of the actual threshold of color difference. Little experimental data exist to test the validity of the assumption that such sub-threshold data may be extended to threshold and supra-threshold conditions. MacAdam, some years ago, conducted an experiment which provided data that led him to conclude that there probably was a proportional relationship between the size of sub-threshold data representing standard errors of color matching and the threshold representing the just perceptable condition. On the other hand, recent data were presented at the XVII Session of the CIE in Barcelona by Dr. Alfred Kurrek which raise some questions concerning the validity of a proportionality assumption. These data were referred to at the Driebergen Symposium and it was pointed out that for equally perceived color distances the number of experimentally determined thresholds was significantly different for various centroids throughout color space.

Any small body of basic data representing experimental determinations of these near-threshold color differences stem for the most part from MacAdam's report of the observations of P. G. Nutting (JOSA, 32: 247, 1942) using a vector colorimeter; from the two observers W. R. J. Brown and D. L. MacAdam (JOSA, 39: 808, 1949) using a tristimulus colorimeter; and from twelve observers' results with the same tristimulus colorimeter as reported by W. R. J. Brown (JOSA, 47: 137, 1957). In some instances, the theoretical predictions of the line-element model proposed by W. S. Stiles (Proceedings of the Physical Society, 58: 41, 1946) are also used as the basis for deriving color-difference formulae. The Nutting observations provide only ellipses on a plane of constant luminance in chromaticity space. Some of the later observations by Brown and by Brown and MacAdam have provided ellipsoids in three dimensional color space. Both kinds of results have been used to develop and to check line elements of color space. At the Driebergen Meeting Wyszecki and Fielder reported 28 new color matching ellipses derived as projections of 28 corresponding ellipsoids which were determined experimentally by three observers under conditions that were very similar to those used in the earlier color matching experiments (JOSA, 61: 1135, 1971). Ellipsoids and their projected chromaticity ellipses of the standard deviations of color matching were determined for each of the 28 color stimuli. A number of numerical methods was used to compare these newer results with older data.

Some interesting results appeared in these comparisons. First, it was found that in view of the inherent experimental uncertainties of data of this kind, the new color matching ellipses correlate reasonably well with those obtained by Brown, and by Brown and MacAdam, but show significant, systematic, deviations from those obtained by MacAdam's observer P. G. Nutting. It is interesting to note that the experimental apparatus used in the Brown, Brown-MacAdam, and Wyszecki-Fielder experiments were tristimulus colorimeters. In each case the results indicate some tendency for the ellipses to have major axes pointing approximately in the direction of the chromaticities corresponding to the instrumental primaries. The Nutting ellipses, however, were determined on a vector colorimeter (i.e., monochromatic-plus-white stimulus mixtures) with no instrumental primaries as such. These new experimental results and their comparison with older color matching ellipses provide an intriguing suggestion that the experimental apparatus may play a significant role in the nature of such results. The unusual threshold results reported by Parra, which were essentially star-shaped with lobes corresponding approximately to the directions of instrumental adjustments, also add weight to this question.

In addition, there were a number of other significant points brought out by the Wyszecki and Fielder paper. One of these relates to the validity of the size, shape, and orientation of ellipses determined from a finite number of observations. In the instance of several of the 28 test stimuli, additional replicate color matching ellipsoids were determined for one of the three observers. It was found that visual color matching data obtained by the same observer on different occasions, but with identical observing conditions, appeared significantly less repeatable than is indicated by normal statistical analyses. Differences in the size, shape, and orientation of ellipsoids determined through replicate experimentations deviate from one another by amounts as great as and more than that found among observers or among experiments. In addition, certain questions were raised regarding methods of averaging, normalizing, and treating the data of color matching ellipses or ellipsoids. The usual techniques of pooling data tend to provide ellipses that are less eccentric than they would appear to be on the basis of unpooled, individual, data.

All of these results raised a number of questions about the base data assumed by most empirical and inductive treatments of color differences based on threshold and sub-threshold data that need to be answered before the question of validity can be resolved satisfactorily.

In considering color differences somewhat larger than threshold, but none-the-less close to threshold, there appears to be a paucity of experimental data. That is, much of the existing experimental data relate to sub-threshold, threshold, and large color differences but little exists to describe small and moderate color differences which, typically, are of greatest interest to commerce and industry. It was the intention of the CIE Colorimetry Committee at its Washington Meeting in 1967 to address this problem in recommending that four color-difference formulae be evaluated during the period 1967 to 1971. During this time there were a number of attempted evaluations of these four (and other) color-difference formulae. However, a number of these evaluations involved acceptability rather than perceptibility. Color differences may be assessed either in terms of their perceptual sizes or in terms of their acceptability with regard to some criterion relating to a specific application. The distinction between perceptibility and acceptability of a given color difference is one of fundamental importance. Whether color difference equations which are derived on data relating to perceptibility and, therefore, are intended to predict only the perceptual size of a color difference can be applied to express the sizes of acceptable (or tolerable) variations from a given color standard is a matter of considerable interest and speculation. In many industries, it has been found that a locus of constant perceptible color difference from a given color standard does not coincide well with a locus of constant acceptable color difference from that same standard.

Among the eight papers presented in Driebergen which evaluated various color-difference formulae, only two related to perceptibility and the other six involved evaluation of color-difference formulae in terms of their ability to predict tolerable or acceptable limits in various industrial applications. A paper by McLaren does, according to the author, relate to perceptibility since in his application acceptability is the same as perceptibility.

Billmeyer delivered a paper by Billmeyer, Campbell, Kandel, and MacMillan in which they had determined small and moderate color differences experimentally and evaluated various color-difference formulae in terms of their predictions of the experimentally determined color differences. In both the McLaren and Billmeyer et al reports the results suggest that color-difference formulae are not completely satisfactory predictors of perceived color differences. That is, most of the color-difference formulae performed about equally poorly in predicting perceived differences that had been determined under realistic experimental conditions. There were significant differences among the formulae in terms of their ability to predict the experimental results but the best results were generally not considered wholly satisfactory. It is, however, important to note that even the poorest color difference equations are used for predictive purposes with some satisfaction and until there are more satisfactory expressions of perceived color difference than exist today, color difference equations provide very useful practical tools.

The most frequently quoted data on acceptability of color differences in an industrial application were those of Davidson and Friede (JOSA, 43: 581, 1953). During recent years, however, a number of additional determinations of industrially acceptable color differences have been presented; e.g., Schultze (Die Farbe, 18: 105, 1969), Schultze and Gall (Die Farbe, 18: 131, 1969), Thurner and Walther (Die Farbe, 18: 191, 1969), McLaren (Color Engineering, 7: 38, 1969), and Kuehni (Color Engineering, 8: 47, 1970). The Driebergen Conference provided a significant addition to the amount of available data on acceptability of color differences: Ishak and Roylance "Colour Tolerances in the Paint Industry," Malkin and Dinsdale "Colour Tolerances of Ceramic Wall-Tiles," Schultze "The Usefulness of Colour-Difference Formulae for Fixing Colour Tolerances," Jaeckel "The Utility of Colour-Difference Formulae for Match-Acceptability Decisions," Coates, Day, Provost, and Rigg "Colour-Difference Equations for Setting Industrial Colour Tolerances," and Simon "Industrial Color Tolerances by XI-ETA Formula." Here again, the ability of the variously available color-difference formulae to predict correctly the size of color tolerances was found to be generally less than completely satisfactory. In some instances, a more satisfactory approach appeared to be the empirical determination of transformations designed to reduce the residual errors of estimation for a given experimental or industrial condition.

Some of the color difference equations evaluated in terms of their ability to predict acceptable tolerances derive from large color differences implied by color order systems such as the Munsell System. The remaining color difference equations derive either from theoretical line element models or from empirical data on threshold or, particularly, sub-threshold color matching data. Virtually all of the perceptibility data and the acceptability data relate, however, to small color differences in the vicinity of but larger than the color difference threshold. Accordingly, neither the data relating to sub-threshold color matching or to supra-threshold large color differences relate exactly to the conditions of commercial and industrial importance. In addition, many of the color matching data were derived under experimental conditions considerably different from those of interest in commerce and industry; e.g., luminances considerably lower than those normally encountered, field sizes smaller than normal, stimulus simplicity greater than normal, and appearance mode different from that of interest in commerce and industry. The net result is that the most appropriate data for either deriving or evaluating color-difference formulae are not generally available. It was the general consensus of those attending the symposium that steps should be taken to provide more experimental data on perceptibility under the conditions that are of greatest interest in attempting to solve commercial and industrial problems. Specifically, the experimental conditions of interest should represent stimuli presented in the object mode of appearance. Surround luminances should be approximately 1,000 $cd \cdot m^{-2}$ and of an extent greater than 30^{o} in angular subtense. Test luminances should range from about 10 to 3,000 $cd \cdot m^{-2}$; thus representing a range of luminance factors from 1% to 300% (the latter including the possibility of fluorescent simulation). The test field should be approximately 10^{o} in extent or larger. The size of color differences of interest are in the range indicated by one to ten 1964 CIE color differences. These conditions represent, effectively, a somewhat more explicit statement of the conditions recommended for study by the CIE Committee on Colorimetry in 1967 and are essentially the same as those which formed the basis for a subsequent recommendation by the Colorimetry Committee at its meeting during the XVII Session of the CIE in Barcelona, Spain.

It is to be hoped that the next four years will provide a considerable body of experimental evidence which may be used to help sort out if not answer many of the basic questions that were raised about the color metrics of color differences during the Helmholtz Memorial Symposium on Color-Metrics held in Driebergen, Holland. This symposium undoubtedly will represent a milestone in the development of maximally useful color-metrics systems which may be successfully applied to the solution of pressing practical problems in science, commerce, and industry.

C. J. Bartleson
ISCC Liaison to AIC and Vice President of AIC

REPORT OF THE SECRETARY OF AIC

The Holmholtz-Memorial Symposium on Color-Metrics organized by the Dutch Color Association NVVK under the auspices of the AIC, September 1-3, 1971 in Driebergen, The Netherlands has been attended by more than 70 specialists from Europe, America and Japan. An excellent survey on color-metrics and color-difference was given which will stimulate further work.

The Executive Committee of the AIC had a meeting in Barcelona September 9, 1971. The plans for the 2nd AIC-Congress COLOUR 73 in York, July 2-6, 1973 have been presented by Prof. Wright and approved by the Executive Committee.

The discussion concerning AIC-membership of international organizations was resumed. It was decided to admit national colour groups only as member organizations in accordance with article 4 of the statutes. It is planned to establish associate membership for international organizations. An amendment of the statutes will be proposed to the Member Organizations giving associate members a status similar to Observers.

E. Ganz
Secretary-Treasurer, International Colo(u)r Association

WARM WEATHER FORMED FALL FOLIAGE FAILURE

Autumn color of trees and shrubs wasn't very good in the Washington area this year. In fact, it was probably the worst year in the past decade. The warm cloudy weather is believed to have been responsible.

The yellow fall colors are due primarily to the carotene and xanthophyll pigments in leaves. These pigments are present all summer but are masked by chlorophyll (plants are green because of the chlorophyll in the leaves).

With the advent of cool weather in the fall, chlorophyll systhesis stops and the chlorophyll present gradually breaks down exposing the yellow pigments. Not all leaves turn yellow. Some turn from green to brown. Others, such as the lilacs, stay green until killed by frost.

The red pigments are called anthocyanins. These pigments form in leaves with a high sugar content. Bright, warm sunny days followed by cool nights with temperatures below 45 degrees are necessary to develop the best red and scarlet colors. Under these conditions, more of the sugars produced by the process of photosynthesis remain in the leaves.

The cool night temperatures prevent the translocation of sugars and other materials from the leaves. The accumulation of these products results in the formation of anthocyanins. At the same time that these anthocyanins are being formed, the chlorophyll is being decomposed. The result is the appearance of the brilliant red and scarlet colors in the leaves of certain plants.

According to a report by the Minnesota Agricultural Experiment Station, an early hard freeze or a warm cloudy fall will prevent the development of the brilliant display of autumn colors. A hard freeze will result in a premature drop of the leaves. During the warm cloudy fall there will be little sugar accumulation and hence little anthocyanin formed.

Soils also can influence autumn color in such plants as the sugar maple, the report said. On some soil types yellow pigments will predominate, while on other soil types reds will be more common. Varieties also differ in their genetic makeup.

These differences are very pronounced in a seedling population grown on the same soil type. The Amur maple will exhibit a complete color range from green through yellow-orange, red, and scarlet on the same soil type. These differences must be due to genetic differences in the plants.

Plants also differ in the time when autumn coloration begins. The red maple growing in a swamp may start to color several weeks before the same species growing on upland soils.

Maples generally color several weeks before the oaks. We thus have a progression of autumn colors that are constantly changing.

The foregoing is in answer to one of the questions being asked by gardeners.

Tom Stevenson
The Washington Post, November 20, 1971

BRITISH COLOUR GROUP

Report on the 79th Meeting Held in October, 1971

The first Colour Group meeting of the 1971-72 session was devoted to reports on the AIC Symposium in Driebergen and the CIE meeting in Barcelona which took place in September 1971.

Helmholtz Memorial Symposium on
Colour Metrics (AIC) September 1971

The aim of the symposium, organised for the AIC by the Dutch Colour Association, was to obtain a thorough evaluation of the present position in the field of colour-metrics. The emphasis was on full discussion of the 25 papers, which had been circulated in advance, and on the major topics arising from them.

The opening paper, by Dr. W. S. Stiles, on 'Line-elements in colour theory' served both to review the historical development of the subject and to outline the major topics requiring further investigation. This subject was further developed in other papers on particular line-elements, and in general discussion.

New techniques reported included the minimally distinct border technique for comparing large colour differences, the tetrachromatic matching technique catering for rod intrusion at lower light levels, and improved statistical techniques for processing the results of visual assessments of colour differences.

New colour discrimination ellipsoids showed significant differences from the MacAdam data in the red region and did not repeat as well as might be predicted. Some errors in the spacing of Munsell colours were reported, and further studies are in progress.

Data were presented from field trials using printed, paint and ceramic samples, and from a most extensive series of experiments on the acceptability of textile samples. This work showed that the Adams-chromatic-value (ACV) type of formula gave significantly better results than any other, and that the CIE 1964 formula gave poor results. The FMC I metric seemed slightly better than the FMC II; and systematic modification of an ACV type formula could give improved fit with the Davidson & Friede data.

In discussions on the 'perceptibility' and 'acceptability' of colour differences, it was agreed that the two are virtually identical for some surface-finish industries; but for other industries the acceptable difference is significantly larger and so will probably be influenced by the particular viewing conditions and requirements of that industry. The importance of the colour difference at the edges of samples being compared, and of the gap between them, was brought out in papers and by demonstrations.

The general opinion was that more discrimination data and field tests were required to develop an improved colour-metric, and that it should be thoroughly tested before release. For successful industrial use it should be as simple as possible, and should provide a clear description of a colour difference as well as calculating its magnitude. An encouraging note is that present formulae do work satisfactorily on a commercial scale, provided that they are applied with common sense.

In addition to the main programme the participants attended a reception at the Institute for Perception at Soesterburg, where they enjoyed an excellent supper and a most interesting tour of the laboratories. The final comment must be to thank our Dutch hosts for the excellent way in which they organised a most stimulating symposium and, of course, for the warm hospitality enjoyed by us all.

CIE 17th Session -- Barcelona -- September, 1971

The CIE meeting in Barcelona was attended by about seven hundred delegates and three hundred accompanying persons from thirty-one different countries.

The session was organised so that during the first three days, single meetings were held when reports of the committees were presented. The various CIE expert committees are arranged in six groups with one person acting as co-ordinator for each group. Most of the subjects of interest to Colour Group members come into Group I under the chairmanship of Dr. Wyszecki (Canada). At the general meetings, the committee reports for each group were presented by the co-ordinator followed by a general discussion.

The programme for the second week consisted of six parallel sessions, one for each group of committees. At these sessions the technical meetings for the committees were held and individual papers were presented.

Prior to, and during the main CIE meeting, many of the expert committees held actual committee meetings to discuss matters of interest and to finalise working programmes for the next four years.

The following reports summarise meetings of interest to Colour Group members, but the full proceedings of the CIE will be published in due course.

E-1.1 Vocabulary. Dr. A. W. S. Tarrant

The main work during the last four years has been the finalisation of the draft and publication of CIE Publication No. 17 (E-1.1.) 1970 which is the 3rd edition of the International Lighting Vocabulary common to the CIE and IEC.

Attention was drawn to BS 4727; Part 4: Group 01:1971 which covers terms particular to lighting and colour. The terms in most cases follow the CIE definitions but will include a definition of metamerism which is somewhat different from the CIE terminology.

E-1.2. Photometry. Dr. O. C. Jones

The main decision taken was to recommend the adoption of the photopic 2 degree field, V(λ) function table as given in CIE document No. 18, 'Principles of Light Measurement.' Values are given to six significant figures and at 1 nm intervals. Values at other wavelengths are to be obtained by linear interpolation. An abbreviated table at 10 nm intervals and with values rounded to 4 decimals is suggested for less precise work. This latter is essentially the same as the 1931 CIE standard observer.

The document 'Procedures for the Measurement of the Luminous Flux of Discharge Lamps' was finally passed to the Action Committee for approval.

Work on $BaSO_4$ powder as a white reflectance standard shows little difference from that on MgO. The $0^o/45^o$ luminance factor and the 0^o/D reflectance for Source A have the same values for both powders (1.000 ± .005 and 0.985 ± .005). Reproducibility is also about the same for both.

Spectroradiometry continues to increase in importance. Nineteen laboratories recently participated in a comparison of tungsten and fluorescent tube spectral measurements. An intercomparison of spectral irradiance scales is being undertaken by several national laboratories.

E-1.3.1. Colorimetry. Dr. R. W. G. Hunt

A final draft was prepared of a recommendation on a "Special Index of Metamerism = Change in Illuminant;" this index of metamerism consists of the difference in colour, measured by means of an appropriate colour difference formula, between a pair of samples under a specified test illuminant, the two samples being a metameric match under a reference illuminant. The reference illuminant is normally D65, and the test illuminant either illuminant A, or one of three fluorescent illuminants (for which spectral power distributions are given) having correlated colour temperatures of about 3000, 4000 and 6500K and having reasonably high CIE general colour rendering indices.

Other topics discussed were Standard Sources, Chromatic Adaptation, Colour Terminology, Whiteness and Colour Difference Formulae. On the latter topic, the importance of the distinction between the perceptibility and the acceptability of colour differences, and the possible need to treat small, intermediate and large colour differences differently, was recognised.

E-1.3.2. Colour Rendering. M. B. Halstead

The main work of the Colour Rendering Committee has been the preparation of the second edition of CIE Publication 13 -- "Method of Measuring and Specifying Colour Rendering Properties of Light Sources." The main points of difference between this document and the previous one are the inclusion of a von-Kries type of transformation to take some account of chromatic adaptation, the calculation of the General Colour Rendering Index as an average of the Special Indices for eight selected colours and the addition of clauses dealing with the meaning, uncertainties and tolerances on indices. Interchangeability of lamps is dealt with by the provision for using a spectral power distribution typical of the lamps under test as a reference standard.

Other topics discussed by the committee included critical test colours, e.g. skin, fluorescent test colours, an improved formula for calculating the index, and improved correction for adaptation, a flattery index and the colour matching properties of fluorescent lamps. One major topic concerns the colour reproduction properties of lamps used in colour television, colour printing and colour photography and it was decided to form an international sub-committee to investigate this subject.

E-1.3.3. Fundamentals of Light Signals and Signs. M. P. Wassall

E-1.3.3. -- Fundamentals of Visual Signals, is to be re-numbered 1.7 and to deal with all fundamentals rather than the colour requirements only.

The revision of CIE Publication 2 on "Colours of light signals" was completed, including recommendations for restricting red to allow for protanopes or for maximum certainty of recognition by observers with normal vision, recommendations for restricting yellow and/or white to emphasise their differences from red and/or blue respectively and from each other -- and separate recommendations for restricting green to allow for prota/deuteranopes, for emphasised difference from white and from blue. An interesting new colour is violet -- CIE does not know if this is a truly distinguishable colour in service conditions but defines it so that any experiments that are made shall be made with this particular, tightly restricted chromaticity range.

The final draft of a new CIE report on limits for surface colours was also approved; this was based on DIN 6171 but it does not exclude any of the standard British information or warning sign colours. Fluorescent yellow pigments are an exception to the general recommendations. Dr. Walraven demonstrated what he thought the visual red, yellow and green traffic signals would look like to a colour defective observer, and they all looked very similar. Mr. Holmes spoke briefly on the particular problems of flashing signals and proposed a consistent terminology. Mr. Douglas outlined the proposed CIE Signalling Handbook which promises to be a comprehensive text book.

There were several papers on luminance and intensity as criteria for signals, leading to a suggestion of setting up a sub-committee on the practical implementation of any fundamental recommendations that may come from the new Technical Committee 1.7. Dr. Werner (USA) gave new data for temperature effects on chromaticity of coloured glasses, generally confirming previous papers, but drawing attention to the merits of the less pure red and yellow colours which are much less temperature-sensitive than the high-saturation colours.

E-1.4.1. Photopic, Mesopic and Scotopic Vision. Dr. D. A. Palmer

After almost total extinction two years ago, the committee has been vigorously revived under the Chairmanship of Dr. J. A. S. Kinney.

A priority is the establishment of a system of mesopic photometry. One system under consideration is based on the V_λ and V_λ' curves. However, before this matter can be settled, an extrafoveal, or large-field V_λ is required in order to supplement the 1924 curve, which is strictly suitable only for foveal vision. The photometric additivity of such a curve is being examined with novel viewing conditions such as that of "minimum border." More photometry experiments, especially with non-monochromatic test lights, are strongly urged for all conditions of viewing, including extrafoveal point sources.

E-2.2. Characteristics of Lighting Materials. Dr. F. J. J. Clarke

Following criticisms of the draft recommendations prepared by the German Secretariat on the photometric characteristics of materials, it was decided to modify both the format and the detailed contents extensively and defer its submission to the CIE Action Committee until the 1975 Session. The working programme was discussed with special reference to glass, fluorescence, turbid media and scattering theory, polarisation problems and discoloration (including "yellowing" by photodegradation). If all these topics were dealt with simultaneously, progress would be slow, so the brief for a programme in each of these topics would be examined, and one or two of them would be given priority.

It was agreed that the English title of E-2.2. would be changed to "Radiometric and Photometric Characteristics of Materials."

Report on the 80th Meeting Held in November, 1971

A talk by Professor R. W. Pickford on "Colour Vision Defective Artists and Art Students" was followed by two book reviews at the second meeting of the Colour Group in the 1971-2 session.

Professor Pickford's talk accompanied a large number of colour slides of paintings designed to illustrate various points concerning different artists' colour vision, sometimes known to be defective from tests or other means and sometimes surmised from their paintings. The first slide was of a landscape painting by Goethe which was the first attempt to show the majority how the world appears to the colour defective.

It was based on Goethe's experience with two men who confused pinks with the colour of the sky, called roses blue and confused greens with dark orange and reds with brown. Now known as protanopes, Goethe thought they lacked the blue sensation and his landscape portrayal contained pinks, oranges and browns only. Interest in colour defectives waned for the next fifty years

Colour-defective artists like Edridge Green, R.A. often passed through art school without it being suspected. He, like many others, was later helped by his wife. A slide of a pair of paintings by Leger illustrated how many artists paint two classes of pictures, one to satisfy themselves and the other for the majority. They seem to adjust well to what other people see. A study of the paintings of modern known colour defectives indicates that the red-green defective usually avoids reds; in some pictures red is included but then green is rarely present at the same time. A known tritanope avoided blues and greens. Consequently it has often been deduced that an Old Master had defective colour vision from the colours avoided in his paintings. But one must be wary of such conclusions, such as labelling Constable a red-defective because of his predominantly brown pictures since the artist may be trying to create a special effect. However, there is additional evidence in Constable's case. A slide of his "Salisbury Cathedral" showed many brown trees although, he himself, claimed he never painted trees of that colour. The yellowing of the lens at 50-55 years is thought by many to have caused a lack of blue in the later paintings of Turner, El Greco and others.

Some races, including the Egyptians, have a low sensitivity to blue light, probably caused by pigment absorption. A weaker sensation is often accompanied by an absence of words in the language; the Ancient Egyptians had no word for "blue" but modern Egypt uses the European word. From reading Homer's description of the "wine brown sea" can we conclude that the Ancient Greeks had different colour vision? This type of conclusion is often wrong; even today the sea around Greece looks reddish. It would also be wrong to assume that the colour vision of early Australians can be linked with the browns of their art; these were the pigments most easily available.

Surveys among art students have indicated that the proportion of colour defectives and the relative frequencies of the different types, are no different from those of the main population. Although problems are present, the colour defective artist is often very able and so should be helped rather than excluded. Unfortunately many art teachers have little understanding of the problem as they think of colour as being objective and of individual differences as comparable to personal opinions.

In the discussion it was pointed out that the colour defective as an artist was a different matter from the art teacher and the architect; the latter may be concerned with bulk buying. Colour defectives were sometimes more perceptive than normals in detecting colours in paintings, perhaps indicating a compensating mechanism. Tests should be made at an early age so that before embarking on a career, a colour defective would be aware of his handicap, even if it did not deter him.

The second half of the meeting began with a review by Dr. S. T. Henderson of two Pakistani books. These unusual books resulted from the 1969 celebration in Pakistan of the millenary of the birth of the Arab scientist Alhazen, following which the Hamdard National Foundation published the proceedings and also a second book. The latter was a pharmacopoeia of Eastern medicine containing numerous remedies, basically herbal but including such remarkable ingredients as powdered pearls, gold foil and sawdust, and was intended to be taken seriously.

The proceedings of the Alhazen meetings were of considerable interest and cause one to regret that only a small part of Alhazen's work is available in European languages. This remarkably versatile man attempted to build a dam across the River Nile; although he failed, the spot he chose was close to where the dam was built one thousand years later. His writings included the subjects of astronomy, optics, vision and geometry and although many of his conclusions we know to be wrong, others were remarkably accurate. For instance, in astronomy he thought the planets to be self-luminous but, on the other hand, because of the lack of observable parallax, he concluded that the Milky Way was amongst the stars rather than in the earth's atmosphere as was generally believed. He considered light to travel in straight lines, demonstrated the camera obscura and believed light to be comparable with heat to the object illuminated. He suggested that the blue of the sky is caused by scattered sunlight and very nearly anticipated Snell's Laws of Refraction of six hundred years later. In vision, he rejected Plato's idea that rays of light travel from eye to object, suggesting the reverse to be true, described the eye's structure and stressed the importance of the optic nerve.

Dr. C. A. Padgham brought us back to present times by reviewing "The world through blunted sight" by Patrick Trevor-Roper (Thames & Hudson Ltd.). Dr. Padgham first quoted from the preface in which Dr. Trevor-Roper, an eye surgeon, described the aim of the book as tracing the influence of altered vision on the personality of man, in particular as judged by the work of the writer and painter. Regarding presentation, Trevor-Roper said "if I have seemed to flounder among too many unrelated disciplines let me plead that, by constantly retreating behind the theories and experiments of others, I have tried to let these speak for themselves and only rarely presumed myself to arbitrate."

The chapter on the "unfocused image" suggested that the myopic personality, although not more intelligent than average, has met with greater success, examples being Dr. Johnson, Tennyson, Milton, Alexander Pope, Schubert, Beethoven and Bach. Moreover, James Joyce's art developed as his sight deteriorated. Is astigmatism responsible for El Greco's elongated figures or was the distortion deliberate? Viewed through a cylindrical lens the figures look more normal but Pirenne has indicated that the astigmatic distortion on the retina would be very small.

The less colourful later paintings of Goya perhaps are associated with his deafness and the brown colours of "Valley Farm" by Constable may be related to a colour defect. However, Padgham considers Constable's "Haywain" and "Cornfield," both recently cleaned, to be more colourful than most paintings in the National Gallery. It is suggested in Trevor-Roper's book that the browns of Turner's paintings result from a cataract, for which there is no medical evidence. Padgham showed slides of other late Turner's at the National Gallery which showed considerable amounts of blue and yellow.

At the close of the meeting it was a surprise and pleasure to hear a few words from the author who reiterated that his scheme of representation was to include all available opinions, irrespective of whether he himself agreed with them, something which he took pains to emphasise in his book. He quoted many examples of theories which he included because they had been suggested and not because he agreed with them.

P.W.T.

CIE DOCUMENT ON COLORIMETRY

The United States National Committee of the CIE (described in a note elsewhere in the Newsletter) has available for purchase several documents and publications of the International Commission on Illumination (CIE) of considerable interest to those ISCC members concerned with color measurement and related subjects.

Foremost among these is CIE Publication No. 15, "Colorimetry," sponsored by CIE Committee E-1.3.1 of the same name. This document consists of a complete listing of all CIE recommendations on colorimetry that are currently in force, including text, explanatory and historical notes, and tables of defining data. Here and in no other single publication can you find fully detailed definitions of the CIE standard observers and standard sources, coordinate systems and color-difference formula, methods of carrying out computations, and complete tables of data. No laboratory involved in color or vision research or measurement can afford to be without this official document. Its price is $5.00.

Other CIE documents available through the USNC-CIE and of interest to ISCC members include the following:

The International Lighting Vocabulary, providing definitions (in three languages, and comparative terms in 6 more) of major terms in the fields of color and lighting. A must for the precise use of the language of these subjects, and for accurate translation of foreign documents in these fields. Price, $16.00.

CIE Publication No. 18, "Principles of Light Measurement," a comprehensive document on the fundamental basis of photometry, compiled by CIE Committee E-1.2, Photometry. Price, $6.00.

CIE Publication No. 18, "International Recommendations for the Calculation of Natural Daylight" deals primarily with calculation of the amount of daylight entering an interior room through windows or skylights. Price, $4.00.

Several older documents available include the Proceedings of the 1967 Washington meeting and the 1963 Vienna meeting. The proceedings of the Barcelona meeting in 1971 will be available when received some time during the coming year.

These documents may be ordered by sending order and check for the proper remittance, made payable to "U.S. National Committee, CIE" to Mr. L. E. Barbrow, Secretary USNC-CIE, c/o National Bureau of Standards, Washington, D.C. 20234.

Dr. Fred W. Billmeyer

U.S. NATIONAL COMMITTEE, CIE

Last September, in Barcelona, Spain, the International Commission on Illumination (CIE) held its quadrennial meeting. Not until 1975 will this organization meet again as a whole, this time in London. But the CIE is not idle in the intervening time, and this is the story of how its activities are organized and sponsored between major meetings.

The work of the CIE is carried out in technical committees, some of which are well known to those concerned with color: E-1.3.1, Colorimetry and E-1.3.2, Color Rendering, for example. (A complete list is given in an article in preparation for the November-December, 1971 issue of the Journal of Color and Appearance.) Each such committee consists of one expert or (for smaller countries) corresponding member from each interested country. In addition, some committees, including E-1.3.1, augment their membership by consultants.

The scene then shifts from international to national operations. Each member of a CIE technical committee is chairman of a corresponding U.S. National

Committee. Thus, CIE E-1.3.1, chaired by Gunter Wyszecki (ISCC delegate from OSA and IES), Canada, has as its U.S. expert David L. MacAdam (OSA); he is also chairman of the U.S. National Committee E-1.3.1. Other ISCC members holding similar positions are Charles W. Jerome (IES), chairman of USNC E-1.3.2; JoAnn S. Kinney (APA), chairman of both CIE E-1.4.1 and USNC E-1.4.1, Photopic, Mesopic and Scotopic vision; and Franc Grum (SPSE), recently appointed as chairman of USNC E-2.2, Characteristics of Lighting Materials.

These groups operate as parts of the United States National Committee of the CIE, which was established in 1913 with its objectives to represent the CIE in the U.S., to represent the interests of the U.S. in the councils of the CIE, to promote in the U.S. the purposes of the CIE as an international forum for matters relating to the art and science of lighting, a medium for the exchange of information and a publisher of international agreements in the field of lighting.

It is in part indicative of the interests of the USNC-CIE, of which color is only a part, and in part coincidental that its 1971-1975 officers are not ISCC members. The reverse does not follow: ISCC members active in the USNC in addition to those mentioned above include Hunter, Hammond, Nickerson, Macbeth and Billmeyer, to name only a few.

The USNC-CIE has several classes of members: The chairmen of the USNC technical committees mentioned above; any other member of a CIE committee; any individual who represented the U.S. at the last preceding session of the CIE; certain honored Members-for-Life; a group of Members-at-Large elected annually in order to assure a well-rounded representation of all phases of lighting; and representatives of a group of constituent organizations who sponsor and in part finance the USNC in a role not unlike that of the ISCC member bodies. In fact, some of the USNC constituent organizations are ISCC member bodies, including ASTM, IES, OSA and SMPTE.

One additional activity of the USNC-CIE should be of interest to many ISCC members: the USNC provides the outlet for purchase in the U.S. of CIE publications. Several of these, of particular interest to those concerned with color measurement, are described in a separate note in the Newsletter. Inquiries regarding the purchase of CIE publications should be directed to Mr. L. E. Barbrow, Secretary, USNC-CIE, National Bureau of Standards, Washington, D.C. 20234.

Dr. Fred W. Billmeyer

INVITATION TO A SYMPOSIUM: ASTM COMMITTEES E-12 AND E-18

We invite the ISCC to participate with ASTM Committees E-12 and E-18 in a symposium on sensory evaluation of materials. Plans for this symposium are already underway.

Specifically, the Joint Task Force of ASTM Committees E-12 and E-18 for planning a Symposium on Sensory Evaluation of Appearance of Materials, in their first meeting held recently, unanimously agreed to invite members of the ISCC to cooperate in the Symposium.

ISCC members are encouraged to participate in a project in which a number of you are already active. The deadline for papers is March 20, 1972. Summaries of papers may be submitted to (or you may get further information from):

Richard S. Hunter
(Member of E-12, E-18 Task Force on Symposium, V. Pres. ISCC)
Hunter Associates Laboratory, Inc.
9529 Lee Highway
Fairfax, Va. 22030

AMERICAN CERAMIC SOCIETY MEETING

The American Ceramic Society in its membership represents the following industries: structural clay products -- bricks, terra cotta, tiles, mosaics; whitewares -- tableware and artware; Porcelain enamel -- curtain walls, home appliances, sinks, stoves, refrigerators and cooking ware; and glassware.

The membership is active in various divisions of which the Ceramic-Metal Systems (porcelain enamel), Design, Glass, Materials & Equipment, Basic Science and White Wares Divisions have interest in color.

The Society has nearly 10,000 members from which about 3,000 attend the annual spring meeting. The 74th Annual Meeting of the ACS will be held in Washington, D.C., May 6-11, 1972.

A symposium on Color in Ceramics is planned for this meeting. Arrangements are being made by the Society's delegation to the Inter-Society Color Council. The purpose of this program is to present the current state-of-the-art in the application and control of color throughout the industry. (Symposium planned for May 9 at Sheraton-Park Hotel.)

The ACS delegates hope to present all aspects of color and coloring. Papers on colorants (pigmentary and solution colors), their use in ceramic products and coatings, measurement and control of color, problems of measuring color differences on pieces made of different materials, and color design, are requested.

Other topics of interest to the ACS would be: color specifications, aptitude tests, measuring instruments, psychology, color standards, color in science, art and industry, metamerism, optimum reproduction of color, and color in the building industry.

The delegation would welcome any help and suggestions the members of ISCC could give in developing plans for this program.

In conjunction with the 1972 Annual Meeting there will be an Exposition where members of the ISCC and their associates are invited to show their products, equipment and services related to color in the ceramic industry. For space reservation please get in touch with Exhibition Management, Inc., 40 West Ridgewood Ave., Ridgewood, N.J. 07450. Phone (201) 445-2455.

The proceedings of the meeting will be published in the ACS Ceramic Bulletin, and excerpts in the ISCC Newsletter.

F. J. Von Tury

BOOK REVIEW

Sources of Color Science, D. L. MacAdam, ed. 282 pp. MIT Press, Cambridge, Mass., 1970. $12.50

Reviewed by A. R. Robertson

This book consists of a collection of writings by pioneers in the theory of color. David MacAdam, senior research associate at Eastern Kodak Research Labs, is a distinguished scientist who, over the past 30 years, has published many papers in the field of color metrics. In this volume, he has brought together extracts from many historically significant works, which he has edited freely to make them comprehensible to today's readers. In many cases, modern terminology is substituted for the original wording, allowing the reader to follow the development of theories of color without becoming confused by differing and obsolete terminology. A purist might object to this, but I found that it helped to make the book more readable.

The collection begins with extracts from Plato and Aristotle and continues with selections from the immensely important writings of Isaac Newton in which he showed so clearly that all colors are composed of the "homogenous colors" of the spectrum. This is followed by George Palmer's explanation of his trichromatic theory and by Thomas Young's better known statement of his version of this theory. Young is given only one page, compared to eleven for Palmer, probably because Palmer's papers, only recently rediscovered, predate Young's by 26 years. However, as James Clerk Maxwell writes in a later chapter, "Young was the first who, starting from the well-known fact that there are three primary colors, sought for the explanation of this fact, not in the nature of light, but in the constitution of man." Palmer thought that light itself contained only three types of ray, analagous to the three types of receptor.

The development of color theory during the second half of the 19th century is illustrated by extracts from the work of Hermann Grassmann, James Clerk Maxwell, and Hermann von Helmholtz, who were able to develop the laws of color mixture more clearly and explain the relationships between color-mixture diagrams and visual sensations. The explanation of chromatic adaptation by Johannes von Kries and the clear exposition by Frederic Ives of the principles of color photography then show that, by the beginning of this century, understanding of color vision had really become quite extensive.

The mathematical formulation by Erwin Schrödinger of the facts of color vision occupies 60 pages, more than is alloted to any other author; this section of the book, because of its mathematical nature, is the most difficult to read. Its inclusion is justified because this is the first readily available English translation of this work, which, despite its importance, has been previously available only in the original German. Nevertheless, readers without a sound knowledge of mathematics will probably omit this chapter.

Two papers by John Guild and one by Lewis Richardson discuss the extent to which it is possible to try to measure and quantize visual sensations, and the book finishes with Stephen Polyak and Sir Wilfried Le Gros Clark's 1949 articles on the structure of the retina and the lateral geniculate nucleus. In all these there is much that is as valid and stimulating today as it was when it was first written.

MacAdam has assembled an excellent collection of writings. Every worker in the field of color will find it fascinating and instructive to follow the development of the foundations of spectrophotometry and colorimetry and of visual theory, which we so often take for granted today. It is a pity that several important works, notably those of Goethe and of Hering have been omitted, but translations of these are available elsewhere. But it is not only historical interest that this book provides. The research worker of today will find, too, that there are many stimulating ideas that may provoke him to new lines of research.

* * *

The reviewer, a physicist, has worked in the fields of color measurement and color vision since 1962, first at the Imperial College of Science and Technology, London, UK, and since 1966, at the National Research Council of Canada in Ottawa.

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VISUAL SCIENCE INFORMATION CENTER

The services of the Visual Science Information Center are now available to the public. The general intent of the Center is to make readily available the literature covering vision: journals, books, theses, reports, and audiovisual aids. The Center surveys the literature on a continuing basis, indexes it in great depth, stores indexed citations in a computer, and retrieves bibliographic citations in response to questions. In addition, the Center will publish a printed author/subject index from this data base, Vision Index, to be issued quarterly with an annual accumulation. Vision Index will be sold on a subscription basis, but at present there is no charge for on-demand searches. Literature describing the services, including Vision Index subscription information, is available from the Center.

Although publication of Vision Index and the satisfaction of on-demand searches are the Center's two principal services, it also publishes bibliographies previous to the beginning date of the data base. A list of these bibliographies and other Center publications will be made available from time to time. Notices of the availability of these publications will routinely appear in several journals. Many of these publications will be available without charge.

The data base begins with publications released after November 1970, and therefore is small at present. The rate of addition is approximately 200 citations per week. Citations previous to November 1970 may be in the data base, but no attempt at comprehensive coverage is made previous to the above date. The intent of the Center is to cover the field of vision as comprehensively as possible from this time forward.

A predetermined set of subject terms is used for indexing, the Thesaurus, which is also the key to retrieval in the system. Searches may be run against a single term or any combination of terms using the operators "and," "or," and "not." Searches may be limited by date, language, author, and type of publication. When limiting by a foreign language, foreign-language documents with English abstracts may also be requested. A term weight of 1 or 2, indicating primary or secondary, is assigned to each index term used, relative to the document being indexed. Searches may be run against terms using term weight 1, or term weight 2, or both. It is not necessary to have a copy of the Visual Science Information Center Thesaurus to submit search requests; the Center will write the search in terms of its system. However, copies of the Thesaurus are available in many libraries. Because the Center indexes in great depth, using 8200 subject terms, irrelevant citations, "false drops," will occasionally be retrieved in response to a search. This is a common difficulty in comprehensive information-retrieval systems. A requestor may disregard all of the details mentioned and simply tell the Center what subject is of interest to him.

Address requests to Visual Science Information Center, University of California, Berkeley, California 94720, or phone (415) 642-4647. "On-demand" searches will be executed within 10 working hours after receipt. Search results will be mailed directly to the requestor, on computer-output paper.

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COLOR EDUCATION

GATF Plans Seventeen Seminars for the Spring Program

Seventeen seminars are included in the Spring Program for the 1972 seminar series to be conducted by the Graphic Arts Technical Foundation at its Technical Center, Pittsburgh, Pa.

The Spring Seminars will include new programs on Lithographic Plates and Platemaking, The Offset Press, and Process Color Photography.

The complete program for the first six months of 1972 is as follows:

Paper and Ink: January 19-21; April 24-26; and June 19-21.

Printing Process Quality Controls: January 24-26; March 27-29; and May 31-June 2.

Color Reproduction: January 26-28; April 12-14; and June 7-9.

Web Offset Printing: April 19-21; and June 14-16.

Process Color Photography: April 10-11; May 15-16; and June 5-6.

Lithographic Plates and Platemaking: April 13-14; May 18-19; and June 8-9.

Sheet-Fed Offset Press Operation: April 17-21; May 22-26; and June 12-16.

Complete details concerning these programs may be obtained by contacting the Special Program Department, Graphic Arts Technical Foundation, 4615 Forbes Avenue, Pittsburgh, Pa. 15213.

Hunterlab 1972 Schedule

Hunterlab will conduct three one-day Area Seminars during February, March and April. The Seminars will cover a study of appearance attributes and their instrumental measurement, color scales, color differences, interconversion between color scales, and techniques of effective measurement. Mr. Richard S. Hunter, President of Hunterlab brings to these Seminars his extensive experience in this field. A demonstration of Hunterlab instruments for Appearance Measurement will be held, and participants are urged to bring samples of their product for measurement.

Hunterlab will also be presenting its regular semi-annual 2-1/2 day Workshop in Fairfax, Virginia, January 26-28, 1972. This course emphasizes practical laboratory exercises in sample preparation and measurement. Lectures will cover colorimetry and color scales, factors other than color that contribute to appearance, and the measurement of appearance attributes.

The Schedule for the Area Seminars and the Workshop is:

Dayton, Ohio, February 3, 1972
Charlotte, N.C., March 2, 1972
Toronto, Canada, April 6, 1972
Fairfax, Virginia, January 26-28, 1972

Attendance for the Workshop and each of the Area Seminars is limited to twenty, and applications will be accepted on a first-come, first-served basis. For full information on any of these courses, please contact Hunter Associates Laboratory, Inc., Education and Information Department, 9529 Lee Highway, Fairfax, Virginia 22030.

CGL Associates Color and Appearance In-Plant Seminars

A new folder from CGL Associates describes low cost color and appearance seminars which are custom designed to meet your needs and are for presentation within your company. Included in the free brochure are examples of how courses are developed such as in-plant training of personnel seminars, state-of-the-art presentations for management or research and development groups, and introductory, refresher and advanced workshops to meet specific requirements.

Complete information is available by writing or calling CGL Associates, 9416 Gamba Court, Vienna, Va. 22180 (703-938-4345).

GATF ON BALANCED INKS -- A REVIEW OF "STANDARDS" IS TOPIC

GATF Research Progress Report Number 87, entitled "Balanced Inks -- A Review of Standards," was authored by Gary G. Field, GATF color technologist. The Report is intended for circulation in the camera area to elaborate on the evaluation of printed ink films, and to pressroom areas to clarify misconceptions about "standard" balanced inks.

"In addition," said Mr. Field, "those concerned with the selection of pigments or inks for four-color process printing should benefit from a description of the printed color shifts that are possible when using a given set of inks."

He continued, "An explanation of the 'balanced ink' concept, as introduced by GATF, is presented with a brief historical review of commercial development. A short list of 'standard' inks is included with the explanation that there are no GATF standard balanced inks. The question of standard printed ink film colors is approached, and the importance of the influence of ink film thickness, print density and paper surface on the printed color is emphasized.

"The use of the reflection densitometer for evaluating color masking is dealt with at length. The concept of 'actinic density' is explained as an aid to more accurate densitometric masking calculations. For the reader with a non-photographic background, a simple explanation of color masking is presented as it pertains to balanced inks.

"The Report is concluded with a brief summary of factors that influence the selection of process color inks."

Research Progress Reports are automatically sent to members of GATF. Non-members may purchase RP Number 87 at $1.00 per copy, beginning May, 1972. For further information, contact the Order Department, Graphic Arts Technical Foundation, 4615 Forbes Ave., Pittsburgh, Pa. 15213.

EDITOR'S NOTE:

From the many things about color, lighting, and illumination that must be available, I have selected two which arose within the Eastman Kodak Company, and which I think would be of general interest to members of the Council. I'm sure that other reports must be available elsewhere, and I solicit their contributions. The Newsletter can only be a product of those interested in communicating their ideas to the rest of the Council.

GLARE AND OTHER QUALITY FACTORS IN ILLUMINATION

Good lighting at the workplace is essential if high levels of productivity and quality are to be maintained. Adequate lighting is also necessary to ensure safety. In order to achieve good lighting it is important that equal attention be given to both the quantity and the quality of the illumination. In the past most research into illumination has been directed at the question of quantity. To some extent this emphasis on quantity has been reflected in lighting practices. Too many lighting installations have been specified solely on the basis of a desired footcandle level. Quantity is an important factor, but virtually all modern lighting systems provide more than enough light. In most cases no significant improvements can be made by simply increasing the quantity. On the other hand, it is often possible to make visible improvements by directing attention to the quality aspects of the light. In the past few years illuminating engineers have been placing an increasing emphasis on these quality factors.

Glare

There have been occasions where an area has had new lamps and fixtures installed to produce a higher light level and this change has resulted in complaints that "the lights are too bright." The complaint suggests that an excessive quantity of light is being supplied, but usually the problem is one of quality rather than quantity. Glare is the most common of the quality problems encountered in the design of a lighting system. A number of different terms have been used to describe the characteristics of glare and its effects.

Disability glare is the phrase normally used to describe a glare source that has a direct effect on visual performance. Disability glare can reduce visual performance in several ways. A bright light source in a relatively dark surround can result in light from the bright source being scattered by small particles floating within the ocular media inside the eye. The scattered light tends to reduce the eye's ability to discriminate between darker objects within the visual field. This "loss of contrast" problem tends to become more serious with age because the number of floating particles within the ocular media increases as a person grows older. Another form of disability glare arises when a person glances at a bright glare source and then looks back at a relatively dark visual task. While the person was gazing at the glare source his eyes were adapting to the higher level of light. Upon returning to the visual task, a period of readaptation will be necessary. Until readaptation is complete there will be some loss of visual acuity and contrast sensitivity. In most practical situations this period of impaired performance only lasts for a fraction of a minute, but there are a number of jobs in which this amount of impairment cannot be tolerated. A familiar example which produces both of these forms of disability glare occurs when passing an oncoming car at night. The glare from the headlights makes it more difficult to see other objects on the road by reducing their apparent contrast and the impairment of vision then persists for a few seconds while readaptation occurs.

Discomfort glare is the term normally used to describe a glare source which results in visual discomfort, but does not directly affect visual performance. Discomfort glare is more common than disability glare. The distinction between the two is a small one since discomfort glare can have an indirect effect on performance. After a period of time, the visual discomfort can result in a feeling of visual or mental fatigue. This fatigue is usually subjective in nature but it can often result in a real decrement in performance. A glare source near the visual task can also have a distracting effect. The eye has a tendency to look at the brightest object within the field of view. In the case of a reflection on a specular surface (like a glossy desk top) this problem is compounded by the fact that the reflected image is not in the same focal plane as the visual task. A person glancing up from his visual task, focusing on the reflected glare source, refocusing on the task and then repeating the process can quickly experience a feeling of visual discomfort.

The use of the words disability and discomfort glare examines glare in terms of the effect that it produces on the people experiencing the glare. It can also be useful to think of glare in terms of its physical characteristics. Direct glare describes the situation where the lamp is within the field of view. Indirect or reflected glare produces the same effect by placing a reflection of the lamp within the field of view. Reflected glare is a very common problem in workplace design, especially where specular materials like glass, chrome, or stainless steel are used. Where these materials must be used it is important to consider the relative positions of the lamps, the operator, and the specular surfaces. These elements should be arranged to eliminate specular reflections from the operator's field of view. This is very important in areas where difficult or critical visual tasks are being performed.

A different type of problem is produced by diffuse or veiling glare. In this situation the visual task and its background have a matte or semi-matte surface. Reading pencil handwriting on ordinary paper is a good example of this kind of task. If the light source shines on the task at an angle so that the light is reflected up into the viewer's eyes, then veiling glare will be present. In this case, there's no specular image of the lamp because the materials are matte rather than glossy. The effect of veiling is to reduce task contrast. Because of its diffuse and indistinct nature people may not be consciously aware of the presence of veiling glare even though their visual performance may be significantly impaired. This makes it especially important to attempt to eliminate veiling glare in the initial design of the work environment. Several approaches to designing lighting systems that minimize veiling glare have been attempted. One of the most recent of these is a new design of fixture for fluorescent lamps. These new fixtures tend to direct the light at selected angles so as to control the directional characteristics of the luminous flux within the room. By controlling the directional characteristics of the light in this way it is possible to exercise some degree of control over glare.

Other Quality Factors

There are many factors besides glare that must be considered when attempting to provide a high quality of illumination. Many of these factors are related to the characteristics of the specific visual task being performed and this makes general recommendations difficult. One of the more straightforward of these additional quality factors is the control of brightness ratios. For optimum conditions, it is desirable to have the visual task slightly brighter than its background since this tends to focus attention on the task. But if the difference in brightness between the task and the background is so great that harsh contrasts are produced, then performance may suffer. The brightness ratio between a task and its immediate background should never exceed 3 to 1. It is also desirable to control brightness ratios everywhere within the visual environment.

In situations where the visual task is difficult or critical the physical characteristics of the light are extremely important. If the task involves fine color judgments then control of the color temperature of the light source is essential. For many inspection tasks the diffuse character of general illumination is not satisfactory. Defects are more easily seen when special purpose lighting is provided. There are more than 20 different types of special purpose lighting. Most of these are described in the report "Illumination: A Human Factors Viewpoint." (Faulkner & Murphy, 1971)

Illumination is a complex subject. This article has only attempted to introduce some of the more important problems that exist. There are many other factors that must also be considered to ensure that the lighting of a task is optimal. Where problem situations exist, it is important to secure the advice of an experienced illuminating engineer. A good source of general information on the subject is provided by Hopkinson & Collins (1970).

References

1. Faulkner, T. W. Illumination: a human factors viewpoint. Proceedings of 15th Annual Meeting of Human Factors Society, 1971

2. Hopkinson, R. and J. Collins The Ergonomics of Lighting. MacDonald, London, 1970, 272 p.

T. W. Faulkner
Human Factors Group, Eastman Kodak Company

LEGIBLE LETTERING AND LOGICAL LABELS

The most important rule to follow in designing a label is to keep it as simple as possible. The purpose of a label is to provide a concise instruction or direction. It should communicate its message to the reader under the most demanding forseeable conditions. For example, a label on a critical control should be legible to a fatigued operator who is hastily reading the label during an emergency.

Experiments have shown that the legibility of a label can be significantly affected by its design. One of the important variables is the type font that is chosen. The many fonts that are available vary widely in their design. One of the design characteristics that is

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WHEN A PRINTED LABEL OR MESSAGE MUST BE READ QUICKLY AND EASILY, IT IS IMPORTANT TO CHOOSE A PLAIN AND SIMPLE DESIGN OF TYPE FONT. THERE ARE SOME SLIGHTLY MORE COMPLEX DESIGNS THAT CAN BE EASILY READ BECAUSE THEY ARE FAMILIAR FROM WIDE USE. LESS FAMILIAR DESIGNS MAY RESULT IN ERRORS, ESPECIALLY IF THEY ARE READ IN HASTE. **FONTS DESIGNED PRIMARILY FOR AESTHETIC REASONS ARE VERY POOR CHOICES.** OBVIOUSLY, EXTREMES LIKE OLD ENGLISH SHOULD NEVER BE USED. AVOID COMPLEX FONTS

KEEP IT SIMPLE

important is the serif. A serif is a small decorative curve or enlargement at the end of a stroke. A type font that omits these decorative flourishes is called a sans-serif font. The first sentence in the illustration is printed in a sans-serif font while the second sentence is printed in one of the conventional serif fonts. Sans-serif fonts should be used for labels. Type fonts also differ in their degree of boldness. Bold fonts use a thicker stroke width. The last line in the illustration is a bolder font than the first line. A bold font is usually a good choice for a label. An extended font is one where the characters are relatively wide with respect to their height. The reverse is called a condensed font. Extreme examples of extended and condensed fonts should not be used on labels.

The fonts that are shown in the illustration are, in order of their use: 1. Venus Medium, 2. Perpetua Titling, 3, Busorama Medium, 4. LSC Manhattan, 5. Old English, 6. Claudius, 7. Futura Demi Bold.

There are many factors besides the choice of font that affect the legibility of a label. They include the size of the letters, the color of the letters and their background, the viewing distance, the illumination level, and the choice of words.

T. W. Faulkner
Human Factors Group, Eastman Kodak Company

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Send Newsletter Items to Editor:

Dr. Robert W. Burnham
Eastman Kodak Company
Research Laboratories, Bldg. 81
Rochester, N.Y. 14650

Other Correspondence to Secretary:

Dr. Fred W. Billmeyer, Jr.
Department of Chemistry
Rensselaer Polytechnic Institute
Troy, N.Y. 12181

LAST MINUTE INSERT

Reprint "Color Measuring Instruments: A Guide To Their Selection" by Ruth M. Johnson. Reprinted from the "Journal of Color and Appearance."

NOTE:

The Council promotes color education by its association with the Cooper-Hewitt Museum. It recommends that intended gifts of historical significance, past or present, related to the artistic or scientific usage of color be brought to the attention of Christian Rohlfing, Cooper-Hewitt Museum, 9 East 90th Street, New York, New York 10028.