Inter-Society Color Council *Newsletter*

NUMBER 217
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PETER GOLDMARK RECEIVES FIRST ISCC-MACBETH AWARD

As part of the banquet ceremonies at the recent ISCC meeting the following citation was presented by the chairman of the 1972 ISCC-Macbeth Award Committee:

The ISCC-Macbeth Award, announced in 1967, is to be awarded biennially in recognition of recent important contributions in the field of color, preferably for contributions made within the 5 or 10 years preceding the award. The Award was established by Norman Macbeth, past director and long-time treasurer of the Inter-Society Color Council, to honor the memory of his father, Norman Macbeth, Sr., and his pioneering contributions to the art and science of color and illumination.

In January 1970 the ISCC Board of Directors adopted a recommended practice for establishment and biennial presentation of the award and appointed a Macbeth Award Committee to select a recipient for the first award in 1972. This committee,* which itself covers a wide representation within the Council, invited nominations from each member body by letter to the chairman of each delegation, and from individual members by notice in the ISCC Newsletter. Among several names received and considered, that of Peter C. Goldmark stood out so prominently that our committee was unanimous in presenting his name to the ISCC Board of Directors at its 1971 fall meeting, where it received prompt approval.

The choice of Dr. Goldmark was made in recognition of his outstanding applications of color, particularly for his recent contributions to the invention of electronic video recording, a milestone in color that promises to become as important to the general public as either color television itself or the long-playing record which Dr. Goldmark also pioneered.

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*1972 ISCC-Macbeth Award Committee: Dorothy Nickerson, OSA, chairman; Robert Feller, AAPL; Leo Hurvich, APA; W. T. Wintringham, SMPTE; J. A. C. Yule, TAGA.

Peter Carl Goldmark

Peter Carl Goldmark, born in Hungary in 1906, was educated at the University of Vienna where he received the degree of Ph.D. in physics. From 1931-33 he was employed by Pye Radio, Ltd. of Cambridge, England, in charge of TV engineering. From 1936 to 1972 Dr. Goldmark was with the Columbia Broadcasting System, Inc., beginning as chief engineer in their television department in one room with a single technician. From 1954, he served as president and director of research of CBS Laboratories in Stamford, Conn., an organization that had grown to a staff of 500 by the time he left in December 1971 to establish Goldmark Communications Corporation. In the intervening years Dr. Goldmark had become known as one of the world's leading electronic inventors and innovators.

While responsible for more than 160 inventions in the fields of acoustics, television, phonograph recording, and film reproduction, two of Dr. Goldmark's inventions are perhaps most widely known -- the long playing record and the first practical color television. While not the system in general public use today, his field-sequential color television system stimulated the entire industry in the development of today's all-electronic method, and laid the foundation for closed-circuit color television, used especially in medical education and clinical diagnosis. More recently Dr. Goldmark's leadership and innovation in the development of electronic video recording (EVR) may help to open up a third whole new field, particularly in education and entertainment. EVR is an audio-visual system which to the visual medium may prove to be what the long-playing record has been to sound. It provides a low cost miniaturized film of prerecorded programs that can be played back into television sets for school or home use.

It is particularly for the development of EVR that Dr. Goldmark was selected for this first ISCC-Macbeth Award. It is a recent development which many of us have followed in the wide publicity it has received. The educational advantages of EVR are well covered in a WORLD PROGRESS Quarterly Review article (Autumn 1967) and the LONDON TIMES Educational Supplement of July 18, 1969. Its general utility is well outlined in a 1970 FORTUNE article. A brief review of the whole matter is given in the American Society of Magazine Photographers citation reported in INFINITY, September 1970, when the society awarded Dr. Goldmark its Technical Achievement Award. The New York Times, Wall Street Journal, Newsweek, and TIME magazine have all carried articles applauding Dr. Goldmark's achievements in EVR. The system is described in detail by Dr. Goldmark and his associates in the European Broadcasting Union REVIEW, June 1970, in the Journal of the Society of Motion Picture and Television Engineers, August 1970, and in IEEE's SPECTRUM, September 1970.

The EVR system combines optics and electronic physics to transfer any film or video taped program to a special unperforated thin film, or optical tape, stored in a small cartridge which can be slipped into a player attached to the antenna terminals of a TV receiver and automatically played on a television screen. This can be done in black and white or in color. To do this a great deal of information must be packed into compact form. Getting the film small enough, yet providing enough light to project, was a problem many regarded as unsolvable. But Dr. Goldmark applied electronic means to the transfer of picture information to film and developed a new kind of photo technology to provide miniaturized film with 20 times the information density in a 16mm film. He also developed the first electronic method for putting color on black and white film, and a method for showing animated film and still pictures on the same optical tape, an important factor in educational applications.

We could mention a number of Dr. Goldmark's other outstanding achievements. He had major responsibility for inception of the field-sequential color television which had the world's first successful color television broadcast September 1940 from New York City. It was this field-sequential system, shrunk to a fraction of its original size by modern technology, that was used by our Apollo astronauts to beam live color television pictures to world audiences from the moon's surface. Dr. Goldmark developed the high resolution photographic transmission system for NASA's Lunar Orbiter spacecraft which provided scientists with the first high-resolution close-up pictures of the moon's surface, called "photographs of the century" by the national media.

Among his many professional duties he is Visiting Professor for Medical Electronics at the University of Pennsylvania Medical School, and Visiting Professor of Communications Technology at Fairfield University.

It is of interest to note that Dr. Goldmark has been an individual member of the ISCC for many years -- thirty, to be exact, for he became a member in April, 1942. In 1954 he prepared a summary of Color Television Progress to that date for Newsletter No. 115 -- Dr. Godlove's JUBILEE ISSUE. The most recent item about him in the Newsletter appeared in 1969, No. 200. It reported the presentation to the Smithsonian Institution of his pioneer color television system, camera to receiver, that helped usher in color TV on earth, the one used in the CBS inaugural broadcast made on September 4, 1940, the system authorized in 1950 by the FCC for color TV broadcasting, upheld by a Supreme Court decision. On the occasion of this presentation to the Smithsonian he demonstrated what he called some of the "electronic grandchildren" of that first invention, including a miniature TV system to transmit color pictures from inside the human body, also the camera carried by the astronauts on Apollo 10 and 11 missions.

Mr. President: We present to you as recipient for the first ISCC-Macbeth Award the name of Peter C. Goldmark.

Unfortunately, because of a commitment made before he was notified in November, tonight Dr. Goldmark is in San Diego. He has, however, arranged for his associate, Mr. Joseph Stern, vice president and director of engineering of Goldmark Communications, to represent him this evening. We are happy to present Mr. Stern to accept the award for Dr. Goldmark.

After the presentation of the Award by President Hanes, remarks were made by Mr. Stern as follows:

Mr. Stern: First I would like to read a letter from Dr. Goldmark addressed to the committee and to members of the Inter-Society Color Council:

"I deeply regret not to be able to be present tonight and receive your Award which means a great deal to me.

"Over so many years color has been synonymous with my professional life and the contributions of your members to color created a common bond between us.

"I believe that color will play a bigger role than ever in the technology of communications. Time and distance are shrinking and ways of bringing and observing information can be made considerably easier through the imaginative use of colors. Spurned on by your Award, I will expend even more effort to apply color to new and better ways of communications.

"With best wishes,

Sincerely, s/Peter C. Goldmark, President, Goldmark Communications Corporation"

Mr. Stern: I would like to take a moment, if I might, to pass on to you some of the concerns Dr. Goldmark has regarding the future of our society.

Like Huxley, Dr. Goldmark recently observed that as he "peeks into the future, it does not work." It does not work because the current trend society is taking could be fatal to our civilization, unless we deal with it promptly and effectively.

For the past three years Dr. Goldmark has been heading the National Academy of Engineering Panel of concerned scientists and engineers who have undertaken a study to find ways of applying communications technology to societal needs to help reverse the trend of high-density concentration of the population and the depletion of natural resources.

We should ask ourselves what is wrong with a nation where more than 90 percent of its inhabitants live on less than 10 percent of the land? What is wrong with a nation which, unless proper action is taken, will use up its natural resources before the end of this century?

The answer lies in a major change of population distribution and of life style. And effecting this change may become one of the largest undertakings we have ever faced. A key element of this challenge is communications technology which Dr. Goldmark sees as a means to provide a better quality of life for people in both urban and rural areas.

The proposal of Dr. Goldmark's NAE committee to the Government of the United States is the use of communications technology in creating a "New Rural Society" to provide people, for the first time, with a choice of whether they wish to live and work in an urban or rural environment. The first phase of the "New Rural Society" Project is now underway in a ten-town area of northeastern Connecticut and is being conducted jointly by Goldmark Communications Corporation and Fairfield University under a HUD grant. The purpose of this project -- the first of many anticipated in states throughout the nation -- is to demonstrate that imaginative applications of telecommunications will provide people living in rural areas with economic and employment opportunities, better health care, improved educational opportunities, better government services and cultural and entertainment advantages which exist now in the large metropolitan cities.

This project will require a nation-wide effort by people from every walk of life -- particularly those of us involved and concerned with communications technology -- to provide the next 100 million Americans who will join us, with the opportunity for a better life.

The time to begin is now. And, we must remember that while we have learned to communicate across space, under water, on records and on tape, by wire, by radio, and by video links, we have yet to perfect that most important form of communication -- from man to man.

PUBLICATIONS BY PETER C. GOLDMARK

Peter C. Goldmark and John N. Dyer, Quality in Television Pictures, Proceedings of the IRE, August 1940

---- with J. N. Dyer, E. R. Piore, J. M. Hollywood, Color Television, Part I, Proceedings of the IRE, April 1942

---- with E. R. Piore, J. M. Hollywood, T. H. Chambers, J. J. Reeves, Color Television, Part II, Proceedings of the IRE, September 1943

---- with Robert Serrell, Color and Ultra-High-Frequency Television, Proceedings of the First National Electronics Conference, October 1941

---- with Rene Snepvangers and William S. Bachman, The Columbia Long-Playing Microgroove Recording System, Proceedings of the IRE, August 1950

---- with J. W. Christensen and J. J. Reeves, Color Television -- U.S.A. Standard, Proceedings of the IRE, October 1951

---- with J. M. Hollywood, A New Technique for Improving the Sharpness of Television Pictures, Proceedings of the IRE, October 1951

---- The Columbia "360," Audio Engineering, March 1953

---- The Columbia XD (Extra Dimension) Sound System, Audio Engineering, October 1953

---- Highway Hi-Fi, Audio Magazine, December 1955

---- with Benjamin B. Bauer and William S. Bachman, Paper on the Columbia Compatible Stereophonic Record delivered at Institute of Radio Engineers Convention, March 25, 1958

---- Latest Advances in Extra Fine Groove Recording, Journal of the Audio Engineering Society, July 1958

---- with John M. Hollywood, Psychoacoustics Applied to Stereophonic Reproduction Systems, Journal of the Audio Engineering Society, April 1959

---- with W. S. Bachman, B. B. Bauer, Disk Recording and Reproduction, Proceedings of the IRE, May 1962

---- Communications and Electronics -- 2012 A.D., Proceedings of the IRE, May 1962

---- Electronic Video Recording, European Broadcasting Union Review, Part A -- Technical, No. 121, June 1970

---- Color Electronic Video Recording, J. Society of Motion Picture and Television Engineers, August 1970

---- Color EVR, IEEE SPECTRUM, September 1970

ISCC CONFERENCE ON FLUORESCENCE AND COLORIMETRY OF FLUORESCENT MATERIALS, WILLIAMSBURG, VIRGINIA, FEBRUARY 6-9, 1972

Abstracts

H. Aach, Fluorescent Pigments in Art and Design

This paper includes a review of current use with resultant technical limitations. Evaluations of positive and negative aspects of such use, not merely on factual grounds, but also their psychological, philosophical, and esthetic implications are examined. The role of the artist as trendsetter and reflections upon our man-made environment are also included.

E. Allen, Fluorescent Colorants: True Reflectance, Quantum Efficiency and Match Formulation

The spectrophotometric curve of a fluorescent colorant can be broken down into a reflected portion and a fluorescent portion. The fluorescent portion is an apparent fluorescence curve and represents what emerges after the true fluorescence generated within the film finds its way out. In the process of emerging, a series of reabsorptions and reemissions occurs. The relationship between the apparent fluorescence curve and the true fluorescence curve can be deduced from an extension of Kubelka-Munk theory to fluorescence substances. From the calculated true fluorescence curve, the quantum efficiency of fluorescence generation can be deduced. The application of these concepts to the problem of colorant formulation with fluorescent colorants will be discussed.

E. Ganz, Fluorescent Whitening Agents for Textiles and Detergents

After a short historic review on the first applications of fluorescent substances for improving the appearance of white, a survey of the chemical groups of fluorescent whitening agents used nowadays is given. The physical and chemical properties of fluorescent whitening agents are discussed. The requirements for application on textiles and the attainable fastness properties are pointed out. The effects of incorporating fluorescent whitening agents in detergents and the consequences of the various methods of laundering are shown.

E. Ganz, Whiteness Measurement

Methods for measuring whiteness had been developed before fluorescent whitening agents were used. The problems of their applications to fluorescent whites are briefly discussed. The influence of the ultraviolet content of illumination and of the surround on the appearance of whites is demonstrated. The problems of correlating visual and instrumental whiteness evaluations are shown. The colorimetric properties of various groups of whiteness formulae are investigated and compared. Using this information whiteness formulae with any preselected colorimetric properties can be constructed. A versatile whiteness formula with adjustable hue preference will be shown.

F. Grum, Instrumentation in Fluorescence Measurements

Fluorescent specimens can be measured by a spectrophotometer or by a colorimeter in which the sample is irradiated with undispersed white light of controlled spectral irradiance power distribution. The radiation reflected and emitted by the sample must then be detected monochromatically. Such measurements also can be made in an instrument which separates the true reflectance and true fluorescence, but the interplay of these two components must be considered to properly evaluate fluorescent materials.

Fluorescent whitening agents are often used as a means of enhancing the overall whiteness appearance of papers, fabrics, and plastics. Chromatic fluorescent dyes, pigments, and inks have also found a wide application as a means of increasing the brightness and saturation. Therefore it is imperative to develop mew techniques and instrumentation for physical assessment of such materials.

Visual appraisal of color of materials, fluorescent materials included, are made in heterochromatic light; hence, the combined subjective effect of reflectance and radiation from fluorescent additives is perceived by human visual observations. Thence, physical measurements on fluorescent materials must be made in a similar manner for the results to agree with visual assessment. These measurements, the subject of this paper, are termed "relative radiance" or the "spectral radiance factor" (SRF) of the test specimen.

H. Hemmendinger, Mechanisms of Release of Absorbed Energy

Energy absorbed by organic molecules always increases the electronic energy of the absorbing material. In most cases, this electronic energy is rapidly transformed to heat, by successive transitions which produce increased energy of molecular motion. If the energy is not sufficiently rapidly degraded to molecular energy, it may be reemitted as luminescence; it may be utilized in a chemical reaction; it may be transferred directly as electronic energy to some other portion of its immediate environment; or it may be transferred to a still higher electronic energy by absorption of a second quantum of light. Each of these possible courses is described, and examples of them are given, to illustrate some of the physical phenomena underlying the interrelationship between fluorescence, susceptibility to fading, and related electronic processes.

G. Wyszecki, Basic Concepts of Fluorescence

An introductory account of the basis concepts of fluorescence, explaining and demonstrating the phenomenon in simple ways is offered. Colorimetric problems associated with the fluorescent materials are also considered.

Å. Stenius, Fluorescence of Paper

Man-made fluorescence of paper by far outweighs the natural one. Amongst the fluorescent additives to paper, the fluorescent whitening agents (FWA) are the most important. Other additives are, for instance, those in stamps for automatic sorting of letters and fluorescent colors (printing inks) for Optical Character Recognition. All these additives to paper are excited by UV and are (preferably) non-colored without excitation. Measurement of fluorescence of paper will be discussed from its specific points of view.

R. Ward, Daylight Fluorescent Pigments, Inks, Paints and Plastics

The concept of fluorescence is examined considering such factors as Stokes law, photons, atoms, electrons, energy distribution of light sources, and the electronic structures and ionized states of fluorescent molecules. Dyes for daylight fluorescent pigments and multi-component dyes are discussed. Early fluorescent coatings, thermoplastic versus thermoset pigments, dye concentrations, and film thickness are all considered.

Fluorescent inks are discussed in terms of early pigments, pigment particle size and structure, and drying characteristics. The effect of heat on molding daylight fluorescent plastics is considered as well as the use of outdoor fluorescent pigments.

Conference Summary (to appear in Proceedings)

First, I would like to congratulate the ISCC for arranging another highly successful Williamsburg Conference. This is the fourth of these Conferences and judging by the amount of vigorous, but also very good-humored discussion which it has provoked, I think it must be regarded as the most successful of the four. You seem to have found the right formula for these specialized symposia, a formula, incidentally, which has succeeded in attracting both the theoretical and the practical experts as well as a significant number of participants from abroad.

Personally, I came to learn and I <u>have</u> learned, but I now know how much I still have to learn. As an academic I must say, "Hear! Hear!" to Professor Allen's emphasis on the importance of a fundamental understanding of the process of fluorescent excitation and emission. Only then can we make intelligent use of the more approximate analyses and shortcuts which have to be used in industry if they are to stay in business. But, Dr. Hemmendinger's paper and the subsequent discussion last night revealed the enormous intellectual challenge that faces us if we are to take Professor Allen's advice seriously.

I think, though, that we have a similar need for a fundamental understanding of how we perceive whiteness. It seemed to me as I listened to Dr. Ganz that we are now in the position of the old woman who lived in a shoe, we have so many whiteness formulae we hardly know what to do. The baffling nature of the problem is brought home to me every time I go out at night in the part of London where I live. We have sodium street lighting in our road, and at the end of the road is a little painted white fence and gate protecting a war memorial. How this gate and fence always look white to me in spite of the fact that they are reflecting only monochromatic yellow light into my eyes. I fancy Dr. Judd or Dr. Helson might have a formula that would explain this but I do not think it was included in Dr. Ganz's list. I fancy the problem of whiteness will be with us for some time yet.

I heard a good deal on the first day about the problems of measuring the colour of fluorescing dyes and pigments and clearly one of the most pressing practical needs is a standard illuminant to simulate D_{65}. But these were some aspects of colorimetry and the laws of colour mixture that were only just touched on. Dr. Stenius gave us one or two examples -- the need to preserve the colour of stamps even though they contained fluorescing inks; also the effect of fluorescing greased proof paper on the colour of butter. His reference to the need for standard office lighting prompted Mr. Derby to bring up the question of metamerism in relation to fluorescence and this has come up again this morning. The definition of an index of metamerism for pairs of fluorescing samples and also of a colour rendering index for illuminants with ultraviolet contents raises some very nice colorimetric problems which we can leave to Dr. Wyszecki since he seemed to think all its problems were solved.

I think the phenomenon of metamerism and of colour indexing is likely to be of particular importance with the use of fluorescent printing inks and paints to which Mr. Ward has referred this morning.

Dr. Thornton asked a pertinent colour mixture question about optical brighteners. "Comparing item watt for watt, do we want an optical brightener with a dominant wavelength of 420, 450, or 480 nm?" I remember being involved in a discussion on this very question when I was visiting Proctor and Gamble's some 20 years ago.

We have not dealt at all with the colorimetry of phosphors by themselves. For example, I remember in the early 1930's when I was involved with the production of cathode ray tubes for use in black and white television screens, being required to mix red, green and blue phosphors to produce a good white. Mr. Grum must have a much more sophisticated colour mixture problem on his hands in the use of fluorescing dyes to compensate for unwanted absorption in colour photography. I wish there had been time to hear more about this.

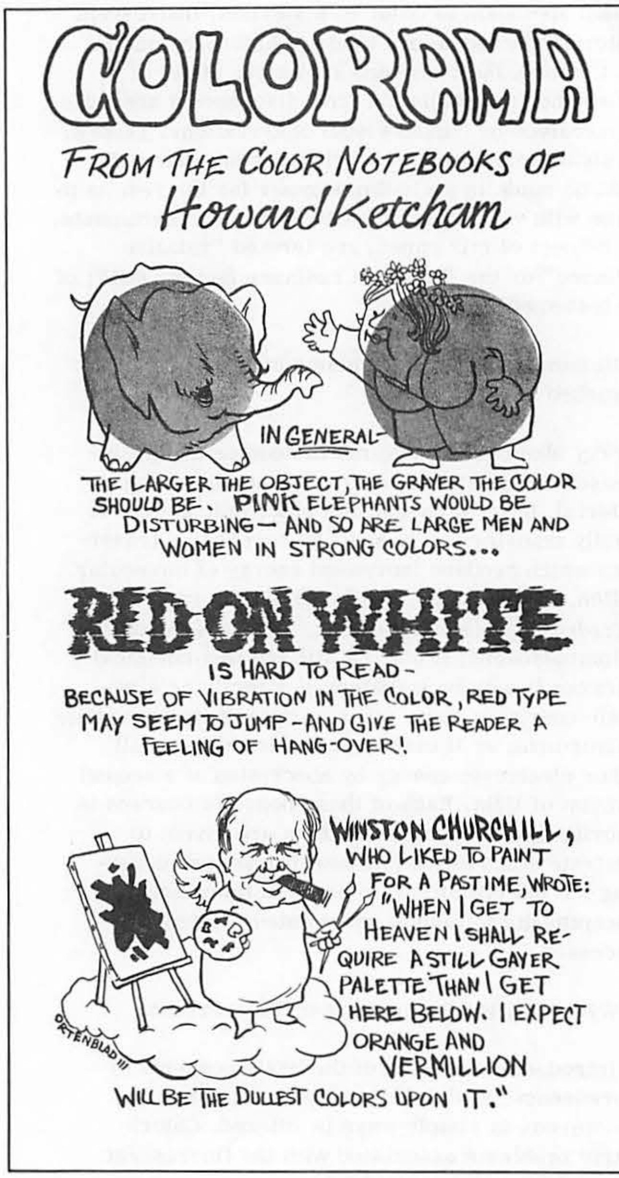
I have a colour mixture problem right here in Williamsburg as the only colours I can get on the television receiver in my room are a blue and a ghastly orange. In this case at least I must disagree with Mr. Derby that the electrons know where they are supposed to go!

Of all the papers, I think the discussion on Mr. Ward's paper this morning has raised the most exciting ideas so far as I am concerned. The availability of fluorescing printing inks and paints has evidently introduced a new range of visual and perceptional experiences which demand to be explored. The trouble is that there are so many things one would like to do and so little time to do them.

I am sorry I have been the only British participant at this Conference, especially as I have had so little to contribute. (I would like to claim Dr. Robertson, but I have to reconcile myself to his inclusion among the Canadian contingent) But at least there have been many references to Stokes' law and Stokes was British. Indeed, for a time he was a Professor in our Physics Department at Imperial College unless my memory is playing me false. But anyway he was British. Yet even here some of you have been so unkind as to refer to "anti-Stokes." The British are really in trouble whatever they do!

Thank you for a very enjoyable Conference. I hope we shall see you all in York in 1973.

Prof. W. D. Wright



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Comment

I felt, personally, the Conference was successful. It fulfilled, to a large extent, what I think a technical conference should accomplish. It attracted registrants, both here and abroad, of reputable status. The scheduling and presentation of the Papers were such as to allow and encourage discussion, of which there was considerable. All comments that I have received, while at the Conference and since returning, have been favorable. The luncheon speaker, Mr. Donnelly, Jr., from Westvaco gave a very delightful and entertaining account of the trials and tribulations of photographing natural fluorescing minerals.

Milton Pearson

INTER-SOCIETY COLOR COUNCIL APPROVED APPLICANTS FOR INDIVIDUAL MEMBERSHIP

Applicant	Member-Bodies and Interests
Dr. Stephen F. Bergen DDS 200 W. 54 St./14J New York, N.Y. 10019	Color matching; colorimetry, spectrophotometry; problems of color as they relate to dentistry.
Ernest A. Coleman Library of Congress Preservation Research and Testing Office Washington, D.C. 20540	AChS, TAPPI -- Preservation of historic documents.
Mr. Anthony T. Giammarise 1130 Brooktree Lane Webster, N.Y. 14580	AChS -- Analytical
Mr. Norbert H. Klein c/o Macbeth Div. Kollmorgen Corp. P.O. Box 950 Newburgh, N.Y. 12550	OSA -- Measure, control, view of color.
Mr. Richard F. Lehman 25 Valley Brook Dr. Fairport, N.Y. 14450	Color reproduction; measurement and analysis of fluorescence; reflectance measurement -- micro and macro. Xerox.
Frank P. Luigi 80 N. West St. Norwalk, Conn. 44857	SPE -- Instrumentation and its usefulness in regards to the different aspects of thermoplastics. Also setting up an easy to comprehend computer system for Plastics and Color Matching of them.
James B. Maher Librarian Brooks Institute of Photography Library 2190 Alston Road, Santa Barbara, Calif. 93103	SMPTE, SPSE -- Reference library usage of students and faculty.
Miss Mary L. Meixner 1007 Lincoln Way/2 Ames, Iowa 50010	Painting in oil, acrylics, starting some experiments in plexiglass and light. All aspects of information for teaching purposes.
Mr. Robert L. Serenka, Sr. Xerox Corp. Xerox Square Rochester, N.Y. 14644	SPSE -- Color measurement/characterization; relationship between perceived and analytical color.
Mr. Robert Frederick Spiegel 8711 Brae Brooke Dr. Lanham, Md. 20801	NSID -- Psycho-physical, psychology.
Dr. Zeno W. Wicks, Jr. 1002 Dogwood Trail Franklin Lakes, N.J. 07417	AChS, FSPT -- Teaching color to Polymers and Coatings Dept. of North Dakota S.U. students (7/1/72)
Mr. Joseph Abelson ICI America Inc. 24 Richmond Hill Ave. Stamford, Conn. 06904	AATCC, DCMA, TAPPI -- Use of color in the textile industry.
Mr. Lester R. Church Rt. 9, Sanders St. Jonesboro, Tenn. 37659	AATCC, AChS -- An eventual standardization of the Tennessee Eastman Co., nationally and internationally, with regard to the determination and formulation of color specifications in all areas and using all instruments involved in color measurement.
Mr. L. A. Curtis P.O. Box 950 Newburgh, N.Y. 12550	Industrial instrumentation quality control.
Terry L. Downes 1723-D East Cone Blvd. Greensboro, N.C. 27405	AATCC -- Spectrophotometry, colorimetry, instrumentation, dyestuff formulation. Burlington Industries.
Mr. Roger L. Harper 616 E. 112 St. Chicago, Ill. 60628	AChS, FSPT -- Am interested in geometry of reflection and transmission especially coatings that exhibit unusual geometric effects such as bronzing, metallic effects, retro-reflection, etc. Sherwin-Williams Research Center, Chicago, Ill.

Mr. William R. Hartman, Jr.
295 Wyndham Rd.
Rochester, N.Y. 14609

Color reproduction within the Xerox community.

Lewis K. Hosfeld
394 Dale Ave., RD 2
Columbia, Pa. 17512

FSPT -- Quality control, formulation (water based paints), color matching.

Mr. John MacMillan
7-23 Griswold Hghts.
Troy, N.Y. 12180

Simultaneous contrast (Graduate student, RPI)

Dr. Vsevolod S. Mihajlov
Xerox Corp.
P.O. Box 1540
Rochester, N.Y. 14603

AChS. SPSE -- Color difference metrics, color reproduction in general.

Mr. Leo Mori
R & D Center
Tokyo Shibaura Electric Co., Ltd.
1 Komukai, Toshiba-cho
Kawasaki, Japan 210

Application of colorimetry in industry, color matching, color rendering, chromatic adaptation, etc.

Harry B. Poole
Collins & Aikman Corp.
Box 1599
Charlotte, N.C. 28201

AATCC, AChS -- Computer applications, control of color in textile manufacturing.

Ms. Carol M. Sheets
2615 Mitchell Dr.
Woodridge, Ill. 60515

CMG -- Color marketing services: Research, sales analyses, styling, color palettes, color names, timing and trends. Publish a semi-annual Color Forecast for designers, manufacturers and buyers of consumer products.

Mr. I. C. Sleight
3109 Northwood Rd.
Fairfax, Va. 22030

I am general manager of Hunter Associates Laboratory, Inc., which is entirely concerned with the development and manufacture of instruments for the measurement of color and appearance.

G. G. Vichare
Westvaco Corp.
Luke, Md. 21562

TAPPI -- Color of white paper.

SYMPOSIUM ON COLOR IN ART, INDUSTRY AND SCIENCE

The symposium on Color in Art, Industry, and Science is a special Symposium arranged by the National Research Council's Division of Physics to provide interested Canadians from Art, Industry, and Science an up-to-date expert view on the multi-faced problems of color.

Authorities on color in the creative arts, in industry, and in science have been invited to present their views on the subject of color as it relates to their specific sphere of interest and expertise. Their presentations are not anticipated to be too technical and specialized so that all participants, whatever their background and specific interests in color may be, will find the presentations informative and stimulating.

During the Symposium the Canadian Society for Color in Art, Industry, and Science will be founded. An ad hoc steering committee, whose members come from different Canadian industries as well as the NRC laboratories, has worked out the necessary details required for the inauguration.

This new Canadian Society will be open to all people from Canada and abroad interested in color. The Society will provide in Canada a much needed forum for discussing color problems of all kinds and will bring together in a single organization all those artists, psychologists, educators, designers, decorators, architects, engineers, and scientists who have a keen interest in color. The Society will develop effective means of disseminating to its members new knowledge on all aspects of color.

Program

The Symposium on Color in Art, Industry, and Science will be held on May 15 and 16, 1972 in the Auditorium of the National Research Council, 100 Sussex Drive, Ottawa, Ontario.

Monday, May 15, 1972

9:00 AM -- Opening of Symposium

9:15 AM -- "The eye and how it works" Prof. J. D. Moreland, University of Waterloo, Waterloo, Ontario

10:30 AM -- "Color in the creative arts" Mr. Guido Molinari, Montreal, Quebec

11:30 AM -- "Color-order systems" Dr. Gunter Wyszecki, National Research Council, Ottawa, Ontario

12:30 PM -- Lunch break

2:00 PM -- "Color and colorants" Dr. E. I. Stearns, American Cyanamid Company, Bound Brook, New Jersey

3:00 PM -- "Color television" Mr. S. F. Quinn, Canadian Broadcasting Corporation, Montreal Quebec

4:00 PM -- End of first day

Tuesday, May 16, 1972

9:00 AM -- "Art and the history of color" Mrs. B. Welsh, Toronto, Ontario

10:00 AM -- "Inauguration of Canadian Society for Color in Art, Industry, and Science" Ad hoc Committee from Canadian Industry and NRC

10:30 AM -- "Color reproduction and its objectives" Mr. C. J. Bartleson, Kollmorgen Corporation, Newburgh, N.Y.

12:00 Noon -- End of Symposium

Note: Following each lecture there will be time allotted for discussions.

In the afternoon of Tuesday, May 16, the Light and Color Measurement laboratory (Radiation Optics Section, Division of Physics) of NRC will hold an open house for all those participants who wish to see it. The laboratory is located in the Physics Building (M-36), NRC, Montreal Road. Open house will be from 2 to 4 PM.

LETTER TO DR. RANDALL M. HANES (THEN PRESIDENT OF ISCC)

The Secretary of Commerce has asked that I reply to your letter of March 7, 1972, concerning the activities of the National Bureau of Standards in color and appearance measurements.

I am pleased with your recognition of the value of the past work of NBS in the area of color and appearance, and can understand your concern that it might be discontinued. Several years ago, NBS discontinued issuing several calibrated material standards such as color plaques, gloss plaques, and haze standards because it was felt that they could be properly handled by the private sector. Let me assure you, however, that efforts are being made to strengthen the Bureau's long-range work in these areas with a view to providing better services.

In a recent reorganization, the spectrophotometry group, which is responsible for the instrumental aspects of color and appearance measurements, was placed in the Optical Radiation Section, which also includes photometry and radiometry. Dr. William H. Venable, Jr., the new leader of this group, has been conducting a year-long study of the needs for calibration and standardization in spectrophotometry and the general direction NBS should move to satisfy these needs. Because of the growing number and variety of calibrations required by the technical community, Dr. Venable does not recommend that his group attempt to directly supply the market with calibrated material reference standards. However, he has found evidence of disparity between reference standards provided by different instrument manufacturers and strongly recommends that NBS move in every practical way to see that the suppliers of these standards calibrate them on a common and correct basis. As a beginning in this area, work is already in progress to develop a renewed capability at NBS in glass measurements. As Dr. Venable's group sets priorities for their work, they would particularly welcome suggestions which Inter-Society Color Council members or committees might have which would aid them. They reemphasize, however, that most of the standards should be issued by private organizations with NBS providing some form of quality control; otherwise NBS would be unnecessarily overwhelmed by a heavy routine workload.

Although there is no longer a specific group within NBS for dealing with the psychological and physiological aspects of colorimetry, Dr. G. L. Howett, Dr. Gary Yonemura, Mr. Isadore Nimeroff, Mr. H. K. Hammond III and Mr. K. L. Kelly are other members of the NBS staff who are knowledgeable in the field of color and appearance and can be consulted when necessary. In addition, the spectrophotometry group is concerned with these other aspects of color as they affect the physical measurements. As one result of this concern, Dr. Venable is submitting suggestions for basic psychological studies in color perception which NBS might undertake in order to provide a firmer basis for the color measurements which are used commercially. He is interested in receiving additional ideas for such studies.

Finally, I should mention that Dr. Venable is a member of ISCC and is participating in the work of Problems Subcommittee 18 on the colorimetry of fluorescent materials. He is looking forward to a close working relationship between NBS and ISCC.

Sincerely,

James H. Wakelin, Jr.

AMERICAN CERAMIC SOCIETY SYMPOSIUM ON COLOR IN COOPERATION WITH ISCC

At its 74th Annual Meeting in Washington, D.C. on May 10, 1972, the American Ceramic Society held a Society Conference on Color arranged in cooperation with the Inter-Society Color Council, of which the American Ceramic Society is a member-body. The symposium was arranged by Francis Joseph Von Tury, Chairman of the American Ceramic Society's Delegation to the Inter-Society Color Council. The speakers and their topics were as follows:

Francis Joseph Von Tury, "Introductory Remarks"

Randall M. Hanes, President, Inter-Society Color Council, "Purpose and Function of the Inter-Society Color Council -- Past, Present and Future."

Kenneth L. Kelly, Delegate from the Color Marketing Group to the ISCC, "What Color Is It? Is It the Color You Ordered?"

Richard S. Hunter, Vice-President and President-Elect, ISCC, "Instrumental Measurements of Color and Appearance of Ceramic Products."

Fred W. Billmeyer, Jr., Secretary, ISCC, "On the Calculation of Color Differences."

Clarence A. Seabright, Delegate from the American Ceramic Society to the ISCC, "Color in the Ceramic Industry."

Ruth M. Johnston, Chairman of the Delegation from the Federation of Societies for Paint Technology to the ISCC, "Colorant Formulation Methods."

William N. Hale, Jr., Delegate from the American Society for Testing and Materials to the ISCC, "The Munsell Color System and its Use in Color Quality Control."

Panel Discussion, "A Step Forward!" Randall M. Hanes, Moderator; Speakers and Delegates from the American Ceramic Society to the ISCC, Participants.

The Delegates from the American Ceramic Society to the ISCC and the Divisions of the Society that they represent are Gordon H. Johnson and Walter A. Hedden, Ceramic-Metal Systems; F. J. Von Tury, Design; Alan J. Werner, Glass; William G. Coulter and Josephine A. Gitter, Materials & Equipment; Gary S. Davis, Structural Clay Products; and Paul D. Henry and Clarence A. Seabright, White Wares.

ASTM AND ISCC COOPERATE IN PLANNING SYMPOSIUM ON SENSORY EVALUATION OF APPEARANCE

With the cooperation of the Inter-Society Color Council, Committee E-12 on Appearance of Materials and Committee E-18 on Sensory Evaluation of Materials and Products of the American Society for Testing and Materials will hold a Symposium on Sensory Evaluation of the Appearance of Materials, to be held at the ASTM Fall meeting in Philadelphia, Pa. on October 24, 1972.

The general theme of the Symposium is "Principles of the Sensory Evaluation of Materials -- Appearance," and papers will be presented in the following subject areas: mechanism of vision; psychology of appearance of materials; correlation of objective facts with subjective impressions; and anomalies, pitfalls, problems, and a look at the future.

It is anticipated that the papers will be published in a symposium volume by the ASTM. For further information write:

Mr. Richard S. Hunter
Chairman, E-12 Task Force
Hunter Associates Laboratory
9529 Lee Highway
Fairfax, Virginia 22030

or

Mr. Paul N. Martin
Chairman, E-18.02 Task Force
SCM Corporation
229 Park Avenue
New York, New York 10017

GATF SCHEDULES NEW YORK CITY COLOR CONFERENCE

The Graphic Arts Technical Foundation has scheduled a Color Conference to be presented in New York City on May 23 and 24, 1972.

Mr. Frank E. Church, consultant, Readers' Digest Association, Pleasantville, N.Y., will be the Conference chairman, with 20 other industry representatives participating in the program. The Conference, entitled "The Preparation and Reproduction of Color Copy," will be held at the New York Biltmore Hotel.

During the first Conference session, papers will be presented on the subject of "Color Copy Origination and Preparation." The scheduled titles of the papers are: "New Dimensions in Color and Creativity," "Creation of Color Copy," "Color Transparency Handling" and "Color Copy for Catalog Production." The speakers will be from the New York City area, and are employed by well-known publishers or photographic studios.

The second session, entitled "Photography and the Reproduction of Color," will deal with the latest developments in graphic arts photography. A review of the significant Williamsburg Inter-Society Color Conference program on "The Optimum Reproduction of Color" will be presented. This will be followed by a manufacturers' representatives discussion of recent advances in "Color Duplicating." The final papers in this session "Direct Screening" and "Automation of Graphic Arts Photography" will be presented by noted specialists in these fields.

"Developing Technology in Color Reproduction," the third session, will be chaired by Dr. William D. Schaeffer, GATF research director. Subjects covered will be those responsible for considerable changes in graphic arts color technology. Presentations include: "A New Color Order System," "Color Scanning," "Electronic Color Previewer," "Pre-Press Color Proving" and "Recent Advances in Gravure." The papers will be presented by individuals extensively involved in research work.

The fourth and final session, entitled "Standards and Controls for the Reproduction of Color," will be led by Francis L. Cox, GATF technical services director. The topics covered during this session will include: the "'Total System' Approach for Control of Color," "Standard Practices for Letterpress Magazine Proving," "Quality Control of Color Printing" and "Standard Color Viewing Conditions." The presentations will be made by persons actively involved in the preproduction and production of color.

Further details on the Color Conference may be obtained by contacting: Special Programs Department, Graphic Arts Technical Foundation, 4615 Forbes Ave., Pittsburgh, Pa. 15213.

INDUSTRIAL DESIGNERS ELECT BOARD CHAIRMAN

The election of Arthur N. BecVar, former ISCC delegate, Manager, Industrial Design Operation of the Major Appliance Business Group of the General Electric Co., Louisville, Ky., as Chairman of the Board of the Industrial Designers Society of America, was announced at an IDSA Board of Directors meeting on January 28th.

The Industrial Designers Society of America is the nation's only professional industrial design society. Its membership includes leading consultants, industrial designers employed by major corporations, educators and students. The Society's objectives include the maintenance of high standards of design and professional integrity, the encouragement of sound design education and research, creative experiment and cooperation with Industry and Government.

WHAT PHOTOGRAMMETRIC ENGINEERING IS

Photogrammetric Engineering is the official journal of the American Society of Photogrammetry devoted to the exchange of ideas and the dissemination of knowledge and new information about the applications of photogrammetry.

Photogrammetry is the art, science and technology of obtaining reliable information about physical objects and environment through processes of recording, measuring and interpreting photographic images and patterns of electromagnetic and accoustical radiant energy and magnetic phenomena.

The principal application of photogrammetry consists of the derivation and production of topographic maps and surveys based on measurements and information obtained from aerial photographs. Photogrammetry also includes the compilation from aerial photographs of various similar types of graphic and numerical data used in highway planning and construction, property surveys, stockpile volume determinations, etc. Another very important aspect is called "photographic interpretation" in which highly accurate discrete information is recognized in the fields of forestry, soils, geology, military defense, urban area analysis, archaeology, etc. Numerous special applications include X-ray technology, dentistry, laboratory deformation of construction materials, shapes of radar telescope dishes, etc. Conventional aerial photogrammetry is sometimes correlated with "remote sensing" in which various other types of data are recorded and analyzed such as infrared scanning systems, and scintillometers and magnetometers for mineral exploration.

ARTISTS AND ART DEALERS CONVENTION

This year in April was the first time artists have had an opportunity to go to a market designed strictly for artists and art dealers. The market was held in the fabulous Astrohall in Houston, Texas. In connection with this market was the first national seminar in art and its related fields.

The reasons for and benefits of such a market and convention were many, but the major purposes for it were to allow artists to meet gallery owners from all over America under the most favorable business conditions; for thousands of artists to meet and discuss art and to upgrade their profession as well as uplift their own spirits, with a seminar on all phases of art held by leading artists and manufacturers of artist materials, supplies, and equipment.

Possibly the most difficult part of an artist's life is the selling of his work -- where to sell, how to sell, and for how much. Most important is where are the markets, how to get to them, and how to approach them in a way that will be beneficial to the artist's career.

Those who for years have called on galleries to sell art know that there is no magic formula; there must be a better way. The ideal situation would be for the artist to show his work at a proper time and in a convenient place to dealers who have come in a buying frame of mind.

Artists are, after all, manufacturers of a sort. They paint, model, or construct objects which are to be sold. Every established manufacturer in America has a market in which to sell to the businesses that distribute his products to the public -- he could not get his products to the people without it. Every artist would like for more people to see, buy, and enjoy his work. He can no longer do without a major market.

Artists sometimes think of themselves as being alone because that's the way an artist has to work. But they are part of an old and honorable profession. They felt the need to generate on a large scale the feeling of belonging to a great profession, and to bring to each individual this sense of belonging for his own personal motivation. The reason for the convention was for artists to get together for four days to talk about art with other artists whom they could not possibly meet in any other way.

All artists, at different levels of success, try continually to improve their work. This is what keeps an artist young and vital. Discussion groups, films, demonstrations by leading artists and manufacturers of artist's materials and supplies, collections of the top museums in the United States were only a part of the seminar held in conjunction with the market and convention. Apparently never before have so many different phases of art been shown at one time.

ANNOUNCEMENT BY AMERICAN ASSOCIATION OF TEXTILE CHEMISTS AND COLORISTS

The Third Edition of the Colour Index, published in five volumes by The Society of Dyers and Colourists with technical information contributed by the American Association of Textile Chemists and Colorists, is now available.

The new Third Edition contains approximately 7,900 C.I. Generic Names of dyes and pigments compared with 6,047 in the Second Edition and Supplement, issued some 15 years ago and now out of print. The number of entries for reactive dyes has increased from 88 to 361. There have also been large increases in the listings of basic, disperse, fluorescent brighteners and pigment entries. The Third Edition contains alternate names given to existing dyes to indicate their suitability for use on one or more of the newer synthetic-polymer fibers and on other substrates, such as paper and leather. The list of commercial names has been increased and many dye manufacturers have been added. The contents of the 5,800-page, five-volume Third Edition include the following:

Volume 1 -- Acid, Azoic and Basic Dyes.

Volume 2 -- Developers, Direct Dyes, Disperse Dyes, Fluorescent Brighteners, Food, Ingrain and Leather Dyes.

Volume 3 -- Mordant and Natural Dyes, Oxidation Bases, Pigments, Reactive Dyes, Reducing Agents, Solvent, Sulphur and Vat Dyes.

Volumes 1-3 contain Colour Index name and number, chemical class, fastness properties, hue indication, and application and usage information.

Volume 4 -- C.I. Constitution Numbers, structures and method of preparation of all dyes of disclosed structure, classified as in the Second Edition.

Volume 5 -- Commercial Names Indexes arranged alphabetically and classified under C.I. Generic Names.

Commercial dyes are arranged under the C.I. Generic Names and appear in Volume 5 together with the Commercial Names Index. This new feature of the Colour Index allows for periodic revision and reissue of these two indexes eliminating the need to republish the technical material in Volumes 1-4.

Orders originating in the United States, Mexico, Central and South America, except British Commonwealth countries, should be placed with AATCC, P.O. Box 12215, Research Triangle Park, North Carolina 27709, accompanied by payment of $260, U.S. funds, net, surface postage included. Prepaid orders from other countries should be sent to The Society of Dyers and Colourists, P.O. Box 244, Bradford, Yorkshire BD1 2JB, England accompanied by £ 100.

BRITISH COLOUR GROUP

Report on the 83rd Meeting on Colour Difference Equations Held in February, 1972

In the first half of the meeting Dr. S. T. Henderson reviewed the subject of colour differences and colour difference equations. He felt that the subject was so fundamental that colour without differences was akin to a language without words, but it is also symptomatic of the subject that of the three references, which he cited as being the best review articles he had found, two were only obtainable by a select body of people and the third is probably out of print. They were the survey carried out for our 1967 conference, a report by Wyszecki for the E.1.3.1 committee of the CIE and a progress review by McLaren for the S.D.C. Since the Driebergen papers are not yet published, they are not available at present to those who were not invited to this conference.

Essentially colour difference formulae should be an evaluation of the size of difference seen by the eye and they should therefore include such parameters as gloss, adaptation etc., but since these formulae are principally required by industry, and it is there where most work has been carried out, we are now in the situation where different industries cannot agree. It is desirable however to establish general formulae applicable to an many types of colour difference as possible.

Initially a method of measurement is required, and thoughts go first to the 1931 diagram, but it should be remembered that in its original construction no account was taken of small colour differences and it was in fact of a highly arbitrary construction. Further a "new colour" results by change in lightness alone and any method of measurement must take account of this parameter.

There have been two lines of approach to this problem; first by considering threshold differences and second considering larger differences such as appear in the Munsell colour solid.

In the first category work began with Helmholtz 80 years ago and has continued with such distinguished workers as Stiles, Friele and Wright. But perhaps the most famous are the MacAdam colour matching experiments of 1942. The unit of colour measurement used was the standard deviation of colour measurement which corresponded to 1/3 of a just noticeable colour difference at 15mL ($48cd/m^2$). These gave ellipses on the x, y diagram, which were later extended to ellipsoids showing nonuniformity of x and y under the conditions used.

There have been many attempts to convert these ellipses into circles one of the most recent being the MacAdam Geodesic space which is where a straight line joins colours separated by a minimum number of just perceptible differences. Wyszecki and Fielder have also recently published in J.C.S.A. an interesting new 3 point matching technique.

In general the methods of introducing the lightness factor Y into the formulae is often somewhat ad hoc, and used as an empirical method of adjusting formulae to the experimental data; always in a limited region of colour space.

The second method instead of starting with a measurement technique starts with a ready made colour atlas where the adjacent chips are intended to have a constant colour difference. In the Munsell colour space these are arranged in terms of hue, value and chroma, and a refinement is the "renotation" which is a smoothing of the plotted chromaticities at selected values to give an idealised distribution.

The major difficulty remains in the scaling viz

H (hue) from 0-100
C (chroma) from 0-14/16
V (value) from 0-10

Further one unit of each dimension has a different visual magnitude. But all of this work raises another problem which is the eye's adaptive behaviour and therefore the viewing conditions must be controlled.

Dr. Henderson then went on to consider 9 of the most famous formulae viz. the N.B.S., the 1964 CIE, Glasser's cube root, the Godlove, the Godlove with the Munsell renotation, the Friele-MacAdam-Chickering, the Friele-MacAdam-Chickering Mark 2 also known as the FMC2, the Adams Nickerson (also known as the ANLAB) and the MacAdam geodesic chromaticity diagram.

Armed with this information the discussion started without any delay at all and was to go on officially for an hour but in practice right through tea time and until trains had to be caught. McLaren was first man in, explaining that although he was acting as a replacement for Frank Malkin who was ill he would not say those things which he knew Frank would have said. Although he had every sympathy with the compulsion of the CIE to choose a formula from the 18 available at the time he felt that the one chosen in 1964 was not the best one and since at the 1971 meeting the only conclusion reached was that more work was required with for example 2^o, 10^o, Illuminant C and D65, when he went to Boston for the ISC meeting of the Textile Industry, he recommended on the basis of his own and Jaeckel's (HATRA) work that a cube root formula be adopted.

Since it is important for the textile industry to have a unified front the ISC TC38 committee, with representatives from 14 countries, selected the Adams Chromatic Formula for their international work. This would hold he said until another demonstrably better formula became available.

Dr. R. W. G. Hunt suggested that a single formula may not be applicable for all sizes of colour differences. It seemed to him that for the smallest differences at or below threshold there was sufficient data available; for the largest differences typified by the Munsell space again there was sufficient data; however between these extremes there is remarkably little information.

He told us that the 1964 formula was adopted to satisfy the demands of the E-1.3.2. committee who needed it for their work on colour rendering. He regretted that the ISO had adopted a formula in which the quintic equation was used and said that the W* function would have been just as good. To encourage us he said that MacAdam has simplified the FMC2 so that instead of having 20 constants it now only had 10. In the course of his contribution Dr. Hunt also brought up the subject of perceptibility and acceptability, and this was followed up by many of the other speakers. In order to simplify this presentation all the contributions on this subject will be dealt with together because they showed quite clearly that the meaning attached to these words depended on the industry with which the speaker was concerned. Dr. Hunt, whose main interest is in the photographic industry thought that the main interest lay in between the just perceptible difference and the larger differences typified by the Munsell space. For Jaeckel in the hosiery trade, the acceptable difference is at the just perceptible level or indeed just below this level so that the two words covered the identical situations. Dr. Douglas MacDougall at the Meat Research Institute found that some large colour differences could be acceptable whereas others were not and to illustrate this he cited the case of brown bananas and redder meat with the same colour difference but a different acceptability. This situation also occurred in leather. Mr. Landman cited the case of suede leather for which the acceptability of shade differences is small, but in terms of lightness, with and against the nap, is very much larger. Gordon Reed submitted that there can be different criteria within one trade and cited the motor industry, where colour differences for seating materials for example could be very much bigger than for the paintwork. Malcolm Lloyd agreed that the tolerances on X, Y and Z were different for different situations, and Miss. Battersby thought that acceptability was the term used by the lay person and perceptibility was the term used by the colourist. For Bill Sproson however the difference between the two terms was not a single constant but depended on personal taste. A colour television set could be adjusted by one person to give an acceptable colour difference with reality which was very large and unacceptable to another. Dorothy Morley commented that this was really a difference between colour comparison and colour memory, and further suggested that we did not have sufficient information at the moment to know whether there was a simple magnitude difference between perceptible and acceptable differences whereas Jaeckel thought that for his industry they would be simply different ΔE limits on the same formula.

Mr. Jaeckel introduced his co-worker Mr. Ward who has contributed greatly to the HATRA work. He is not happy with the 1964 CIE formula, but also agrees that introduction of the quintic equation in the ACV formula is rather horrid, and would be pleased to see another cube root formula. From his experiments in which observers were asked whether two colours had an acceptable difference (later established that in other peoples terms this was the same as whether there was a perceptible difference) the resultant cloud of points gave a higher correlation coefficient with the Adams Chromatic Value than with the Adams Nickerson, although the difference was not significantly higher when tested by the normal "f" test than it was with the Hottellings T test.

He also mentioned the work at Bradford University and the possibility of a new formula coming out of this effort.

Reed commented on the desirability of obtaining the colour difference in terms of a and b so that the colourist knew the direction in which adjustments must be made, and McLaren mentioned the inadequencies contained in a two parameter statement.

David McConnell introduced his correction to the lightness in the Adam's formula which had originally arisen from his work on near whites in the paper industry. To give an appearance of white, he has found that down to 80% Y the blue reflectance needs to be greater than the green reflectance and this locus continues to a maximum 7% difference at Y of about 69%. If the Adams Chromatic Value diagram is based around this axis it also works better for colours. Further since the red-green axis is displaced from the red-green appearance he has corrected for this and then finds that the Munsell space instead of having the characteristic ears which stick out for the yellow and blue hues becomes more spheroidal in shape.

Although not connected with the last contribution Hunt had earlier said that the British E13.1 committee has proposed an improved scaling of the Munsell space which then works along axes designated as Hue Angle, Purity and Saturation.

Finally Michael Poynton gave some advance information on his work which had shown that the same length of just noticeable difference vectors in the u, v diagram were obtained when the match was made with a surround of either Illuminant C or tungsten light.

D.I.M.

Report on the 84th Meeting Held in March, 1972

Dr. W. Carr (CIBA-Geigy U.K. Ltd) gave the first paper on "The Effect of Pigment Particle Size on Colour Properties."

Pigments are colorants that are insoluble in the vehicle in which they are used. In their powder form they appear dull and consist of aggregates or clusters of basic particles which must be broken down and dispersed into a medium or vehicle by grinding before they become satisfactory to use as colorants. The most efficient mill is chosen, which if toxic or inflammable materials are involved must be enclosed. The process is often slow and expensive. After grinding there is some aggregation, the basic particles being very fine. Sometimes fine dusts are caused in handling, which can be unpleasant. Pigment powders must therefore be easy to handle as well as to disperse. They vary in these respects, some, usually soft powders, being easy to grind and others, hard ones, are more difficult. They can also vary from batch to batch, sometimes from one manufacturer, and in a way that is not necessarily directly associated with chemical constitution.

In paints, plastics, papers and so on the dispersion of the paints can markedly affect properties such as brightness, shade, strength, bronzing, etc., and it has not always been possible to determine the relation between these properties and the particle size which is often less than 1μm. A picture was shown of a modern centrifuge for separating particles, from which they could be extracted, by suction, from different levels according to their size and the length of the grinding period to which they had been subjected. It was necessary to repeat the process ten to twelve times for uniform selection.

A slide was shown illustrating the marked differences in the appearance of a bluish colorant at different dispersions, contained in a number of small cylindrical transparent tubes.

In the estimation of pigment, for organic materials use is made of solution and spectrophotometry. Inorganic materials are more difficult to analyse, and take a long time, up to two days to obtain a spectral distribution curve, but the method used is sound, and sensitive to 0.05μm.

To investigate the effect of particle size on the colour properties of a colorant, paint stainers are made containing colorant varying only in size and are added in small known proportions to a larger bulk of white base. A large number of stainers differing only in dispersion are prepared after grinding in a ball mill for periods from two to seventy-two hours. The mixtures, all of the same formulation, are painted out on a board, dried and measured on a spectrophotometer.

For two pigments curves were shown indicating the range of improvement in colour strength for particle sizes below about 0.4μm. Both examples showed increases as the size decreased below this value, one slight but the other very considerable. Most pigments are found to fall between the two illustrated.

From general results it seems that probably most manufacturers are not getting the best out of their paints because of insufficient dispersion, and consequently there is a large potential as yet unexploited.

Curves relating colour properties to pigment particle size for all colorants examined showed increases, usually rapid, below 0.4μm, for some more than others, but no maximum or leveling off has been found for the smallest sizes perhaps because experimental results could not be extended below about 0.1μm.

To examine the effect of dispersion on shade, mixtures with different dispersions are all brought to the same colour strength and their shades evaluated by deriving X, Y, Z from spectrophotometry and calculation. Some showed a change, for example a violet showed a reddening of up to 5 N.B.S. units, a blue a shift towards green of 1 to 3 N.B.S. units, and a yellow also became greener, while for two greens there was no change. The behavior seemed quite random.

For brightness the Y value is used as a measure. Plotted against particle size for six examples, increases of about 10% were found for sizes below 0.3μm.

Is there any theoretical relation between colour properties and particle size?

Mie (1908) worked with dilute colloidal metal solutions such as gold, and obtained expressions for colour and particle size, but the mathematics was very difficult. It can now be assisted by computers.

Latterly a Swiss worker Felde (1968) has shown how to measure n and K as applicable to the Mie theory, which he has developed in relation to n, K/S and particle size. He found a limited agreement between Mie and experiment, partly because the theory did not cover adequately the region where change has been found to be most marked. It was confirmed that, as has long been suspected, particle size has a marked effect on pigment colour properties.

In the second part of the meeting, Mr. S. C. H. Rowe from Andrew Babington spoke on "The subjective scaling of hue and saturation." The work, done at City University and Kodak, was a joint university and industrial venture.

Many psychophysical measurement techniques are now well established but the subjective estimation of the magnitudes of sensations has been neglected, especially for hue and saturation. These have industrial applications, in particular in the field of photographic reproduction where conventional colour measuring methods are inapplicable because of the difference of lighting conditions in the original and reproduction. Hunt tackled the problem in a different way, by the binocular matching technique, where the two eyes could have different adaptation conditions; but the weakness of this method lies in the assumption that the 2 eyes are adapted independently.

The apparatus used for subjective estimation provided a 2^{o} field, of which the colour could be controlled, with a 20^{o} surround which could provide 3 different adaptation conditions, viz illuminants A, B and C. Chromaticities could be measured in situ by a Joyce Loebl Colorimeter.

Subjective assessment of hue was based on the

Hering-type theory of 4 psychological primaries, opponent R-G and opponent Y-B, the 2 components of a pair being mutually exclusive. Consequently every hue can be subjectively assessed as relative amounts of only 2 psychological primaries -- RY, YG, GB or BR. Observers are asked to designate a number to the predominant primary and another number to the ratio of the 2 primaries. In the case of saturation, the observer is asked to form a concept of pure hue and then to assess the saturation of a given colour as a percentage on a subjective scale from an achrometric colour to this ideal colour. Colours were presented at random, 5 times for each colour for each of 3 adaptation conditions, for 5 observers; each time judgement was made on saturation and then hue. Chromaticities of the various assessments were plotted on the u, v diagram.

Results showed that lines of constant hue varied between straight lines in the purple and orange to a line of large curvature in the blue; somewhat surprisingly, the psychological primary R at high saturation is not a spectral colour but a purple. In hue assessment, observer differences were small, but in saturation they were larger. Curves of constant saturation showed that up to 90% saturation covered a remarkably small part of the u, v diagram. Agreement was good with MacAdam's and Kelly's results and with the theoretical line element. The relationship between estimated saturation and purity is a Stevens-type of power law, the power having different values for the different primaries. Regarding the spread of readings, in the saturation estimate the standard deviation does not change with hue, but is smaller for low saturations than for high, and in the hue estimate it is lower forpu reh

and in the hue estimate it is lower for pure hues than for mixed; these agree with Ishak's results for Munsell surface colours.

In colour reproduction, the colours most critically viewed include sky-blue and grass-green. Concentrating on one of these, a scene was chosen with a large expanse of uniform green grass; this was measured for chromaticity and photographed. The grass chromaticity was varied in a set of prints and a set of transparencies, leaving the remainder of the scene unchanged. In each case the print or transparency was viewed with a neutral background and the acceptability of the grass colour assessed on a subjective scale. Results showed that although natural hues were preferred, the preferred saturation of both grass and sky was greater than in the original.

Low luminance level experiments showed that 4 psychological primaries were not sufficient, and brown was needed in addition; observers were unable to assess brown in terms of the other 4 by using a purely subjective judgement.

In the discussion the point was made that brown is a standard signal colour in the U.S.A.; the applicability of a Stevens-type power law to saturation, and the validity of scaling a ratio of 2 sensations were questioned.

G.E.V.L., P.W.T.

Second Symposium of the International Research Group on Colour Vision Deficiences

This symposium will be devoted to "Recent Advances in (Congenital) Colour Vision Deficiences" and will be held in Edinburgh University from 28th to 30th June 1973. It will be organised on behalf of the International Research Group by the Scottish Section of The Colour Group (Great Britain) in collaboration with the Department of Ophthalmology of the University of Edinburgh. Accommodation will be available in the University Halls of Residence from 27th June to 1st July, allowing delegates to proceed directly to the 2nd Congress of the AIC which is being held in York from 2nd-6th July 1973.

Correspondence regarding submission of papers, and the technical program should be addressed to:

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BOOK REVIEWS

Sources of Color Science, selected and edited by David L. MacAdam, The MIT Press. Cambridge, Massachusetts, and London, England, x + 282, 1970, $12.50

When I was asked in October 1970 to review this book, I was glad to undertake it, but because of illness I was prevented from fulfilling this commitment. When

Dr. Burnham renewed his request more than a year later, I was doubly glad, first because I have recovered enough to complete this assignment, and second because I welcome the chance to support Dr. MacAdam in this his unique tutorial project. I think that he has done color science a great service by selecting excerpts from the writings of those who have shown the greatest insight into the mysteries of color, editing them by incorporation of modern (1970) terminology, and arranging for publication of this compilation in a most legible and attractive format by the MIT Press. In this way Dr. MacAdam has done much to resolve the apparent contradictions among these expressions of basic views, and so has left them in a form that encourages the reader to attempt his own resolution of them.

The excerpts chosen by Dr. MacAdam deal with the most difficult questions in color science, particularly those arising from attempts to measure color, and from the development of the three-components theory of color vision. He has purposely omitted the enormous literature on the psychology of color and the literature dealing with the dependence of the color perceived to belong to a central field on the characteristics of the surrounding field. He finds much of this literature controversial and decided that confusion rather than clarification would result from an attempt to extract it.

The subjects that are covered by these excerpts are as follows:

Aristotle (10 pages) identifies the process by which light reaches the eye, the process by which signals from the eye reach the brain, and the location of the perceived color; but he proposes to account for color as a juxtaposition, or perhaps a superposition, or perhaps an interpenetration of black and white.

Newton (24 pages) describes his experiments proving that the color of light depends upon its refrangibility and states the center-of-gravity principle for computing the colors of mixtures of lights of different refrangibilities that is known as Newton's law of color mixture.

Palmer (11 pages) outlines the three-components theory of color vision 25 years before the far briefer statement by Young which resulted in that theory becoming known as the Young-Holmholtz theory.

The single page devoted to Young includes almost all that this famous scientist ever wrote about color. He first adopted (1802) the then current view that red, yellow, and blue are the principal colors, but later adopted the choice, red, green, and violet, still held by modern adherents of three-components theory.

Grassman (9 pages) formulates the laws identified by his name and generally recognized as the basis of modern colorimetry. He gives the arguments leading to the conclusion that color may be specified by the three variables now known as dominant wavelength, purity, and luminance.

Maxwell (22 pages) states the connection between partial color blindness (dichromatic vision) and normal (trichromatic vision). The former is a reduction form of the latter. He was the first to measure the tristimulus values of the spectrum colors (color-matching functions), and the first to construct a chromaticity diagram, still often referred to as a Maxwell triangle. He points out that the spectrum locus on that diagram corresponds much more closely to two straight lines intersecting at the point representing the green color of the spectrum at 510 nm than to the circular locus favored up to that time.

Helmholtz (17 pages) gives a clarifying discussion of Aristotle's view that chromatic color is some kind of combination of black with white, and he points out that Huygens then new hypothesis that light consists of undulations of an elastic medium is not inconsistent with Newton's experiments. One must only substitute different frequencies of vibration for Newton's different degress of refrangibility. Helmholtz also discusses clearly the dissimilar results of light mixture and pigment mixture, as Maxwell and others had done before him. From Young's brief statement of the three-components hypothesis he sketches an estimate of the spectral distribution of the three fundamental sensations, red, green, and violet, not too far different from the results of measurements Maxwell had at that time not yet undertaken. He states that the essential element in Young's hypothesis is the idea that all color sensations are composed of three processes in the nervous substance that are perfectly independent of one another.

Von Kries (26 pages) describes the method used by him to study adaptation phenomena, to discover the conditions under which optical matches persist, and to verify the idea that under these conditions (chiefly freedom from involvement of the retinal rods) the color changes caused by chromatic adaptation are accounted for within the three-components theory by the assumption that the three spectral response curves (color-matching functions) remain unchanged in shape but different in absolute magnitude (the v. Kries coefficient law). He reports that the principal colors, those remaining unchanged in quality regardless of changes in chromatic adaptation, are red, green, and a violet or blue, all more saturated than the spectrum color of the same hue. These colors do not agree with the principal colors deduced from experiments with dichromatic vision.

Schrödinger (60 pages) treats as elementary color measurement the derivation and use of color-matching functions, first determined by Maxwell. This kind of color measurement is elementary because it includes only information derivable from settings of equality in the appearance of two fields. The color space implied by the use of color-matching functions has only affine structure. Transformation of the functions expressed relative to one set of calibration colors to another is linear and homogeneous. By such transformations straight lines are converted into straight lines, and plane surface into plane surfaces, but angles and ratios of length in this kind of space have no meaning. Schrödinger discusses the transformations required to throw the color-matching functions into a form (no values less than zero) suited to represent the spectral sensitivities of the red, green, and violet processes of the Young-Helmholtz theory.

Schrödinger treats as advanced color measurement methods of determining brightness, hue, and saturation, and of deriving a geometry suited to their representation. The basic assumption is that a measure of the dissimilarity of two colors can be set up in this geometry, in a manner originated by Helmholtz to accord with the Fechner law, such that for all just distinguishable color pairs this measure has a constant value. He proposes a differential formula to express the dissimilarity of two colors that differ by not much more than the threshold, and proposes further to measure the dissimilarity of other color pairs according to the number of just noticeable differences required to pass from the one to the other by the shortest path (geodesic path). He then analyzes the setting of equality of two fields of different chromaticity to equal brightness by adjustment of their radiances in terms of finding, from the series of colors of the second chromaticity produced by varying the radiance of its stimulus, the particular member differing from the color of the first chromaticity by the minimal number of just noticeable steps. The loci of constant hue on the chromaticity diagram are evaluated on the assumption that these are simply the geodesic paths among colors of constant luminance from the point representing the neutral color to the point representing any non-neutral color. The loci of constant saturation and brightness are taken to be loci in the chromaticity diagram corresponding to a constant dissimilarity with the neutral color.

Guild (47 pages) states in the first of the two papers reprinted that in his view the three-components theory of color vision, whatever form it takes, is an attempt to explain the fundamental empirical fact that to set a color match between two fields the observer need never operate more than three independent controls. From this beginning Guild derives a more general view of what a three-components theory consists of than had been formulated previously. By this view many new forms of three-components theory are seen to be possible, and all have to be disproved before the three-components idea can be rejected. The relative spectral sensitivity of the reception system depends entirely on the properties of the receptors, but the restriction to three degrees of freedom might mean that there are only three modalities of response of the post-receptor neurons.

In the second paper Guild analyzes the characteristics of a photometric process by which it may be said that luminance is a measure of brightness strictly analogous to the measurement of length by counting the number of unit lengths required to equal that length. Guild sternly insists that photometry has meaning only with regard to luminance of an extended area. The idea officially sanctioned by photometrists that a particular luminous efficacy may be regarded as associated with radiant energy of a particular quality without reference to its spatial distribution is quite unjustified, he says, as are the ideas of luminous flux, luminous intensity, and allied entities. Guild also develops a colorimetric procedure entitled to be called measurement in the strict sense. This method is identical to that developed by Schrödinger in his elementary color measurement except that Guild insists that the amounts of the primaries must be stated, or stateable, in luminance terms. Evaluation of hue and saturation by Schrödinger's measure of degree of dissimilarity does not even come close to satisfying the conditions laid down by Guild for true color measurement.

Richardson (5 pages) points out three ways of measuring the sensations of hue, brightness, and saturation as distinct from stimuli. He suggests that standardizing institutions are led to measure stimuli, not sensations, because it is easier to do physics than psychology. In discussion Guild replies that the evaluations mentioned by Richardson are not measurements but only subjective estimates.

Polyak (23 pages) gives a detailed description of the anatomy of the central fovea with emphasis on the various types of nerve cells in the retina and how they are interlocked to form the complex retinal tissue. He described bipolar cells, ganglion cells, and the synaptical relations of retinal neurons. Only the midget bipolar cells (besides the cones) preserve the character of a strictly cone mechanism; all other structures may be stimulated by rods and by cones, either or both. The cones are microscopically indistinguishable, and if this means that they all have the same spectral sensitivity, Polyak suggests that the bipolars and ganglion cells must in some way be the carriers of the process by which the global cone excitation is transformed and directed into one or the other channel according to the spectral position of the stimulus. This suggestion is contrary to Guild's well-based contention that the receptors, and receptors alone, determine the spectral sensitivity of each reception system.

Le Gros Clark (8 pages) presents convincing evidence based chiefly on atrophy of particular cells in the lateral geniculate nucleus corresponding to destruction of particular portions of the central retinas of macaques that from each local spot in the central retina three types of fiber pass back in the optic tract, one to each of three lamina in the nucleus, one type signalling red, another green, and a third violet. Corroborative evidence also comes from monkeys kept for several weeks in light from which the short-wave end of the spectrum is excluded, and from two cases of diabetic amblyopia reported by Rönne showing central scotomas for red and green with corresponding degeneration in one of the two lamina of the nucleus.

In the preface Dr. MacAdam emphasizes that he is not a linguist and has not examined the original Greek texts. The selections have been ruthlessly pruned, he says, and all selections, whether based on published translations, literal translations especially prepared for this book, or works originally published in English, have been freely edited, by substitution of modern (1970) terminology and by elimination of circumlocutions made unnecessary by such terminology. Often the most confusing bar to comprehension of these works is uncertainty about what the author intended his words to mean. No such uncertainty handicaps these edited excerpts. They have a clarity achievable only by a master scholar of color science, such as Dr. MacAdam, and this is far beyond what any purely linguistic scholar could hope to do.

These excerpts from the foremost thinkers about color pack a punch greater than the writing of any one color scientist first because of the greater diversity of the views and concepts developed, and second because the concepts are defended, not by someone-else's rehash of the arguments, but by the most pithy statements that their originators have managed to put together. The clash of these views is most dramatic, and the reader is forced to some hard thinking to decide whether the apparent contradictions are really different ways of saying the same thing, and, if not, to decide which view is correct. This compilation is thus in a sense an intellectual mystery. By juxtaposition of apparently conflicting views the reader is almost forced to decide for himself where the complicated truth lies. Readers with no more sophisticated mathematical background than that possessed by this reviewer will find that they have to take some passages in the Schrödinger excerpts on faith. The greater the knowledge of the reader, the more valuable he is likely to find this book; but even the beginning student, by skipping some of the passages from Schrödinger and Guild, will find that this compilation provides a quick and very readable introduction to the outstanding physiological problems of color science. This compilation should be studied by anyone who has more than a passing interest in color, particularly by those who have any intention of carrying out any serious researches in color.

Deane B. Judd

Psychic Discoveries Behind the Iron Curtain, by Sheila Ostrander and Lynn Schroeder, Bantam, 1971, Paper Back, $1.25. Prentice-Hall, 1970, Hard Back, $8.95

In a lengthy report on psychic research in Russia and other iron curtain countries, exciting things are reported. Among those of interest to the ISCC is the phenomenon of eyeless sight.

Pupils trained in extra-sensory perception (some who were blind) were able to read print, discern pictures and shapes and to identify color and light by sensitive skin perception. Many were able to identify printing and colors by placing the fingers, toes, eyebrows or even the seat of their pants over the material and correctly "read" the pattern. Many could do it thru a sheet of glass or even beneath a sheet of paper.

The descriptions of the physical feelings of the colors are described by one subject when he stated "I feel a clinging, pulling, viscid sensation, that paper is red." The general effect of colorists was that colors arranged themselves into smooth, sticky and rough sensations. "Light blue is smoothest. You feel yellow as very slippery, but not quite as smooth. Red, green and dark blue are sticky. You feel green as stickier than red, but not as coarse. Navy blue comes over as the stickiest, but yet harder than red or green. Orange is hard, very rough and causes a braking feeling. Violet gives a greater braking effect that seems to slow the hand and feels even rougher." Fingers were observed to slow down as they moved over the "sticky" colors.

"Considering the color spectrum -- if you start on each side of the middle color, green, the sticky, rough feeling increases as you finger your way toward either end of the hand. Black is most sticky, viscid and braking of all. White is smooth, though, with a coarser feeling than yellow. She sensed the colors as crosses, straight lines, wavy lines, dots." Blue felt cool and pleasant, orange had warmth and a loathsome tepidity.

It is suggested that you start learning this ability for eyeless sight by training your hands to sense the difference between colors from different groups -- like sticky red versus smooth light blue. "Colors were described also as stinging, hitting, pressing, biting and pinching. Some said it blew on their hand."

This potential of eyeless sight may suggest to colorists that color usage may have new implications. No longer can color be considered as only a visual sensation; apparently there is more to color than meets the eye.

M. D. Folley

Synthetic Polymers: Building the Giant Molecule, Fred W. Billmeyer, Jr., Doubleday, 1972, Science Study Series

The Series, originated as part of the Physical Science Study Committee program for the teaching and study of physics, provides up-to-date books, prepared by prominent scientists and educators, for students or laymen.

Naturally occurring polymers play an integral part in man's life; long chain polymer molecules form the tissues of plants, animals, and the human body itself. Knowledge of the unique structure of these giant molecules began to emerge in the last century, but only in the last forty years have scientists discovered the basic nature of polymer molecules and learned to copy and improve special properties to bring us the now familiar products such as polyethylene, nylon, fiberglass, and acrylics.

In "Synthetic Polymers" Dr. Billmeyer describes the structure of the polymer molecule and the characteristics that make it the perfect building block for an infinite variety of materials such as synthetic fabrics, vinyl floor covering, water pipes that never rust, see-through packaging, artificial heart valves, and heat shields for space vehicles. The list is endless and new applications are constantly emerging as ploymer scientists continue to investigate the amazing giant molecules.

J.A.C.

TEN DEFINITIONS OF AN ARTIST

Many English words have several definitions, though often not all these definitions are in the dictionary and are therefore only evident from usage. The word "artist" is perhaps one of the most ambiguous ones in the language, particularly as it is used among critics, intellectuals, and those who profess to know most about artists, including artists themselves. We have listed below ten definitions of the word artist as it is used in normal conversation among supposedly educated people -- there could probably be more than ten. We would like to suggest that the extreme mobility of this word is closely allied to the nuclear picture most of us have of what an artist really is or should be and how he functions in society.

1. An artist is someone who makes a living from his work.

2. An artist is someone who under no circumstances should be allowed to make a living from his work.

3. An artist is someone with a lot of money and a lot of spare time.

4. An artist is someone who has no money and no time to work at his art because he has to work to pay off his debts.

5. An artist is someone who is recognized as such by American Artist.

6. An artist is someone who is recognized as such by Art News and Artforum.

7. An artist is someone who works at another job and does his art on the side.

8. An artist is someone who works mainly at his art and takes time off to earn money when necessary.

9. The only person who can be called an artist is a Superstar recognized as such in his own time.

10. The only person who can be called an artist is someone who is totally ignored in his own time.

Very often several of these definitions get combined inside people's heads, or even inside a single sentence. But the real question is this: when we talk about an artist, what are we really talking about?

From Artworkers Newsletter

STUDY-TRAVEL WORKSHOPS

Three separate study-travel workshops offering photography or painting and research in Europe with or without college credit will be offered this summer by Rochester (N.Y.) Institute of Technology's College of Continuing Education.

Information on the workshops may be obtained from Mrs. Brenda Reimherr, Extended Services Division, Rochester Institute of Technology, One Lomb Memorial Drive, Rochester, N.Y. 14623, or by calling (716) 464-2213.

GOING METRIC

Britain's changeover to the metric system of weights and measures is proceeding. A White Paper issued in February notes that British industry has already gone a long way toward adopting metric specifications for both home production and export. The changeover should be nearly complete by the end of 1975. There will, however, be no M-Day for metrication similar to D-Day for the decimalization of the currency (BR 1, Special Report, January 25, 1971). The Government expects that some sectors of the economy may wish to delay completion beyond 1975. There will be no attempt to speed the process, but the White Paper does point out that a target date of January 1, 1978 has been set by the European Communities after which only a prescribed list of metric units may be used by member states.

So far as the general public is concerned the move to metrication is becoming more and more noticeable. In a recent poll over 60 per cent of the population indicated an awareness of what was happening. Produce in supermarkets is increasingly carrying metric equivalents; pharmaceuticals and toiletries are almost all metric. The Bedding Association has decided that beds shall go metric and that the standard size shall be two meters long, about three inches longer than the standard feet-and-inches bed now in use. So sheets will have to follow on to fit the metric bed. Do-it-yourselfers were among the first to experience the change. The paint industry started to introduce metric quantities last year and popular colors are pretty well all metric although untrendy colors, it is reported, can still be found in imperial measures. Wood, glass and wire are all metric as are most other construction materials, and, increasingly, architectural drawings.

From British Record #3, March 2, 1972

From the Adirondack Echo, April 14, 1972

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.

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