Journal of the

Colour Group

Number 6 April, 1966

Reports of Meetings

by **K. H. Ruddock**

The twenty-ninth science meeting of the Group was held on the 6th October, 1965, at Imperial College. Reports were given of the C.I.E. meeting in Basle earlier in the year and of the International Colour Meeting at Luzern.

COMMITTEE E.1.3.1, COLORIMETRY

Report by R. W. G. Hunt

The main discussion concerned the standard daylight source. T here was unanimous agreement on the proposal to supplement the present standard sources with D6503 daylight. The relative energy distribution is defined, although the equivalent black distribution is normally sufficiently accurate. In general, sources A and D0533 should suffice for practical purposes, although DG533 has yet to be realised in practice.

Sources D550) and D7500 are also defined and two further distributions enable relative energy distributions to be calculated for any other correlated colour temperature in the range 4,000/ to 25,000/ K. Wherever possible, however. D6500 should be used.

A formula is given for computing the chromaticity of sources of given correlated colour temperature. Four notes were appended to the recommendation:

1 Seasonal variations occur in daylight, especially in the ultra-violet content.
2 Experimental data were available between 330 nm. and 700 nm. and were extrapolated to yield the range 300830 nm. The data in the extrapolated regions may not be suitable if high accuracy is required.
3 The relative spectral energy distributions are given at 10 nm. intervals, being averaged over ± 5 nm.
4 For samples which fluoresce under ultra-violet it is necessary to use one of the new illuminants.

Other work covered by the committee was the definition of 2/ observer at 1 nm. intervals, and some vocabulary changes and new definitions were drafted.

Discussion:

Mr. Sproson: Are the specified distributions of consistent with those calculated from the formula?

Dr. Hunt: Yes.

Mr. Tarrant:

1 The recommended illuminants have not

been realized in practice and their specification ha.; no;. involved much direct observation, whereas source C is widely used in industry.

2 Does the interpolation function give results significantly different from those obtained by straightforward interpolation?

3 Seasonal variations in daylight, which give appreciable scatter of chromaticity on either side of the Planckian locus, have been ignored.

Dr. Hunt:

1 Although X, Y and Z are obtained by observation in colorimetry, for comparison and stabilization purposes, only the energy distributions of sources are required.

2 The interpolation function is necessary to obtain smocthed data.

3 The standard, average values for correlated colour temperatures have been taken.

Mr. Perry: Existing data on daylight is not perfect and the committee have hence approximated to imperfect data in choosing and defining the sources.

Dr. Hunt: Data relevant to daylight conditions are required, and the data given are correlated with observations on daylight illumination.

Dr. Henderson: Xenon lamps used with filters and fluorescent lights can be used for colorimetry. Such sources give some flexibility of energy distribution and hence the new standard sources should soon be available.

Dr. Crawford: The present sources B and C are only realizable approximately.

COMMITTEE E.1.3.2. COLOUR RENDERING

Report by D. A. Palmer

The committee proposed no new developments and was unanimous in agreeing on the recommended method of testing and measuring colour rendering properties of light sources, namely, the test colour (or colour shift) method. Fourteen colours are recommended, of which eight are basic, the remainder providing more saturated colours. Either set of colours may be used, but the test conditions should be specified. The test colours are defined by their spectral reflectances. hence spectrophotometric data of the sources is required.

The recommended daylight scurces defined by E. 1.3.1. are used as reference sources above 4,000/K. For lower correlated temperatures, the black body series is to be used. If the sources differ from the standard radiators (e.g. fluorescent lamps), a linear shift method was proposed to adjust the chromaticities of reference and test sources in U.C.S. and then compute the colour shift. It was hoped to improve on this method at a later stage.

Other methods of assessing colour rendering could be used and would be examined by the committee in the future.

COMMITTEE E.1.3.3. SIGNAL COLOURS

Report by B. H. Crawford

For self-luminous signals, revision of the chromaticity boundaries defining such signal colours was discussed. Modifications of the green signal boundaries are likely, as at present these boundaries cover all specifications used in all countries. It was proposed to introduce restricted areas for specific purposes, and to amplify the text in exploration of their use.

A purple signal colour is not to be specified, but a note will be added on the need for care in using this colour. Other signal boundaries are to remain unchanged, at least for the present. It is likely that the u,v system will replace the R.U.C.S. in specification of signal colours.

For surface colours, a study by Jainski yielded fairly close agreement with I.S.O. and A.S.A. boundaries. These boundaries should hold for illuminant C, or if not, any combination of source and surface colour yielding a chromaticity within the boundary can be used. In retrospect, it appeared to the speaker that the committee had overlooked adaptation effects which tended to keep colour appearance constant with change of source. A Japanese proposal that less saturated surface colours would reduce the effect of ageing and dirt was deferred for further work.

Discussion:

Mr. Perry pointed out the difficulties of using purple signals.

Dr. Crawford: Purple is more effective as a surface colour, and in practice it is used as a short range signal, thus reducing chromatic aberration effects.

Mr. Perry: Would the Japanese proposal lead to brighter signals?

Dr. Crawford: Yes, but it was felt that the colour is the more important factor. In any case, more work is needed to study this proposal.

Mr. Gloag: Has the use of coloured backgrounds between signals been considered?

Dr. Crawford: The role of surround, pattern and colour contrast in the design of signals lies outside the scope of the committee. Co-operation between the committee and E. 3.3.7. will be of great value in tackling such problems.

INTERNATIONAL COLOUR MEETING, LUZERN

Report by S. T. Henderson

This conference was the biggest yet organized and devoted solely to colour. One hundred and twenty papers were given in three parallel sessions during four days. The duration of each paper was a quarter of an hour (except for general lectures which were longer), with five or ten minutes for discussion. The absence of a translation service limited the scope of the conference for non-linguists.

Special emphasis was laid on subjective aspects of colour, and papers by Togrol and Wright contributed notably to this section of the proceedings. In the field of colour measurement and colour scales Billmeyer, Friele, Graham, Judd and Tonnquist gave interesting papers, the last also being associated with the display of Swedish Colour Atlases. A number of papers were given on teaching of colour, and Balinkin gave a lecture containing a number of fascinating demonstrations.

An exhibition of colour equipment was on view, including a visual colorimeter designed by Wright and Ishak.

Finally, Wilson's lecture "Colour is where you see it" deserved special mention for the pleasure it gave.

Summing up, it seemed that no new trends in colour emerged, although the emphasis on subjective aspects proved stimulating. The chief value of the conference lay in the personal contacts between workers in the field of colour.

The November meeting of the Group, also held at Imperial College, was concerned with colours in building.

COLOUR CO-ORDINATION OF FACTORY COLOURED PRODUCTS IN RELATION TO

B.S. 2660

A. C. Hardy (University of Newcastle-on-Tyne)

The change from craft to mass production in the building industry has meant that 'on site" adjustment is no longer possible. Hence it is necessary to specify a range of colours from which an architect can make his selection. In specifying the colour range, the environmental aspects of colour were considered. One hundred and one colours are defined, together with their Munsell references, from which reflectivity values can be deduced. The range was chosen for paints, with consideration given to their internal and external uses and their durability.

For materials other than paint, existing colour ranges have been built up by manufacturers from special orders and these are reviewed annually in the light of sales orders. In building B.S. ranges, colours have been selected from manufacturers' ranges which correspond to, or are near matches to, colours in B S. 2660. The function of the particular material has to be considered, as many B.S. 2660 colours would be unsuitable for certain uses, for example, floor materials. Non-plain colours have also been studied, and it is found that a combination of a single hue and a neutral gives a good relationship with other colours in the range.

The question of tolerances has proved difficult and complaints often arise because of the particular viewing conditions prevailing. Gloss samples present the greatest difficulty due to internal reflection from one surface to another.

Summing up, the specificat. on of colour ranges has advantages for both manufacturer and customer. Precise definition of colour names is obtained and the choice of colours is restricted to those suitable for the particular application. A reduction in the range of colours to be supplied results and, as the colours are not governed by personal choice, they have longer production runs.

COLOUR TOLERANCE OF GLAZED WALL TILES

F. Malkin (British Ceramic Research Association)

An experiment was undertaken in view of the close control required in the production of coloured wall tiles. The aim of the investigation was to find the acceptable variation in a panel of wall tiles. Five panels of blue tiles and five of pink tiles were made up, with variations in the panels ranging from ± ¼ N.B.S. unit for the most tightly controlled panel, to I½ N.B.S. units.

Five hundred and ninety observers, with ages from 16 to 73 years, took part in the investigation. The observers were asked to state whether or not a given panel was acceptable. For blue, up to ± ½ N.B.S. unit of variation was accepted, but larger variation produced a rapid increase in the number of objections. The pink panels gave similar results except that some irregularity occurred in scoring larger variations. It was found, however, that one of the pink panels was not within the required tolerance. Analysis of data by groups revealed that experienced colour workers showed higher than average discrimination. A trend towards lower discrimination occurred as observer age increased. In answer to a further question, some 2-4% of the observers appeared to object to uniform panels of tiles.

A subsidiary experiment was performed using large panels containing small variations on a uniform background. It was found that lightness differences were less well detected than equal N.B.S. hue differences. Further, acceptibility was higher for a more saturated blue hue difference than for an equally desaturated difference. Again, a slight trend to poorer discrimination with increased age was detected.

A repeat experiment with a smaller observer group confirmed these data. In this case, the error in the pink panel was eliminated, and the pink and blue panels gave very similar results.

Camouflage was the theme of the 32nd meeting of the Group held in January in the Aeronautical College at Kensington.

ANIMAL CAMOUFLAGE AND MIMICRY

V. Weidmann (Birkbeck College)

Camouflage in nature is employed as a means of disguise or concealment. In animals, colour change can either be almost instantaneous, or can occur during growth. Camouflage may also be the result of evolutionary changes.

Permanent camouflage features can be of fundamental significance in the life of some animals. The snapping turtle obtains food by using its worm-like tongue as a bait for fish. Other examples occur where reproduction and feeding are dependent upon camouflage markings of the animals concerned.

Instantaneous colour change as a camouflage mechanism is demonstrated by a species of squid, which when threatened turns black and ejects a black inky cloud, equal in size to itself. The squid then moves rapidly away at the same time reverting to its original colour. Some animals obtain camouflage by utilizing objects from their habitat, for example, caddis fly larve. Other species have an appearance which is almost identical with that of part of its environment. Examples include stick insects and moths with tree bark type markings. In such cases movement of the animal is of importance in detecting its presence.

Evolution of camouflage can be observed in some moths inhabiting industrial areas. Since the industrial revolution pigmented varieties of these insects have become more common in urban areas, while un-pigmented varieties have remained commoner in country districts.

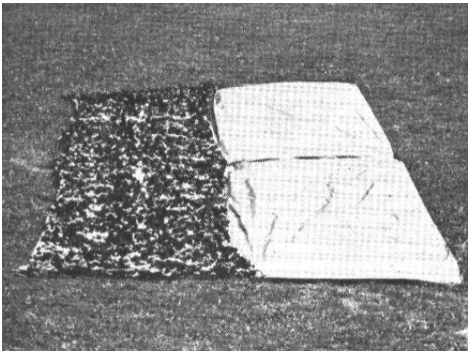
Thus, background, environment and animal behaviour are important factors in animal camouflage.

COLOUR AND CAMOUFLAGE

T. K. Overton (Ministry of Defence)

Man's first attempts to camouflage himself are very ancient, the subject usually having been considered an art, similar to, say, hunting. Very recently some efforts have been made to use the methods of experimental science to analyze the effectiveness of camouflage, and to develop ways in which camouflage of people, and objects, can be improved.

It should be noted that observation may include photography; black and white, colour, or "camouflage detection" in which the colours finally seen by the photo-interpreter may bear no resemblance to the inherent shade of the object. For example, interpretation might well include the study of prints in which natural "greens" appeared blue and ordinary camouflage greens appeared pink or vice versa.



A shiny fabric (right) contrasts sharply with the grass background. The same fabric is shown on the left after being incised, or cut into with short curved knives. (Crown copyright.)

Although on a world-wide scale land backgrounds are predominantly white (snow), green (vegetation), or tan (desert and rock), the talk was confined to green backgrounds.

"Average" backgrounds vary widely; thus if one stands on the edge of freshly cleared secondary jungle, one sees a very light green fringe where sun falls on the vegetation, a deeper green at the jungle's edge (this shade resembles the green of an English wood), while inside the jungle will be seen patches of very deep green.

Khaki, a shade in the very dull orange/ yellow region, is well suited to operations in sand, or to war in regicns devastated into dust and mud. When a war of movement is being fought, the landscape suffers far less damage, which means operating (in temperate and hum'd zones) against a background of mixed green and brown.

Since the need is to hide fairly large objects against a mixed green brown background. we chose dull yellows as our bas c colour, disrupted with brown and a little shadow black. 1 he correct texture can be achieved by incising a sheet of relatively smooth material.

The Armin J. Bruning Award

Dr. D. R. Duncan, a Principal Research Officer of the Paint Research Station, Teddington, has been presented with the 1965 Armin J. Bruning award of the U.S. Federat;on of Societies for Paint Technology. This award "for the most outstanding contribution to the science of colour in the field of coatings technology" was established in 1962 by John W. Masury and Sons, Inc., Baltimore, and commemorates the name of Armin "Joe" Bruning who headed the Colour

Control Department servicing both the Masury and H. B. Davis companies.

Dr. Duncan is best known for his extensive work on pigment mixtures, including his pioneer investigation of the problem of using numerical methods to formulate colours to match a given standard. He is also the Editor of the Review of Current Literature in the Paint and Allied Industries, pubished by the Paint Research Station.

Experiments Relating the Test Colour and Spectral Band Methods of Colour Rendering

D. A. Palmer

There are two types of system for assessing the colour rendering properties of light sources, the test colour method and the spectral band method. One example of the former is now preferred by the C.I.E. If both types of system are based on similar experiments, it would be very surprising if they gave wildly differing assessments, and in fact the correlation between them may often be fairly good, as Figure 1 illustrates. The figure shows the colour rendering assessments of a number of fluorescent lamps in the C.I.E. system (R) plotted against the assessments for the same lamps in the N.P.L. spectral band systern (FM). Unfortunately the agreement is not so perfect that the systems could be regarded as complementary, and apparently the polemics have reached a stage where one must accept either one system or the other. Some probable causes of the differences will now be reviewed with the aim of resolving them.

The proposed C.I.E. method assesses the differences in chromaticity of certain test colours as seen under the test illuminant, and under the reference illuminant. The colour space is the C.I.E. 1963 u,v uniform chromaticity diagram. This apparently implies that the tolerances for chromaticity differences in colour rendering are similar to those found in colour matching, for which the u,v system was originally devised. This is by no means self-evident, for in colour matching experiments the tolerances indicate how closely two uniform areas of colour may be made identical in appearance, whilst in colour rendering, the problem involves a complex array ofdifferent colours in all their subtle relationships. The justification for the assumption is that lamps ranked by the C.I.E. test colour method lie in more or less the same order as that found by direct visual assessment[1]. However, this could be said of several other colour rendering methods[2]. The "raw" colour shifts themselves, and the proposed tolerances have not been investigated directly. With these objections removed, the C.I.E. method would be very good indeed.

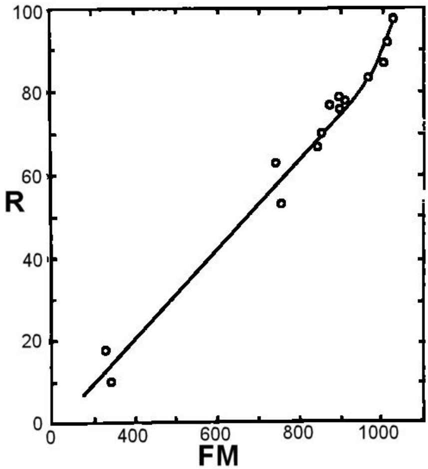


Figure 1

Now the N.P.L. spectral band method[2,3] is based on numerous experiments in which portions of the spectrum of the illuminant were added or subtracted slowly and continuously in various combinations, until the observers noticed differences in the colour appearance of various test objects. Such experiments naturally caused colour shifts in the appearance of various portions of the test objects, so that the results are applicable to a test colour system as well as to a band system. Indeed, it is difficult to devise an experiment to test colour shift tolerances directly, in which the spectral composition of the illuminant is not altered in some way.

To make use of the N.P.L. results to compute the associated colour shifts, the spectral reflectance characteristics of various parts of the test objects must be known. As a first approach, four pictures were selected which had actually been used in the experiments, and which seemed typical test objects for colour rendering. These pictures were divided into elements approximately 1 cm. x 1 cm., this being the smallest area which could conveniently be measured. The elements were allotted numbers 1, 2, 3 . . . which were then picked out at random with the aid of a table ofrandom numbers. Then the spectral reflectances of the areas so chosen were measured on a Hardy recording spectrophotometer. To obtain a homogeneous area of colour, it was sometimes necessary to move the measured path slightly, but never to an area of colour which did not overlap the chosen element. The chromaticities of the specimens, under a full-radiator source at 5,000/ K, were calculated and plotted in the u,v diagram. Figure 2 shows these points, ten from each picture, together with the fourteen proposed C.I.E. test colours, under the same source.

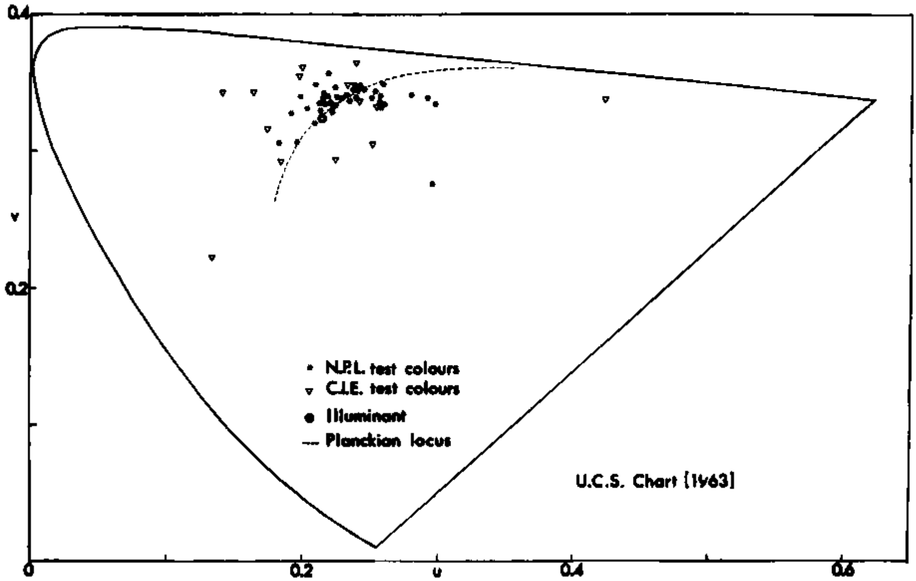


Figure 2

Evidently the colour gamuts of the two sets are different. Now the pictures so far measured are a watercolour of a quayside scene, an oil painting of a street with trees and cottages, a printed reproduction of a portrait in oil, and a printed reproduction of a colour photograph of a bowl of fruit. Even with allowance for the limited range of pigments in watercolours and printers' inks, the lack of saturated colours is remarkable. The bowl of fruit was very natural in appearance and vivid in colour (it was originally sold as a Christmas card). It is intended to include pictures of other types, together with other coloured surfaces, such as fabrics. Although the results to date are not complete, they seem pertinent to the choice of test colours in any system, and one wonders whether the C.I.E. colours were chosen as representative of the colours of common objects.

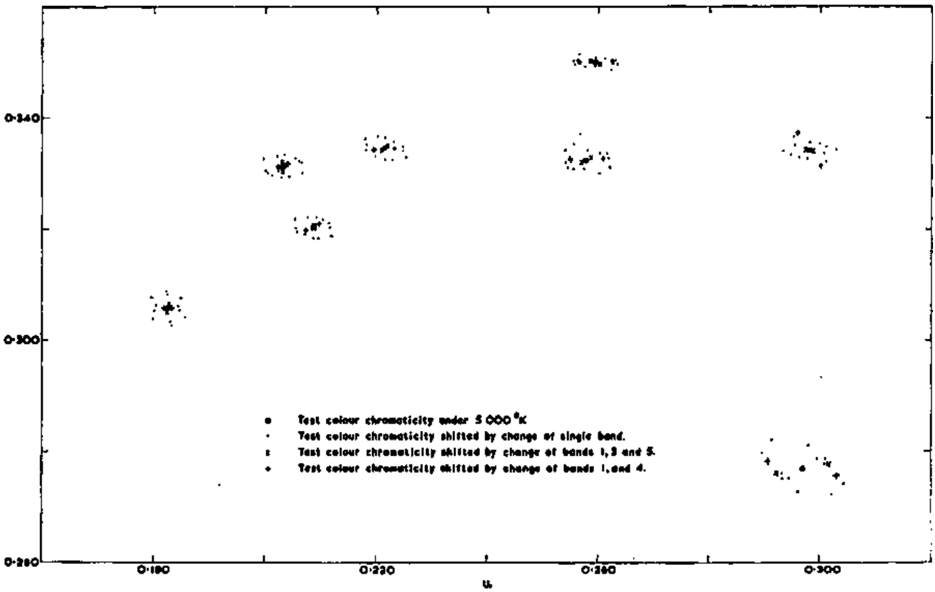


Figure 3

The N.P.L. experiments[2, 3] showed that if the spectrum were to be divided into six spectral bands of equal colour rendering importance, then their limits would have to be approximately: (i) 400-455 nm., (ii) 455-510 nm., (iii) 510-540 nm., (iv) 540-590 nm., (v) 590-620 nm., (vi) 620-760 nm. Removal of 10% of any one band causes a difference in colour rendering detectable by only 5% of a population critical in colour assessment'. If contiguous bands are changed together, their effects are additive, so that the tolerance for each is halved. Separated bands display independent effects.

These band tolerances can be used to compute the associated colour shifts in the test colours from the pictures. Theresults for a selection of test colours are shown in Figure 3. The tolerance ellipse around the parent points result from changes of 10% in the single bands. These ellipses, be it noted, are neither circular nor uniform in size in the manner implied by the use of the u.v diagram. Indeed, they more resemble uniform circles when plotted in the C.I.E. x, y diagram.

Of course, when only one spectral band is changed, the white point is shifted also, contrary to the intentions of the C.I.E. method of colour rendering. which as yet does not allow for such "chromatic adaptation", unlike the N.P.L. system. Therefore the calculations shown in Figure 3 also include shifts produced by the simultaneous removal (and addition) of 10% of complementary bands, for example, bands (i) and (iv), which were found by Crawford[2] to give the same tolerances whether removed separately or together (Crawford actually used bands 400-450 nm. and 540-600 nm.). Apparently this combination also gives tolerances lying near or on the perimeters of the ellipses, at least for the more saturated colours, although of course the effect is reduced for the near whites since the bands are complementary. On the other hand, computations of the shifts for simultaneous changes of 10% in bands (i), (ii) and (v), which together also form a white, display colour shifts much smaller than for the same bands acting singly, with the exception of the purple test colour.

This result is contrary to the general predictions of the N.P.L. system, and is given to show that that system itself may not be impeccable. However, the purpose of this report is to relate the N.P.L. experiments to a test colour method, and in fact the combination of bands (i), (iii) and (v) has not yet been tested by direct experiment, unlike the other combinations mentioned. Computations for the shifts produced by other combinations are still proceeding.

There is therefore much information from the N.P.L. experiments which is applicable to a test colour method. The present C.I.E. proposal is not in good agreement with this data. This is not surprising, as the colour shifts in that system had to be assessed with respect to the uniform chromaticity diagram for want of anything else at the time. The C.I.E. was probably right to choose a system which is fairly good at the moment and still capable of improvement, but development may not take place unless the imperfections are realised. If the C.I.E. system evolvesso that it becomes more firmly based on colour rendering assessments in practical situations, then it would probably be in very good agreement with the N.P.L. band method; or rather, the N.P.L. method would then agree with the improved C.I.E. method which would probably be decidedly superior. Eventually also, the colour rendering scale, at present purely arbitrary in the C.I.E. system, would be related to experimentally determined colour rendering tolerances, as in the N.P.L. system. There would then be a reliable test colour method, somewhat elaborate perhaps, to be used whenever precise assessments were required, and regarded as basic, and an associated spectral band system in good agreement with the basic method, more rough-and-ready, but much simpler. The intelligent interest of the users of colour rendering assessments is needed to bring about this situation, if it is considered desirable.

REFERENCES

I D. Nickerson and C. W. Jerome. *Colour*

Rendering of Light Sources. IES. Technical Conference. Reprint by U.S. Department of Agriculture, June, 1964.

2 B. H. Crawford. Measurement of Color Rendering Tolerances. *J. Opt. Soc. Amer.* **49**, 1959, 1147.

3 B. H. Crawford. The Colour Rendering Properties of Illuminants. *B.J. Appl. Phys.* **14**, 1963, 319.

Classic Books

The remaining reviews of books given at the December, 1964, meeting of the Colour Group.

"A COLOR NOTATION"

A. H. Munsell (Boston, 1905)

Reviewed by Miss NI. Morris

"Clear mental images make clear speech. Vague thoughts find vague utterances," says A. H. Munsell, and the attack on vagueness is a keynote of his book.

Born in Boston, Massachusetts, 106 years ago, Munsell was a painter of some distinction—in particular of portraits and seascapes. As a teacher of drawing and painting he urged that systematic colour training should begin with the young child. His book "A Color Notation" was first published in 1905, but it is clearly the outcome of years of experience and study, beginning at least in 1881 when he became an art school teacher. He opens with denunciations of the ambiguity of the language used to describe colours. He saw this as the first obstacle to colour education.

He deplores the use of all the colour names that refer to a coloured object—vegetable references annoy him most of all. Orange and violet he specially hates. Several times he refers wistfully to music with its comparatively rational terminology not depending, he says, on loose allusions to the sounds of nature. "Can we imagine," he asked, "musical notes called Lark, Canary, Cockatoo, Crow, Cat, Dog or Mouse because they bear some distant resemblance to the cries of those animals?" Indeed the musical analogy runs as a thread through this book. We see it in the title and in the words "harmony", "discord" and "score".

The clarity of Munsell's own mental image led him to name the three colour variables hue, value and chroma :

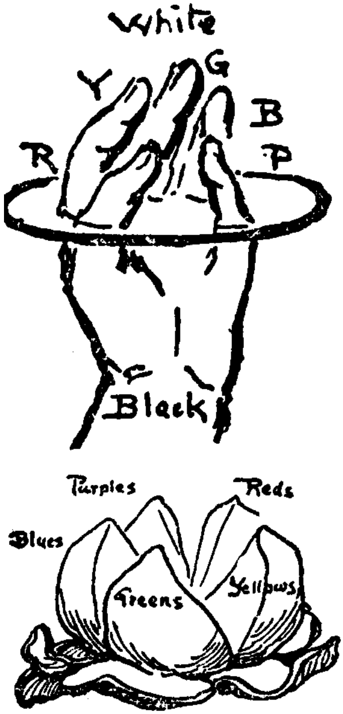
"Hue is the name of a color." "Value is the light of a color." "Chroma is the strength of a color.

Colour description should be in terms c f definite scales of these three. He would like to root out words such as tint, tone, shade and purity: these build up a mental blur.

After some dalliance with the idea of three, five principal hues were chosen, and visual judgment of their spacing was checked by the complementary hues found by the Maxwell disc. Adjustments were made until the complementaries were the intermediates of the principals so that a 10-step scale resulted. For fixing the steps of the value scale three methods are mentioned — personal decision, the rotating disc and a photometer which measured percent reflectance. From her study of Munsell's diary, Miss Nickerson tells us that he was undoubtedly familiar with the Fechner Law, but the first edition of the book reads as though this were not so. Also the first edition of the Atlas is definitely in error on this point, calling value five 50 percent reflectance, and so on, and also claiming equal visual intervals.

The chroma scale was based on the areas of complementaries in disc misture, but this was later revised to give theintervals a more regular perceptual spacing.

The next step takes us to the conception of the colour solid, or three dimensional array with a position for every surface colour and, by extension, for the spectrum colours. His main concern was with the pigments used by painters, but it is clear from the start that the array includes all colours. There is much emphasis here on visual aids to teaching.



The "hand" and the "orange" from "A Color Notation" by A. H. Mansell.

As a student, Munsell had made a double tetrahedron. From this he had progressed to a sphere before he learnt that the notion of a sphere had been common to psychologists since Runge described it in 1810.

It was clear to Munsell that the surface of his sphere was neither an absolute nor a practical limit. Of the early sphere of the psychologists he says, "It is the desire to make colors fit a contour that produces distortions like ancient maps made to satisfy a conqueror." His sphere was no mere figment of the mind but a great globe mounted for rotation about any diameter at choice. Ten meridians separate the principal and intermediate hues, ten parallels establish the value scale, and the surface elements are painted with pigment mixtures which are actually listed on the do-it-yourself principle. "Also necessary," he says, "are a clear mind, a good eye, and a fair supply of patience." The interior of the sphere is separately illustrated by radial charts at three value levels. Whether through the effects of time or the limitations of printers' inks, the charts in the book are certainly very "dull"—to use a forbidden word—but the actual sphere and all teaching materials were painted with great care and exactness by painters employed for that purpose. The colour balance of the sphere was tested by rotation about any diameter. The result was always a neutral grey.

The young painter is encouraged to trace certain lines around and into the sphere. An oblique curved path approaching the vertical, so that changes of value and chroma are more marked than changes or hue, characterises a Luminist like Rembrandt. But a Colorist such as Titian, without the violent extremes of black and white, is illustrated by a more nearly horizontal curved path with a great range of hue.

I have tried only to give the general flavour of this book, and it is no part of my purpose to claim the superiority of the Munsell system over the many others which exist. But it has stood the test of time and the wide currency of his terms hue, value and chroma are a tribute to A. H. Munsell. The mainachievements at the time of the first edition were in the tidying up of the terminology and the description of the colour solid. The bulk of the quantitative work on the scales of hue, value and chroma and the first Munsell colour atlas came later.

"AN INTROIX,CTION TO THE STUDY OF COLOUR VISION"

J. H. Parsons (Cambridge, 1915).

Reviewed by W. D. Wright.

The author, Sir John Parsons, was one of the leading ophthalmologists in Britain and through his close association with Sir William Abney, developed a very keen interest in the subject of colour vision in the early decades of the century. This report on his book is an opportunity for me to acknowledge my debt to him, as he was the Chairman of a Committee of the Medical Research Council which in 1926 gave me a research grant to do research on colour vision. My basic reading as a research student was Parsons' "Colour Vision" and Guild's massive paper on "A Survey of Modern Developments in Colorimetry" in the Proceedings of the Optical Convention, 1926.

Parsons' "Colour Vision" gives an extensive review and discussion of the experimental data, theories and literature, particularly from about 1850 to its date of publication. As much of this literature was in German, e.g., by Helmholtz, Konig, Hering, v. Kries, etc., I found his book of special value.

In the short time available, it is only possible to pick out a few points of special interest. He appears, from what he writes on p. 20 (2nd Ed., 1924), to have been the first person to introduce the terms "photopic" and "scotopic". On p. 11 he refers to the yellowing of the crystalline lens with age. Again, from his remark on p. 12, he appeared to have no doubt of the existence of the yellow spot at the macula. He also has some interesting things to say on p. 74 about the relation of peripheral ana foveal colour vision, and the extent to which colour matches hold for both regions of the retina.

He was fairly deeply involved in controversy with Edridge-Green and gave same fairly trenchant criticisms of his theory of colour vision. Rather surprisingly, however, he makes some comments on pp. 311 and 313 as to whether or not yellow is a simple sensation, and here he seems to be confused between the evidence that can be deduced from physical relations and that which more properly belongs to the psychological realm. This confusion between stimulus and sensation has been a trap for a good many people, but is not one into which we should have expected Sir John to fall.

Should we recommend the book today as basic reading for a research student who is just entering the field? I think not, partly because it is naturally out-of-date on some matters, partly because some of the arguments are no longer relevant to modern problems and partly because a beginner would not have a sufficiently critical sense to weigh up the merits of some of the arguments. But for a person with some experience of the subject, it is invaluable both as a source book and as a stimulus to new thinking cn problems that have not yet been solved.

Perhaps I might close this assessment by quoting Lord Adrian from the special number of the British Journal of Ophthalmology (Vol. 32, No. 9, September, 1948) published to mark the occasion of Sir John Parsons' 80th birthday. Lord Adrian wrote : "His book on colour vision was first published in 1915, and has remained our surest guide through the intricacies of a fascinating subject. 1 he great originator of it all, Sir Isaac Newton, did not like hypotheses and 1 homas Young's three colour theory ran very cicse to the facts which he discovered, but from the time of Goethe to the present day the subject has been beset with speculation and the proportion of new theories to new facts has been dangerously high. Sir John's book was a masterly analysis of the facts and an unbiased examination of the theories, both rare delights. Much of the material was assembled for the first time and given orderly presentation and meaning.

His book soon became the classical work of reference on colour vision and its redressing of the balance between fact and theory gave a new impetus to the subject. The impetus has remained and much of the present-day interest in colour vision can be traced to this source."

"AN INTRODUCTION TO COLOR"

R. M. Evans (New York, 1948)

Reviewed by R. W. G. Hunt

"An Introduction to Color," by Ralph M. Evans, published in 1948, is one of those books which, in spite of successive re-arrangements of my bookshelves, always ends up within easy reach. Some books achieve this status because they are mines of factual information, and this book is certainly an excellent compendium of facts, some of which are hard to find anywhere else. But for me, the outstanding feature of "An Introduction to Color" is the completeness of its treatment of the subject. It is complete in that the physical, physiological and psychological aspects of colour are all dealt with, and in each of these three parts of the subject the reader is constantly having his attention drawn to important details or effects which are often omitted elsewhere. Thus in considering the colour of a flower, the way in which the presence of an adjacent red brick wall will alter the physical composition of the light coming from it is fully considered. The spreading effect is illustrated so well in Plate XI that this important physiological phenomenon has for very many people only become known since Evans' book was published. Of the physiological effects illustrated, one of the most striking is the illustration on page 155 where, by the simple device of printing a photograph of a dented boiler upside down, its dents become bumps and its protruding rivets become dents. To Evans, colour is never fully described until its effect on the observer as a whole is considered, and the book is appropriately concluded with chapters on "Color in Art" and "Design and Abstraction".

Printed by the Seven Corners Press Ltd., Onslow Street, Guildford and published by The Colour Group (Great Britain). Institute of Ophthalmology. Judd Street. London. W.C.1.