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SETTING UP FOR COLOUR

With the beginning of colour transmissions on BBC1 and ITV, numerous organizations and their staffs must for the first time face the problems of producing high-quality colour programmes on a daily basis. This article discusses many of the difficulties to be overcome if the final goal of consistent and satisfactory colour performance is to be achieved.

HUMAN COLOUR VISION

The ultimate assessment of any colour system is made subjectively by a human being viewing the picture on a colour monitor or receiver. This is true whether the individual is a producer looking for a particular artistic shot, an advertising agent or his client assessing a commercial, a technician adjusting a camera or telecine, or the viewer at home.

Statistically a high percentage of males suffers from some form of colour blindness. It is therefore essential that all engineering personnel be checked for this characteristic and that only those who are found to have good colour vision be assigned to duties which affect colorimetry.

Unfortunately nature is no respector of status and this defect can equally apply to chief engineers or visiting VIP's, and so their comments on colorimetry cannot necessarily be regarded as authoritative.

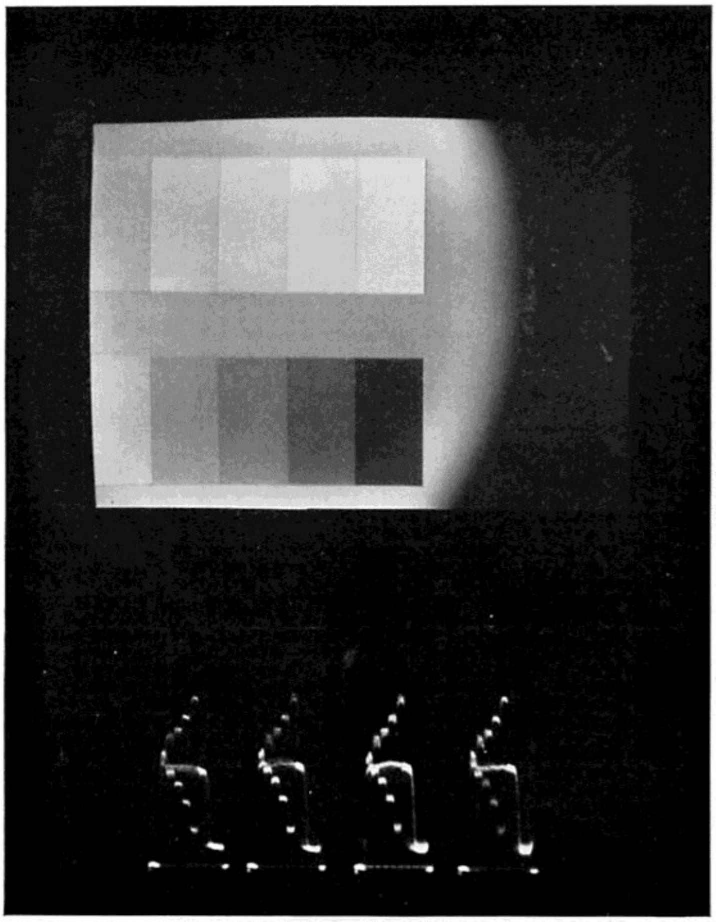

Fig. 1 Illustrating the use of the 'half-chart' method of setting up grey scale tracking and using partial capping to give a reference black (gamma correction in).

MONITORS

It is of great importance that viewing conditions for all colour monitors on a station should be similar, especially so far as the intensity and colour temperature of the ambient light are concerned. They should be frequently checked for the following parameters:

Convergence.
Colour temperature.
Purity (particularly on mobile installations).
Hue and Saturation.
Close matching.

At present many monitors are set up by purely subjective methods. Where two monitors are adjacent, it is possible, with considerable care, to obtain very close matching and some technicians are quite skilled at this operation. However, where the monitors are positioned in different rooms, it is virtually impossible for an operator to retain an exact mental picture of the display when moving from one to another, because the eye adapts so readily to changing conditions. If two or more operators individually adjust different monitors then the probability of obtaining a good match is even more remote.

A number of more scientific methods have been devised to facilitate matching the colour temperature of different monitors.

Among these are:

(i) The use of a portable slide viewer containing a plain white slide illuminated at a colour temperature of 6500°K. This is compared directly with a peak white picture fed to the monitor.

(ii) An instrument which, when placed against the monitor screen, gives a display half of which is derived from the monitor and half from an internal light source of 6500°K. The monitor colour temperature is adjusted so that the two halves match.
(iii) An instrument containing a set of red, green, and blue colour filters which can be placed in turn in front of a photocell connected to an amplifier and meter. The monitor colour temperature is adjusted to give standard meter readings for each filter.

While none of these methods is foolproof they represent an attempt to eliminate some of the variables in monitor matching, and provide a reference which can be taken from place to place.

The stability of many colour monitors leaves much to be desired, and it is a parameter which should be carefully considered when purchasing them. It is well worth paying comparatively heavily for good stability, particularly for those monitors used in critical positions, i.e those used in setting up picture originating equipment. The ultimate colour quality of every programme produced is dependent on the performance of these monitors and economy is unwise. It is worth considering locking monitor controls accessible to unskilled personnel.

THE SYSTEM

Next we must consider the effect of the equipment between the camera and the studio output. It is of the utmost importance that the amplitudes and phases of the coded signals should be matched. Comparisons should be made at the vision mixer output (by means of a vectorscope) to ensure that phase errors in the various paths to the mixer are eliminated.

Experience shows that, on the PAL system, amplitude differences of 5–10% and phase differences of 5–10° are noticeable on a colour monitor. It follows that coders must be matched well within these tolerances and must remain matched over long periods (because tolerances must be allowed for the remainder of the system). Similarly distribution amplifiers must be of the highest performance.

THE CAMERA

The majority of modern colour cameras employ Plumbicon® tubes and much has already been written concerning the setting-up of such cameras and of the operating problems likely to be encountered.[1] The advent of separate mesh tubes eases the problem of limited highlight handling ability, and the equalizing of the signal currents in the colouring tubes of a four-tube camera greatly reduces coloured lag and dynamic misregistration.

GAMMA

After a camera has been carefully registered it is necessary to set up the gamma and grey scale tracking of the luminance and colouring channels.

It is well known that the light transfer characteristic of the system, from the original scene to the eye of the viewer, must be linear i.e the gamma must be unity. Early picture tubes had a gamma of 2·2

Fig.2 Colour Balance Control Units and Operational Control Panels for Mark VII cameras.

(leading to a reciprocal value of 0·45 for the camera channel), but for modern tubes the figure is nearer to 2·6. Furthermore, the gamma of a picture tube is dependent on the amount of stray light falling on its face, and the specified figure is only obtained in a completely darkened room. These facts should be borne in mind when setting the gamma of a camera channel.

While it is possible to set the gamma controls by use of a sawtooth test signal fed through the camera video circuits, it is important to carry out a final check using a grey scale, so that any departure from linearity of the Plumbicons can be taken into account.

For this purpose and for setting the lifts and gains, a grey scale chart, such as the Marconi number 20 square law,[2] should be placed on the set under the lighting conditions intended for the scene concerned. Past practice has been to frame the chart carefully and adjust lifts, gains and gamma controls to match the channels one to another. Under these conditions the white and black chips on the chart are placed so as to be on the outside area of the picture. Since no Plumbicon or colour splitting optic is entirely without shading, a better result may be obtained by using the 'half chart' method in which the camera is panned to bring the black and white chips into the centre of the chart as shown in figure 1.

The reflectance value of the black chip on a grey scale has been the subject of much discussion. Charts are measured and calibrated when manufactured but they frequently suffer from mishandling in use and the original reflectance value no longer holds. Attempts have been made to produce less vulnerable blacks by the use of black felt or flock paper; the use of a recessed black chip on which little incident light can fall has also been tried. Even so these blacks have some reflectance value and it is difficult to know its precise amplitude when setting the lift control. The problem can be overcome by

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positioning the filter wheel to cover part of the chart, as is also shown in figure 1. All incident light is excluded from that part of the picture and the level so obtained should be set to 0·1V (with gamma in, i.e. 0V with gamma out) by means of the lift control.

Before leaving the subject of grey scales, it cannot be overstressed that they should be handled with the greatest care and be stored in some kind of protective bag or box when not in use.

FLESH TONES

Undoubtedly the most exacting test for a colour camera is the pleasing reproduction of the many variations of flesh tones. In this respect the eye is more tolerant in some directions than in others; for example, a slight tendency to red, giving a sun-tanned appearance, is more acceptable than a blue or green face.

One of the more difficult tasks of a vision operator is the matching of several cameras on the same face and it is customary to make a final check of cameras under these conditions. A 'colour girl' on the set is often used for this purpose, but better results may be obtained if a man of suitable complexion is used as a subject. The absence of make-up enables the vision operator to make a more accurate assessment of colour fidelity and also gives an indication of any difficulties which may occur if some artists are not made-up (as might be the case in guest shows or interview programmes).

MAKE-UP

The human face can exhibit many kinds of blemish – shine from bald heads, five o'clock shadow, pimples, scars and veins. These tend to be exaggerated in colour, and therefore greater care with make-up is necessary than in black-and-white operation. Experience shows that just a little of the right type of make-up is required and that small variations can give misleading results.

It is particularly important that women wearing sleeveless dresses are not over made-up, since the camera will accentuate the difference between the face and arms, giving a 'clown' effect. In some instances it may be necessary to make-up the hands and arms to prevent this from happening.

COSTUME

Because of the relatively low contrast ratio capability of the colour system, it is important that large areas of white should be avoided. This is much easier to decree than to enforce, but it should not be difficult to persuade regular staff, such as news readers, to avoid white shirts etc.

Where guest artists who choose their own wardrobe are concerned, the problem is best approached by means of guiding notes addressed to performers in general. It may well take some time to educate artists in the art of dressing and making-up for colour.

LIGHTING

The general principles of lighting for colour are the same as those for black-and-white. Normally the scene illumination is required to be rather higher, being typically 1500–2500 lux. Some organizations advocate the principle of working at a fixed iris setting and of adjusting the video level by variation of scene illumination. This presupposes a very high

Fig.3 A Mark VII camera on a typical outside broadcast.

Fig.4 The Mark VII camera used in difficult conditions in the shadow of the giant television mast in Moscow – the tallest of its kind.

degree of lighting control, which may well be beyond the capability of small organizations.

The use of coloured lights for artistic effects should be treated with the utmost care, as undesirable results may sometimes be obtained; for example, the coloured light may be reflected into an area where it is not required. Lamps should be tungsten filament and they should all be operated at the same colour temperature, within the range 3000°K–3200°K.

OUTSIDE BROADCASTS

Because of the superiority of natural colour over man-made colours, it is probable that outside broadcasts benefit more from colour than studio productions. But the production of colour pictures of consistently high quality is much more difficult on an outside broadcast than in the relatively controlled conditions of a studio.

Apart from the usual difficulties associated with black-and-white O.B's, such as rigging, long cable runs and inclement weather, there are three additional problems to be faced.

(a) Registration of cameras.
(b) Matching of grey scales.
(c) Maintenance of correct colour balance under varying lighting conditions.

In order to register a colour camera it is necessary to find a suitable position to place either a 27in×20in registration chart or a light box with a 12in×10in slide.

For many camera positions, such as towers or high platforms, it is extremely difficult, if not impossible, to find a suitable place to set up the chart at the correct distance from the camera. In such situations there is a requirement for a discscope attachment for zoom lenses and it is to be hoped that one will be produced before too long.

The second problem, that of matching grey scales, can be more difficult. Ideally, all cameras should be able to see the same grey scale, exposed to the predominant light of the scene to be televised. In some cases, such as football stadia or ice rinks, this may be possible. However, conventional grey scales are normally too small for this task and large improvised charts, about ten feet square and consisting of two steps (mid grey and white) may be more useful. Partial capping by means of the filter wheel, as previously described, can be used as a reference black.

However, in some circumstances, for example motor-race meetings, where the cameras are widely separated, it is likely that two or more grey scales will be used; here it is possible for matching errors to arise in the initial setting up of the cameras.

The third problem associated with colour O.B's is the maintenance of the correct colour balance as the lighting varies. Overcast skies produce the most stable conditions giving diffuse daylight and an acceptable contrast ratio. The sort of conditions which make a vision operator's task more difficult are:

(i) The passage of fast moving clouds across the sun causing temporary obscuration and a relative increase of blue content.

(ii) The lengthening of shadows in the late afternoon.

(iii) Twilight conditions with low light levels.

(iv) Twilight conditions mixed with artificial lighting, such as may be encountered at football stadia.

(v) Fog or mist.

(vi) Wholly artificial lighting of mixed lights,

Table 1

Front wheel			*Rear wheel*		
Position	*Neutral Density Filters*	*Transmission*	*Position*	*Colour Filters*	*Nominal Illumination Colour Temperature*
1	Clear	100%	1	Clear	3000°K
2	0·6	25%	2	Wratten No.86A+81EF	6000°K
3	1·0	10%	3	2×Wratten No.86A	9000°K
X	Cap	0	0	Clear	

leading to different colour temperatures in different areas.

The Mark VII camera is fitted with two four-position filter wheels, one for neutral density filters and one for colour correction filters. Table 1 gives the recommended complement of filters for outside broadcast use. In addition, each colouring channel has a gain range of 18dB to facilitate colour balancing.

Slow lighting changes are relatively easy to accommodate by changing a filter or by adjusting the appropriate colouring channel gain.

A rapid change caused, for example, by the passage of a cloud across the sun, and needing a temporary adjustment while the camera is 'on air' is best compensated by means of a Colour Balance Control Unit (Fig. 2). This gives a ±2dB gain range for each of the colouring channels but leaves the average level of the three colouring channels unaltered.[3] It is therefore possible to make a smooth adjustment to the colour balance during transmission and to return easily to the original setting.

Should sports authorities seek the advice of the Television Companies on the optimum lighting conditions for colour, the following suggestions should be offered:

(i) The average illumination should be 1000–1500 lux with a minimum of 500 lux in the darkest areas.

(ii) Lamps with a colour temperature of about 6000°K (e.g Xenon arc) should be used, to try to match daylight conditions as far as possible.

REFERENCES

1 N. N. Parker-Smith: Operating the Mark VII; *Sound and Vision broadcasting*, Vol.9, No.1, Spring 1968.

2 G. D. Shevel: Test Charts for Television; *Sound and Vision broadcasting*, Vol.9, No.2, Summer 1968.

3 N. N. Parker-Smith: The Mark VII Colour Camera – the Camera in Relation to the System; *Sound and Vision broadcasting*, Vol.8, No.1, Spring 1967.