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The Engineering of Colour TV

by

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Colour television is much more attractive than black-and-white television but imposes very stringent conditions on engineering. This is partly because colour television equipment is more complex than that for black-and-white but also because departures from perfection are so much more noticeable in colour than they in black-and-white. Errors or imperfections, which in black-and-white can cause the picture to look either lighter or darker than it should, are still acceptable but in colour similar errors can lead to colour changes, or no colour at all, and hence are unacceptable. Much more care is therefore required in the design, manufacture and operation of all the equipment involved. This applies right through the chain from the camera to the domestic receiver.

All colour systems are basically the same in that they send the signal which carries the picture information in two parts, one of which is identical with the signal that is used for black-and-white television, while the second carries the information required, in a coded form, to make the signal capable for reproduction as a colour picture. The difference between SECAM, PAL, and NTSC is the way in which this colour information is coded, PAL and NTSC being not so different one from the other and SECAM being appreciably different. However, the arguments that went on for so many years as to the best way of coding the colour signal have now been settled, at least as far as this and a number of other countries are concerned, in that we are going ahead with the PAL system while some other countries are using NTSC or SECAM.

Because of its attractiveness, colour television will increase the demand for international programme exchange and again presents complexities ever and above those for black-and-white programme exchange, in that

we will have to deal with conversion between the various systems. This is not too difficult, and means have been developed for breaking down the coded colour signal from the incoming system into its basic components and recoding these on the outgoing system. There is some loss of picture quality in doing this, but not to any appreciable extent between NTSC and PAL in either direction, or with PAL or NTSC into SECAM. There is, however, a rather greater loss, but not too serious, in the transcoding of SECAM into the other systems. A more serious problem is converting television signals between the 50 pictures per second areas of the world, which includes the whole of Europe, and the 60 pictures per second area, which includes the whole of North America. This has been done in the past by optical methods but with colour signals such methods are not practicable. The BBC has developed a method for doing this conversion purely electronically using a process of electrical storage in which signals are fed into the store at one rate and sampled when taken out of the store at another rate. In converting from 60 fields per second to 50, ten pictures must be lost every second, while in the other direction ten additional pictures must be derived. In both cases this must be done without in any way affecting the smoothness of the motion or the quality of the picture. The electronic equipment which has been developed by the BBC for this purpose is so far unique in the world.

International programme exchange means that international link lines and, for the longer distances, satellite relay transmitters must all be capable of handling the complex colour signals without distortion. A number of colour signals have been transmitted via Telstar and Early Bird and plans are in train to send colour signals from the Winter Olympics early in 1968 across the Atlantic, and to send them from the main Olympics at Mexico City in the summer of 1968 all over the world. This very ambitious colour programme exchange will need the highest grade of engineering at all points.

In this country colour will be put out on 625 lines, initially only on BBC-2, but as from some time towards the end of 1969 or early 1970

also on BBC-1 and ITA. For some years past, equipment design and planning for everything from the studio to the recording equipment, programme mixing facilities, programmes lines, transmitters and so on, have all been engineered to include all the eventual requirements of 625-line colour.

The channel allocation planning has all been done to meet the needs of four programmes in colour distributed on 625 lines in UHF, with the final possibility that, when complete coverage of all services has been obtained on 625 lines in UHF, 405 lines black-and-white on VHF will be closed down and the VHF bands will then be re-engineered for 625-lines colour. There will be a long period when the BBC-1 and ITA services will be transmitted on both standards to allow for the 405-line receiver to become obsolete. The complete concept, that will take more than ten and perhaps up to twenty years to complete, will eventually give this country six programmes all on 625 lines, in conformity with Europe, and all capable of taking colour. To carry out this programme means a heavy capital expenditure extending over very many years. There will be a very considerable economy on the receiver side as the single-standard receiver will cost less than the present dual-standard receiver, both for black-and-white and colour.

Of the total capital to be spent on the introduction of colour on all services, it is impossible to sort out how much expenditure is due to the introduction of colour itself and how much is due to the changeover of the line standards from 405 lines to 625 lines or the development of UHF, as each is dependent on the other. On the transmitter side for all the services eventually to be provided the total expenditure will be well over £100M, but this will be spread out over a period of more than ten years. On the studio side the total expenditure will be some tens of millions of pounds, again spread over an appreciable number of years. This part of this expenditure is unavoidable in any case in view of the rapid rather/obsolescence of studio equipment. On the other hand with a total

annual receiver production of the order of two million sets, a reduction of a few pounds on a black-and-white set and as much as £20 on a colour set will eventually result in overall economies very much greater than the expenditure on the capital equipment. Also the economies on the receiving equipment go on indefinitely whereas the capital expenditure is limited to a period of years. In addition to this there is the advantage that British manufacturers will be no longer obliged to manufacture equipment for the very limited 405-line market.

On the studio side for some time past, all new equipment installed has been made suitable for 625 lines and has been so operated, although a large part of the output has been converted by electronic means to 405 lines. New equipment now coming in will produce 625-lines-only colour. For as long as the 405-line monochrome is in use that component of the colour signal which gives the black-and-white signal will be electronically converted down to 405 lines for distribution over the existing BBC-1 networks.

The introduction of colour has required considerably better training both for the technical staff and the programme staff involved in order that colour can be produced with the same expertise as has been built up in black-and-white operations. A limited number of staff have been gaining experience with colour in the various experimental projects over the last fifteen years or so, but for the last fifteen months intensive training in both the theory and the operation of colour equipment has been in hand, and hundreds of men and women have been through this training period. This is absolutely necessary because BBC-2 will have a very high proportion of the total programme in colour, and when BBC-1 also takes in colour in some two to three years' time, a very high proportion of this programme will also be in colour.

The engineering of a good colour receiver is as important as the engineering of any other part of the whole chain, and the radio industry has given very great attention to this. The use of the PAL system gives

some easement in the manufacture and operation of the receiver but the requirement still exists that the receiver must be stable and able to operate without adjustment over very long periods. Although most colour receivers have only <sup>one</sup> knob additional to those of black-and-white receivers, and not more than two additional knobs, some care in the adjustment of these additional knobs is necessary. [ One of the most important factors in obtaining colour reception is the quality of the signal at the input of the receiver which is, of course, dependent on an adequate receiving aerial. Whereas an inadequate aerial on black-and-white can result in a poor but perhaps acceptable picture, the deterioration of a colour picture due to an inadequate aerial is much more marked. ] It will be essential that all classes of colour receiver are equipped with an aerial, which in nearly all cases must be external, and this aerial must be so adjusted to enable it to give good quality colour reception, not only of BBC-2, but, as they come into use, also of the additional programmes for BBC-1 and ITA.

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