

BBC LUNCH-TIME LECTURES FIFTH SERIES - 6

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by

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COLOUR TELEVISION

When an organisation is about to start a new service as fundamental as a colour television service, as we are to do later this year, it will have had to ask itself, as we of course have had to, why do we do it, how do we do it, what will it cost, what will it give us and how will it affect us? Will it all be gain or shall we lose anything?

Taking the first of these - why do we do it? Well, the Government has told us to do it, and of course we wanted to do it for various reasons, like keeping up with the Jones's*, helping the export trade, and so on. These are all important, but I think the real reason is that it is the natural thing to do. By a sort of curious inversion of logic, we have come to regard black-and-white television as a normal thing and colour as abnormal, whereas in life the natural thing is to see everything in colour and the abnormal to see black-and-white versions. The interpretation of black-and-white images calls for a certain amount of understanding of a convention and to remember what we have seen ^{from this} and to guess what the image is really like.

But in this respect television has only followed the normal course of all the graphic arts. The caveman drew in charcoal on the walls of his cave and later started adding pigments. Printing started in black and white; photography started in black and white; the cinema started in black and white; and so did television. In all these things, the later addition of colour made an enormous difference and, although black-and-white holds its own for many purposes, colour is dominant and, as in most graphic arts, is likely to be so in television.

When we are making our guesses in black-and-white television, we probably guess rightly that the sky is blue but, while we probably guess that a dress is blue or red or green and almost certainly not yellow, we cannot be sure. Except for very dark eyes, we are not sure what are the colour of the eyes, and we are left with an unwelcome feeling of uncertainty. But colour in television will remove all this guesswork and will give to pictures a realism and meaning that is otherwise missing. Before the next decade is out, I think there is not much doubt that ^{in most countries} colour television will be normal television, although some black-and-white will be retained for certain purposes where the need for colour is not so strong.

Well, if we are to do it, how are we to do it? We have to do it in such a way that there can be a gradual changeover in viewing habits of the public from black-and-white to colour and so that people with black-and-white-only sets - and initially this means virtually everyone - can continue to receive black-and-white pictures, although the programme may be being transmitted in colour. Also of course the colour receiver must receive black-and-white transmission, as for a long time, and perhaps always, this will be an important part of the programme. To achieve these ends, we have to add a form of electrical signal additional to the black-and-white electrical signal of existing television, and use this additional signal to carry the information about the colour content of the picture. In this respect all colour television systems are ^{basically} the same, and all of them will leave the black-and-white viewer unaffected by colour transmissions but will enable the viewer with a special receiver to obtain a colour picture - and I must emphasise that there is no possibility of modifying a black-and-white receiver to obtain colour. 95% of the equipment both in the studio and in the receiver is the same whatever the system used; and 95% of the cost and 95% of whatever difficulties there are in colour television are also about the same and are not dependent on the system. It would have been a very great advantage if,

at the international discussions which took place last year, an agreement had been reached on a world-wide basis for the other 5% of the problem and cost. Unfortunately this was not done and world-wide we have the position that North America, Japan and some parts of Central America and South America are firmly committed to the NTSC system. About half a dozen countries in Europe, including ourselves and Germany, are committed to the PAL system, and ^{about} the same number of countries in Europe, including France and the USSR, are committed to the SECAM system. The rest of Europe and that part of the world not committed to NTSC are clearly going to sit on the fence and see how the three systems turn out in practice. The USSR, France, Germany and the U.K. have all announced that they will be starting colour towards the end of this year. Other countries will gradually make up their minds, and by the end of the present decade most of the countries with well-established television services will be operating in colour.

So much for the system standards, but we have in the United Kingdom another complication, and this is the question of line standards. Of our existing three black-and-white programmes, two are on the obsolescent 405-line standard and one, BBC-2, is on the 625-line standard in uniformity with Europe. It was ⁱⁿ announced /the Government White Paper in 1962 that colour should be introduced on 625 lines only, but in the middle of last year there was considerable ^{public} /discussion as to the possibility of introducing colour also on 405 lines. It is of course possible to produce colour pictures on 405 lines, or on any line standard for that matter, but the results obtained would not have been so good as those obtained on 625 lines, particularly in areas subject to interference from continental stations, while the receiver for 405 and for 625 would have been very complex indeed and quite appreciably more expensive than the receiver for a single standard. Also it would have given a further lease of life to 405-line television and in my view this would be regrettable. The possibility of 405-line colour has now been rejected, and the decision in favour of 625 lines confirmed.

In the interests of cheapening television generally, both for the operating organisations and more particularly for the viewer, we ought to get away from the dual-standard receiver for black-and-white and colour television, and we ought to get as quickly as possible to a standard uniform with Europe, and large parts of the world, because of the ever-increasing amount of programme exchange and the ever-increasing amount of topical material which becomes available to us through programme exchange facilities, such as satellites, and so on.

As was announced by the Postmaster-General on 15th February, this question is now settled and all three programmes in the United Kingdom will eventually be radiated in colour on 625 lines. BBC-2 will be the first programme to start before the end of this year, and the other programmes will start within the next three years. The initial stations for BBC-1/BBC-2 on 625 lines will be in the London, Birmingham, Lancashire and Yorkshire areas, and after this the 625-line BBC-1 services will spread all over the country, and within a few years will catch up with BBC-2 on 625 lines and serve the same areas. 405 lines however will not be abandoned for an indefinite number of years. The operating procedure will be that all three networks' pictures will originate and be transmitted on 625 lines. For the BBC-1 and ITA programme, the 625-line signals will be converted electronically to 405-line signals and will be radiated in black-and-white only, irrespective of whether the original picture was in black-and-white or in colour. We can see therefore at some time in the future 625 lines will be universal and 405 lines will then lapse - but this will be only after many years.

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We have therefore a quite clear problem of how to introduce colour on a single standard with a high-quality system. Preparations for this introduction were made around five years ago, when the BBC planned its 625-line transmitter network, and the Post Office planned their new distribution circuits to feed BBC-2 and three other programmes then to be authorised in colour on 625-line transmissions.

Although the immediate requirements were for BBC-2, the need for BBC-1 , the ITA programme and a possible fourth programme was borne in mind, and the planning was carried out in close collaboration between the Post Office, the ITA and the BBC. For both the distribution and transmitter networks, this was done on the basis that they should be suitable to meet the most exacting requirements that could be foreseen. Therefore they should have some margin in hand for meeting the demands of the PAL system, which are somewhat less than those of NTSC system. This has caused a small amount of extra design effort and a small increase in the overall cost of these facilities, but transmitter and line costs are not appreciably increased by colour requirements.

Where the costs really start to rise is in studio/and programme operation origination. Costs of such items as cameras and picture monitors are much higher for colour. Other items such as telecine equipment and video tape recorders require only minor additions, the black-and-white performance of these equipments having been specified so that with comparatively small modifications the requirements for colour would be met. The same approach was made in the planning of large studio complexes, such as the Television Centre, where the technical area spaces were made adequate for the bigger bulk of the colour equipment, and the basic supply of electricity initially planned was made suitable for the requirements of colour, which at the present time needs more light and hence more power than does black and white. These basic facilities were provided for in the planning of the Television Centre which was carried out in the second half of the 1950s. As a result of this forward planning, the cost of equipment now to be provided, while still very appreciable, is reduced, while the time required for conversion is correspondingly reduced.

Over the last decade, and increasingly in the last few years, there has been very intensive research work into all fields of colour problems. These have ranged from measurements to test the sensitivity of the human eye to colour in order to decide exactly how much colour need be transmitted

and in what detail, to measurements of the performance of colour picture display tubes and the design and performance of colour cameras. This colour camera problem has received an enormous amount of attention, both in the BBC laboratories and in the research and development laboratories of a number of the most important firms in the business, both here and abroad, and of course ^{work} will go on for many years yet. One very important problem concerns the basic design of a colour camera. We have to take ^{separate} pictures in three colours, and ^{therefore} the light entering ^{the} camera has to be divided into three or perhaps four parts. Hence the light available for a camera tube on any one colour is only of the order of a third or less of that which is available to a normal tube in the black-and-white camera. The simple answer to this problem, and this was done for the earlier colour television cameras, was to put three times as much light on the scene. This however was not only very expensive but also very tough for the artists and the technicians, who even in black-and-white television work are in not too comfortable conditions as far as light and heat are concerned. To avoid this, the effort that has been spent of late years has therefore been towards making the cameras more sensitive so that adequate colour pictures could be obtained with the same amount of light as, or perhaps only a little more than, is used for black-and-white television. This result has been achieved, and sharp pictures with good colour fidelity are obtained from these modern types of camera. The developments in this direction are however by no means finished. In the BBC, we shall be starting the service with three different types of camera, although they will all use the same pick-up tube. One of the cameras will use three pick-up tubes and will combine the output of all three to obtain both the black-and-white and the colour signals, while the other two cameras will use a separate pick-up tube for the black-and-white signal in addition to the three tubes used for the colour signal. This situation holds all over the colour world, and these two basically different approaches are in sharp competition.

We can expect that in the future further improvements in tubes will be made, and further developments in camera design will also be made, with new approaches to the problem. We can expect to see in camera development a situation something like that which held in black-and-white television at the start, when there were many competing designs of camera which were basically different. After some years, the techniques developed in certain types of camera went entirely out of use, and practice in camera design became much more uniform. This is a very great advantage, not only to organisations such as the BBC in easing the operation and maintenance problems and reducing costs, but also to industry when production to meet considering/the needs of a world-wide market.

For the capital goods industry of the television world, this is an important matter, as within the next decade many thousands of colour cameras will be required all over the world. At the present time there are more than 5,000 black-and-white cameras in use in the world, and possibly within the next five years a very large proportion of these will have been replaced by colour cameras. The amount of money that will be involved is very large.

In all this question of camera design for colour television, we have to keep in mind that, although eventually colour television will become universal, at the start it will be very much the minority interest, and it will be many years before it approaches the majority, and we must make absolutely certain that the quality of the black-and-white picture it produces is in no way impaired, so that reception for the black-and-white-only viewer gives him the same quality of picture that he has had with black-and-white television. We cannot afford to ease the colour problem if this would be to the detriment of the black-and-white viewer.

When we talk about costs, we are of course concerned both with the programme-originating organisation and the viewer. As far as the programme-originating organisation is concerned, we can say that the cost of transmitting the signal, over lines to the transmitters and over the air,

is very little more than for black-and-white. There are however very appreciable costs on the studio side, as I have already said, from the increased cost of the camera to the additional cost of telecine, video tape recorders and equipment generally, and of course from the fact that it will take longer to stage rehearsals for a colour show than it does for a black-and-white show. Initially this increase in time taken - or reduction in studio output - could be quite appreciable, but with increasing skill in colour production this will come down, until eventually there should be no serious difference. There are also additional costs because the colour camera will have three or four pick-up tubes as compared with a single pick-up tube in the black-and-white camera, and the cost of lighting will be somewhat increased. Overall however and after the initial period, the increased ^{operating} costs for colour programme origination will not be too important when considered in relation to the programme costs, but the capital cost of the equipment will continue high for many years.

The cost however which will be felt by the public is the cost of the receiver. Some parts of the receiver, such as the loudspeaker, the tuner unit and the box, will cost no more than in a black-and-white receiver, but the tube used to display the colour pictures will for a long time cost appreciably more than a black-and-white picture tube, and there is considerably more complexity in that part of the set which converts the television signal into a picture. Within the picture tube, we have to form three separate pictures in red, green and blue so that actually we have nearly three times as many components in the picture-forming part of the receiver as in the black-and-white receiver. Moreover we have to have additional complication to ensure that the three pictures are equally focused and accurately in registration one with the other, that is, accurately superimposed. All this is additional to the part of the receiver which has to decode the coded signal from the transmitter and resolve this coded signal into its component parts. All these differences lead to receivers

which at the beginning will cost perhaps from three to four times as much as a black-and-white receiver. There are however good grounds for hoping that, as production techniques improve and production quantities improve, these costs will come down. This has been the experience of the United States but, because of the inherent complexity of the equipment, the cost of lining up the receiver both in the factory and in the home where it is installed is appreciably greater than that for a black-and-white receiver. On the other hand, if a colour receiver is to work at all, it has to be made with a greater degree of precision than a black-and-white set, and this tends to lead to a greater reliability in service. In this country the amount of experience in this matter so far is limited, but what there is confirms the very considerable information available from the United States that, inspite of the added complexity and the larger number of components in the receiver, its reliability record is as good as a black-and-white receiver, and service calls are not appreciably more frequent or costly for colour than for black and white.

Colour will add to the attractiveness of international programme exchanges. The first of these television programmes took place in 1952 and at first the number of exchanges grew slowly. But within the last decade there has been a very rapid advance in such exchange, and satellite communication in the last few years has accelerated this tendency. There is no doubt that in the future years this will go on, and will become commonplace, and indeed the public will expect to see programmes and events coming from all parts of the world. So far the bulk of these exchanges has been in black-and-white, although there has been a little exchange of colour programmes between this country and the United States. The first transmission of ^{BBC} colour pictures to the United States took place in July 1962.

That programme exchange will eventually be in colour was one of the most important arguments for reaching international agreement on colour systems, and that agreement was not reached appreciably complicates

the situation. The problem can however be solved, and means are available for changing not only between the colour systems used, but also between the various television standards which are in use. The most difficult of these problems is that involved by the difference in field frequency between Europe and North America, i.e. the number of pictures transmitted per second. In Europe, we have 50 fields/per second, and the Americans and other countries, including Japan, have 60 fields/per second. The BBC laboratories have however developed equipment, which I believe is unique in the world, for solving this problem by purely electronic means, and we shall be providing a service to Europe of colour pictures on 625-line 50-field standards from pictures taken from the Olympic Games in 1968 on 525-line 60-field standard. If possible, we shall also try to send pictures from the Winter Olympics in France in February 1968 to North America, doing the conversion the other way round. This equipment is of very great sophistication, and has been the result of both inspiration and hard work - the secret of engineering development.

It seems fairly certain that perhaps before the end of the present decade, and certainly in the next decade, as well as for programme links such as the Transatlantic relays, satellites will be also used for the distribution of television programmes over wide areas. Initially such a service would probably start with educational services in North America, either in the United States or in Canada, with a comparatively low power in the satellite to be picked up on the ground by sensitive receiving stations and relayed for reception on the ground by local stations. Eventually, the power of the satellite transmitters will be increased, and direct reception over wide areas will take place. This kind of transmission is not of the greatest interest to countries like the United Kingdom where the area is small and the land-based facilities are good. It is however of the greatest interest for large areas such as the United States and Canada, South America, Africa and Asia,

particularly where land-based communications are not so good, and the area to be covered is very large indeed, resulting in very high costs for conventional circuits. Eventually colour is likely to be used for all these services, and the problems then posed by the different standards of colour television used in various parts of the world will be very real.

In considering the growth of colour television so far, it is of interest to look at the progress achieved in the United States in the last few years. For reasons that I will give later, in the early years progress in the United States was very disappointing. Since 1963 however the progress of colour in the States has been quite extraordinary. In 1963 there were only a few hundred thousand or so receivers, and only one of the important networks was doing any appreciable amount of colour transmissions, and this for only a few hours a day. Since then however sales of colour receivers in the States have doubled every year as compared with the preceding year, and last year they sold round about five million. Overall therefore the number of colour receivers in the United States is now of the order of ten million and is advancing rapidly. It looks as though within another ten years virtually every home in the United States will have a colour receiver, although of course many of these will have black-and-white receivers as second or third set also. At the same time the cost of the cheapest receivers, which was \$500, has now fallen to less than \$400. The early receivers were also large relative to the size of the picture displayed but appreciable advances have been made in the design of the receiver with the result that overall sizes are not now much greater than those of the black-and-white receiver. On the programme origination side, the major stations are now transmitting colour virtually the whole day long.

In this country we shall start off with these economies and design improvements from the start, and receivers here will be smaller overall and give a better picture than those sold initially in the United

States. They will be in fact more attractive in this regard than a fair proportion of the current production in the United States as all sold here will have rectangular pictures, and will have design features not present in the American receivers.

There is another development taking place in receiver practice in the United States, and that is the quite decided trend towards smaller picture sizes. All sets of new design in the States will have a rectangular picture display, that is, a picture going well out into the corners of the tube, and the majority of the screen sizes will be of the 23" and 25" tube, which is the same as is to be used on the sets in this country, but there is the possibility that an appreciable proportion will use the 14" or 15" tubes. These may be used for the second set which is more common in the States than it is here. Whether such a development will also take place here remains to be seen. Whatever the size of the tube, it seems unlikely that the shadow mask tube will be displaced.

What we have got to do at all costs is to make sure that in this country we do not repeat the early experience of the United States in having a colour service in existence for a number of years without adequate public response. This lack of public support in the early years of colour was due to a number of clearly definable factors. We have to examine these and ensure that the faults and shortcomings are not repeated here.

Firstly we have to profit by the American experience in the design and manufacture of equipment, both in the studio and the receivers, and this has been done. The receiver which will go on the market in this country will be every bit as good as, and indeed better than, the set now on sale in the United States. We shall be using only the latest types of colour tube, circuitry will be very advanced, and we shall also get an improvement in receiver performance and easement in receiver design and adjustment because of the use of the PAL system, as compared with the NTSC system in the United States.

We shall keep our programme distribution lines and transmitter network fully up to scratch by repeated careful adjustment. In addition to the features required for the maintenance of the best quality in black-and-white, provisions for colour have been built into all these parts of the network. Here too we have to admit that we are very much helped by our easier geographical situation and the fact that, whereas in the United States the systems are operated by a large number of independent organisations with the networks having only indirect control over their quality of operation, here all the transmitters will be operated initially by one organisation, and eventually by two, each of which will have complete control over the standards operation in this field, and the whole of the programme distribution network will be operated by a single body, that is, the Post Office; and again the PAL system gives some easement of the problem.

In the studio the cameras we shall use will be of very advanced design, very stable in performance and capable of producing good quality pictures consistently both in studios and on outside broadcasts. The recording devices we shall use will also have been specially equipped for colour and we can expect to give good quality in reproduction.

This brings me to the area where both we on the originating side and the Industry on the receiver side are vulnerable and where the greatest care is needed. The equipment should be very good indeed, but how will it be handled? Colour operation, although in the limit involving the same basic skills and techniques as in black-and-white television, does require that the men concerned have not only become familiar with all the details of colour operation but also have sufficient expertise in its operation to recognise immediately the action required in any situation, as they now do in black-and-white. This kind of experience can only be and prolonged acquired by very careful training. I think there is no doubt that in the United States colour started before all this experience had become available in the minds and hands of the people concerned, both on the broadcasting side and on the receiving side, with consequent variable picture quality.

Here, we are determined to avoid this, and on the broadcasting side we set up last year a most intensive series of instructional courses in both the theory and practice of colour television. Some hundreds of men, spread out all over the BBC network, have already been through these courses. In addition we have had in use an experimental colour studio occupied in training programmes, for both technical and programme staff, since the latter part of last summer. On the transmitter side, we have equipped the transmitters with all the required additional test equipment and are giving training in the use of this equipment. As far as possible therefore we are doing all we can to build up the necessary basic knowledge and experience in handling colour well before the start of the service.

We have had for a long time a most extensive series of test transmissions and the programme of these is being extended. By this training and repetition in practice, we hope to maintain the highest standards of picture transmission. ~~The~~ The problem for the receiver industry is more serious and in many ways more difficult than is our problem. We have to have adequate numbers of trained men in specified places, but they have to have men with the necessary qualities available over the whole country and in very considerable numbers. They also have to get adequate test equipment into the hands of the radio serviceman. This brings in not only an economic problem but a manufacturing problem if this equipment is to be ready in time, as in one way or another it must be. But the most important, and perhaps most difficult, problem is to give training to these men, either centrally or locally. The industry has these problems well in hand. It is realised that the situation has its difficulties, but everybody concerned realises how serious it would be if adequate solutions are not found for all sides of the problem, and the arrangements now in hand will ensure that by the time the receivers are being installed in the homes of the public adequate service arrangements will be available. The BBC will help in this programme by radiating special films illustrating some of the problems of colour receiver installation and adjustment.

This problem is not eased by the fact that, whereas all other television services, both BBC and ITA, have spread over the country gradually

over a long period of years, colour television will start simultaneously in a large part of the country. All the BBC-2 transmitters are suitable for taking colour and, when colour does start, we shall have a simultaneous opening of the service in all the major areas of the population of the country from thirty transmitters, making the service available to over 36 millions of people.

As a result of all the care and thought being put into all phases of the operation, I feel confident that we shall get consistently good reception of colour from the receivers in the hands of the public and that we shall not have the reports of ^{poor} and bad reception which were very prevalent in the United States and which still occur there to some extent.

Now, what will these 36 millions have to do to get a service? Firstly, they will have to buy or rent a set at a cost appreciably greater than that of their black-and-white set. They will have to ensure, if they have not already got one, that they have an aerial adequate for the reception of UHF signals. An adequate aerial is important for all television reception, particularly UHF reception, and even more particularly for UHF colour reception. An aerial which gives indifferent reception of black-and-white UHF will simply not be good enough for colour on UHF. Some may view these aerials as a regrettable expense additional to the cost of the receiver., but it really ought to be accepted for all television reception and particularly so for colour. It is an advantage that once it is installed it will last indefinitely.

The public also have to accept a little more care in tuning the UHF receiver compared with the VHF used on 405 lines, but this is not really a thing of any great significance. As compared with an ordinary black-and-white receiver, they will have only one additional control and this will adjust the intensity of the colour. With this control the colour can be faded down to nothing, brought through the pastel shades to the natural shades and even beyond this to colours of much greater intensity. People will adjust this control to whatever degree of colour they find most pleasing.

After they do this, what will they get out of it? Well, they will get a picture which is more natural and one that I think they will find more pleasing. It will not only be easier to identify objects for obvious reasons, but things like reds, which at present get lost in a green background, will stand out very clearly indeed. Colour will give to the picture an apparent increase in detail and an apparent solidity, with objects standing out from their backgrounds much more clearly than is the case with black-and-white.

It is sometimes said that colour is an extravagance and that we could do without it. This is of course true - we can do without a great many things. We could do without television at all for that matter and rely on radio; or we could do without radio and rely on newspapers; we could do without daily newspapers and rely on weekly papers and still perhaps be as fully informed as we are now, but experience shows that human nature does not work this way. Colour is such an essential part of human living that it would be an unnatural deprivation to do without it. We have seen colour taking over the photographic fields and films, and I am sure that it will take over in television. As I have said, it is already on the way to doing so in the United States where already colour receivers are approaching 20% of the total in use, and are increasing at the rate of more than five million per year, and I am sure that it will do so at a fairly rapid pace in the rest of the world. In the world as a whole, there are already around 200 million black-and-white sets, and by the end of the next decade this number will be many hundreds of millions, and an appreciable part of this audience could be going over to colour in the next few years. For a country engaged in manufacture, this represents an enormous potential market and, although many countries will naturally seek to make their own television sets, in most countries there will be a lot of importation from abroad, at first of whole sets, and then for a long time afterwards of the most important and most difficult-to-make components in the set.

For a country such as this, it is most important to be in early at such a stage of development, and although for various reasons we are at the present time still behind America we must be sure that we do not also fall behind Europe.

In addition to the direct and obvious advantages of being in the manufacture of colour sets, experience has shown that every new advance in telecommunication techniques - and colour television is undoubtedly one of them - has brought to light other fields in which these same techniques can be applied. In the United Kingdom we have for many years been well in the forefront of all telecommunication practice, and advances in colour television must be used and exploited to ensure that we keep this position.

I think there is every reason to welcome and press forward with the start of a colour television service, and for my part I particularly look forward to it as the natural form of television.

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