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FUTURE DEVELOPMENTS IN TELEVISION

by

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The title of this talk is "Future Developments in television" but, if we are to assess future developments adequately, we must take a good look at what has happened in the past. It is nearly thirty years since public service television started in this country, but its growth and development into such an impressive influence on public opinion in this country and throughout the world did not really start until after the war.

SLIDE 1

The first slide shows the world growth of television receivers. At the start, television was regarded as a localised service and limited to services contained within the various countries but sixteen years ago, in 1950, the first international exchanges of television took place between France and Britain, and since then there has been a rapid increase in such exchanges. They now take place on a worldwide scale, and use colour as well as black and white. Receiving sets have improved enormously in quality of picture, in ease of adjustment and in value for money. In a world where prices generally have risen so much, the television set price stays more or less constant. The list price today of a 19" dual-standard multi-waveband set is about the same as the list price of a 12" single-standard single-waveband set of fifteen years ago. The real price of the present-day receiver is of course much lower - being about half that of the 1950 models - average incomes having about doubled since 1950. This has been achieved by continuing improvements in the design of the sets and the manufacturing techniques involved.

625-line pictures give improved quality as compared with 405 lines. But it is a sobering thought in all this that 405-line television, which was the first to start, still serves the biggest individual audience in Europe and the picture quality is still found by the greater number of people to be adequate. In television therefore we have the situation which happens so frequently that new developments are accepted as improvements, but people do not relinquish what they already have, and we are likely to have 405-line television with us for many years yet.

That the growth of television in the world was gradual, and there was little realisation of the possibilities of programme exchange, led to a multiplicity of standards. There are in use in Europe eight different standards of black-and-white television and a standard, again different, in use in North America.

The reasons for the differences in standard are partly historical, partly due to strongly held views that to make a certain change in parameters will give a worthwhile improvement over something which is already existing, or will give some financial or political advantage. While there is only one 60 field 525-line system (in the United States), there are no less than five 625-line 50 field systems in use in Europe. This may reflect the individuality of the European outlook but it is very regrettable when viewed from a world television standard point of view.

It was at one time thought essential that the field frequency of the television system must be the same as the frequency of the mains supplying the receiver and indeed locked to the mains frequency. With modern receivers however, this is no longer necessary, and BBC-2 runs on a stable 50-field system asynchronous from the mains. It is to be hoped that, before long, it will also be possible to unlock the 405-line service from the mains as this gives advantages in many directions. Demonstrations have been given of the problem of making receivers asynchronous from the mains to the extent of the 10 c/s difference between the 50 and 60 cycle supplies. Indeed in Japan the national

network runs on a uniform 60-field basis, although the power supply in one part of Japan is 50 cycles and in the other 60 cycles. The same situation holds in some countries in the Caribbean. It may be that eventually the whole world will be on a common standard, and if this is so it may be a 525-line 60-field system or the 625/50 system. Programmes could then be exchanged and radiated on the standard of origin and there would be no need for standard conversion. This however must clearly be well in the future. A more reasonable prospect to be hoped for in the foreseeable future is that we would have standardisation in the world on either 525/60 or 625/50 in the appropriate areas, and with the minimum number of variations in the parameters used with these standards. Receivers could then be made capable of working on either standard by simple field time-base switching. This would lead to easements in programme exchange, viewing across frontiers and the normal commerce of receivers. Anything that could be agreed to bring the colour television standards for the two basic systems as close together as possible would be advantageous in the long run. A reduction in the number of television standards is therefore very much to be hoped for in the future.

In colour, only one standard is at present in regular use. This is the NTSC standard used in North America and Japan, and discussions are going on in the rest of the world to see what standards should be used elsewhere and what degree of standardisation will be possible in the future. It is certain that, because of the 50-field and 60-field areas, there must be at least two colour standards in use in the world, at least for very many years to come. Probably there will be at least three, of which two will be special to Europe, or perhaps even four, of which three will be special to Europe, and there may be even more. All these systems will have the same basic approach to the problem but will have important differences in detail and in their parameters.

As far as the United Kingdom is concerned, the use of the UHF bands has been planned and the transmitting stations are being constructed so that eventually four programmes in black and white or colour can be radiated on 625 lines. The Government White Paper said that colour should be radiated only on the new standard and this was again recommended more recently by the Television Advisory Committee. Accordingly there are no plans for colour on 405 lines.

The T.A.C has also recommended to the Postmaster General that in the U.K. the PAL system should be used. Whether this recommendation is accepted or not, operating organisations and manufacturing organisations in the U.K. will have to take an interest in and be able to manufacture or operate in both NTSC and SECAM because of the programme exchange that will take place between the various countries and because of export of programmes and equipment to countries no matter what system they are using.

Although other types of picture display devices have been and are being studied in various laboratories in the world, it looks as though for many years to come we shall be relying upon conventional cathode-ray picture tubes for both black and white and for colour television. These are comparatively cheap and give a very acceptable picture quality. They do however fall short of the quality that we are accustomed to see in cinematography, both in definition and contrast range. The possible definition is however restricted by bandwidth considerations, particularly in the bandwidth that can be transmitted over the air, and increases in definition are therefore somewhat unlikely. The contrast range, that is, the ratio of intensity between light and dark areas, on a cathode-ray display tube as available at present is about one third of that possible on cinematograph projection. We can expect that there will be some, but not decisive, improvements in this respect. For home viewing however the greatest limitation of the cathode-ray tube at present is in highlight brightness. The picture is simply not bright enough to give satisfactory

viewing in full daylight conditions. There have been, over the last ten years, considerable improvements in the brightness of picture tubes, and no doubt there will be further improvements until we have pictures that will stand bright sunlight. There is however a limitation to the permissible brightness of a picture tube composed by the effect of flicker on the human eye. Perception of flicker varies as approximately the fourth power of the frequency. Thus the highlight brightness of a picture which is flickering at 60 fields per second can be about twice that of a picture flickering at 50 fields per second for the same apparent amount of flicker. Here is a very definite advantage of the 60 field system and one that could have a strong influence towards an eventual move from 50 to 60 field television. All viewers accustomed to 60 field pictures tend to notice immediately and to be disturbed by flicker on 50 field pictures.

All regular television transmission up to the present has used separate carriers for transmitting the sound and vision signals, but demonstrations have been given of applying the sound signal in the form of a pulse which is position modulated in the line blanking period of the vision signal, and promising results have been obtained. There are however considerable problems still to be solved, particularly in the receiver. If successful however, the method could have advantages in that it would eliminate the need for a separate sound transmitter and also avoid the complexity of the combining circuits at the transmitter. At the receiving end, it could have very great advantage, particularly for colour reception, in that the separate sound carrier would be entirely eliminated and interference to the chrominance signal from the sound carrier disappears. Its major advantage is however that it makes much more efficient use of the frequency spectrum space so that possibly, at some time in the future, channels could be moved closer together or the space allocated to the sound channel could be used for some other purpose. If found acceptable it could not be introduced for some years, as it would be dependent on the wide availability of new receivers and an assurance

that existing receivers would not be disturbed by the additional signal. It would of course be necessary to continue transmissions with separate sound carriers for some years until existing receivers had been replaced with those designed for the new system.

Regular services in colour television started in the United States in the early 1950s using a sequential system which was unsuccessful and was soon abandoned. This was because it required too much bandwidth and was not a compatible system. A colour transmission must be capable of being received as a black-and-white picture on existing monochrome receivers. Viable colour television on a simultaneous compatible system was achieved in 1954 when the NTSC system was authorised for use.

SLIDE 2 The next slide shows the growth of colour television receivers in the United States both at the present time and projected. Initially the growth of the service was very slow, but now some 10% of all receivers in the United States are colour receivers, and by 1970 it looks most likely that something over a third, and possibly approaching a half, of all receivers will be colour sets.

This major change in the situation has been accompanied by a

SLIDE 3 marked fall in the price of the receiver. The next slide shows the cost of colour receivers in the United States since 1954 and projected to 1969. It will be seen that the cost fell by 30% over the five-year period of 1960/65. At first the colour receiver cost about four times as much as a black-and-white receiver of the same size, but now the cheapest colour receiver costs only about 75% more than a black-and-white receiver of the same size picture, and small size colour receivers sell for very little more than full-size black-and-white sets. An 11" colour set sells for $250 (that is, about £87). At the same time, the picture quality and the electrical stability of the receiver have vastly improved. But the lower price and improved performance of the receiver are not the only reasons for the rapid increase in popularity of the colour service. Improved operating techniques in the studio, much improved video tape recording machines and a better understanding of how to handle the NTSC colour signal have all contributed to the situation.

The only other regular colour service in the world is in Japan, but it is expected that in a number of European countries colour will start in 1967. We can expect that in the European countries colour will have benefited from the American experience, from the improved designs of receivers, components, colour tubes and so on, which will be available and which will be reflected in the European receiver, whatever the system used. We can expect to see colour receiver sales in all European countries start off much more briskly than did sales in America, and if we are lucky we can expect to skip the doldrum years and perhaps rise from the start at a slope similar to that which has now been achieved in the United States.

In the United States colour transmissions now take upall the evening hours and many other hours besides on the major networks. When colour starts in this country, it is likely to be on a basis of perhaps ten hours per week at the start. Most of this will be in peak viewing hours but some will be of attractive outside broadcasts at other times. After the initial period it is to be expected however the developments will follow the accepted pattern, and before too long nearly all evening programmes on BBC-2 would be in colour.

It seems beyond doubt that there can be no question of a change of colour standards in the United States, Canada or in Japan, and the problem is, will Europe and the rest of the world follow these countries, or will it use another system or systems. Because of the difference in power supply frequency, and the consequent basic difference in black-and-white television standards, the system used must differ from the American system in some parameters. The question is, should it differ only in those parameters enforced by the black-and-white situation or should it also differ in other respects?

In their basic approach, all colour systems which are practicable for a public service are similar in that they all send the brightness information in the luminance signal and the colour information in the chrominance signal.

SLIDES 4 This is shown in the following five slides. The first slide shows the brightness information in the luminance signal which provides a

5 monochrome picture. The second slide shows the colour information in the chrominance signal only. The chrominance signal consists of two components known as the I and Q signals. The I-signal provides the chrominance information in the orange/cyan region and this, together with

6 the luminance signal, is shown in the next slide. The Q-signal provides the chrominance information in the green/Magenta region, and this together

7, 8 with the luminance signal is shown in the next slide. Finally, the last slide shows the complete colour signal. Whichever colour system is used, it must be compatible so that the colour pictures can be satisfactorily received as black-and-white pictures with monochrome receivers.

The differences between NTSC, PAL and SECAM reside in the different ways of transmitting the chrominance information. It would be clearly advantageous if there could be agreement to use only one of these systems as this would be so helpful in many ways, particularly in programme exchange and in viewing across frontiers. If however agreement is not possible, then programme exchange will still be possible by means of systems transcoding devices. These devices have already been developed for transcoding from one system to another when the field and line frequencies are identical with a comparatively small loss of picture quality. Improvements in these devices will no doubt be made, and this is really no serious problem. The serious problems occur when we have to change either the line frequency or the field frequency. The line frequency changing problem has been largely solved with the storage type of line frequency converter. In this process there is very little loss of quality, and the device is extremely simple to operate and it will give good quality conversion of colour signals. Up to the present time, however, the only possible way of conversion between systems having different field frequencies has been by means of a photo-electrical system in which the image on the one field frequency is displayed and viewed by a camera operating at the other field frequency.

This brings many problems; the quality obtained, although acceptable, is not good and distortions are evident. The device is difficult to operate and it has moreover so far only been possible to do the conversion on black-and-white pictures. The additional difficulties of colour have so far made this method of operation impracticable. However, work continues on the development of storage conversion systems, and there are hopes that before very long it will be possible to have field frequency conversion by a storage system that will be satisfactory both on black and white and on colour. When this happens we shall then have the means of transcoding between any of the television standards in black and white or in colour on any line standard and on any field standard. This however, while it will be a convenient means of getting over a difficulty, will not remove the basic attraction of world-wide operation on a single standard.

World-wide programme exchange has become a very real need. Although it is only sixteen years ago that we first exchanged programmes across the English Channel, by 1964 we were taking live programmes via satellite, Syncom and Telstar 2, from Tokyo and achieving remarkably good results. Since then the Telstar satellite and later the Early Bird synchronous satellite have been giving even more striking results. The next series of slides show some colour pictures received at the Post Office station at Goonhilly Down from the Telstar satellite in July and August 1962. They were all photographed from the screen of an American domestic colour receiver at Goonhilly, as the pictures were on the 525-line American standard. The first four pictures had been transmitted to Telstar from Goonhilly, and back to Goonhilly.

SLIDES 9, 10, 11, 12

The next three pictures had been transmitted to Telstar from the United States and received at Goonhilly. There is no doubt that, within the next few years, we shall be taking programme by satellite of all interesting events wherever they happen in the world.

13, 14 15

For entertainment programme exchange, the probability is that video tape and film will continue to be used, but probably not for too long and eventually live transmission will be required. Cable transmission of television pictures is likely to be in use also but probably on a very limited scale. The more the means exist for exchange of programmes over the world, the greater is the value of uniform world standards.

SLIDE 16 The next slide shows the number of programmes exchanged between Europe and America and various countries in Europe since 1950.

As far as the United Kingdom is concerned, the method of changing the existing programmes from 405 to 625 lines presents a more difficult and costly problem than does colour. On both the existing 405-line services, we have a very high coverage figure, and we must ensure that all viewers satisfactorily receiving the BBC-1 and ITA programmes on 405 lines get an equally, or preferably more, satisfactory signal for the same programmes on 625 lines.

Proposals have been made for achieving the changeover by a duplication of existing programmes on UHF. This proposal has the merit of simplicity but could be very expensive and at the present time it is not sure that the UHF service could in fact be a replica of the VHF service. Consideration is also being given to a gradual changeover from 405 to 625 lines area by area, but to do this satisfactorily some additional channels in VHF would be required in order to give room for manoeuvring. At the present time the prospect of obtaining these channels seems small. A third proposal is to set up a complete network on VHF plus UHF on 625 lines and to make a very rapid changeover from one standard to another. This however, at least for very many years, would seem to set an impossible task for the receiver industry. The whole problem is of course complicated by the fact that, whereas the VHF spectrum, when used on 405 lines, gives thirteen 8 Mc/s channels, sufficient for rather more than two nationwide programmes, on 625 lines only eight 8 Mc/s channels are available.

One of the advantages of the sound-in-sync pulse I referred to earlier was the possibility that it offers of reducing the spectrum space requirement of the 625-line channel. When a decision has been taken however, the amount of work and the expense involved are such as to require many years' work before the changeover can be completed, and it is beyond doubt that 405-line television will be with us for very many years yet.

On the programme origination side, the problem is not so difficult and it will be easy to generate all programmes on 625 lines or 405 lines, as changing the equipment from one operation on one standard to another is a simple and quick operation. Alternatively it looks most likely that all programmes will be produced on 625 lines and standard converted to 405 lines when so required with no appreciable loss of quality.

Important for long-term development is the possibility of broadcasting direct to the home from satellites. This could also affect the solution of the 405/625-line problem I have been speaking about. It has been under study in the C.C.I.R. for a number of years, and at a recent meeting figures were put forward for the powers required to give an effective service in this way. These are shown in the next slide.

SLIDE 17

You will see that the primary power required to give an effective signal on VHF is comparatively small and, although at one time it might have seemed that development of this kind of power would be difficult, the rapid growth of power of satellites in the last few years would seem to indicate that it would not be long before this kind of power can be achieved.

It has been estimated that, within a possible satellite weight of 5,000 lbs., by using nuclear reactor power, 30 kW of input power could one day be generated. This would be sufficient to transmit three separate radio and television signals directly to domestic sound receivers on the ground over an area of the order of one million square miles. To receive such transmissions the aerial in the home need only have dimensions of the order of 6 ft, elevated to about 45° to the horizontal. The cost of such a satellite system at the moment would be high and would undoubtedly

be many millions of pounds. To cover the United Kingdom with four programmes in UHF with conventional ground stations will however cost a sum of the order of £100 M, that is £25 M per programme. It could well be therefore that some time in the future the cost of serving an area such as the U.K. from a satellite could be actually much less than doing it by conventional means, and if it were desired to serve an area larger than the U.K. then the cost of satellite coverage could be very much less. Equipment to give this kind of service is of course not yet available, but there seems little doubt that eventually it will come and that the cost and difficulty aspect of the matter will not present a serious problem. What will present a problem however is finding channels on which such satellites could work. The present channels in Bands I, III, IV and V are all either fully occupied or fully allocated. Moreover, with conventional ground-based broadcasting stations in an area such as Europe, each channel is used some fifty times in various parts of Europe with adequate geographical separation between the locations to ensure satisfactory reception in each location. With satellite broadcasting however, one channel will cover a very large area, but it would probably be difficult or impossible to use any single channel more than once in an area such as Europe. We should therefore arrive at the position when additional channels would be required as there would be a net loss in the efficiency of channel usage. It takes some twelve channels on UHF to give complete coverage of one programme over an area such as the U.K. As I have said, for gound-based broadcasting, each channel can be used some fifty times in Europe. With satellite broadcasting we would gain in that for one programme only one channel would be required instead of twelve. But the channel could be used only once in Europe instead of fifty times. In individual countries therefore the channel requirement would be reduced by a factor of twelve, but over the whole of Europe the channel requirement would be increased fifty times, so that at a first approximation we could say that something like four times as many channels would be wanted to cover an area such as Europe by satellite broadcasting as would be wanted for normal broadcasting.

To meet the needs of additional programmes and regional programme fragmentation, the total European channel requirement would increase far beyond the available channels in the existing broadcasting bands. This situation could of course improve if the transmitting aerials on the satellite could be made adequately directive, but this would seem to be difficult. The probability is therefore that, to find additional channels suitable for such use, it almost certainly means we should have to go higher in the frequency spectrum than the frequencies at present in use and possibly appreciably higher. In view of the advantages in staying with the present broadcasting allocations, this problem of channel sharing between satellite and territorial stations is being further investigated.

While perhaps there could be objections to direct broadcasting from satellites on the grounds of the number of channels required and possible difficulties in domestic reception if the available channels are too high in frequency, the attractive proposal exists that programmes could be relayed for reception over a wide area by satellite and then transposed on the ground to a lower and more convenient frequency for direct reception by the public.

In television, as in all forms of communication, there is an increasing use of automation and an increasing investment in equipment in order to save manpower. Studies of switching problems and general design problems are carried out by computer and, although no on-line switching of television facilities has yet taken place in this country, it is done in the United States and there is no doubt that this will come here in the not too distant future. On the maintenance side, we are more and more providing additional switchable equipment, plug-in units, and the like, so as to relieve the necessity to carry out instant maintenance in the case of fault. This has very appreciably improved the breakdown record and has also very appreciably relieved the stress on the staff concerned.

A very revealing instance of this progress is indicated in this

SLIDE 18

slide which shows BBC transmitter operations. Because we operate sound and television transmitters from the same site the figures actually represent overall transmitter operation. You will see that in ten years the small number of supervisory staff has increased by 50%, but the number of technical staff actually concerned with the operation of the transmitters has increased by less than 5%, and this has happened while the number of sites has doubled, the number of transmitters has tripled, and the number of transmissions provided has also tripled.

The result of this improved productivity has of course been achieved by putting much more investment into equipment. Transmitters have been installed in duplicate, normally working in parallel, so that in the event of trouble one half of the installation would carry on. This procedure has been carried out as far as possible, and where possible the aerial itself is divided into two halves.

Many transmitters have been installed completely unattended and for the operation of these we have mobile maintenance teams who make periodical visits to each site for general inspection or go specifically to a site if trouble is known to exist. An example of such an unattended station is

SLIDE 19

shown on the next slide - the combined television and VHF sound relay station at Grantown-on-Spey, Moray. This radiates a peak power of about 400 watts on television and the same power on each of three channels on VHF sound. These changes have made much more interesting work to all the people concerned, and I think there is no doubt that these trends will continue. The increased investment in equipment in transmitters as in studios has increased the overall reliability.

The use of transistors has improved the reliability and the stability of performance of all equipment. Studio equipment at the present time is nearly all transistorised, and in the future will be entirely so. On the transmitter side, high-power equipment still uses valves, but the input stages of transmitters are becoming transistorised,

and in low-power equipment transistors only are used. An interesting development for the future is in the very low-power transistorised relay transmitter powered only by batteries.

In the problem of programme distribution, there are many developments which are likely to be of interest. For a long time, major programme distribution is likely to continue on the basis of cables and radio link operation by the conventional form. Developments in wave guides and surface waves, as have been carried out notably by Professor Barlow at University College, offer new possibilities, particularly for transmission over fairly short distances. These modes of transmission offer very low attenuation and a very good performance over a wide bandwidth. In conventional programme linkage, the use of 7 Gc/s is likely to continue for a long time but frequencies and equipment are now available in the 12 Gc/s region, and these frequencies are likely to be used also. This arises not only from a need to use frequencies wherever they are but also that these higher frequencies do offer advantages in the size of the aerial systems required.

The television signal has very much redundant information and considerable work is going on all over the world in methods of cutting out these redundancies with a view to a saving of spectrum space. All such proposals seem to be inherently difficult and expensive, and at the present time also give an unsatisfactory performance. That they will be brought up to a level of satisfactory performance seems undoubted but their cost and complexity is such that they would be likely to be used only on the longest links but particularly of course on the very long links encountered in satellite communications.

A further means of communication which might have future application to television is the laser which has extended the spectrum of coherent electro-magnetic wave generators by a factor of 1,000. The optical laser can produce a very sharp beam which can be modulated with signals extended over large bandwidths - up to thousands of megacycles, thus

they become attractive as possible means of point-to-point communication for a multiplicity of channels including monochrome and colour television transmissions. Potentially, the value of the laser to communications is considerable, but in practice there are still many problems to solve. Absorption and scattering by the atmosphere, especially under conditions of mist or rain, is likely to prevent reliable working over distances in excess of one or two miles. To overcome this, practical systems will presumably be based on some form of long distance microwave waveguide system as suitable waveguides can be built with losses of only 1 or 2 db per mile when filled with a controlled atmosphere. The National Aeronautics and Space Administration has tested light beam communication between the Gemini VII twin-man spacecraft and the earth using a laser device, but lasers are not likely to be suitable for television and broadcasting communications unless frequencies can be found where the absorption and scattering losses of the atmosphere are much lower than the average.

In the field of television cameras, image orthicon tubes have held an unchallenged position for more than the last decade. They are however now being challenged by new tubes of the photo-conductive type, of which the most advanced at the moment is the plumbicon tube. These tubes have high electrical stability, low noise level, high sensitivity and above all a small physical size which means not only is the camera small and convenient, but small and convenient optical systems can also be used with them. These types of tube are particularly useful for colour cameras.

The requirements of receiver performance are already being increased by the development of the UHF bands. Not only are receivers giving better general performance but the sensitivity of the receivers as expressed in terms of reduced noise factor has already made remarkable advances. This

SLIDE 20

slide shows the improvements in overall noise factor of VHF and UHF receivers in the last ten years. It is to be expected that initially the noise factor in receivers in the higher frequencies will be higher

than in the broadcasting UHF range; noise factors in both VHF and UHF are continually falling and undoubtedly developments will occur to bring the noise factor in the new higher frequencies down to those now being obtained with VHF receivers. If it becomes possible to use parametric amplifiers for domestic receivers - and this does not seem as remote at present as it did only a short time ago - the noise factor can be brought down to about $1\frac{1}{2}$ db. This will give better reception and increase the service area of the transmitters.

The improvements in performance of receivers will come from development of improved types of transistors, from further developments in special circuity, with integrated circuitry and the like. These improvements in turn will not only make the receiver suitable for the very much higher frequencies now coming into operation but will also reduce its weight and power consumption, and increase its reliability. We shall undoubtedly find that television receivers will go along the way already marked out by sound receivers in that the small lightweight portable will become more and more popular. On the one hand we shall probably see lightweight portables providing small black-and-white and colour pictures, and on the other hand we shall see the development of very large-screen picture tubes for wall mounting. Up to the present time only the shadow mask three-gun colour tube has been available for use in colour television receivers. A great deal of work is going on to develop a single-gun television tube which would be cheaper. Several versions have been produced in the laboratory, but not one has so far proved satisfactory and at the same time capable of mass production at an economic price. It seems probable however that a single-gun tube will eventually replace the three-gun tube in colour television receivers with an appreciable reduction in the circuitry and overall cost of the receiver. The tube used in the American $250 11" receiver has three parallel not conical guns.

Stereoscopic television has been demonstrated many times over the last few decades, but it is expensive both in equipment and in channel usage, and probably offers insufficient overall attraction to justify its use. It is not to be expected that stereoscopic television is a likely development in the near future. Experience in the cinema has shown that stereoscopic pictures have a relatively small appeal, and stereoscopic effects in the cinema are probably easier to achieve than stereoscopic effects in television.

Stereophony is however another matter. Demonstrations have shown that, for some types of programme, stereophony applied to television can be attractive and the problem of putting stereophonic sound on to a television channel does not seem to be insoluble, and it is quite possible that systems will be developed which will enable stereophonic sound to be used. In some areas having two languages the two channels of a stereophonic system would be used for the two separate languages when necessary. This question is under study at the C.C.I.R. and, although it is not clear whether there are such services anywhere in the world, it is likely that they may start in the not too distance future in some multi-language countries. One report states that such a service exists in Russia.

Improvements in television transmitters will result from the development of transistors capable of handling higher powers on UHF. UHF television relay stations in this country are already using solid-state circuitry up to the output stages of the transmitters, providing greater overall efficiency and improved reliability such that the stations can be designed for unstaffed operation. It can be expected that it will be possible to use these techniques in the future for installations of higher power.

Home recording on tape for sound is now in general use. Recording of television signals is much more difficult, but the advances made in video recording in recent years have already produced machines

which give a very satisfactory picture at a reasonable price, and there can be no doubt that further improvements in picture quality and reductions in cost will be made.

It seems unlikely that the four-head type of recorder used in studios will ever become an article of domestic equipment. Claims have been made that a domestic machine can be made using a single head and fast running tape, but a more attractive and promising proposal at the moment seems to be the helical scan machine with either one head or two heads.

The title of this talk has been "Future Developments in Television" and as prediction must always be largely based on exterpolation of the past, it has necessarily dealt very much with what has happened and been somewhat tentative about what may happen. There is however no sign at all of any slowing up of television development in any part of the world but rather an ever-increasing rate of development, and perhaps we shall not have to wait too long for some of the developments suggested. There seems little doubt however that there will be plenty of interesting work for the television engineer, always provided of course that the public finds the programmes of sufficient interest that they will continue to pay for it all.

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