BBC/Sussex Working Conference 1966

Saturday, 14th May, 1966

Session No. 3 — 11.15 a.m. - 12.45 p.m.

Technical Possibilities in Television and Radio

Chairman: Sir Peter Venables,
Vice-Chancellor,
University of Aston (designate).
Chairman,
Further Education Advisory Council, BBC, and
Adult Education Advisory Committee, ITA.

The papers will deal with the existing distribution systems for radio and television in the United Kingdom at the present time, for BBC, ITA and CCTV; and will also cover reception systems and methods of recording, storing and reproducing programme material. Programme production and developments abroad will not be covered. The papers will discuss developments already planned, such as the extension of BBC-2 and developing CCTV systems, and others which are technically foreseeable, including local radio systems, with a radius of up to 10 miles, larger radio systems, covering, for example, the extra-mural catchment area of university centres, and local authority and inter-university link-ups.

Other subjects to be discussed will include the technical aspects of an additional national educational radio programme, the allocation of a fourth television channel and/or educational network, and, looking further ahead, the extent to which the use of satellites might transform the broadcasting scene by making it possible to dispense with costly transmitters and land-lines. The use of relay systems will also be examined and the extent to which they are particularly suited to educational purposes.

Papers attached by: Mr. F.C. McLean, (Paper 3/A)
Director of Engineering, BBC.

Mr. D. Street, (Paper 3/B)
Head of Operational Services,
Rediffusion Limited.

Ten minutes will be allowed for the presentation of each paper.

First respondents: Mr. William Beaton,
Director,
Educational Television Service,
City of Glasgow.

Mr. Norman MacKenzie,
Director,
Centre for Academic Services,
University of Sussex.

Five minutes will be allowed to each respondent.

Paper 3/A

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Session No. 3 — Technical Possibilities in Television and Radio

Paper by Mr. F.C. McLean, Director of Engineering, BBC.

I Introductory

1. Radio reception is subject to physical laws which determine and limit the range over which satisfactory results can be obtained. From their nature there is nothing that can be done about these. The range is also limited by the number of stations using any given channel or wavelength or operating near to any given channel or wavelength, but, by control of the operating power, transmitting aerial height and above all transmitter spacing, something can be done about this.

2. Most of the physical laws are dependent upon the frequency used. The lower frequencies, as used for medium and longwave sound broadcasting, penetrate obstacles and bend round the curvature of the earth. The higher the frequencies the less the waves penetrate obstacles and the less they bend round the curvature of the earth under normal propagational conditions until at VHF and UHF, that is at frequencies above 200 Mc/s, there is virtually no bending but only line-of-sight transmission. We find therefore that the lower frequencies give the greatest range of usable signal over the ground and the higher frequencies less. Frequencies in the HF band from 3Mc/s to 30Mc/s are, however, used for long-distance sound broadcast transmission by making use of the reflected properties of the ionosphere. In this way signals are bounced between the earth and the ionosphere either as a single or series of hops and provide sound broadcast reception over very great distances extending to several thousands of miles. Long-distance television reception cannot, however, be provided in this way. All radio reception is troubled by man-made electrical noise arising from motor cars, vacuum cleaners, electric blankets and the like, and is subject to natural atmospherics or static. Here the balance is reversed and the lower frequencies are the most subject to these factors, and the higher frequencies less so.

3. The long-distance propagation of waves affecting co-channel stations is in general most marked at the lower frequencies but, under particular atmospheric conditions, transmissions in the VHF and UHF bands can be ducted in the atmosphere and long distance reception becomes possible also at higher frequencies.

4. The net effect of all these factors differs somewhat depending on whether reception is to be in town or country and the extent to which directive aerials can be used. As far as sound radio is concerned, the best wavelengths or frequencies are undoubtedly those around 100Mc/s such as are used for VHF reception. These can give interference-free reception over a quite adequate distance. Reception within a range of 50 miles or so is reliable, free from fading, substantially free from interference from distant stations and almost immune to man-made interference. In the case of VHF sound service, there is, in addition to the advantages resulting from the use of these higher frequencies, the fact that for this service frequency modulation is used instead of amplitude modulation and this provides additional advantages.

5. As far as television is concerned, the probable optimum wavelengths for satisfactory reception over a large area are those frequencies in the neighbourhood of 200Mc/s, that is Band III. Band I transmissions on frequencies from 41 to 68Mc/s give good reception over large areas but at times reception is subject to considerable interference from continental stations. The UHF frequencies, that is from 470 - 850Mc/s, give good interference-free line-of-sight reception but they are much more affected by obstacles such as buildings and hills, and for some years, until a wide network of relay stations has been built, there will be an appreciable number of blind patches within the service area.

II Coverage in the Bands Available

6. To illustrate the differences in coverage, Figure 1 shows the coverage of the Home Sound Service on mediumwaves which in the daytime has a population coverage of 97% but which becomes much less at night because of interference from continental stations. Figure 2 shows the coverage of the same service on VHF. This is 99% and

is the same at night-time as it is in the daytime. Figure 3 shows the BBC-1 television coverage in Band I provided by a total of 66 transmitting stations. This is generally about 99.4% of the population but during the summer there is at times appreciable interference to a fairly high proportion of the total population due to long-distance propagation effects. When all the relay stations now being built or planned are in service, bringing the total number of stations up to 108, the BBC-1 population coverage will increase only to 99.5%. This brings out the problem of serving the many small and scattered communities in the remote parts of the country, such as the Scottish Highlands. It is of interest to note that the approximate capital cost per head of the population served by the first five main high-power stations built for BBC-1 was £.046, whereas the approximate capital cost per head for the later relay stations can be as high as £20. Figure 4 shows the ITA coverage figures for their service. Figure 5 shows the coverage for the first 28 stations so far approved for UHF (BBC-2). The double-cross hatching shows the service areas of stations which are already in service. The single hatching shows the service areas of stations which have been approved by the PMG and are under construction, while the blank areas show the service areas of stations on which construction has not yet started. Figure 6 shows the population coverage against time for the BBC-2 programme.

7. From these figures it will be seen that BBC-2 and any other service carried on UHF will fairly quickly reach about 70% of the population but after that the rise in coverage is fairly slow. The basic reason for this is that it requires very many more transmitters on UHF than on VHF; perhaps finally ten times as many.

III Colour Television

8. The whole of the planning, both in the studios, the programme distribution chain and the transmitter chain, for BBC-2 has been on the basis that colour can be added with the minimum difficulty. To this end, the programme distribution chain and the transmitters are designed to handle colour without further modification while the necessary equipment can be added to the studios at minimum cost.

IV Broadcasting by Conventional Means

9. All the frequencies available in Bands I and III are virtually already completely used. It is possible to insert a few more very low-power stations into the pattern that we saw in Figure 3 but these can make only very slight differences to the completeness of the coverage and it is out of the question for many years to envisage any new services in these Bands. However, when it has been possible to find a means of changing over the existing services from 405 to 625 lines and possibly accommodating all the present services in UHF then the VHF Bands may become available for new services. It seems impossible to visualise that this could be within a period of ten years and could be much longer.

10. The situation on UHF is however completely different. So far only one service has been authorised and the rate of development is as shown in Figure 6. The design of the stations is, however, that the sites, buildings and transmitting masts and aerial are such that up to three additional transmitters can be added at each site. Moreover, because the basic work for the transmitter has been done, such additional facilities can be added at a cost appreciably lower than the cost of building the initial stations for the BBC-2 network and the time involved will also be very much less. Dependent upon conditions at the time a decision is taken, it will probably mean that a second network would follow at something like 2 - $2\frac{1}{2}$ years after the BBC-2 network for the initial stations and at later stages the construction programmes of the two transmitters could be simultaneous. The provision of studio facilities for an additional network could in all probability be adequately accomplished within the time required for the transmitter construction and the transmitter construction would therefore remain the decisive factor. The cost of building the new UHF stations is being shared roughly 50:50 with the ITA.

V Broadcasting by Satellites

11. Television and sound Broadcasting from satellites is an improving prospect for future development. It might take the form of transmission from satellite for re-transmission over a large number of

local stations, or it might take the form of broadcasting from a satellite for direct reception in the home. The power requirement and difficulty of the first is less than that of the second but, of course, it is somewhat less attractive. In either case there is a problem of finding sufficient channels to enable such a service to be given but this problem does not appear to be insuperable and is under international study at the CCIR. If the satellite stations were to be used for re-broadcasting from a large number of local ground stations then the receiving aerials could be large and sensitive. For direct reception in the home, however, large receiving aerials are clearly impossible and hence the power in the satellite transmitter would have to be much higher. The powers required, extending into some 10's of kilowatts, do not seem to be insuperable with the developments at present envisaged in satellite design. There is talk of providing such power from large solar batteries or even from nuclear power cells. The cost is, however, very high and while the total cost of a satellite station could be less than that of a conventional ground-based station network there is an enormous risk of failure to operate which does not exist with the ground-based stations. It looks unlikely that satellite broadcasting could start within this decade but it may well start in the next decade. This form of broadcasting is of course of the greatest interest for large areas for covering the whole of Europe, the whole of Africa, Canada and such like areas, but appears less atrractive as a means of covering a small area such as the United Kingdom. It could of course be a useful means of distributing programmes as an alternative method to distribution over land line, as at present.

VI Local Broadcasting

12. This has been very much to the fore in all BBC thinking for a number of years past. It can be done at a relatively low cost and with low-power transmitters. Adequate channels for local sound services exist in the VHF 88 - 100Mc/s band and a satisfactory service could be given in areas of high population density. This would cover areas of up to, say, 10 miles. Larger service areas such as might be required for the extra-mural catchment area of a university could present some difficulty in finding channels because of the higher powers which would be required and the reduced channel sharing that

this would permit. Such stations could be linked for programmes of educational value or indeed for other programmes. Local television, however, seems to be out because of the shortage of channels.

VII Television Recording

13. Recording of television can be done either photographically or on video tape. If a large number of copies are made or if very widespread distribution of the programme is required then photographic recording has advantages in that it is the cheapest and the playback facilities required are the simplest. The approximate cost of photographic recording is given in the following table:

	Cost per hour for negative + 1 positive	Cost per hour per print for a large number of prints
35mm.	Approx. £200 + £35 for sepmag.	£60 per print approx.
16mm.	Aprrox. £60 + £8 for sepmag.	£20 per print approx.

Film recordings can be played back 100 times with no significant loss of picture quality and many hundreds of times if some loss of picture quality is accepted.

14. Magnetic tape recording allows for an appreciable improvement in the quality of the recording. It is an instantaneous process that enables the product of the recording to be seen immediately and to be amended if required but it is a process in which it is expensive to make a large number of copies and the playback device can also be expensive. There are at the present time three grades of machines available:

(a) The top quality broadcasting machine (Ampex VR2000) using four heads and costing about £45,000 installed (including full editing and broadcasting ancillaries), or the Ampex VR12000 costing £30,000 for a basic machine with minimal facilities.

(b) The second quality machine also used for broadcasting purposes (in this category I mean machines like the Machtronic MVR65) for which there is a helical scan. Such a machine would be suitable

for short items such as news or sports highlights. This would cost about £5,000 - £6,000.

(c) The third quality machine doubtfully good enough for professional broadcasting and costing about £1,000 - £1,500. In this I have in mind machines like the Philips and Ampex VR7000.

15. Magnetic tape has only a limited life and can be used for only about 100 or so playbacks before the quality of reproduction begins to suffer appreciably.

16. The cost of video tape recording in the three grades is as follows:

	A[1]	B[1] and C[1]	
		1" tape	2" tape
Cost of making recording including tape cost and head cost	£100	£24.10.0.	£28. 0. 0.
Extra cost per hour for playback 100 times	£2.	nominally 10s.[2]	nominally 10s.[2]
Cost per hour if played back only once and then erase tape	£3 4.	nominally 10s.[3]	nominally 10s.[3]

(1) Four-head machines have reworkable heads - the others have not.

(2) Costs on this form of machine are very indefinite.

(3) The tape then becomes available for recording further material.

17. In addition to the high cost involved the magnetic recording equipment is much more complex than the photographic recording and should only be used if fully competent technical assistance is available.