Source: Communication & Broadcasting - Autumn 1976

D. H. Mills, Pr.Eng., B.Sc.(Eng.), F.S.A.I.E.E., C.Eng., M.I.E.E.
Director: Technical Services, South African Broadcasting Corporation

The introduction of television to South Africa

Summary

This article outlines some of the problems associated with the provision of a television service in South Africa and proceeds to indicate the solution adopted for some of these problems. The extent of the project is discussed in some detail and in conclusion some indication is given for the plans for expansion in the future.

Introduction

In order to understand the problem facing a broadcaster in providing a service for the people of South Africa, it is necessary to go into some detail as to the nature of the country and the people occupying the country.

The area of the country is of the order of 1¼ million square kilometers and the average population density is 19 people per square kilometer. Distances are considerable and the terrain varies from very flat almost featureless desert-like country, some of which is very sparsely populated, through undulating rolling hills to very mountainous country. The total population of South Africa is 22.6 million.

Traditionally, people speaking the indigenous languages have tended to group themselves into fairly well-defined areas, whereas the English- and Afrikaans-speaking sections of the population are fairly evenly distributed over the country although primarily in the urban areas (figure 1).

If one considers that the duty of the broadcaster is to produce aural and visual programmes for the general population, the first and most important problem facing a broadcaster in South Africa is that there are a considerable number of different languages spoken and the people speaking these languages have completely

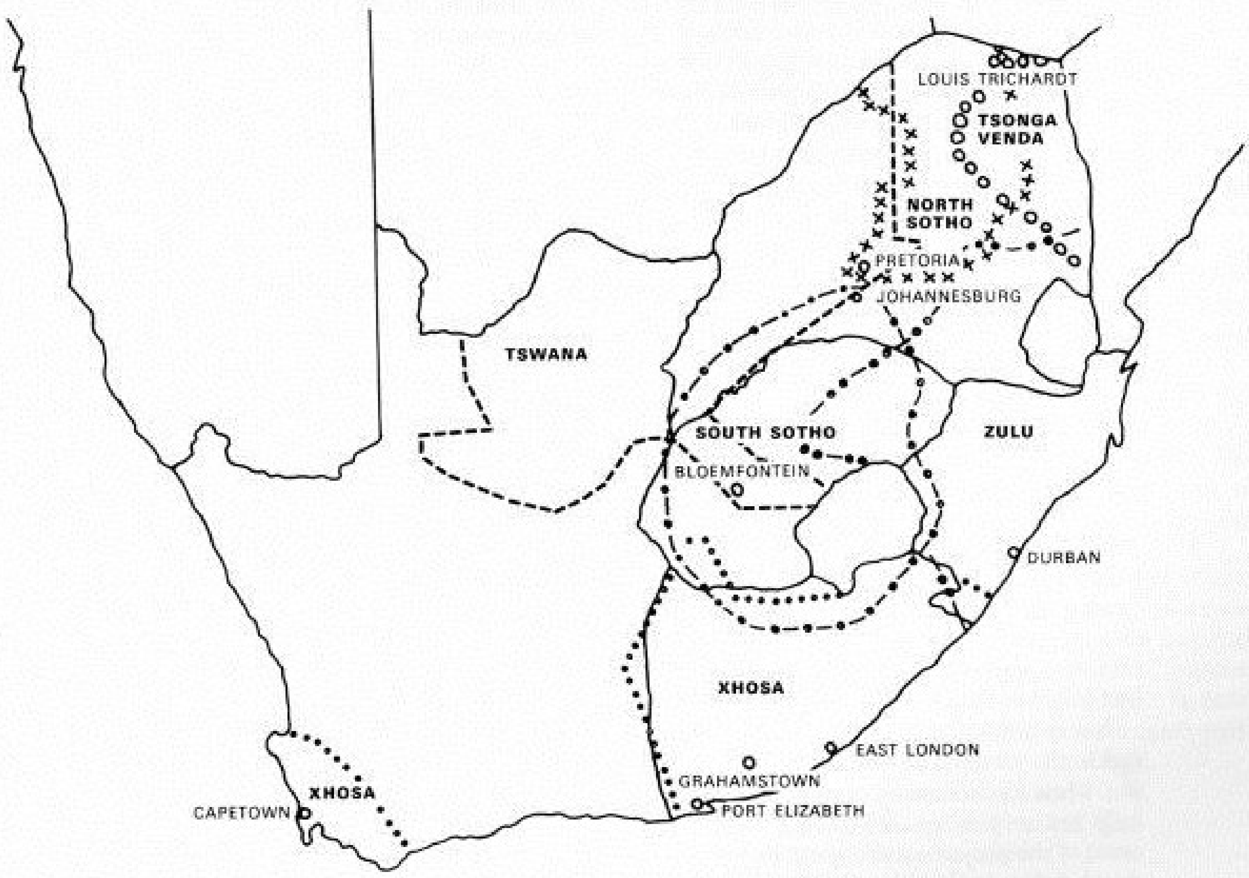

Figure 1. Map of South Africa showing main language-areas

different cultures, backgrounds and to some extent interests. The tendency for different language groups to occupy different areas of the country is fortunate, since, had it been otherwise it would have been necessary to produce a great multitude of programmes from any one transmitter station. In any case several channels need to be planned for radiation from each station to cater for language groups in any particular service area.

Perhaps some idea of the complexity of the broadcasting problem can be gained from the sound services. There are 14 different programmes in nine different languages, providing services for about 98% to 99% of the total population of South Africa. Some 200 hours of sound programme material is created every day. To achieve this, eight studio centres have been established and just over 400 transmitters are operating in the v.h.f and m.f bands from 92 transmitter stations.

Quite clearly the television equivalent of this sort of service could not be an economic proposition. None-the-less in the long term planning, provision must be made for television for all sections of the population. The time scale for the achievement of this sort of radio service has been quite considerable taking something of the order of 15 or 16 years. Television being a more expensive medium means introduction as quickly as possible to avoid inflation problems, but the break-even point from a financial point of view arrives at a very much lower population coverage than is the case for radio.

It was considered, therefore, that the maximum number of people should be covered in the shortest possible time and that studio facilities would be constructed to produce one programme initially which would be shared by the English and Afrikaans section of the population. Planning would make provision for studio facilities to produce programmes for the other sections of the population and eventually to consider a second channel to separate the English and Afrikaans language groups. The initial coverage would bring in sufficient revenue to cover approximately 80% of the population with the inauguration of the service.

Another aspect that had to be considered was the manner in which this target for phase 1 of television in South Africa was achieved. The SABC at that stage was (and for that matter still is) involved in major sound service development both from the point of view of production facilities in studios as well as transmitter stations for additional coverage. Because of the shortage of skilled technical labour in the country and with the technical labour available to the SABC being fully extended with existing projects, it became obvious that help for the TV project would be necessary.

It was decided that it would not be unreasonable to tackle the transmitter section of the project ourselves but when it came to achieving the target for studios, help not only in the design but also in the management of the project would be needed. It was, therefore, decided that we should seek design and project management help by going to international enquiry. Subsequently a company was formed to provide this service and the constituents of this company were American, British and South African.

Frequency planning

The first point at which the problem was attacked was the matter of frequency assignments.

The use of frequencies for broadcasters in the v.h.f and u.h.f bands was planned in 1963 at the Africa V.H.F/U.H.F Conference.[1] For South Africa the Frequency Assignment Plan for Band III and Bands IV/V was based on two u.h.f assignments and one v.h.f assignment per station. At that stage we were under considerable pressure to give up the v.h.f bands altogether and concentrate all requirements in the u.h.f Bands IV and V. We felt, however, that the propagation characteristics in Band III were so advantageous that we should try to accommodate as much of our requirements as possible in Band III, and this appeared to be possible as we had an extended band. We had sacrificed Band I some considerable time ago at the Administrative Radio Conference in 1959 in order to obtain the expanded Band III.

The problem with the scheme that was drawn up in 1963 was that there were no detailed plans at that stage for television and the anticipation of the requirements was based on a very cursory examination of the problem. Subsequent investigation indicated that three channels per transmitter station giving near equivalence of service would be required, and that was patently impossible with a plan that gave one v.h.f and two u.h.f assignments per station. The reason for three channels being required is that two are needed for English and Afrikaans and one for a black language group where there was no overlap between black language areas. In areas where there was such an overlap four channels would then be required.

In order to satisfy these requirements it was decided that it would be necessary to depart from the formal planning associated with uniform coverage of an extended area and rather concentrate on the use of v.h.f channels in the densely-populated areas and produce a second plan in the u.h.f bands to cover the country in general. The consideration of the frequency assignments in these bands was carried out with the help of the Institute für Rundfunktechnik in Hamburg. The success of replanning can be appreciated by

Table 1(a)
Band III – Comparison of old and new plans

Plan	Number of channels assigned	Average interference level (dB)	Standard deviation (dB)
Africa	77	73.12	6.97
New	113	76.35 (69.23)	7.25
Change	+36	+3.23 (−3.89)	+0.28

Note: The interference level figures given in brackets refer to precision off-set being used between a few stations where critical conditions exist.

Table 1(b)
Bands IV and V – Comparison of old and new plans

Plan	Number of channels assigned	Average interference level (dB)	Standard deviation (dB)
Africa	330	71.17	12.49
New	459	68.41	4.90
Change	+129	−2.73	−7.59

referring to Table 1, indicating the difference between the Africa plan assignments and the new plan assignments.[2] The use of v.h.f as far as possible rather than a complete move to u.h.f has meant a very considerable saving not only in capital cost but also in running costs and the new plan has proved to be a great advantage to the SABC. This departure from the formal planning methods can really only be applied in countries where the population is comparatively sparse and the densely-populated areas are concentrated in a manner which allows the consideration of moving v.h.f assignments from the rural areas to the densely-populated areas. This may be considered to be an unfair approach since some time in the future the sparsely-populated areas may warrant the use of v.h.f rather than u.h.f. It was considered, however, that by the time this took place, satellite transmissions for direct reception by the public will have come into their own and this would be the third means of covering the country rather than a terrestrial system.

Perhaps it should be mentioned before going into the frequency assignment plan that due consideration was given to the use of cable and satellites for nationwide coverage but these systems do not compare favourably with the conventional terrestrial means yet. In this particular case, comparison was most unfavourable because there is an already established v.h.f transmitter station network for the f.m service and this meant that access roads, sites, masts and power as well as maintenance crews had already been established.

The next step was to predict the coverage from the various transmitters and establish the need for gap-filling stations and the position of the gap-filling stations. To this end Marconi Communication Systems was employed to carry out the service area predictions, and this work was completed some considerable time before the transmitters came on the air. The result of these predictions allowed us to tailor the transmitters' power and the antenna gain to suit the particular environment. The saving that was achieved can be judged from the fact that the transmitter powers were very much lower than was required in the purely theoretical planning.

The CCIR System I using PAL encoding was chosen as the colour television standard for South Africa and this choice was made sufficiently far in advance to allow of the publication of transmission characteristics long before the first transmitters came on the air.[3]

Transmitters

Some general characteristics of the transmitters may be of interest.

(a) The vision to sound ratio is 10 to 1.
(b) No group delay pre-correction for receivers is used.
(c) The transmitters are unattended and the degree of stability required is such that only infrequent maintenance visits are necessary.
(d) Both v.h.f and u.h.f transmitters have a passive standby with automatic changeover from the operating to the reserve transmitter when required.
(e) The v.h.f transmitters which operate in the extended Band III also use CCIR System I, the transmission characteristics being identical with the Band IV/V transmitters. The upper end of the extended Band III is 254MHz.
(f) A minimum number of thermionic valves of the quick-heat filament type are used. In the case of u.h.f transmitters, klystrons are preferred.
(g) Low level vision and sound modulations systems are used.
(h) In general, the v.h.f vision power is 12kW at synchronizing pulse tips and the sound output power 1.2kW.
(i) The transmitter performance is very much that which is required by the BBC and the IBA, and perhaps the only difference is in that the SABC transmitters are operated 24 hours a day and this performance is required to be achieved under continuous operation at altitudes up to 2000m above sea level at transmitter and blower-room temperatures of 0°C to +45°C with an outside air temperature of −5°C to +45°C and the relative humidity between 20% and 95%. The blower room is fed with filtered air and the transmitters' dust-filtering system must be capable of intercepting 95% of dust particles of 1μ size, 99.9% of 5μ size (figure 2).

Experience in the past has shown that it is as well to be extremely sceptical of manufacturers' claims for operating ambient temperatures, and we have therefore cooled the air fed to the transmitters.

As far as the transmitting antenna is concerned, on many of the stations, particularly where v.h.f transmitters were anticipated, provision was made for the TV antenna. In the case of the u.h.f antenna provision was made on the top of the mast to bolt on the complete antenna (figure 3).

The u.h.f and v.h.f antennas are in general of the split type with two main feeders, the feeder impedance being 50Ω. The v.h.f antennas are made to take the total output power of three channels on half the antenna and the u.h.f four channels on half the antenna. In normal operation half the total power is fed to each half of the antenna.

The general antenna characteristics are:
(a) Polarization is horizontal and vertical
(b) Beam tilt is used where required
(c) Null fill-in is used where necessary
(d) The gain is such as to produce 100kW e.r.p from a

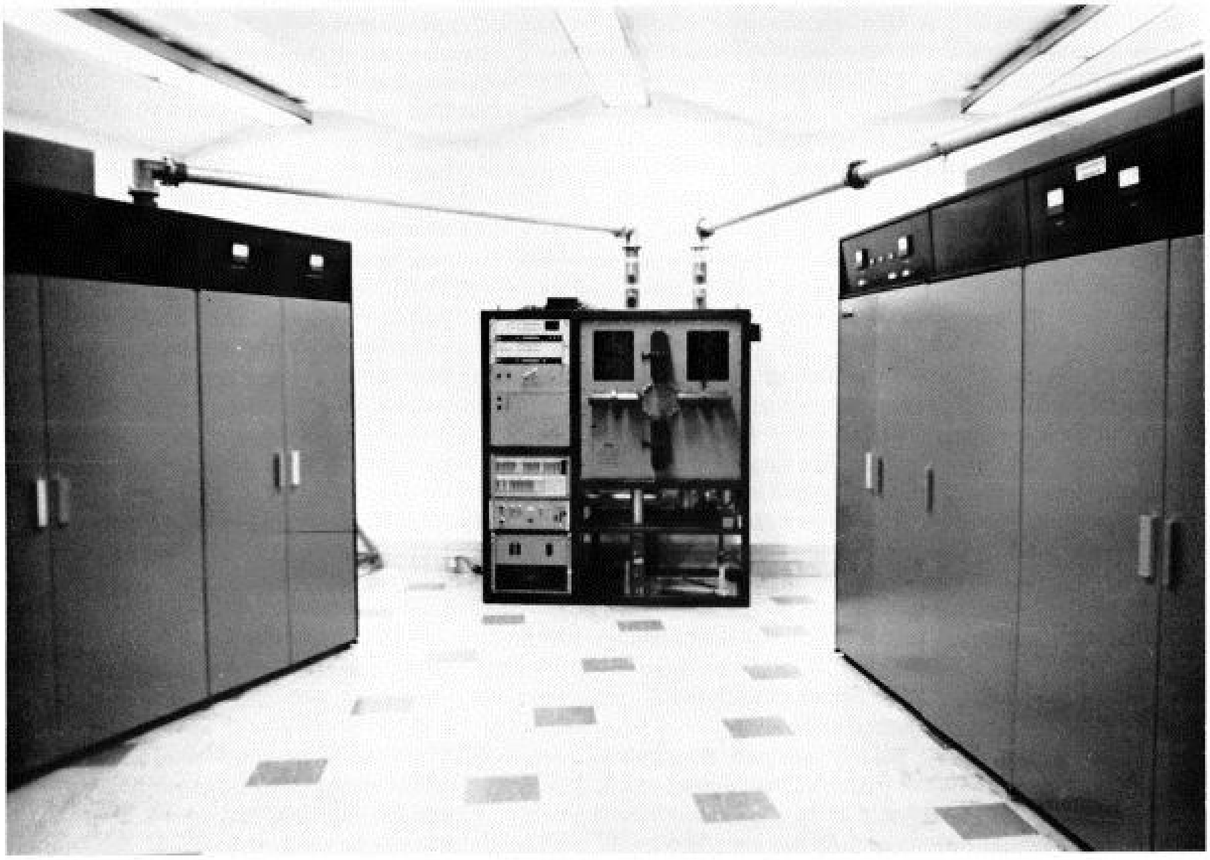

Figure 2. Two Marconi Band III transmitters and change over equipment

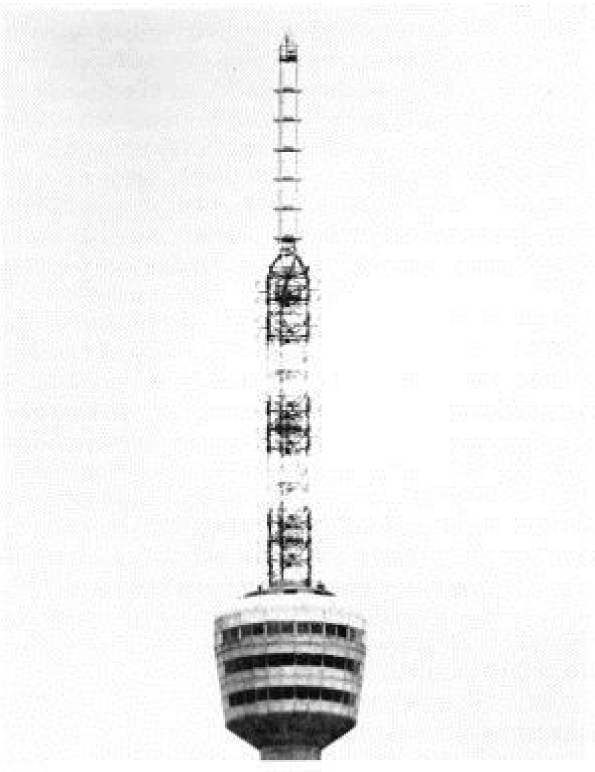

Figure 3. Marconi antenna at Johannesburg: The u.h.f antennas are seen above the v.h.f

vertical aperture of approximately 17m

(e) Typically the voltage reflection coefficient over the channel bandwidth should not exceed 4% and is less than 1% at the vision frequency of all relevant channels.

All the transmitter stations are unattended and the building design allows for modular construction so as to facilitate expansion for subsequent additional transmitters. The whole building is pressurized with filtered air and where necessary the air is cooled. Diesel standby generators are provided in the form of several medium-size generators rather than one large one so as to obviate light loading of the generators if power fails with the main transmitters off the air.

In the case of the low-power gap-filling stations, standby power is not generally provided, since these are usually located in fairly densely-populated areas where the power supply is more reliable.

Production facilities

The site that is available for the television production centre is closely coupled with the sound centre and administrative building and is situated in Johannesburg, South Africa's largest city and is some 4km from the city centre. As you will see from the photograph (figure 4) approximately half of the site is taken up with the sound studios, the workshops, stores and laboratories and the office block and parking garages. The

Figure 4 The Broadcasting Centre at Johannesburg from the east. The television complex is on the right of the office tower block, and the sound complex, workshops, stores and laboratories on the right

southern section of the site between the tower block and the transmitter is the portion that has been assigned to television.

When planning the use of the site various assumptions were made. It was assumed that the first channel and for that matter subsequent channels would be involved in a total on-air time of something of the order of 35 to 38 hours a week. Of these hours the studio centre would be committed to producing approximately 40%. In other words, something of the order of 14 hours per channel per week.

The development of the site would take place in three phases. Initially it was assumed that these three phases would have an identical complement of studios. It was, therefore, not illogical to divide the site into roughly four, three sections of which would be allocated to the studio and scene assembly and artist facilities for three channels and the fourth segment to a scene factory and various storage areas.

The scene assembly for the three phases has been planned for an area forming a north/south axis and the centralized facilities such as videotape, telecine, film processing, the plant room for mechanical and electrical services, would be housed on an east/west axis (see figure 5).

In the initial master planning, it was assumed that the second phase for the black language service would consist of production facilities for one channel only. However, this is already outdated and planning at present centres around facilities for two channels for the second phase. It will also be necessary to provide much more than 14 hours per day as little material is available from outside.

Considering for the moment the first phase, and basing requirements on the production of approximately 14 hours of programme per week, the studio complement decided on was two of approximately 250m², three of 500m² and one of 900m². A seventh studio has been built with also a floor area of 500m² but at the moment has not been equipped. The two small studios are used for news and magazine programmes. From the start it was considered that maximum productivity from the studio complex was to be aimed at and automation was to be used wherever possible and warranted. Maximum economy of technical and operational effort had to be borne in mind at all times.

In order to help achieve the requirements for efficiency, an automated programme presentation system is used. Also a comprehensive machine control system has been introduced so as to make comprehensive control of telecine, videotape, character generators, etc. possible from the studio control rooms. Facilities booking is handled by the data processing computer, and this information is presented to the

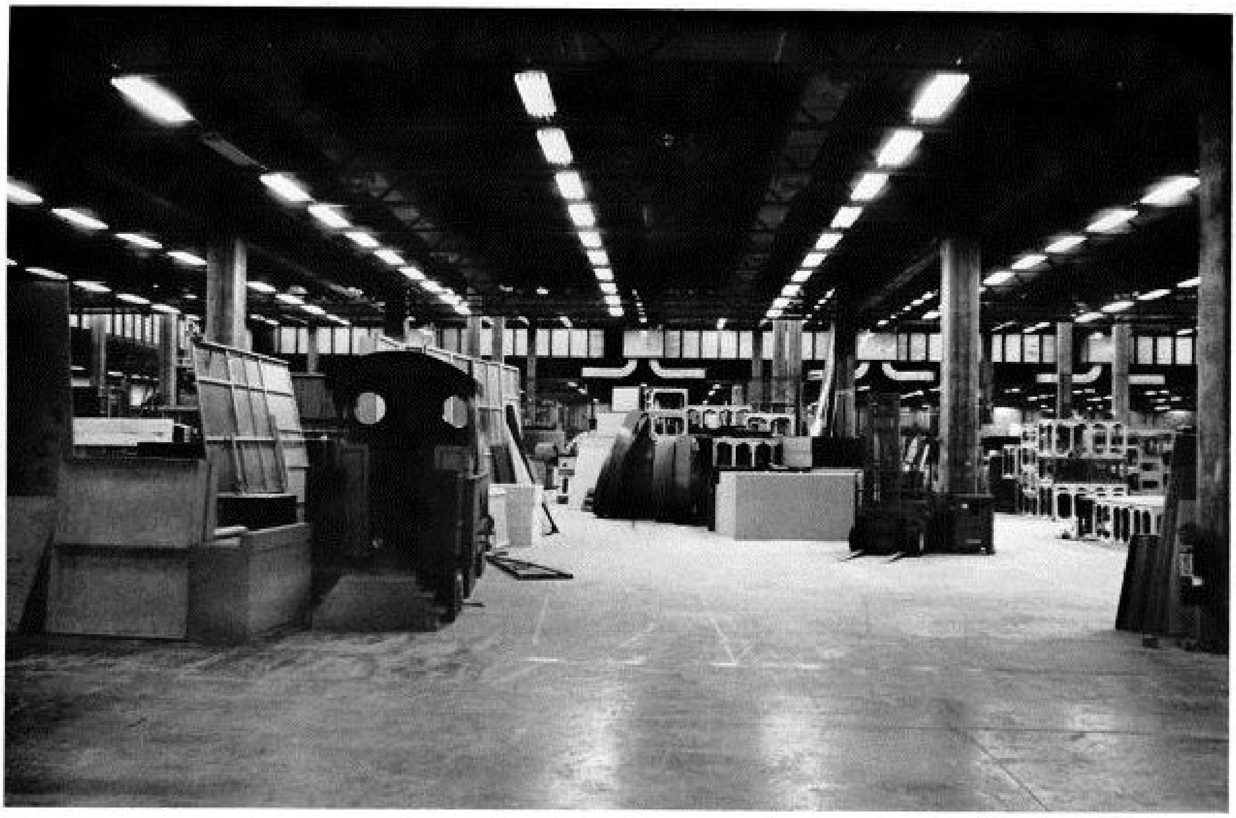

Figure 5. Scenery assembly area

process control computer which not only arranges for presentation of programme material to the transmission chain but also caters for facility assignment.

The videotape and telecine centres are unusual in that all the machines are placed in a large room, and the control is remoted to two control areas, one primarily associated with production activities in the studio block and the other one primarily associated with on-air presentation. The philosophy being that operators would load the machines, assign the control to the appropriate control room, where the quality of the output of the machine and the material would be checked, and they in turn would assign the control of the machine to the studio control room or to the computer for automatic presentation. In the case of the videotape centre there is an additional recording control room so that material can be recorded without having to use a studio control room.

The most important floor in the technical spine contains the centralized electronic equipment such as matrices, camera control units, standards converter, process control computer, etc. Adjacent to this area are two control rooms, one whose specific task is to monitor the technical quality of material being routed throughout the studio complex as well as incoming and outgoing feeds. The second control area is primarily for operations and contains the computer terminal for the presentation and assignment system.

Also on this floor and adjacent to the two control areas and the main electronic centres are three final control suites. These consist of a small announcing studio and a comprehensive control room with facilities for taking over the manual presentation and comprehensive remote control of videotape, telecine and slide scanning machines as well as character generators. Normally this area would not be manned.

Also on the same floor is the videotape centre and the various maintenance areas. Immediately above this floor, and connected by vertical cable ducts, is the telecine centre and the film area. Above is an area devoted to review theatres, language dubbing and sound dubbing and film editing. The ground floor of this spine contains the news facility which is adjacent to the studio delegated to news. The basement houses the film processing plant as well as the library for film and tape.

The traffic flow in and out of the studios has been planned in such a way that sets move in from the scene assembly area from one side of the studios at ground-floor level while artists move in from the artist's block, also at ground-floor level. The studio control room suite is some 5m above the studio floor, with no windows looking into the studio and access by means of internal staircases. Public access to the studio is also some 5m above the studio floor and the public filter into the gallery running around three sides of the studio from above the artist's block. They then move down on to the folding seating which can be brought into the studio as and when required.

In spite of the fact that the control-room layout is conventional and well proven, a mock-up was built to make sure that all the ergonomic considerations were taken into account.

Within the studios themselves the luminaires are suspended from monopoles travelling on a lighting grid. The grid is some 10m above the studio floor level. In general, studios have 136 5kW dimmers and four 10kW dimmers. The 900m² studio, however, has 236 5kW and four 10kW dimmers. The studio floors have a tolerance of 1.3mm in 3m. The doors from the scene assembly area into the studios are some 4m high by 5m wide, so that large pieces of the sets can be moved into the studios in order to cut down turn-round time.

A start was made on the building in September of 1971. At the time of writing, that is the beginning of 1976, all the studios except one, which has not been equipped electronically, are operational.

There are three articulated four-camera vehicles, one two-camera vehicle and three videotape vehicles. Because of problems peculiar to this country these vehicles travel comparatively large distances, and in order to be as kind as possible to the electronic equipment air suspension has been used wherever possible. Air-conditioning is provided for the driver's cab and there is also a place for the co-driver to rest. It is not uncommon for the vehicle to travel 1600km for an OB several times a year.

Conclusion

In conclusion I would just like to record that up to now things have gone reasonably well. There have been comparatively few design mistakes and I think that these could be considered insignificant when looking at the extent of the project. There has been general acclaim for the quality of the transmission and it is necessary to add that we should be ashamed if this was not the case since we have had the benefit of everyone else's experience. I would also be remiss if I did not pay tribute to the unstinting help and co-operation we have received from sister broadcasting organizations in England and on the Continent.

It may appear that as we move into the second phase which is for two channels for the black section of the population that this would be easy and merely an extension of the first phase. This is very far from the truth, since we are dealing with a highly talented section of the population with very little written history, literature and theatre in their background but with tremendous ability to communicate and entertain. The challenge of the second phase would be the adaptation of modern technology to make the best use of the programme potential that is latent in this section of the population, and in particular not to introduce bad habits and non-productive practices from an allegedly more civilized section of the population. The possibility of replacing film with videotape is very seriously under consideration and the need for more economical, highly-productive outside broadcast units is a major consideration because of the need to produce so much programme material locally.

I would also like to take this opportunity of thanking the SABC for permission to publish this article and in particular my colleagues whose unstinting devotion to duty and enthusiasm for their work has made this achievement possible.

References

[1]African V.H.F/U.H.F Broadcasting Conference, Geneva 1963.

[2]'Television Frequency Assignment Plan for Bands III, IV & V in the Republic of South Africa' by N. Smuts. Published, in the *Transactions of the South African Institute of Electrical Engineers*, February 1975.

[3]'Specification of Television Standards for 625–Line System I Transmissions in the Republic of South Africa'. Published by SABC, March 1972.