Discourse on TV Technology over the years – as per BBC practice

The best thing about being accepted by the BBC as a Technical Operator was the in-depth training given in all aspects of Television Broadcasting.

Ideally, the entry qualifications required study to GCE 'A' Level in Physics and Maths, since one was taught exactly how the hardware actually worked. Microphones, loudspeakers, electronic cameras, film cameras, the chemical principles of photography, composition and lighting to make a good picture, sound and magnetism were covered in great detail at residential training courses at BBC Wood Norton, near Evesham, with practical periods to learn the use of everything needed to generate and transmit a programme.

In the Television Centre and Lime Grove Studios in London, one was under the supervision of a more senior member of a studio camera crew whose job it was to train one in his functions and learn familiarisation with all the equipment. Familiarisation included the make-up and wardrobe departments too, as well as vision control, quality control and the switching centre at Broadcasting House; following the transmission path and visiting main transmitters, the better to understand the role that each department played in television production. We were supplied with a small book, (called a "ration book" by those who ran the system and had lived through a war). Each page had things to learn and had to be signed off by an appropriate person. After a while, having operated in the fields of both camera and sound, the trainee was asked to choose a progression specialising in either camera or sound. *(This author elected for sound, thus is rather more versed in audio techniques, until retirement some thirteen years ago.)*

Camera and image making:

Starting this discourse around studio equipment in use from the early 1960's, the cameras were CPS Emitrons, (B & W, obviously, in those days). They were somewhat unstable, for if the target voltage that was applied to the light sensitive tube was not kept accurate, the picture would "peel" to an overall white overload. This effect was actually used for the early "Dr.Who" episodes, when the Daleks zapped someone! By 1962 the Emitrons were obsolescent, surviving only in the Lime Grove studios. 4½" Image Orthicons had replaced them everywhere else (including the Television Theatre).

Cameras were equipped with four lenses of various focal lengths, on a rotating turret. In TV, the lenses were referred to by the horizontal angle in degrees across the screen. This was different to film cameras for the cinema, which are named by the focal length in mm. TV camera lenses were also referred to by their focal length in inches. On the Marconi Mk III these were 2", 3", 5" and 8".

Focussing was effected by the cameraman's focus control, which physically shifted the camera pick-up tube, the lenses remaining in position. Exposure was remotely controlled by Vision Control from a room usually adjacent to the production gallery, with the vision control operator next to the Lighting Supervisor, who could vary the intensity of each luminaire in the studio set. Vision Control also set up the cameras to match contrast and brightness of their individual electronic output, so cutting between them would not be jarring to the viewer.
Zoom lenses came later, and the early Taylor-Hobson model was mounted in place of one of the turret lenses, the turret being securely locked to prevent rotation! The camera operator then had local control of shot size and focus. Zooms meant that a shot could be framed precisely without

minute adjustments to a camera's physical position. Later cameras had built-in zoom lenses and a pan handle-mounted control panel on which the cameraman could pre-select various focal lengths.

Cameras then, were unwieldy and heavy, thus mounted on wheeled pedestals ("peds") which could be manipulated as to height and steered around the studio floor. Other mounts were the motorised dolly (Vinten) having a small amount of crane up and down movement of the camera head and operator's seat, requiring a tracker to steer and position; the Mole Richardson (Mole) crane which had a counterbalancing bucket filled with lead weights equal to the camera and operator – he could not dismount until the arm was locked off and the weights removed! As well as the arm 'swinger' there was a tracker to drive it. The Heron was another crane, which had the facility to 'crab' i.e. travel sideways, in total silence, which usually caught out other studio staff unwise enough to stand alongside!

Much later, with cameras becoming smaller and lighter, it became possible to mount them on the end of jib arms, with an operator controlling pan/tilt, focus, zoom size, all from a standing position at floor level.

When colour started, the earlier colour cameras had separate pick-up tubes for each colour and luminance, the colours being separated out by prismatic filters. The RGB and luminance signals could be used in various ways, meaning a further degree of Vision Control, which now had to match multiple cameras for colour consistency.
In the early days of Television Centre's colour equipped studios (for public transmission programmes), a pretty make-up girl was seated for what seemed ages, well lit, with all the cameras focussed on her during the 'line-up' period preceding any recording or transmission. Of course the colour monitors had to be matched as well, and there were electronically generated test signals for this (Colour Bars). Each camera's separate colour outputs could be measured and matched. Later, the live girl was replaced with a colour photograph with something like 128 degrees of print control.

As colour monitor sets were expensive, the sound control rooms were often denied one, even for a master transmission screen.
This produced a flood of complaints as it was mooted that a mike boom shadow falling onto an actor's dark costume might not be visible in b/w, but was very apparent in colour! A similar trap existed for the cameraman, since camera viewfinders were also monochrome.

TV picture line standards:

In the early 60's British television pictures were created with interlaced scanning at 405 line resolution. Interlacing was the way of getting over the problem of fade caused by the display receiver cathode-ray tubes losing brightness a comparatively short time after the electron beam hit the light emitting phosphor surface. Thus the vertical scan was achieved by missing out every other horizontal line scan, and when the line scan had reached the bottom of frame, it went back to the top and filled in the gaps. So the viewer saw a reasonably bright, even, picture over the whole frame. In those days the picture was just black & white, although the improved so-called 'High Resolution' 625 line monochrome was introduced in Britain in time for the start of BBC2 - thus requiring complex TV receivers capable of operating on both systems.

Although the BBC had been running evaluations on the various colour picture systems (PAL, SECAM, NTSC), they held back from plumping for a transmission system until the EBU (European Broadcasting Union) had concluded that PAL (Phase Alternated Line) would be adopted for most European countries using 625 line resolution at 25 fps. This apparently gave the best transmission and most stable quality in mountainous and built-up areas and over longer distances. Thus the BBC was in a compatible situation for exchanging programme material via Eurovision without any conversions being necessary. France which had operated on 819 lines black and white, invented their colour on the 819 line system in SECAM but it was never introduced - later adopting the EBU standard of 625 line PAL (?).

The American NTSC (National Television System Committee) system used there, in parts of South America and in some Far Eastern countries, runs on 525 lines and at a different frame speed – 30 fps. In closed circuit recording, the pictures look very nice, but transmission over distances was variable, leading to the rather cruel mnemonic of 'Never Twice the Same Color'.
Similarly the French system was sometimes known as 'System Entirely Contrary to the American Method'

The PAL system works because any phase errors are cancelled out by the adjacent line displayed.

The different frame speeds are explained by the syncing of the signal generation to the country's standard electrical frequency. In the UK this was, in early days, sometimes a problem where areas - such as Northern Ireland - were not locked to the same grid frequency. With TV pictures being scanned at the rate of 25fps (frames per second), the transmission of cinema films shot at the standard frame rate of 24fps, meant an increase in the running speed of 4%, which would affect the pitch of the soundtrack – perhaps a problem with music to persons having perfect pitch.

With commercial television, Directors quickly latched on to shooting the adverts on film at 24fps, as 4% more visual information could be squeezed in!

Links/Radio links/Satellite

Radio and TV programmes needed to be sent around the country between studio centres and to transmitters, and Outside Broadcast programmes needed Sound and Vision circuits to the studio centres. Initially, Post Office lines (cables) either permanently installed or specially set up, were used. These needed special balancing and equalisation, and when stereo came along, corrections to allow for differences in audio response and phase between the pair of lines used to provide the two channels. The later use of digital equipment for stereo sorted this out. Wireless (Radio) links were used, mostly for remote cameras back to the control vans (scanners), and for sending the mixed signals to a receiving point – maybe the nearest local main transmitter mast, from where they could be routed to the central broadcast production point. As radio systems became more developed and stable, more use was made of them – viz. the touchline cameras at soccer and rugger matches and on the wide open spaces of Golf Courses, obviating the need for cables. The introduction of fully digital transmission systems allowed for good quality pictures in difficult situations.

Once geostationary satellites became available, Outside Broadcasts and News inserts were made possible back to the studio via these satellites, and could be quickly set up and available worldwide. The downside of that system is the appreciable delay in the signal path, leading to the reporter

apparently waiting with egg on his face before he gets an audio cue from the studio to speak. To obviate the extra considerable delay in also sending the cues back via the satellite path, sometimes the cues are sent by ordinary telephone line or mobile phone. Satellite links are even also made use of, quite locally, instead of setting up cabled connections at an event.

The latest systems for News Inserts use special combining units to split the audio and video signal over multiple mobile telephone channels so reporters can send their pictures even before a satellite truck arrives. However at sites where there is considerable interest, often the mobile networks can become overloaded thus preventing this clever system being useable.

Today's delivery of TV pictures to the viewers by digital transmission has thrown up a problem with the synchronisation of sound-to-picture. The coding of the signals takes an appreciable time and the decoding on arrival at the domestic receiver can result in 'out-of-sync' sound as the decode process is faster for the audio than for picture, depending on how complex the picture shot happens to be. Often the sound is ahead, so the picture is late, maybe it's the picture that is 'out-of-sync'.
There are differences in the decode circuits from different manufacturers, so this seems an insoluble problem, at present.

Recording of TV pictures

Prior to the early sixties, Videotape was in its infancy. The BBC experimented with a picture recorder, named VERA (Vision Electronic Recording Apparatus). To achieve the necessary bandwidth for magnetic tape recording, the head-to-tape speed had to be high. VERA attempted this by running the tape very fast past the head – this could have the possibly lethal result of the spools leaping off the deck and being projected across the room! Thus it was the invention of Alexander M. Poniatoff who came up with the idea of a quadruple spinning head, recording tracks transversely across the width of the tape and switching in and out. This was AMPEX (A.M.Poniatoff + EXcellence).
The tape width was 2" and was held against the record/replay heads by a vacuum device.

At the same time, there was a film recording system in use. A 35 or 16mm film camera was pointed at a high quality TV monitor, and photographed the picture. In order to capture as much as the image as possible, the film transport was modified to be 'fast pull-down'. In other words the movement of the film was accelerated between each frame arriving in the camera gate. It resulted in the loss of the top two lines of the TV picture being un-photographed, but acceptable. As these recordings were on standard cinema film, there was the facility to sell programmes to overseas broadcasters, who could therefore easily run these films via telecine scanning machines, sprocketed film being a global standard. Many supposedly 'lost' programmes have surfaced in the form of these 'tele-recordings'. The sound track could have been initially on matching magnetic stock, but it's likely that the sales version would carry an optical sound track.

Eventually, 2" videotape was superseded by newer formats: 1" helical scan, Betacam, which was a derivation of the domestic Betamax, but running at 3x tape speed – used extensively for mobile use, in place of 16mm film. Then Digibeta, a method of coding the signal in digital format, which also led to the Digital Broadcast machines.

This all allowed the editing system to change. Computer editing was possible with the electronic picture and sound material loaded into computers and manipulated. It was non-destructive as unlike

takes that were left on the (film) cutting room floor, the computer remembered all the last operations.

All this changing of recording formats and conversion between formats for archive purposes leads to significant signal degradation and difficulty in finding sufficient near-obsolete tape players. In fact old film still looks surprisingly good when projected on modern equipment. To avoid this problem in future, the BBC is currently transferring its archive to a computer based format for which players should be available for some considerable time.

Later developments with lightweight video cameras which record both picture and sound to the same media, meant that handholding by the cameraman was possible, but led to worryingly unsteady pictures which could annoy the viewer. Some news teams dispensed with a separate sound man which is argued to result in poor quality – quality being sacrificed for cheapness.
In fact, small TV stations in the USA, just sent out a reporter, responsible for setting up the camera, plugging in his mike and going round in front to deliver his spiel!

Many a single cameraman, with his eye glued to the viewfinder, would rely on his recordist to 'watch his back'!
The BBC were guilty of handing out jobs to researchers, instituting courses to give minimal training in the operation of lightweight 'prosumer' cameras, which were capable of providing high quality results – in the right hands! What happened to the superb in-depth training given to the technical operators of past years, who were able to pass on their knowledge and skills to the people following them?

Quality Control

There was a suite in TV Centre where the quality of picture and sound could be monitored at every stage of a programme's route from studio or videotape/telecine source right through to the transmitter, and if a live programme, via an off-air monitor as well.

Also two Presentation suites, with a small studio and control rooms, would oversee the junctions between programmes to ensure a smooth seamless transition. There was a pride taken in the professional delivery to the nation.

Sound

The production of audio for television stems from four traditions: the Sound Recording studio, the Film Studio, the Television Studio, and the Outside Broadcast.

<u>The Sound Recording Studio</u>.

This dates from the earliest attempts to produce gramophone records. In order to record clear sound it was necessary to have an environment free from extraneous noise, and with a pleasing acoustic. It was soon found convenient to have a separate control room, which enabled the engineer to hear the result as it was recorded, and to adjust the levels of the different sound sources, such as the microphones. Radio studios have changed little over the years, with attention being given to isolating the microphones from mechanical disturbance. Large studios were

developed for musical performances, enabling the instruments to be sourced separately, with complex mixing desks and recording equipment.

Development: The late fifties saw the development of stereo recording, and variations on this led to the multichannel recordings of today, and to digital recording.

The Film Studio

Since early movies were silent, the development of the film studio concentrated on the lighting, from the merely adequate to the atmospheric. The introduction of the sound to the movie caused a revolution - the cameras had to be given synchronous motors to run at a constant speed, and attention had to be given to eliminating the sound of the camera mechanism by means of large sound-absorbing covers, called "blimps". Studio discipline had to be established so that there was no extraneous noise during recording -- hence the "Camera! – Speed! – Action!" routine.

From the earliest days of television, film production has been found to be a useful alternative to "live" techniques, giving high quality, though requiring much time and effort.

The Television Studio.

Until the development of telerecording and videotape, all television was produced “live”. A one-hour play was performed and broadcast in an hour. The television studio provided an environment in which this could be done. Sound capture was a problem. Except in the very simplest productions, there was bound to be extraneous noise in the studio, such as the movement of cameras, actors, and even scenery. “Live” acoustics would exacerbate this problem, so studios were made acoustically dead, which gave an unrealistic sound. Directional microphones were used to pick up actors’ voices in preference to other sounds, and great deal was contributed by skilled operators of the microphone “boom” which could place the microphone near the actors without it appearing in shot. Movement of cameras and booms during a production required planning and skilled teamwork.

Development: The great breakthrough was the development of “wireless” microphones which enabled actors’ voices to be picked up even in a “wide shot” in which a boom would otherwise be visible. It became practicable to mount microphones on the person of the actor, either in a concealed pendant or even taped to the skull.

Outside Broadcast

Recording sounds in the open air has always presented a considerable challenge. Wind noise becomes unavoidable, despite the use of foam rubber “blast guards”. Further developments with silk lined mesh covers and nylon ‘hairy’ windjammers render the energy of the breezes down to an acceptable level. Commentators who were out of shot used lip microphones, which were held very close to the mouth.

Interviewers used “stick” microphones, and learned to hold them close to their own mouths, and then close to the interviewees. Again, “wireless” microphones” were a considerable help.

Filming out of doors has always been a great challenge. Even with the best equipment and expert operators, sound captured in the open has been so problematic that actors are often taken to a post-production facility after shooting is over, to re-record their dialogue with the help of the "guide track" edited from the sound recorded on location. However, this often results in a performance suffering as co-artistes may not be present and the emotion captured at the time of filming may be difficult to reproduce.

The Television Studio as Synthesis

The television studio borrows equipment, techniques, and personnel from all of the above.

Acoustics are an almost insoluble problem. Realistic dialogue and, in particular, musical instruments, demand a "live" environment, but long reverberation times accentuate unwanted sound such as the movement of equipment and even scenery. Film directors are accustomed to directing from the studio floor, but this is impractical while sound is being recorded there.

The sound team is also responsible for providing "talk back" circuits so that the production personnel can communicate with camera and audio teams, though this presents its own challenges such the "talk back" sound being accidentally incorporated into the programme content. A set of headphones carelessly left hanging on a microphone boom is a simple way in which this can be done, and difficult to detect in a control room full of its own technical chatter.

The sound control room borrows techniques from the radio studio, including record turntables, and tape decks for "sound effects" and music. These have followed the audio industry, with the development of stereo, and then multi-channel techniques. Mixing a programme so that it can be reproduced on monaural, stereo and multi-channel equipment is understandably difficult. Today's productions often have a differently balanced mix depending on the final distribution being for the cinema or television or commercial DVD release.

Indeed, the challenges of quality "live" production are so great that the production of "live" drama has been virtually abandoned, and most productions now shoot discontinuous recordings, with considerable "post-production" editing after the actors have gone home. Indeed, drama production for television now frequently looks like film production, being done shot by shot, and the old skills of the integrated technical operations team are beginning to disappear and the great television studios demolished.

Microphones

The first tool in sound capture is the microphone. In the early '60's the standard TV studio mic was the STC4033, mounted in Mole Richardson dolly booms. The 4033 was a combination of a moving-coil omnidirectional mic with a ribbon mic which was a figure-8 pick-up pattern. The sum of the two electrical outputs produced a perfect cardioid pattern (heartshaped) with good rejection of sounds arriving from the rear. Later microphone manufacture gave the condenser mic which had a crisper, cleaner sound and a better 'sucking power' i.e. a sensitivity that pulled in sound from a greater distance. Often it was used in the boom in the Television Theatre, but as it required a power supply,

was mounted in a dual rig together with the reliable 4033, in case of failure during a live theatre show. It also meant a double cabling system along the telescopic boom.

Later studio equipping replaced the Mole Richardson booms with the Fisher boom, which had an amazing 33' reach, allowing room for the ped cameras to work in front of the boom dolly. However, the 4033 proved a bit too heavy for the thinner telescopic section of the Fisher, so the AKG D25 was adopted. This was a moving-coil cardioid mic of excellent quality, also used by the BBC Film Unit out of Ealing Studios, as there was a sensible windshield available – very necessary for exterior filming where wind could be a problem, unlike a TV studio. Other standard mics were the STC 4038, a ribbon figure-8 which was excellent for strings, and brass instruments, the latter especially, as it could handle the sound pressure of a full-blooded brass section. Neumann KM54's and AKG C28's and C451's, all condenser mics were much used, the C451's being particularly versatile in that the pick-up capsule could be detached from the head amplifier and two different length extension tubes (stalks) inserted, allowing closer positioning into an orchestra or the longer one as a stand mic for a vocalist on stage.
(The author came across an American film crew in the 70's who were utilising this facility – the pick-up capsule was at the end of the hand-held mic pole and the head amplifier clipped to the operator's belt. Thus a very lightweight rig). Today, many sound engineers on films have the boom mics radioed back to the mixer, avoiding cables, but tend to tape the transmitters at the far end of the pole, making a heavy system for the boom operator). Other mics which came along were the AKG C12, a large diameter capsule mic which although rather expensive, was ideal for orchestral use – a large capsule renders the lower, bass frequencies much better and this mic was used a lot for a string double bass. Smaller mics were appearing, and an early one in the 60's was the BK6B by RCA, This was a moving coil dynamic mic and much used as a personal body worn mic, suspended on a lanyard around the neck of the presenter – hence the name 'lavalier' from the definition of pendant jewellery. This mic was sometimes used, wrapped in foam and stuffed into the bridge of the double bass, the cable being tied off to the spike. The BK6B was also used inside grand pianos to avoid contamination by outside noises.

Later personal mics appeared – the Sony ECM50 found favour, an electret capacitor mic of good quality and quite small, allowing unobtrusive fitting to costumes or lapels if permitted to be seen in vision. As time went on, more and smaller personal mics were manufactured – the Tram TR50 - beautiful quality, COS 11, very small diameter, and most recently, a DPA which having very small holes in the entry mesh, makes it suitable for use in spray/rain situations, as the surface tension of water droplets prevent the entry of moisture.

ITV companies used a Neumann U87 in their studio booms – a mic much employed in recording studios for vocalists, but quite heavy – the Fisher booms seem to have coped, though.

It's worth mentioning a difference here between usage of mic booms in TV studios and film studios. TV booms had racking in and out (obviously) and pan, but also tilt, meaning that the mic could be positioned ahead or over the head of actors progressing upstage, back to camera with the mic flattened off over the top. Film booms did not have the tilt facility. Possibly, if the camera could not see lipsync (viewing actors from the back) then the dialogue could be recorded later and edited in. Also tilting the mic back away from the set could pick-up unwanted noises from who or whatever was behind the camera!

Other forward moves in microphone directivity pick-up was the interference tube design. This consisted of a slotted tube in front of the diaphragm, which meant that sounds arriving from the rear of the mike travelled in various path lengths before impinging on the diaphragm, but due to the mathematics, a bunch of frequencies were rendered almost null by phase cancellation.

Theatre Stage shows often fit headset mics to the actors – clipped behind the ear and extended on a wire boom to be positioned close to the mouth, these may escape notice by the theatre audience, but for close up TV cameras – no! However these mics are finding favour in presentations where the mike is deemed acceptable in shot – a bonus is that the mic-to-mouth separation is constant so if there is PA required, less chance of inadvertent howl-round. (Where the relayed amplified audio is picked up by the mike generating it).

Live News programmes use a twin personal mic clip, in case of failure of a mike. They are often mounted, apparently upside down. As these mics are omnidirectional, i.e. the polar pick-up is spherical – equal in all directions, it was discovered that by directing the pick-up holes away from the mouth, lessened the problem of consonant popping – 'p's, 'b's and 'd's engender a stronger expulsion of breath which can distort sound when impinging upon the microphone diaphragm.

Concerning TV sit-coms with a studio audience.

Several of the Television Centre (TVC) studios were fitted with extendable audience seating, as many sit-coms were recorded with a live audience in the '60's. There were loudspeakers slung over the seating, to provide a feed of the dialogue and sound effects. These were line-source speakers which means they had a narrow field of delivery, thus it was possible to suspend mics, the lovely 4038's to capture the audience applause and laughter, without picking up the output from the PA speakers. (sideways on, these mics were dead!). This also meant that the boom operators had to work the mics as close as possible to the actors to avoid picking up the relayed sound to the audience (colouration).

Thus it was essential that the boom operators knew what the cameras were seeing – frame size. With the turret lensed cameras, a boom op could see what lens a camera was on, (and if it was punched up there was a red light on top), and with knowledge of lenses and experience, had a good idea of the limits of the shot. Zoom lenses were a problem, as you could not see the setting. There were always trolley mounted monitors on the floor for the boom ops to glance at, and set the limits on rehearsal by dipping into view – one could kick people's heads from the boom platform if they inadvertently obstructed the boom op's view!

After this author left Television, it was understood that the booms were fitted with their own TV monitors which could be switched between the current shot selected, or the next wide coming up. Definitely an improvement! Prior to that, the Sound Mixer in the Sound Control Room (Gallery) could preview the wide shot and warn his operators via talkback.

Also, *(and this is where the author diverges from TV to Film….)*
The author, who was accustomed to using floor monitors when positioning a boom microphone in a television studio, was startled when he started to work on film sets to be told by the camera operator that HE was the only one allowed to look through the viewfinder! Asked to give a limit for

the top of the shot, the camera operator tilted up, said “You’re all right there” and tilted down again – not good enough. Luckily, later on came ‘video assist’. This was made possible by the 35mm film cameras being fitted with reflex shutters, and a prism divert to a miniature TV camera, which gave a view though the actual lens.

This could be recorded, and was often said to lengthen the time taken to shoot a movie, as it seemed necessary to review each shot, before progressing. Previously, everyone had to wait for rushes to be processed and viewed the following day.

Digital audio reared its head, with DAT recorders (Digital Audio Tape) becoming manufactured and offering high quality 2-track capture. These were not particularly liked by sound recordists as the tape cassette was quite small, and could be easily damaged. An advantage was that a single cassette could record up to 2 hours material. Some machines had the facility of recording a timecode signal to synchronise with film cameras at the edit stage.

Later hard-drive and solid-state recorders of varying complexity (Deva, Cantar, Sound Devices) now offer multitrack capability, allowing mike booms and artiste worn radio mikes to be recorded to separate tracks, giving post-production editors flexibility in finding the best quality sound for each take. This actually works against production costs as it is a time consuming exercise and seems to have made acquisition of the audio a more complicated process than the old days of one or two booms and perhaps a couple of wireless mikes, mixed at the time to a single track recorder. Some of the skill of a good floor mixer has thus been taken away and left to the post production stage. There are on-going tangles with timecode synchronisation with today’s digital picture cameras, and the latter have shown to be causing problems as the electronics require noisy cooling fans, compromising a decent sound capture. Film cameras used also to be noisy, but good design of the modern Panavision camera and other camera bodies’ sound proofing render them practically noiseless.

Talkback

This was the communication system from the director in the production gallery to the cameramen and floor managers – also fed to the vision and lighting and sound control. The Sound Supervisor could inject his own talkback mic into the circuit, to speak privately to his boom ops, as they had a separate feed to headphones. This was a cabled system, but the studio floor manager had a radio receiver, any interchange back to the director in the gallery being via the boom mics (during rehearsal only!). An innovative chap worked out a connection system to allow the boom operators to talk to each other, in order to clarify who was going to cover which dialogue on a wide scene. Talkback also carried the programme sound, so it was possible to detect when your boom was faded up, and in use.

Aside from this, with licensable short-range wireless systems becoming available, musicians demanded IEM’s (In-Ear Monitors), fed with either a mixed balance or their own instrument.

Echo and Ambiophony

(At this point, the author is unaware of current practice, but with TVC being destroyed, maybe just historical).

TV studios were built with very short reverberation times, sound being absorbed at the walls to assist clear audio pick-up off the set. This did not help musicians who were used to hearing themselves reflected back off the structure of a concert hall. So at least two of the TVC studios were equipped with Ambiophony. This entailed extra mics, separate from orchestral balance, being hung over the orchestra and fed to a recorder with multiple replay heads, in turn driving a network of loudspeakers positioned around the walls and ceiling of the studio, thus giving the impression of a larger hall.

Echo:

As TV studios were necessarily 'dead' to reduce unwanted reverberations and suppress noises generated within the space, a production set in a baronial hall, for example, needed a sound environment to suggest such to the viewer. This could be produced by echo forming devices. Early Lime Grove studios had a beast of a machine, consisting of a rotating drum, coated with magnetic material, and one record head, and several replay heads which did not touch the drum. So certain repeat intervals to the initial sound was possible. Later, TVC studios were equipped with an AKG Echo plate. This was a suspended metal sheet, inside a soundproof box, with a source driver directly in contact with the plate, and pickups positioned at critical points to feed back the vibrations. Different delays could be effected by a damper applied to the plate via an external twist control. There was also the facility of echo rooms, with a speaker and microphone to pick up the echo. However these were of fixed reverberation times, and had a sound of their own.

Some Sound Supervisors used to feed the return from the echo device via a tape recorder to institute a slight delay, as this gave a cleaner rendition to the reverberation for brass section attack notes.

With today's computer programmes, it's possible to apply echo to any source and reproduce that of real concert halls and other venues. While it is possible to add reverberation easily, it would be difficult to remove the unwanted echo. Today's computer edit programmes can now do this!

There are now clever computer programmes to deal with unwanted noise, such as coughs in a quiet orchestral concert! (CEDAR).

Sound Effects and Playback (TV = Foldback)

The Sound control rooms were equipped with means to play in sound effects. These were usually off gramophone records of which the BBC had a huge library, both in Television Centre and Broadcasting House. The gramophone turntables (TD7) situated in the Lime Grove studios ran at 78 rpm, had a pick-up that moved radially across the disc, with steel needles, in a trailing mount. It was possible to accurately cue an effect by discovering where it started, marking the edge or centre blank with a chinagraph pencil and gently clicking the stylus across the grooves from the outside inwards. Some runup time had to be allowed for. Later developments in turntables led to the DRD5 (Disc Reproducing Deck) which boasted a multi-speed turntable and a lightweight pick-up.

All decks had pre-fader monitor sockets for headphones ('pre-hear' or 'pre-fade') allowing the Grams Operator to set up the cueing of the disc.

A further improvement came with the kit installed in TVC studios. A Garrard 301 turntable was modified with a cam-controlled lower bearing to the turntable. The disc to be played, with the pickup in the groove, was seated on an aluminium disc, which also had strobe holes at the circumference to precisely adjust the play speed. The turntable was set going, and the cam lever operated to lift the turntable to contact the stationary disc holding the record. Thus it came up to speed within a quarter of a revolution, allowing even more accurate cue timing. The pickup was fitted with a stereo cartridge, which although not used for 2-channel, did have vertical compliance which enabled the disc to be carefully rotated backwards to find the start of the required effect. (This was used – years later by the 'rapper' disc jockeys, who scratch the records back and forth, probably without knowing how that's now possible!) This was never an option with the earlier TD7 decks as the steel needles would have stuck in and ruined the grooves. The BBC gram libraries started to store FX on 7" 33⅓ rpm microgroove discs, which the Gram Ops didn't like, preferring to cue by transferring to ¼" magnetic tape.

Whereas very early tape recordings were made on the Marconi-Stille machine which used steel ribbon tape, magnetic tape improved things no end. The tapes could be edited with a cut and splice with adhesive tape, very accurately. The Gram Ops who were tasked with this job, always carried an EMI Block which had a groove to hold the ¼" tape, to be cut with a razor blade at the premarked chinagraph point, using 45° slots in the block. The tapes were nearly always cut at an angle to ensure a smoother gradual transition of the recorded signal across the replay head.

When editing the tape, Red leader was used at the end, to indicate that there was nothing else on that spool, and White BBC printed leader at the front, on which the title of the piece would be written. When more than one item was placed on a spool, Yellow leader was used between sections and this was the standard throughout BBC radio and television.

The main studio machines available were by Leevers-Rich and EMI. The EMI TR90 was usually the most favourite as it had the facility of a very fast start, allowing precise cueing of spot sound effects. The EMI TR90's came as either full-track (single across the whole tape width) or half-track, two tracks available which could be recorded separately, except that the erase head was only full track, and had to be switched off when laying down audio to the second track.

EMI manufactured a portable battery operated ¼" tape recorder, the L2 which was used by the Film Unit to record sync sound against 16mm or 35mm film cameras. Later machines were the Perfectone, and Uher but the ace recorder was the Nagra, a beautiful Swiss-made recorder which recorded a pilot tone derived from the camera, cleverly laid over the full track audio by means of a narrow double track head with the two tracks out of phase, thus cancelling the 50Hz pilot signal, when scanned by the audio head.

The Music Studio at Riverside (formerly the music stage when they were film production studios) was equipped with firstly, EMI BTR2 tape machines which were standard kit in radio studios. Nice but very bulky. Later, the splendid Studer Swiss made decks were installed. These had a neat gadget in the form of a small pair of scissors which, on demand would rise from the deck surface and cut the tape. Sadly they offered a 60° cut which did not match the EMI Blocks in usual use. (people would come in and ask what does that button do? and press it, resulting in possible destruction of a master tape!)

In radio, when stereo arrived, 60°cuts were adopted to reduce the prospect of image shift, which confounded many of the non-magnetic brass scissor users, some of whom could manage very accurate 45 degree cuts in mid-air, but fell at the 60 degree hurdle!

Again when stereo arrived, the radio standard ¼"stereo machine differed from the television twin-track machines by having a specific width of guard band between the stereo tracks, which maintained separation between the legs and determined that when a stereo recording was replayed on a mono machine, the output level would be correct - following the radio standard that M = (A + B) - 3dB. BBC stereo programmes were nominally modulated to PPM 5¼ for central images, so that coincident signals on left and right legs achieved a mono PPM reading of 6, the accepted peak level, and maintained a comfortable subjective balance between peak signals on the extremes and more central sources. Lack of understanding by the remaining hierarchy when BBC craft heads were abolished, eventually led to television adopting the commercial standard of M = (A + B) – 6dB. A most aggravating departure from logic and strongly argued against by experienced practitioners, who were ignored by accountants and managers who seemed to think it was wasting signal not to peak to PPM 6 on both legs!

Loudspeakers, microphones, sound desks, vision mixers and all manner of wizardry were developed by BBC Designs Department and once prototypes were approved, BBC Equipment Department took over production. There was very little by way of commercial manufacture of suitable equipment at that time, but gradually, companies began offering off-the-shelf items which the BBC could buy. For a very considerable period, with a BBC handle you could influence designers and manufacturers very significantly to produce equipment that worked the way the Corporation wanted, so "off-the-shelf" often became modestly bespoke before being put back on the shelf for the benefit of others. Equipment Department has long since gone the way of all good things and if Designs Department still exists, it is almost certainly a mere shadow of its former greatness.

There were one or two intriguing devices that were evaluated in the 60's:
The Mellotron – a machine resembling an electric organ with a similar keyboard. It was intended as a unit to play, not synthesised music examples, but real instrument samples. It achieved this with several banks of reels of ⅜" tape which could be wound forwards and back to find the required sound. Each tape carried three tracks, and other banks could be fast wound back and forth while one bank was playing. The BBC thought it could be used for sound effects generation, and loaded it accordingly. It was disastrous as it wasn't possible to move quickly enough from one effect to another if the next one required was some way down the library on the same reel.
The Programme Effects Generator (PEG) – this had possibilities. It used small matchbox-sized cassettes of ¼" tape which had a very fast start, once cued up via a locating signal recorded on the tape. Maximum run time was 30 seconds, but separate effects, for instance war battle stuff could be played in, accurately timed against the actors' dialogue.

Later, sound effects could be played in off computer storage programmes such as Audiofile.

Foldback/Playback

Foldback was the term used to feed music or sound effects to the artistes on set. Usually a very large loudspeaker (LSU10) or a smaller unit (LS3) which latter could be positioned closer to an artiste.
In the TV Theatre, for shows that required miming, a small speaker was mounted under the camera head of the main crane camera, so that a close up of the 'singer' was assured of lipsync.

For other music shows, where the orchestra could be in another studio, the sound was fed to the acting area via Pamphonic line-source speakers mounted on the boom dolly. This meant that the speaker was always on the 'dead' side of the mike, minimising any stray pick-up. In practice, any slight pick-up was masked by the mixed in orchestra anyway, (Except in stereo).
If a replay system was employed, then using a twin-track tape deck, it was often with the vocal on one track and the orchestra on the second, so the balance of the sound fed to the artiste could be modified at will.

The author worked on the film adaptation of "Fiddler on the Roof" and brought the two track playback to that production.

Studio Sound desks

The Lime Grove studios in the early sixties were equipped with very sparse kit compared to today's facilities. There were rotary faders (max 8 channels), same as on the grams turntable decks. Zero to flat out was a 180° twiddle, so quite fast for the Sound Supervisor. Later installations of the EMI desk in LG brought quadrant faders, as fitted to the desks in TVC. The faders worked the opposite way to recording studio desks, in that zero was pushed right away, and to fade up brought towards the operator. (There was a theory that if the supervisor suffered a blackout and collapsed, the natural inclination would be to fall forward, closing the faders and thus preventing the transmitters from overloading!).

TVC desks were more sophisticated than the early LG rooms, and boasted many more channels and grouping facilities. There was also a system in place to switch channel faders to follow vision mixer cuts, so that atmospheric effects or music would be neatly cross-cut automatically.

The TV Theatre desk was remodelled with a PYE desk which had a load of multiple faders and compressors/limiters to handle shows incorporating large bands and orchestras.

Previously there had been only one GB Kalee compressor/limiter, mounted on a trolley and booked as required by a particular production. Useful for stopping unexpected over mods from enthusiastic actors.

In Bristol, a regional centre for the BBC in the West Country, the main control room housed the West of England Home Service continuity studio and control desk. WEHS and all the other regional home services opted out of the national programme from time to time, for news, part of the Today programme and suchlike. There was an announcer, who had main and spare mics, with cough-cut key, and a turntable which always had a standby disc on it in case of a programme breakdown or under-run. The operator had two quarter-inch tape machines for playing out regional pre-recorded programmes. All of this continuity function was superseded by the introduction of local radio. The old guard of senior staff in the main control room were horrified when an engineer from P & I D,

Planning and Installation Department turned up to install a Leak RSA (Response Selection Amplifier) in the continuity announcer's mic circuit. This was to reduce the amount of traffic rumble from Whiteladies Road, three floors below, by allowing the STC 4038, a figure of eight ribbon mic, the absolute BBC standard of the time, to be placed closer to the announcer, by rolling off the bass tip-up which is a feature of close(ish) working with a ribbon. It worked perfectly well, but the old guard refused to use it for some time, as the BBC's mainstay in all things was absolute fidelity, both from a technical and production standpoint. Microphones and loudspeakers were designed and manufactured to give an almost completely flat frequency response across the audio range, within plus or minus one dB, and to affect the flat response thus achieved was to fly in the face of all they held dear! What they ignored was the fact that equalisation was creeping in to the main studios by stealth, so many programmes which passed through their hands already "suffered" from non-fidelity.

It speaks volumes, though, that at the outset a non-professional piece of kit was used, designed to account for the indifferent living room acoustics of most audiophiles. It was undoubtedly of good enough quality, but was impractical for serious studio installation, so, within a few years, BBC Research Department designed RSAs, made by BBC Equipment Department, began to appear as pluggable units in most studios, but only a few units per studio - not the current EQ per channel expectation of modern desks.

When dramas were transmitted live there was a facility for prompting actors who had ‘dried’. The AFM (Assistant Floor Manager) would hold a pushbutton and press it to mute the studio mics whilst the prompt was given. The sound effects would continue and the mic signals would be replaced with a tape loop of atmosphere recorded when the studio was quiet. It needed a degree of discipline as any inadvertent pressing of the button could have serious consequences!

Sound Post Production in BBC Television 1960s to 2000.

Initially when television programmes were recorded either on film or videotape a full sound track was provided by the Sound Supervisor in the studio as if it were a live transmission. This meant that the Grams/Tape operator would play-in all the music and sound effects appropriate to the picture and script.

When television programmes were recorded on film (‘telerecorded’) sound post-production work could be carried out in existing dubbing suites and the work of the Tape and Grams operator could be postponed until after the pictures had been edited. This meant, for example, music need not be played in at the studio recording giving the Director the freedom to use differing takes within a sequence without ‘jumps’ in the musical performance. Audio tracks were available on which could be laid sound effects, incidental music and voice-overs etc. The whole could then be mixed down to one or two tracks, the full final mix on one, and an ‘M & E’ track, (Music and Effects) on another. This latter being all sounds except dialogue, which would be required if the programme were to be available in different languages.

This dubbing technique was not initially available to videotaped programmes. The editor could do some of the work and/or the programme could be played from one video tape machine through a sound studio, extra sounds being added and then the final mix rerecorded onto a second VT

machine. Finally this sound would be transferred back to the first machine to avoid reducing the picture quality by copying the latter.

Here, the reference is to quadruplex video recorders using 2"tape; machine time was expensive and the tape was optimised for recording the video signal across its width rather than the audio signal along its length, so with two machine-to-machine copies the sound quality was significantly compromised. Thus the need was seen for a dedicated area for post-production sound work and SYPHER was born.

The brainchild of Sound Manager John Eden-Eadon this facility used a multi-track audio recorder synchronised to a non-broadcast quality helical scan video tape machine this latter having a picture with burnt-in EBU timecode. Hence Synchronous Post dub with Helical scan and Eight track Recorder. When the programme was in the studio, ¼" recordings would have been made of all the takes for use when the video subsequently edited in was not the best sound. In the Videotape Area the programme sound was copied to one of the tracks of the audio machine and to that of the video player. The tapes were taken to a preparation room and work was done selecting and editing sounds against the video player pictures and timecode.

On the day of the dub the Sound Supervisor and Grams Op would move into the Sypher Studio, everything was played into the Sound Desk and a complete and final mix was recorded onto a designated track of the 8 track machine. The process could start, stop, and re-record whenever required until a satisfactory result could be reviewed. The tapes were then returned to the Videotape Area and VT staff would transfer the completed track back to the master videotape. The multitrack recorder ran at 7.5 inches per second allowing up to a 60 minute programme to be accommodated on one reel, but Dolby noise reduction was needed due to the slow tape speed.

The system worked well and over the years the principle remained the same, the technology evolving to offer such refinements as more tracks and computer assisted mixing. The fact that the Sound Supervisor in the studio would be the one doing the post production work was much appreciated by production teams, but it meant that operators did not 'live' in Sypher and know the equipment inside out, so they sometimes struggled to get the best results.

It was a wise Sound Supervisor and Gram Op. who learned about Video recording in the Sypher era, certainly in the later years when dubbing to D3 VTs. On "Eastenders" locations involving the 2 camera Insert Unit the Sound Supervisor used to change VTR tapes (VPR5 reel-to-reel), line up, record, play back & review programme material. Such skills were necessary abroad when on the Olympic Games, it sometimes fell to the SS to man the News Studio where he would be the sole Technical Operator.

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Authored by Pat Heigham, with valuable contributions, additions and corrections from:
John Howell
Bernie Newnham
Peter Combes
Mike Jordan
Mike Giles