

ENGINEERING

Summer 1987 No. 29

New Director of Engineering looks ahead.

"I am pleased to have this opportunity to reflect upon what I see lying ahead for engineers and engineering in the BBC over the next five years.

The real world of broadcasting in the United Kingdom sees RDS immediately upon us in its first phase of infancy, with a significant impact anticipated on listening habits so desperately needed to coax the listener to VHF-FM; similarly we have an early opportunity to incorporate the benefit of stereo sound with television. In the more speculative areas the technology of Digitally Assisted Television (DATV) is just around the corner; whether the broadcaster uses it as quickly as technically possible remains a more sophisticated non-engineering argument.

BBC engineers are seen once again demonstrating that they are at the front of the queue in developing a further new era of technology to the benefit of broadcasting in general, and the BBC in particular. It remains important in my opinion for this situation to continue, and not to allow a situation to develop where the BBC is merely reacting "post hoc" to the impact of new technology. This is particularly important given a situation where the broadcasters are not wholly convinced of the benefits of the new technology.

Whilst providing the engineering climate within which programme making can be developed in the most cost effective way, our technical standards should not be allowed to fall. BBC engineering continues to lead in the field of broadcasting research and development, and both our engineering excellence and our operational standards in Radio and Television set an example which is envied by broadcasters the world over. It will

be a testing time over the next five years, given the overall environment within which the Corporation will have to work, but there are no grounds to suggest that there is any incompatibility between this environment and the commitment to further the excellence of engineering.

The development of the White City site, which to many people must seem a slow process, will be a dramatic event for those involved both in managing its execution and its occupation. The profile of the project is heightened since it offers for the first time the opportunity to build a centre that will incorporate the latest technical advances in the fields of radio, television and business communication media. Whatever broadcasting use is finally realised on the site the techniques used will have the capacity for expansion and to carry the BBC into the next century.

In contemplating the next five years we must not forget the sterling work of transmission engineers, whose efforts so often go unnoticed. Theirs is a remarkable success story of using technology to advance transmitter operation and automation to a very high degree of refinement. After all, without a reliable transmission network viewers and listeners alike would become disenchanted with the service however excellent the programme material.

Finally, on a personal note, I would like to say a sincere thank you to all who were kind enough to send their best wishes on my appointment. I can do no more than hope you will continue to give me the level of support you have so readily given to Bryce over the past years."

Bill Denny

Editorial

Congratulations

I am sure that all engineers will join me in congratulating Bryce McCrirrick on the award of the CBE in the recent Birthday Honours list.

Deadline

Copy date for the Autumn edition of Eng Inf is September 4th, and I would welcome any stories, articles or material by then. If you feel that your job, department, project or new facility deserves a wider audience, why not contact me on LBH 5432 or Room 707, HWH.

Alan Lafferty

Licence Agreements.

The following licence agreements have recently been granted.

The DIGITAL AUDIO WAVEFORM GENERATOR, GE7S/21, is available from Pro-Bel Ltd. of Reading. This unit provides left and right signals, either independently or locked together, to the AES/EBU 48 kHz format; several spot frequencies are provided in either sine, square or ramp waveforms, and discrete output levels are selectable.

BAL Components Ltd. of Nuneaton have signed up for the component video MATRIX AMPLIFIER, AM23/521, of which four versions are available. Conversion between RGB and YUV can be achieved in either direction, and at either standard PAL amplitudes or 700 mV weighted. (EDI 10531 refers).

Another, licence which has been recently agreed, is for the Radio Data System transmitter, CD4L/21; this is available from both VG Electronics Ltd. of Hastings and Eddystone Radio Ltd. of Birmingham. The equipment was described in some detail in Issue 26 of Eng. Inf. (Autumn 1986), and includes all the hardware and software required to be able fully to utilise the RDS methods of operation.

Details of these licences are available from the Liaison Engineer, Peter Jefferson, 108 Western House, LBH extn. 4345.

Transmitter News.

The following transmitters have opened or changed since March:

UHF Television

Brixham	Devon
Cilycwm	Dyfed
Durness	Highland
Easdale	Argyllshire
Holyhead	Gwynedd
Singleton	W.Sussex
Southend	Argyllshire
Tayvallich	Argyllshire

VHF Radio

Belmont	Lincolnshire
Les Platons (R3)	Channel Isles
Wenvoe	S.Glamorgan

Local Radio

Redruth	R.Cornwall
Isles of Scilly	R.Cornwall
Exeter	R.Devon
North Hessary Tor	R.Devon
Okehampton	R.Devon

RDS

RDS codes are being radiated from the following:

Sutton Coldfield x	R1/2,3,4
Wrotham	R1/2,3,4
Peterborough x	R1/2,3,4
Tacolneston x	R1/2,3,4
Wenvoe	R1/2,3,4
Lancaster	R.Lancs
Hameldon Hill	R.Lancs
Winter Hill	R.Lancs
Mendip	R.Bristol
S.Benfleet	BBC Essex
Sandy Heath	R.Beds
Crystal Palace	R.London
Swingate	R.Kent
Heathfield	R.Sussex
Sandale	R.Cumbria
Sutton Coldfield x	R.Derby, R.WM
Peterborough x	R.Cambridgeshire
Tacolneston x	R.Norfolk

Codes are PI,PS,AF,ON & CT

New digital editing suite for TRU.



The TRU digital editing suite.

The advent of digital recording techniques into audio areas has in some cases revolutionised operating practices, despite the fact that much of the hardware is based upon modified video equipment. For about four years, Transcription Recording Unit have been using the Sony F1 format/B-max video cassette system as the mainstay of their 2-track audio recorder complement for monitor-mix recording at live concerts. Apart from the obvious quality advantages, it has also meant big savings in line-up time and tape costs. Digital recordings also foresee the future requirements and technical format of programmes distributed to Transcription Service customers.

However, TRU have encountered some problems when it comes to editing material in this form. To this end, TRU acquired the Sony PCM1610/DAE1100 recording and editing system, which uses modified NTSC U-matic video recorders, and in order to enable transcoding (conversion) from the F1 system to the 1610 system to facilitate editing, they also acquired an "Audio and Design" modified PCM701 processor. It became evident that a dedicated work environment for the editing system was needed and this has materialised as TRU Digital Editing Suite, believed to be the only dedicated facility of its kind in the BBC.

The Editing Suite is equipped with a pair of Sony 5850 U-matics, a PCM 1610 processor, a DAE 1100 editor, an F1 system comprising an A & D professional PCM 701, and C9 Betamax, A & D Ad-mix processor which can interface with the 701, and auxiliary 701 for the addition of reverb. A Neve 10 into 12 analogue sound desk enables monitoring and mixing from analogue sources, and a video switching

unit interconnects all the components of the system in its various modes.

In reality, the Digital Editing Suite is two rooms; a working area and an apparatus room. A large window with sliding double-glazed units links the two rooms, behind which, in the apparatus room, the system hardware is positioned whilst being acoustically and thermally isolated from it. The working area contains a purpose-built console which encompasses the control surface for the editing system, an analogue mixing desk and a computer used in conjunction with the editor for TRU's own development: "Transcode Editing".

In practical terms this has removed much of the system hardware from the listening environment, leaving only the control surfaces and monitoring system. This reduces background noise to a minimum and offers easier monitoring of the quiet passages of digital recordings which is more important in view of the improved signal-to-noise ratio available.

To keep costs down most of the installation work was done in-house. The control surfaces are mounted in a TRU manufactured customised console, the analogue desk was purloined from Radio Training when they left the Langham. The glass screen behind which the rest of the equipment is positioned was fitted by House Services. The acoustic treatment of the control room is a little bright, but should improve when heavy drape curtains are fitted.

Thus F1 material can be transcoded to 1610 format, edited, announcements added, and reverse-transcoded back to F1. However, this process is very time-consuming; a 3-hour programme requires continuous monitoring to ensure that there is no data corruption. To reduce the man-hours spent monitoring tapes, Gareth Watson from TRU wrote a computer programme for a BBC Micro that enables editing directly from F1 to 1610, basically by "fooling" the DAE1100 editor into thinking it has a U-matic across its input when in fact it has a C9 Betamax machine sitting there, this process being known as "Transcode Editing". This innovation drastically cuts down the time taken for the whole programme which enables the monitoring

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Film dubbing at Lime Grove.

The film dubbing theatre at Lime Grove has recently undergone a major refurbishment by PID Tel using minimal outside contractors. A new control desk and small studio have been installed and the working arrangements transferred to forward projection from the old back projection system. The new area has a similar desk to the new Manchester theatre.

The old type C desk, which had to be constructed in the mixer room when the theatre was built, has been replaced with a Calrec desk offering twenty-eight channels that can be mixed down into four stereo groups. Gone are the old quadrant faders associated with the Type C and in their place will eventually be special motorised faders driven by linear motors. The desk will soon be fitted with computer control, the software for which has been specially adapted for BBC use from the music industry standards. Associated with the desk are AMS digital reverb and delay units and two Klark Technics graphic equalisers re-installed from the old theatre. LS 5/8 loudspeakers are used for monitoring.

The sound effects area remains unchanged with four Technics gram decks fitted in SCPD bases, two Studer B62 reel-to-reel tape machines, two Soniflex cartridge machines and a Philips CD player. An extensive gram library completes the set-up. The projection room also remains substantially unchanged, except that the two Albrecht PB42 projectors

no longer have the complicated optics for back projection. Normally only one of these is used, in a forward mode, projecting to a conventional 1 metre wide screen in the mixer room over the head of the dubbing mixer. A Sony DXC101 CCD camera is coupled to the projector to provide pictures for the new studio next to the control room. Video dubbing is also possible via a BVU 800 U-matic and Editon synchroniser in the projection room, and Sony 26-inch monitor in the mixer room. The arrangement of the four Duplex Perfectone Rapimag film recorders in the projection room has not been changed. The whole theatre is locked to bi-phase pulses, which are converted into time-code for the desk controller.



Lime Grove dubbing theatre mixer room

An unusual part of the refurbishment is the new dubbing studio. A prefabricated galvanised steel acoustic cabin was purchased from Sound Attenuators Limited. This was constructed by them on top of a concrete screed laid by Building Engineering Services at Lime Grove. Sound Attenuators were also responsible for all of the electrical work, air-conditioning and decoration of the cabin/studio. Being the first medium-sized studio to use this arrangement, Ian Hare from Film Unit, PID Tel, who was project leader for the refurbishment, was pleased to find that it fully met operational requirements, including the 0.1 second reverberation time. He said, "Using a prefabricated studio was a much quicker and cheaper alternative to conventional practice, and without all of the normal building disturbance".

The new studio features a small range of sound effects equipment such as a re-deployed gravel tray, as well as Neuman, AKG and ECM50 mics. A Sony monitor is coupled to the CCD camera in the projection room for dubbing, and an LS3/7 speaker is provided for sound foldback.

TRU Digital Editing Suite continued from Page 3

equipment to be set up in a quiet period overnight and by morning the computer provides an error-status readout of both the 1610 and F1 cassettes; the tape can then be accurately checked at any 'error points' for audible degrading.

Roland Allen, who planned and built the Editing Suite said: "Our main objective when we set out to design the suite was to make it as convenient in use as possible whilst accepting that this facility would be somewhat experimental by nature. It has now been working successfully for four months and is processing all our serious music output".

Research Department demonstrate digital audio editor.



Demonstrations of the disc-based digital audio editor, which is in its final stage of development at Research Department, were given to senior engineering management and operational staff at Broadcasting House on 22nd May.

During the demonstrations, a news bulletin was recorded from the ring-main and then edited to show the capabilities of the equipment. The order of the news headlines was changed and a mistake by the news-reader was corrected.

The equipment uses two winchester discs on which nearly one hour of stereo can be recorded. A 68000-based computer control system allows the operator to replay recordings from the discs and identify the sections which will be needed in the final programme. These sections can then be arranged in any order to build up the

required programme which can be replayed immediately.

By turning a wheel on the control panel, the operator can 'rock and roll' through a recording in the same way as spools of tape are rocked by hand so that edit points can be identified accurately whilst hearing the programme material.

A powerful feature of the equipment is that edits are performed non-destructively as the programme is replayed. As a result edits can be adjusted and rehearsed any number of times until they are precisely correct and, if necessary, material previously discarded can be re-inserted into a programme.

Installation of the Digital Audio Editor at Broadcasting House is planned for later this year when work on the Digital Transfer Suite is completed.

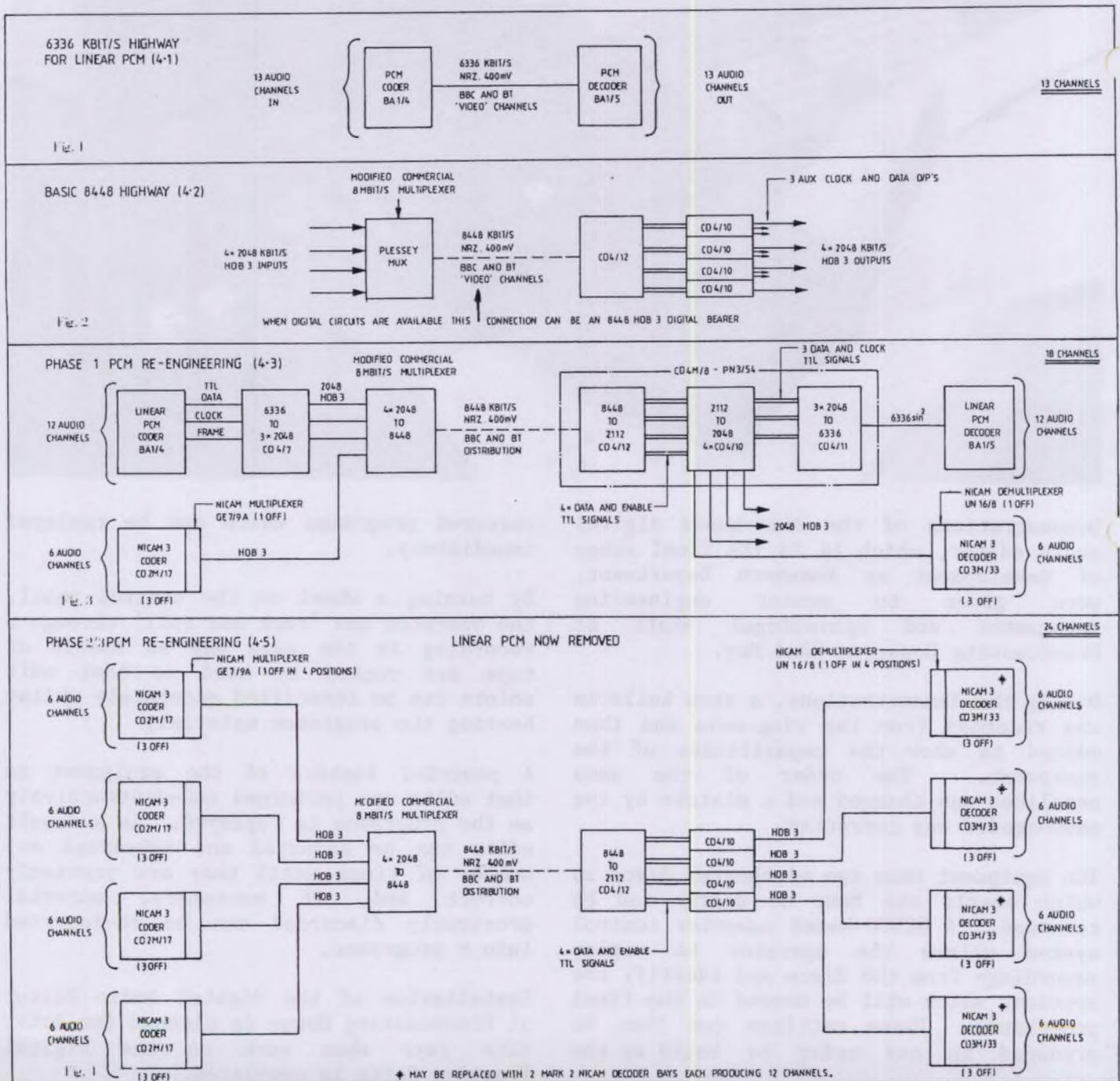
PCM re-engineered bit by bit.

The first phase of PCM re-engineering has very nearly been completed. This article gives a technical overview of the present system, outlines the development of phase one and looks at stations which will be PCM-fed in future.

The major building block of PCM is the BBC-developed NICAM system (ref 1,2) which (among other arrangements) can code six high-quality audio channels into a CCITT standard 2048kb/s (2Mb/s) digital multiplex package. This equipment is in widespread use in the BBC, and is made commercially under licence by ST&C.

However, the necessary supporting equipment to allow economically-phased National PCM development, is just as important. The CD4M/6 and CD4/11 are transcoders which have been designed to split twelve channels of the linear PCM system into three 2Mb/s multiplexes, and then recombine them into 6336kb/s "linear PCM". Other Multiplexers and Demultiplexers are used to form the 8448 kb/s distribution signal and then separate the various 2Mb/s tributaries as necessary.

The way the PCM re-engineering has



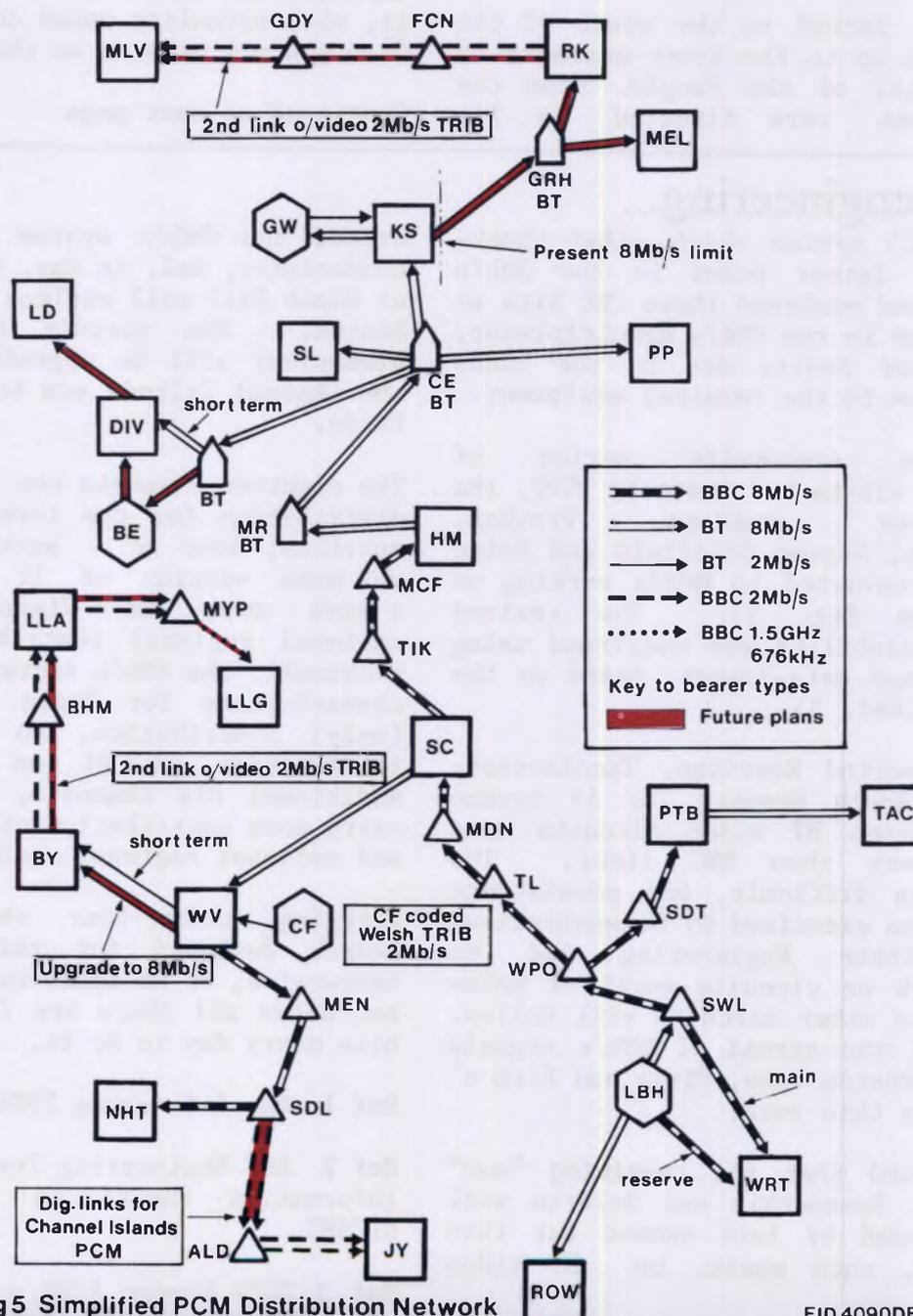
developed is shown in figs. 1 to 4. By the end of the present scheme the equipment in service will be as shown in fig. 3 with decoding at fifteen locations.

The actual progress of commissioning the 8Mb/s system has been slower than originally envisaged, as often happens with innovatory systems, but in overcoming the various snags a superior equipment has evolved. During proving tests between London BH and Wrotham on the "roof-link", it became apparent that system jitter, caused by the various multiplex/demultiplex processes, was causing linear PCM decoding problems. (It should be borne in mind that the 13-

channel system was in service before jitter was invented!). It also became clear that it was extremely difficult to distinguish between PCM equipment problems and faults due to bearer interruptions.

D&E investigated the problem and quickly found solutions. First they reduced the jitter in the 8Mb/s bearer to less than the linear PCM could detect. Then they designed subtle modifications for the linear decoders so that they could tolerate much more jitter (to make absolutely sure of reliable working). Finally they designed a Cyclic-Redundancy

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EID 4090DF

The Queen's visit to China: Part II.

Barry Luckhurst, from Tel OBs, concludes his account of the technical aspects of the Royal Visit to China in 1986.

The Welcoming Ceremony

The Queen arrived at the old airport in Beijing on the evening of Sunday 12th October and the welcoming Ceremony took place the following morning. Television coverage of it was transmitted live to London and recorded for later transmission.

Following the ceremony, "Breakfast Time" links and interviews were recorded.

The CMCR was parked to the south of the steps leading up to the front entrance of the Great Hall of the People. From the CMCR cameramen were directed by Tim



The Shanghai television studios

Marshall through an interpreter. It had four China. Central Television (CCTV) cameras, and one from BBC News linked to it, with actuality sound coverage obtained from gun microphones on the cameras.

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PCM re-engineering...

Checking (CRC) system which added check-bits at the latest point in the 8Mb/s multiplexer and analysed these CRC bits at an early stage in the 8Mb/s demultiplexer. This separated faults due to the links from those due to the terminal equipment.

Following a systematic series of modification visits and tests by TCPD, the first four stations Wrotham, (Peterborough, Sutton Coldfield and Holme Moss) were converted to 8Mb/s working on 15.1.86 (see fig. 5). The revised equipment reliability was confirmed using a TCPD-designed data-logger, based on the BBC Micro. (Ref. 3).

As TCPD converted Rowridge, Tacolneston, Wenvoe and North Hessary Tor it became clear that some BT video circuits were poorer bearers than BBC links. The situation was difficult, but persistence and persuasion exercised by Communications and Transmitter Engineering led to remedial work on circuits north of Holme Moss; work on other circuits will follow. This allowed the spread of 8Mb/s signals to Sandale, Pontop Pike, Divis and Kirk o' Shotts in May this year.

It is expected that the remaining "new" equipment at Rosemarkie and Meldrum will be commissioned by late summer but this does depend, once again, on BT video circuits. In the near future, it is planned to

extend the 8Mb/s system to Belfast and Londonderry, and, in due, course equipment at Black Hill will replace that at Kirk o' Shotts. The circuit from Wenvoe to Blaenplwyf will be upgraded to 8Mb/s and the Channel Islands are to have two 2Mb/s feeds.

The eighteen channels now in service carry distribution for the three stereo VHF-FM services; four mf services; a special vhf mono version of 1f R4, to fill a mush area in Ulster; and three national regional contribution circuits. Eventually the 8Mb/s bearer will carry two channel-pairs for Radio 1 and Radio 2 (only) distribution, to cater for the introduction of R1 on VHF-FM. The additional six channels, long-term, will carry more contribution circuits and local and national regional radio feeds.

Carrying twenty-four channels on the bearer designed for thirteen may seem impressive, or at least worth waiting for, but after all there are 729,907.2 million bits every day to do it.

Ref 1 Eng Inf Autumn 1984.

Ref 2 BBC Engineering Training Information Sheet: An Introduction to NICAM3.

Ref 3 TCPD Report 1/87 - Findings of the NICAM Data Logging Project.

CHINA: continued from previous page

BBC staff rigged a position from which Sue Lawley could give her commentary in a small coach provided by CCTV. The BBC provided the lip microphones that were used. Frank Bough's "in vision" position for the "Breakfast Time" links was covered by cameras three and four. He and his interviewees were provided with stick and lanyard microphones. Communications to personnel other than the cameramen were by means of further radio talkback sets.

The Great Wall, Badaling

The Queen was taken to the section of the Great Wall at Badaling about 50 miles north west of the centre of Beijing. The Wall is approximately 3000 miles long and much of it is in a state of disrepair, but this section has been extensively restored. Her Majesty was due there on 14th October in the afternoon. We recorded links and interviews for "Breakfast Time" during the latter part of the morning and they were fed to London prior to the live feed of the walk itself.



The STV OB van in position in Shanghai

The CMCR was driven there the day before and parked hard by an arch where the road goes through the wall. ITN had already installed the News Hawk on a high tower on the west going section of the wall about half a mile from the road. It had been lowered into position by helicopter and was powered from a portable generator.

The commentary positions were rigged in a coach as before, with a second one for ITN. An error in the cabling of the feeds led to TV AM getting Sue Lawley's commentary at the beginning of transmission, although the mistake was quickly rectified.



Cable de-rigging, Shanghai style

The China Telecommunications Directorate and British Telecom provided two standby commentary and two four-wire coordination circuits, plus three direct exchange lines.

The vision signal was fed through a stereo sound-in-syncs coder. The stereo sound signal had the BBC commentary on one channel and ITN's on the other. The composite signal, with clean effects (or recorded sound), was fed via a microwave link to the News Hawk and then to London via the Indian Ocean Satellite.

After the end of the transmission we fed some recorded material down the line, and then had to de-rig the BBC equipment. We then moved at some speed to the airport in order to catch the plane to Shanghai, with barely two hours between the start of the derig and the plane's take off. We made it on time thanks to Mark McConnell and Tony Crake of Comms and to Peter Chow and Nick Buckley of News.

The Old Town, Shanghai

The OB team emerged from Shanghai airport at past 10 o'clock in the evening, but we went straight to the Old Town where Shanghai Television had been rigging since 5 o'clock. Apart from a problem of access to the camera positions in Yu Yuan Gardens, everything seemed to be proceeding very well. The main CMCR was parked near the centre of the town overlooking the lake, whilst the second was in a side street near the entrance. The next morning, we recorded and fed the "Breakfast Time" links and interviews. The Queen arrived at about 4 o'clock in

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CHINA: continued from previous page
the afternoon and the coverage was transmitted live to London. We then recorded further links for the next day's "Breakfast Time", although by this time it was beginning to get dark.

On this occasion the cameramen were directed by two Chinese directors, one in each of the two CMCRs. They worked to the overall direction of Tim Marshall in the main van and Dave Pickthall in the second. They spoke passable English but nonetheless the interpreter remained on hand, which was just as well as I found that I needed her services to sort out technical problems more than I had done hitherto.

The output of the mixer was fed from the second to the main unit. They were kept in touch by means of radio talkback, actuality sound coverage coming from gun microphones on the cameras.

The "in vision" position for the "Breakfast Time" links and interviews was covered by cameras seven and eight. An attempt to use radio microphones in position, was abandoned in favour of a cabled stick microphone.

The pictures from camera nine inside the Teahouse were considerably underexposed. STV had brought some lights with them but we were not able to use them mainly because the Chinese were very wary about having lights in historic wooden buildings, and because of the protocol involved in televising Her Majesty eating or drinking.

We then went on to Guangzhou, a more leisurely move compared with that to Shanghai.

The Children's Performance, Guangzhou

Her Majesty the Queen was in Guangzhou for one day only. She was taken to the "White Swan" hotel for lunch, and then onto the Children's Palace, arriving at the Bud Theatre to watch "The Muppet Show" at about half past three. We transmitted the whole of the performance live to London and to the whole of Guangdong Province.

The CMCR, from Guangdong Television, (GDTV) had parked up at the side of the theatre early that morning. From it Tim Marshall directed the cameramen with the help of a GDTV Director acting as an interpreter.

Actuality sound of the arrival and departure was obtained from gun microphones. These, and the stage microphones, were mixed on a desk located in the front stalls. The lighting control desk was also situated in the front stalls although thankfully on the other side of the theatre. Both positions were equipped with monitors.

The lighting of the show left something to be desired. The little girl who was presenting the show and introducing the acts always missed her mark to the point that I began to wonder if my request that she be told where to stand ever reached her. Another difficulty was caused by a banner welcoming the Queen which was placed across the top of the proscenium arch and very successfully flagged off the key lights from the back of the stage. Commentators' positions were provided in a small room just off the main auditorium and overlooking the side courtyard. Most of the commentary was "off tube".

Guangdong Television's "OB Vans" are not equipped with 1" video recorders and so the back-up copies were made on 3/4" BVU machines. The composite signal (vision and clean effects and performance sound) was sent by microwave link to GDTV's studios and thence, via another microwave link to Cable and Wireless in Hong Kong for onward transmission to London. The China Telecommunications Directorate and British Telecom supplied the two outgoing commentary and two, four-wire co-ordination circuits.

That was the last programme we made on the Queen's tour. She boarded the Royal Yacht that night for an extremely slow cruise down the Pearl River into Hong Kong. The OB team left Guangzhou the next morning, our hydrofoil overtaking "Britannia" en-route.

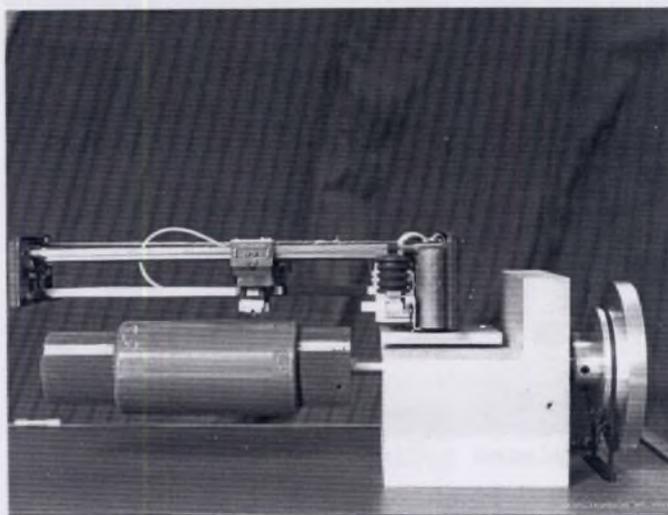
I had mixed feelings at the end of the venture. We had certainly broken new ground. We had managed to transmit live pictures from The Great Wall, which is something the Americans had not tried. We had made four programmes transmitted over six days and filled nearly three hours of air time - more if you include the compilation programme in the evening. I could not escape feeling though that if I could have done it all again with the knowledge that I had gained, there would have been many improvements and less problems. Perhaps the Chinese practice of self-criticism is catching!

New machine to replay old cylinders.

Since the early days of radio broadcasting the BBC has used the state-of-the-art to make and reproduce sound recordings. However, the phonograph or cylinder player never featured as a recording device, although it was used to replay early cylinders. Until recently the only replay equipment for cylinders in the BBC was a modified Eddystone machine some 60-70 years old which had appalling reproduction because of mistracking and rumble.

Historically the first phonograph was invented by Thomas Alva Edison in 1877, and patented the following year. His first machine consisted of a metal drum with a fine spiral groove across its length, and this was covered by a sheet of tin-foil. A handle attached to the drum provided rotary motion, and a mica needle attached to a diaphragm provided the record/replay function. This system was not a great commercial success, and it was some ten years later that Alexander Graham Bell and C.S. Tainter perfected a method of recording sound onto a wax surface having a paper or cardboard foundation. Edison, too, filed a patent in 1888 for his white wax cylinders. Instead of indenting the sound onto tin-foil, the stylus cut a track onto the wax.

About the same time Emile Berliner successfully produced a machine that made a recording on a flat disc. The advantages of easier manufacture and storage of this system were eventually instrumental in the demise of the cylinder. Furthermore, another fundamental difference between the Edison and Berliner system of recording was that with the latter method the track was lateral and the recording stylus moved from side to side, rather than up and down ("Hill and Dale") as with the Edison method. The lateral tracking flat disc system became accepted commercially and by 1912, Edison had begun employing the flat Berliner disk with a standard speed of approximately 78 rpm. During the early 1920's cylinders became obsolete. However, many valuable recordings were made on cylinders and about 5-600 have survived in the BBC's gramophone library. Particularly interesting are the fragile white wax cylinders, dating from the 1880's which include many historical recordings. The majority of the catalogue consists of "commercial releases" of the time ranging from opera to light music. It represents a valuable archive provided



The cylinder player pick-up arm.

that it can be replayed and recorded onto a more dynamic medium for broadcasting.

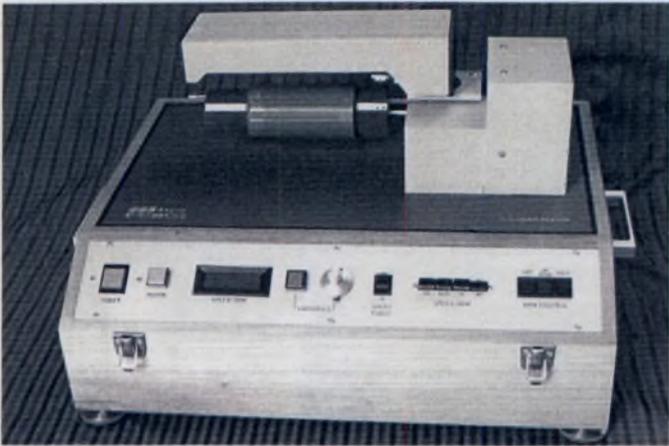
This was the challenge facing Pete Thomas from BBC Radio's Operational Engineering Services when he was asked to produce a modern machine, to replace the 60 year old model, which would take account of the variations in speed, groove-size and cylinder-size without destroying the original cylinder in the process. He turned to the National Sound Archives to see how they reproduced cylinders and found that they were facing a similar problem. As a collector of 78 rpm records, Pete used his contacts to see if his fellow collectors had better machines; he also contacted broadcasters around the world to find out what commercial machines were available.

The research took some time, and most machines were rejected because of the operational facilities they provided and because of the costs involved. The only solution was to build a machine that would meet operational requirements, using existing in-house facilities, in between other more important tasks, and at minimal cost. A survey was launched to find existing "off the shelf" products which could be suitably modified.

The first problem to be solved was where to find a motor that could drive the cylinder at speeds varying from 50 to 250 revs per minute. Record decks were the obvious choice, but their speed range was limited. Tape machines offered a better

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Cylinder player cont.



The completed cylinder player.

alternative and the choice was eventually made to use a Studer A80 motor linked via a belt drive to the mandrel. The servo system associated with this motor offered either continuously variable speeds, or fixed speeds, both controllable to a fine tolerance.

The specification for the pick-up arm was more complex. The arm needed to cope with warped or damaged cylinders whilst still tracking accurately. This led to a low-mass system, with a tangential movement, rather than a pivoted arm that was more prone to bounce and poor tracking. The choice was made for a Revox arm. Although the response time for lateral warps and variation in track pitch was quite good enough for a normal turntable, it did not quite fit the specification for replaying cylinders. Several modifications to the servo loop resolved these difficulties.

The final problem was the choice of styli and cartridge. The cartridge needed to be very stiff (ie, low compliance) if it was to track warped cylinders successfully and for mechanical robustness the Shure SC35 - already in use in BBC studios - was an obvious choice. The styli were retipped in five sizes ranging from 0.0037 inches to 0.018 inches.

Compare these sizes with the standard 0.0006 inch used for current day micro-groove long playing records!

The mandrel on which the cylinder would be mounted was made from solid aluminium in BBC Radio's mechanical workshops. The cone shaped mandrel, 8 inches in length was to be supported at only one end. The design was chosen to allow different sizes of cylinder to be used, and allowed easy

accessibility for the fragile cylinders when the pick-up arm was swung out of place. To achieve this, two fine-tolerance bearings spaced about 2 inches apart were precision engineered in the workshops to support the mandrel. The mandrel was covered in a stiff felt which enabled the cylinders to be firmly gripped without causing them to crack under undue pressure.

Operational controls were engineered to enable ease of use. A variable speed control and pre-set switches for the common commercial speeds were electronically linked to a digital readout so that, once the correct speed for a particular cylinder had been established, it could be unobtrusively marked for future playings. The pick-up arm controls offer left and right movement as well as up and down. Cylinders tend to have no lead-in or lead-out groove and the modified Revox controls provide these necessary functions.

The electronic output of the player is set to line level, without equalisation, by internal pre-amplifiers. In normal operation the dual-channel (stereo) output of the player is linked to a Packburn 'de-clicker'. This selects left, right, or sum signals according to which is providing the least noisy output and produces a final frequency response of up to about 6 kHz. The de-clicked output is then equalised and recorded onto standard magnetic tape for future replaying. Surprisingly the output quality of the archive material is very good, with most background noise and scratches coming from poor replay equipment and not from the original recordings.

Besides use in BBC Radio, the new cylinder player is taken to record auctions and to private collectors who allow the BBC to copy their recordings. The National Sound Archives were consulted during the initial stages of the design and manufacture of the new player, and engineer Lloyd Stickells, who was already working on a similar design, gave much valuable advice. Credit must also be given to Peter Bulley, from BBC Radio Operational Engineering Services, who took over the project from Peter Thomas and saw it to completion; to Derek Lewis from the BBC's gramophone library transcription service who provided much operational expertise; and to the BBC Radio mechanical workshops, who's skilled engineering translated into a first class piece of equipment.