ENG INF

The quarterly for BBC engineering, technical and operational staff

AUTUMN 1993 No 54

Studio TC6 re-opens

Studio Production Resources

Panoramic view of TC6 studio floor

Studio 6 at Television Centre (TC6) re-opened in September after a complete refurbishment. It offers a facility which is strongly competitive in the market-place — in terms of equipment, style and cost — and which underlines the BBC's commitment to its internal resource base.

John Lightfoot — Head of Studio Production Resources — told **Eng Inf**: *"This major capital investment confirms BBC management's commitment to a strong internal resource base, within the Producer Choice system. We needed fewer studios than in the past, but those we keep must still provide reliable facilities for our programme-makers. I am delighted that we are being supported with the right tools for success."*

Tim Manning — General Manager of TE & PS — added: *"We have been pleased to be in partnership with Studio Production Resources in this collaborative venture to provide BBC programme-makers with the latest technical facilities in the refurbished TC6."*

Starting on page 3 is a description of the new facilities.

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ENG INF

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This is the last issue of *Eng Inf* that I will edit, as I'm starting a new job with EBU Technical Publications in Geneva, during January 1994.

My warmest thanks go to the many contributors who have helped fill these pages with interesting and informative articles over the past six or so years.

My EID colleague, Dan Smith, is taking over for the time being and I wish him every success.

Mike Meyer

Transmitter News

The following services have opened, changed or closed since the last issue:

New TV relays

Cromarty	Ross & Cromarty
Earl Sterndale	Derbyshire
Gorleston	Norfolk
Lochgoilhead	Argyll
Lydgate	W. Yorkshire
Risca	Gwent

Addition of *Nicam* Stereo

Craigkelly	Fife
Tacolneston	Norfolk

New FM stations

Marlborough	Wilts

Radio 1 on FM

Limavady	Co. Londonderry

Radios 1 and 4 on FM

Bowmore	Islay
Cambret Hill	Dumf. & Galloway
Keelylang Hill	Orkney
Long Mountain	Powys
Port Ellen	Islay
Varteg Hill	W. Glamorgan

New LR relays on FM

Marlborough	Wiltshire Sound

It's time to sync your PC!

For a number of years, the punctuality of broadcasting operations in LBH has been based on a sophisticated *Time Standard*, comprising a system of highly accurate and stable clocks. Radio Production Resources will soon be offering a pilot service to make the LBH Time Standard accessible over the *Public Switched Telephone Network* (PSTN).

Information on date and time, in coded data format, will be available to anyone with a telephone modem and PC or other computer system. It is hoped that the service will prove useful to computer systems which do not currently have access to a high-stability real-time clock. It is foreseen that such systems would dial in to LBH periodically and resynchronise themselves to the Time Standard; the frequency of dial-in would depend on the stability of the remote clock and the degree of accuracy required. Daily or weekly dial-in is anticipated for such applications.

Two identical sets of terminal equipment are provided at LBH to support the service. One set, accessible via a single *Direct Exchange Line* (DEL), will supply Universal Co-ordinated Time (UTC) information which is notionally the same as GMT. A duplicate set, accessible via a second DEL, will supply time-of-day information which takes account of GMT/BST changes automatically.

How accurate is it and what will it cost?

The LBH equipment will supply time information accurate at source to 3 mS. However for this accuracy to be realised at the remote end of the telephone connection, account must be taken of the delays inherent in the PSTN. The LBH equipment can be switched into a loop-back test during a dial-in call, so that the remote system can measure the round-trip delay to LBH. Provided that the delays on "go" and "return" paths are symmetrical (ie equal), the remote system can calculate the correction to be applied to time information supplied by LBH; the remote system clock can then be maintained to an accuracy of 5 mS, provided that it is capable of resolving intervals as small as this.

Unfortunately, it is not possible to guarantee symmetrical delays on a PSTN that is largely composed of digital plant. Advice has been sought from BT on the maximum asymmetry likely to be encountered in practice. When received, this will form the basis of the Accuracy Statement in the *Technical Data Sheet* to be issued for the service. In this context it should perhaps be noted that the real-time clock on a PC cannot resolve time to better than 55 mS.

Calls to the LBH equipment will be delivered via the BT *Callstream* facility which allows the BBC to recover a small sum of money from each call. Lest anyone be deterred from using the service on the grounds of cost, it should be noted that a typical call will require a connect time of less than 20 seconds. At the peak rate of 48p per full minute, it should cost no more than 16p while, at standard rate, this would fall to 12p.

How can I use the service?

At the time of going to press, the telephone access numbers had yet to be assigned by BT. However, the service should be in operation before Christmas.

Anyone wishing to use the new service, or requiring a Technical Data Sheet on it, should contact Andrea Kafizas of Radio Projects, in Room 504 Western House (LBH ext 54304). Andrea should know the telephone numbers by the time you read this, and will have details of software for an IBM-compatible PC.

Roger McCartney
Radio Projects

The refurbishment of Studio TC6

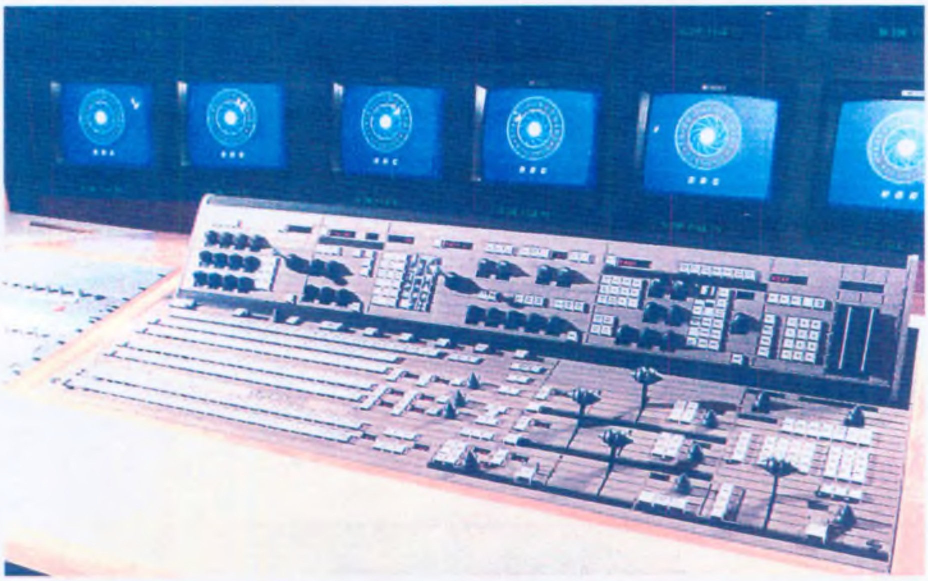
Members of the project team describe the new facilities provided in TC6 at Television Centre.

TC6 came into service in 1968 as the BBC's first large colour studio. By the Autumn of 1991, its equipment was between sixteen and twenty-three years old and it had become barely capable of meeting current production requirements. The decorative condition was poor and the whole package was generally unattractive to programme-makers.

This was at a time when the number of BBC studios in London was being radically reduced. The strategy was: (i) to reduce staff and resources to a scale that gave us viability and (ii) to improve efficiency and reduce costs. However, under Producer Choice, our studios had to become the preferred choice of programme-makers by being competitive on price, facilities and environment.

To achieve this aim in TC6, it was necessary to reduce the cost of the planned refurbishment by one third and at the same time continue to provide engineering and operational staff with the proper tools to complement their skills. We were also keen to provide an environment which was smart, but not lavish, calm and comfortable to work in for long periods.

A major problem in TC6 was the difficult access to the control room suite from both the studio floor and the rest of the building. If the studio was to be made more attractive, access had to be improved, so we decided to move the control rooms to the ground floor. This was not an easy decision as the available space was small and the maximum ceiling height was limited. It has, however, brought many benefits, not least for disabled staff.



Studio Production Resources

TC6 Production Control Room: the vision mixing position

In the past, all Television Centre studios were equipped to handle the most complex productions, even though the demand for such complexity was rare. The majority of programmes made in our large studios are of medium complexity — Comedy, Variety and Childrens Programmes. With limited funding it was essential to target the needs of these programmes as a priority. TC6 would not be built to handle a General Election, Children in Need or other complex programmes for which TC1 and TC3 are well suited.

Nevertheless, it was important for TC6 to be seen as a market leader with the infrastructure to meet programme-makers' requirements well into the next century. This led to the choice of a serial-component digital vision system which provides a solid foundation for future developments. This innovation put extra pressure on cost reduction elsewhere in the scheme. Every part of the installation was carefully examined to eliminate all those items which were: (i) "nice to have" (but not essential), (ii) traditional (but rarely used), (iii) duplicated or (iv) customised. The aim has been to use standard products wherever possible and keep customisation to a minimum.

Operational staff have needed to adapt their techniques to use a system which is flexible enough to make a range of programmes in a professional manner.

Project Overview

The refurbishment of TC6 was managed by Wynne Griffiths of Television Engineering & Project Servives on behalf of Studio Production Resources. After initial planning, which started in November 1991, the studio was taken out of service on 6th July 1992 and returned to service fourteen months later. A trend-setting aspect of

Drake

TC6 Vision and Lighting Control Room with Production Control Room in the background

the project was that the customer and the implementers were involved in the project team more closely than ever before. All areas of the studio were brought up-to-date, but this did not always involve new equipment as many items were refurbished.

Asbestos in the area was removed at the beginning of the project, inevitably requiring the whole area to be cleared. The studio structural trusses were stripped, cable-ways emptied and cleaned, and the air conditioning system had various silencers removed. Miscellaneous pipes were revealed almost everywhere you looked. Finally, the whole area was cleaned and handed back to the project team for the rebuild.

The asbestos work was managed by Property Services Group. Cassella provided the analysis services and Pectel were the removal contractors.

Control Rooms

The control rooms contain several features which represent a radical new approach in Television Centre.

The decision to build them on the ground floor actually brought about serious difficulties, due to the restricted floor to ceiling height of 2.35 metres. Also the absence of any raised floor void meant that the normally-free routeing of cables had to be strictly controlled to a small number of specific positions set into the floor screed.

The need to proceed as quickly as possible suggested a prefabricated partitioning system to form the control suite, instead of traditional double thickness masonry walls. Previously unthinkable, this idea gained acceptance through the relaxation of acoustic requirements in the Production and Lighting & Vision control rooms where the standard required was comparable to that of a good quality office. A metal-faced partition system by Clestra Hausermann — in panels on a 1200mm module, together with perforated-metal ceiling tiles on a 1200mm square module — was installed. The predominance of hard surfaces together with full-height glazing met the acoustic standard established at the outset. The only concession to absorption were the carpets, perforated ceiling tiles and a very small number of perforated wall panels. The aesthetic quality achieved with a colour scheme of subtle shades of grey and white has brought the suite right up to date.

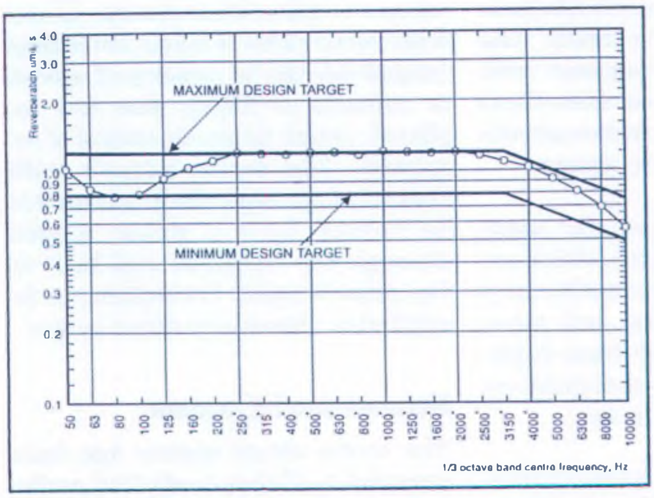
The Sound control room, however, was built in the traditional manner with masonry walls, acoustic treatment and appropriate finishes, to achieve the more stringent acoustic standards normally associated with the operational requirements of this area. Colour co-ordination and the use of a metal ceiling tile have achieved aesthetic continuity with the main suite.

The old control room areas were converted into an electronic workshop, store and office, plus technical and ventilation plant areas.

Studio & Ancillary Areas

The old linoleum floor finish was stripped, together with its asphalt and screed base. Next, a new proprietary epoxy-resin floor was laid by Elgood Flooring Ltd, as the modern alternative to lino.

The old acoustic treatment system was completely stripped out during the asbestos removal contract, thus providing an opportunity to test the acoustics of the raw studio shell. The reverberation time measured an average of 4.75 seconds, which gave the acoustic adviser a starting point for the design of a whole new system of acoustic treatment. In order to reduce costly and time-consuming labour on-site, a prefabricated system of timber vertical frames, acoustic boxes and absorbent facing panels — designed to a module of 1200 x 600 mm — was used. The final result is a neat and well organised design to the wall finishes. An absorbent suspended ceiling of Ecophone fibre tiles was installed which, together with the wall treatment, gave an average reverberation time of approximately 1 second, as shown in the diagram below.



BDMS

TC6 Studio reverberation time

Studio ancillary areas were rebuilt and fitted out afresh with quality joinery and bright finishes to give a pleasing atmosphere, especially in the Make-Up and Costume rooms. The main audience entrance was given an extra visual boost with display cabinets and improved finishes, colour scheme and modern signs.

Environmental Services

A new air conditioning distribution ductwork system was introduced into the new control room which, together with a supplementary air handling unit, provides a refurbished air supply/extract system for the Control Suite and Workshop areas.

The studio supply and extract ducts above lighting grid level were removed during the asbestos stripping works. A new method of supply — using outlets connected direct to the air shafts in the walls — was introduced, which now makes TC6 consistent with other TC studios and has improved the acoustic performance of the air conditioning system. The extract ducts alone were replaced above the lighting grid, to reduce the congestion in this area and to provide better access to the lighting and scenery winches.

Electrical Work

The electrical work was another area that required an extensive refit after the asbestos strip. Power feeders needed reinstalling, while production lighting cables, winch control cables, general power outlets and technical power for the control suite were all needed.

This work was managed by Television Engineering and Project Services and the electrical contractor was MJN, the current term contractor at Television Centre.

Winches

It was decided not to replace the existing winch equipment. Instead the winches would be carefully removed, refurbished and stored while the asbestos removal work was undertaken.

The studio is equipped with 202 lighting and 96 scenery winches; it is easy to see that a relatively large store was required. Another problem encountered was that each winch was unique in some respect (eg cable configuration) and the winches would have to be reinstalled in an order determined by the constraints set by other works in the studio. After fifteen days of dismantling, the winches were transported on eleven 12m lorry loads to a factory unit in Nottingham. The sight of three hundred winches filling a factory unit, each the size of a typical office desk, is somewhat daunting when it is realised that each one had to be stripped down and rebuilt.

The refurbishment work on the winches consisted of all new electrical equipment (including wiring looms) with the exception of the motors and brake assemblies which were retained. The winches were found to be in good mechanical order, apart from a few problems due to the vintage of the equipment (dating from 1966). The winding drums had to be shimmed to fit a metric rope, as the imperial sizes were unavailable, and the oil in the gearboxes had thickened to such an extent that it would not drain and had to be steamed out. The units were rebuilt with new oil seals, worn bearings were replaced and asbestos-free brake linings fitted. In the meantime, the lighting barrel assemblies were recabled with various power and technical circuits, and new BS4343 sockets fitted. The equipment was finally returned to the studio, set up, commissioned and certificated.

New winch-control consoles were specified and fitted. The opportunity was taken to improve safety by including a warning system which signals the operator if a winch is overloaded or the rope has gone slack.

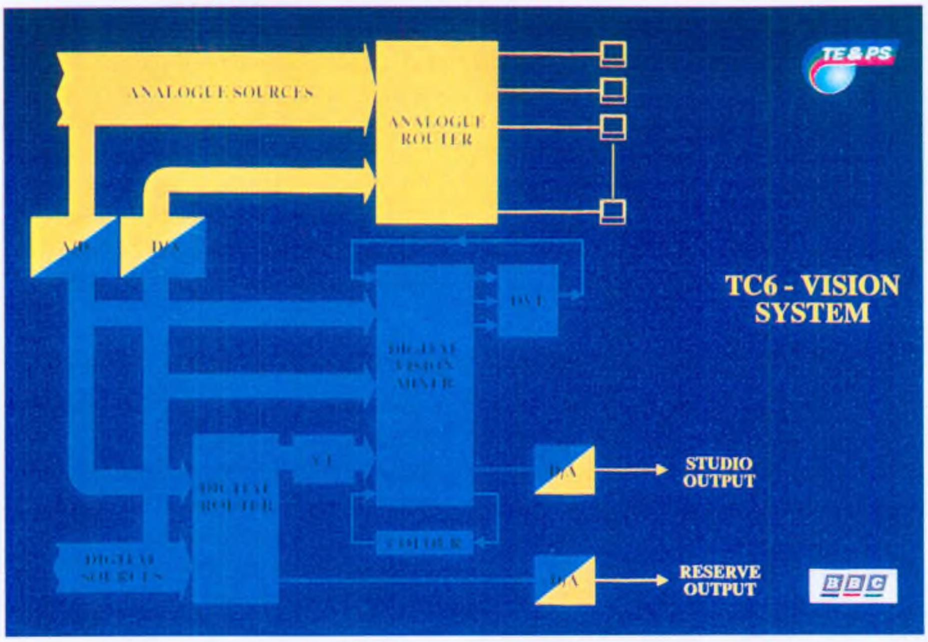
Lighting

Six hundred and forty-eight production lighting channels were distributed onto two hundred and two lighting bars plus a number of wall and gantry outlets. A Galaxy Nova — Strand Lighting's latest version of the much-used Galaxy lighting control system — was installed as the main control system, with ADB "Eurodim 2" digital dimmers. A fault-reporting system continuously monitors each lighting channel and gives immediate warning of a variety of possible fault conditions. Improved earth leakage monitoring provides a more accurate measurement of the total leakage of the production lighting installation, with the ability to monitor an individual dimmer cabinet if required.

The DMX digital lighting protocol was used in preference to an analogue-based system for the control between the lighting control desk and the dimmers. Each DMX stream can control up to three hundred and eighty-four dimmer channels on a single cable. This offers a significant saving on cabling over a conventional analogue system which requires a connection for each channel.

It was a requirement for the lighting director to have an output of the fault reporting system, so TE & PS specified a VDU-based data display which was designed by BBC Research and Development. This set out each channel in the studio, geographically on the screen, thus providing a warning of dimmer faults as they developed. The system has been further developed to incorporate information on the setting of each lighting channel, by monitoring the two DMX streams that control the dimmers. A distribution of DMX data was installed on twenty of the lighting bars for use by special-effects lights. This removed the requirement to rig control cables from the gantry across many lighting bars.

A Softlink DMX patch was incorporated to enable up to three lighting special-effects desks to be used in the studio, with any of their control channels patched to any dimmer channel in the studio.



TE & PS

The vision system in TC6

Vision

The vision system has been provided under contract by Philip Drake Electronics Ltd, making extensive use of standard equipment and systems to meet the requirements, while controlling the cost. The vision system is a hybrid: the programme chain has been implemented in Rec 601/656 serial digital components whilst the monitoring system is in PAL. The cost of converting to and from analogue PAL is still prohibitively high and this concept minimises the number of such interfaces. The serial-component digital system gives performance and reliability benefits and is best placed to accommodate future formats (eg wide-screen TV).

The heart of the system is a Thomson digital component vision mixer. This has been digitally integrated with Questech Charisma digital video effects and a Pro-Bel control system to provide a powerful effects memory system.

The studio is equipped for eight Thomson 1647 Sportcams, which are lightweight cameras adapted to carry large full-facility lenses and viewfinders. The conversion from studio camera to handheld configuration takes less than two minutes.

The studio's four local VTRs conform to the Television Centre D3 (digital composite PAL) standard. Coding and decoding between component and PAL formats is carried out entirely in the digital domain by Innovision DX converters. Other recording formats can also be accommodated.

Electronic slide storage and retrieval is done on a Slidefile Plus, with digital input/output ports. This is a standard Slidefile still-store, upgraded to provide Rank Cintel Silhouette facilities.

The vision mixer can accommodate sources timed within a range of nearly ± $\frac{1}{2}$ of a TV line time. This allows easy integration of additional sources.

A Thomson Colorado provides digital colour correction in the system. Effects from colour casts to colour inversions (negatives) can be sequenced, stored to memory or floppy disc and replayed (under timecode control if required). The vision mixer's wide input timing range allows pictures to be routed from a mixer output through the Colorado and back to the mixer's input. Correction can be applied to almost any mixer source.

Sound and Comms

The studio sound system has been provided by Calrec Audio Ltd, under contract. It is an analogue system built around a 60-channel Calrec Q-series sound desk. There were no suitable digital mixing consoles on the market when the TC6 tenders were invited. The comms system has also been provided by Calrec — designed around a Pesa system, with Calrec control panels.

The *timescale* and *financial* constraints were tighter than usual and it was even more important to constantly scrutinise them as the job progressed. If either or both were drifting away from the predicted progress, early corrective action was taken. Time and cost problems were thus identified at a stage when corrective action would be effective.

The eventual successful completion of the project on time and within budget is due to the combined efforts of the whole team. Thanks are due to engineers in Studio Production Resources and Television Engineering & Project Services, as well as staff in Building Design & Management Services, Property Services Group and many contractors.

Trevor Parkins
Head of Production Systems
TE & PS

In preparing this article, the author wishes to acknowledge the valuable contributions provided by members of the project team, including:

John Carter
Studio Production Resources

Wynne Griffiths
TC6 Project Manager, TE & PS

Conrad Franklin
Project Engineer, TE & PS

Richard Hill
Architect, BDMS

News Branding Graphics

Following on from the article about *News Programme Branding* ***in the previous issue, Jerry Clark offers us an insight into how the title sequences were computer-generated.***

The design work for *News Branding*, originally referred to as "Concept News", started in earnest in November 1992. A "virtual studio" scenario had been discussed for several months prior to this and, in close collaboration with Studio Production, it was decided to go along this route.

Following the design concept to use the BBC Coat of Arms, the first task was to form a computer model of the virtual studio. However, as a precaution against a technical failure, it was decided that a "real" studio should also exist, for use as an emergency backup. Computer modelling of the virtual studio was done in close collaboration with the real studio construction, both using the same design drawings to ensure a perfect match between the virtual and the real.

After obtaining high-level permission to use the Coat of Arms, the layout was digitised from the BBC Style Guide and fed into the computer. This was then used as a pattern on which to model the various elements. The model of the crest was made as realistic as possible with every element forming an individual object, even down to each feather on the eagles being unique.

In the centre of the crest is a globe. The design decision was to have the globe rotating with the camera starting very close up, pulling back to reveal the crest and, further back, the studio. As this required a very de-

NCA Computer Graphics

The Crest-Sides layer showing the wire-frame model, the final rendered frame and its associated matte tailed globe, data was purchased from Bartholomews to maintain accuracy and detail, even very close up. To ensure later post-production flexibility, and to speed up render times, the whole crest/studio model was built up from nine "object" layers and three "reflection" layers:

Object Layers

- The globe
- The crest centre
- The crest sides
- The crest plinth
- The studio floor
- The studio desk
- The studio ceiling
- The studio lights
- The set backings

Reflection Layers

- The crest reflection
- The desk reflection
- The set backings reflection

Glossary

Anti-aliasing

A technique employed to avoid the jagged edges which used to be common with electronically-generated images, particularly text.

Fettling

"Fettling" an image is the process of altering the colour balance of that image.

Matte

A "matte" is the graphics term for "key", as used in a Colour Separation Overlay (CSO). The matte is generated, for each frame, as part of the rendering process.

Render

"Rendering" is the process of drawing, colouring and anti-aliasing the computer-generated model for display on the TV screen. Depending on the complexity of the model, this may take from several seconds to several minutes for every frame rendered.

The three reflection layers are used as a relatively quick and easy way to give the model realism, without the need for very time consuming ray-tracing when rendering the model. Other techniques — refraction and reflection mapping — were used on the glass objects in the model, again to obviate the need for ray-tracing during the render.

Four differing models were built, one for each of the four news programmes. To maintain a similar look and feel, the models only varied slightly but the camera movements around the model varied to a larger extent. Rendering started in January 1993 and proceeded for the next month. The largest layers — the globe and crest components, each containing about 200,000 polygons — took about 10 minutes a frame to render and the other layers up to about 5 minutes a layer.

The output from the renderer includes a matte for each frame rendered. Using this matte, all twelve layers were composited together within the computer to give the final set of rendered frames. A complete render for one programme, including compositing time, required about four days on an extremely quick Silicon Graphics super-mini computer. All frames, the individual layers with their associated mattes, and the final composited sequence, were layed off frame-by-frame onto an Abekas A66 and from there dubbed onto D1 video tape.

The final post-production process was carried out on a Quantel Henry, the main work being to slightly alter the colour balance of some of the layers and to add lighting "flare" to the scene to improve realism. For the Breakfast titles, VT clips were run through the globe during the initial camera pull-back.

The set backings for the real set were also rendered on the graphics computers. To maintain detail, each panel was rendered at a resolution of 4640 by 3712 pixels. Each frame was then transferred, via computer tape cartridge, onto a Quantel Graphic Paintbox for final colour fettling before being printed directly from the Paintbox. To ensure a perfect match between the virtual and the real studio backings, camera shots of the real backings in-situ in the studio were grabbed into the computer and used as a texture to wrap onto the virtual set during the render process. Due to the judicious choice of layers, this single layer could be incorporated into the title sequence with the minimum of time and effort.

By March 1993, the final titles were safely on D1 tape, and the music and voice-overs were on DAT. For day-to-day play-out, the video and audio components were recorded onto a Sony CRV, while a travelling matte in the position of the presenter's panel was recorded onto another CRV. Software was written on a PC to coordinate the simultaneous playback of both CRVs with a Charisma move. The latter performs a DVE operation on the feed from a studio camera and inserts the resulting image into the "hole" formed by the matte in the title sequence.

Content Graphics

Design of the content graphics (boxed stills, phone comps, still & quote, histograms, line graphs, sports results etc) started in January 1993. It was decided that a Silicon Graphics computer running appropriate software could be usefully integrated into the graphics production area. Automation software was commissioned from Iontrek Pty. Written to a News Branding specification, this software — christened *Flashframe* — would automate the production of much of the content graphics, thus allowing designers more time to work on complex one-off graphics.

The design of the content graphics was mainly carried out on a Quantel Harriet and, as each design was finished, the result passed onto Iontrek for incorporation into Flashframe. This ensured that, should the computer fail for any reason, the content graphics could be produced, albeit at a much slower rate, on a Harriet. Simultaneously with the writing of Flashframe, another software package — christened *Mapper* — was being written in-house. This package would allow the very rapid production of on-screen maps to a house style. Data was obtained from various sources at various scales and a database of the entire world was formed. The software would allow a designer to "fly" around the world and produce a map of any area. Later an animation capability was added, allowing the designer to specify a beginning and end keyframe, the computer then rendering the in-between frames to form an animation in a user-specified time.

Epilogue

News Branding has now been on air for over six months. From the comments given, both internal and in the press, the launch can only be described as a great success. The realism of the virtual studio is demonstrated by remarks such as *"Isn't it at all dangerous to have that amount of glass in a studio?"* and *"it looks too real — you can't tell its a computer generated sequence"*. To be fair however, to the critical eye there are faults but these are minor.

Everybody involved with the project has learnt an enormous amount; new ideas, new methods of working, and the introduction of general-purpose computers into areas that have been hitherto the domain of special purpose-built hardware. Despite the large increase in complexity in the studio gallery, mistakes have been few and far between. The graphics software packages, Flashframe and Mapper, have been remarkably stable and bug-free. Development of both packages continues to increase their flexibility and overall capability. The success of these packages is demonstrated by the recent purchase of both Flashframe and Mapper by BBC World Service Television News for their re-launch due later this year.

Jerry Clark
Computer Graphics Manager
News & Current Affairs

Hardware

2 x SGI 4D/310 VGX systems, 64M RAM, 1.0G disk
SGI R4000 Indigo BLG system, 96M RAM, 2.6G disk
Abekas A66 (disk recorder)
Sony DVR9000 (D1 video cassette recorder)
Quantel Harriet, Graphic Paintbox & Henry
Sony CRV9000 (laser disc)

Software

Vertigo Modelling & Animation System (titles only)
"Flashframe" from Iontrek Pty (Dave Clement)
"Mapper" written in-house (Sean Kirwan)
Various utility software written in-house

Credits

Senior Graphic Designer:	Tim Goodchild
Lead Graphic Designers:	Steph Uter, Piers Helm,
Graphic Designers:	Mike Afford, Kate Finding
Studio Director:	Don Harley
Set Designer:	Paul Trerise
Graphics Consultant:	Dave Clement
Computer Modelling:	Jo McGrogan, Dave Clement, Simon Hunt and Tim Kilgour

Transmission

Automation of test equipment

Howard Holt describes some new automatic test equipment for use in Transmission.

Over the past three years, staff at Winter Hill have had the opportunity to use new pieces of test equipment, the design of which has been based around a microprocessor control unit. The use of computer-based test equipment has caused a revolution in the way many performance checks are undertaken, the main differences being the use of digital displays and the fact we can nowadays press buttons rather than twiddle knobs. A demonstration at Transmission's spring meeting — held at Wood Norton — showed how an external machine could be used to press all the right buttons, retrieve the required results and store them for later use.

HP 8591A spectrum analyser

On show at the HP 8591A demonstration was the new software which has been written for the analyser by Hewlett Packard to make UHF performance checks. The software named

BRD-TV now includes routines to measure accurately a NICAM second sound carrier, NICAM intermodulation products and many other utilities useful to an operations engineer. A second demonstration showed the analyser being controlled by a laptop computer to perform the necessary measurements on a UHF television signal.

The experimental program semi-automatically executes and records outstation performance checks, producing a printed output similar to that currently hand-written. To commence a test, the engineer enters a station abbreviation and the computer retrieves the station information and relevant channel numbers. The engineer can choose to perform a complete station performance test, or take measurements on a single channel only. During the test, commands are sent to the analyser as a string of characters that perform the several hundred button presses required. The results are returned to the computer and stored in a file for later examination.

The program is written and compiled using Microsoft Quick Basic 4.5 which is a well-structured language with many debugging tools. The computer uses the RS232 port to communicate with the analyser and uses a baud rate of 9600. There are many improvements that could be made to the programming but it was adequate for demonstration purposes.

Neutrik TT402A audio test set

For the purpose of the demonstration, the Neutrik equipment was used to test a BAND II stereo drive. A Rohde & Schwarz FMA Modulation Analyser was used to demodulate the FM stereo signal into left and right channels, while a Psion Organiser, printer and comms link enabled remote control of the Neutrik.

Quick operation of the FMA was achieved by pre-programming the internal presets. These can be used to recall the FMA settings for all the required measurements (ie pilot tone level, RDS deviation, etc). Once the FMA has been configured to demodulate the stereo coded signal, it need not be touched during the performance test.

L to R: Paul Hollings, Tom Hardcastle, Bob Baxter and Howard Holt at the Wood Norton demonstrations. (Photo: Martin Ellen)

The demonstrated program controls the Neutrik by sending strings of commands that configure the test set to generate and measure the relevant tones during a VHF performance test. The stereo tests can be performed on off-air-fed VHF stations with the use of a Panasonic stereo coder. When the results from a test have been gathered, the Psion stores the data for later examination. The program is written in Organiser Programming Language (OPL) which is very well structured and enables good programming techniques. The program could be adapted to a PC but it is not currently available.

Tektronics VM700 video waveform analyser

The VM700 is probably the most advanced item of test equipment that a team base possesses. To become fully conversant with the many configurations possible for this item of equipment, many hours of operation are needed. The demonstration showed how many of the necessary modes of operation and measurement (ie sound-in-sync mode, etc) could be achieved by the use of function keys. Once the function keys have been programmed, the operator need not know the intricate details necessary to select the various combinations of measurements at different locations in the transmission path.

The Winter Hill VM700 has been configured so that a selection of menus and functions are displayed when the front-panel button labelled "Function" is pressed. These menus have been named Normal mode, Sound-In-Sync mode, Timed Functions and Multi Functions.

The Normal and Sound-In-Sync modes allow quick access to the one-line ITS and the performance of various measurements relevant to our systems. The Timed Functions menu allows easy logging of any source faults over a day of transmission, or measurements during regional opt-outs. The Multi Functions menu gives a selection of routines that toggle between measurements; for example, between Differential Gain & Delay and Luminance Non-Linearity, with an interval of ten seconds.

These functions were devised to aid an engineer whilst adjusting the klystron amplifiers at Winter Hill. Another function key called "Powerup" is looked for by the firmware of the VM700 at startup, thus instructing it to select line 21 of input channel A (the one-line ITS). With a different powerup function, the VM700 could be made to perform a selection of measurements after startup, on any of the three video inputs.

Winter Hill purchased software that can recall and save all our VM700 configuration and function files from and to a PC for backup purposes. This method could be used to distribute standard configuration files for use by all team bases, thus minimising duplication of effort.

Conclusion

The advancement of technology in the last decade has opened the door to automation of performance testing. Transmission Operations is now considering whether this technology can offer any great advantages to Maintenance Teams.

Howard Holt
Winter Hill

New Eurovision Control Centre

The Eurovision Control Centre has recently moved from Brussels to Geneva, as briefly described here by John Garrett.

Eurovision was established almost 40 years ago under the auspices of the European Broadcasting Union (EBU), to facilitate television programme exchange between member countries. For most of those years Eurovision was confined to the countries outside the Soviet bloc, but following the recent political changes in Eastern Europe, it has absorbed the national broadcasters of Eastern Europe and now embraces nearly fifty countries, extending from Iceland and Morocco in the west to Russia and the Middle East.

Some five years ago, the decision was made to move the Eurovision Control Centre from Brussels to Geneva, and on 1st September this came to fruition when the new Centre was officially opened in a new building opposite the EBU's Geneva headquarters. The move came at a time of technological change. In the words of Project Engineer, Brian Flowers: *"If the old mousetrap was PAL/SECAM/NTSC, then the new one is analogue/digital, composite/component, and 4:3/16:9, with provision for future HDTV"*.

Piraud & Grivel, Geneva

The new building opposite the EBU headquarters in Geneva nears completion

The new Centre is not really an international switching centre but rather a monitoring and coordination centre. Its major functions are:

- To ensure that the required network is established on time for each transmission, by coordinating network switching with the national technical coordination centres.
- To monitor the quality of the network and take corrective action when necessary.
- To record the real-time circuit utilisation for cost-clearing.
- To pre-record intercontinental news items for subsequent distribution in the regular news exchanges.
- To plan transmissions at less than one hour's notice.

Connections to the Eurovision terrestrial network are made through microwave links which utilise a new dish on the roof of the EBU Headquarters building. EBU-leased Eutelsat channels are received from the Swiss PTT's earth station a few kilometres away at Vernier, using fibre optical cables. The Centre has only two outputs to the international network, primarily for the injection of pre-recorded news items from the Centre's VTRs into the daily news exchanges. Betacam (analogue component) machines have been chosen in preference to the new digital component formats, mainly on the basis of cost.

Signal distribution within the Centre is based on a 270 Mbit/s serial component system, but composite analogue switching and routeing are also provided.

A wide range of hardware has been installed at the Centre, including digital and analogue switchers, communication and conference facilities, and automatic video and audio measurement equipment.

Personal Note

The man responsible for planning the new Control Centre is Project Engineer (and Head of Service) Brian Flowers. He started his career at the The Eurovision Control Centre in Brussels in 1962, on detachment from BBC Television, and has served at the Centre ever since. He claims that most of his ideas and solutions to problems come to him at 3 o'clock in the morning after three hours sleep, which he says raises the interesting idea of being paid overtime for sleeping! Appropriately, the jingle that will be played over the network between programme transmissions is a flute duet written by Brian which won a BBC *Children's Hour* Young Composers' Competition in the early 1950s. He does not say whether the inspiration for this music came at 3 o' clock in the morning!

The planning and engineering of the new Centre are fully described in an article *New Eurovision Control Centre* written by Brian Flowers and published in the EBU Technical Review, Winter 1992. Updated copies of the article are available from EID — please send your requests to:

John Garrett,
Room 3400, White City

No more freeze-frames at OBs – courtesy of RINSE

Richard Evans describes a new system for eliminating freeze-frame at outside broadcasts where radio-cameras are in use.

Television producers today are demanding more live action shots from an increasing number of mobile cameras. This of course is pushing facilities to the limit, as OB departments try to provide exciting camera angles while still maintaining picture quality.

BBC Research Department

Scotland v Wales at Murrayfield earlier this year: picture shows the result of a typical synchroniser failure on a radio-camera link

Remote mobile cameras — such as the one-man radio-cameras used at golf or rugby matches, or those mounted on helicopters and motorcycles to cover the London Marathon — require microwave links to carry the pictures back to the scanner. Although these links are planned carefully to provide sufficient signal level at the receiver under normal conditions, during a live OB various problems can reduce this margin, and the video signal can often become degraded by noise (and multipath). Typically, the helicopter might bank as it turns or the motorcycle might pass behind a tree. In these circumstances, the pictures seen *at the receiver* are mostly usable but become further degraded by the next piece of equipment downstream — the synchroniser.

Digital frame-store synchronisers

Whereas cabled cameras are all synchronised to a master source, allowing the vision mixer to cut cleanly between them, radio-linked cameras on the other hand operate independently; they are not synchronised to each other or to anything else. This problem is overcome by using a digital frame-store synchroniser, connected into the video chain between the microwave receiver and the vision mixer. The synchroniser automatically delays the incoming video by the appropriate amount so that its output signal is synchronised to the local or station syncs.

Unfortunately frame synchronisers are, without exception, designed for use with "reasonable-quality" video signals and can fail dramatically when presented with noisy video. This leads to the characteristic picture-quartering freeze-frame effect, shown in the photograph above. In the lab we found that this freeze-frame effect starts to occur at noise levels which otherwise are acceptable for short periods during a live OB. Often the noise burst may only last for a few lines of video, but the effect on the synchroniser can cause picture disturbances lasting several fields. Apart from being very annoying, synchroniser break-up can give the impression that the event is recorded. When persistent synchroniser failure occurs on-air, the vision mixer is forced to cut away to an alternative camera, but by then the poor quality pictures have been seen by the viewer.

The solution

If a "heavy flywheel" action sync separator is used to recover the sync timing information from the incoming video, then in the event of signal degradation or even complete loss, it will carry on providing sync pulses. A design for such a robust sync separator was already available at Research Department, as a self-contained module within the switched-horn radio-camera system described in *Eng Inf* No 52. This module, with minor changes (see below), was adapted to regenerate the full mixed-sync pulse train and then substitute the syncs back into the outgoing video, in place of the incoming variable-quality syncs. The resultant system is known as **RINSE** — **R**egeneration and **Ins**ertion of **N**ew **S**ync **E**quipment.

Regenerating the full mixed sync pulse-train produces several benefits. The consistent quality of the syncs means that:

* Synchronisers are no longer the weak link in the video chain. Freeze framing is virtually eliminated.

* For a frame of mixed quality video it ensures that the useful picture information is kept in its correct place on the screen.

* It helps maintain the colour by providing a reliable timing reference, identifying the position of the colour burst.

How it works

RINSE generates the outgoing sync pulses by dividing down a high frequency master oscillator using digital counters. The oscillator is automatically tuned to match the frequency of the incoming syncs, while the phase of the counters is adjusted to match the phase of the incoming syncs. An adaptive windowing system allows the sync separator to be affected by only genuine incoming syncs and rejects mis-timed pulses caused by noise.

Once the circuit has locked on to the incoming syncs (which takes about ten seconds from switch-on) it is then able to flywheel. On detecting a drop in signal quality, the phase and frequency of the regenerated syncs are held constant, and further incoming syncs are ignored until the signal quality improves. The frequency adjustment is carried out digitally and so there is no charge decay, allowing the required frequency to be accurately held for a considerable time during the flywheeling.

In the past, the use of synchronisers for mobile vision links has led to a degradation of the signal, which most people have accepted as unavoidable. With RINSE, this need no longer be the case.

London Marathon

The main test for RINSE came during the London Marathon in April when it was used for most of the coverage from the two motorcycle cameras which followed the men's race. The signals relayed from the mid-point helicopter were received from the top of the East Tower at Television Centre and then RINSE'd and synchronised at Studio 5 — the *Grandstand* studio. As was expected, most of the coverage was very reliable, but there were times when the transmissions from the bikes were disrupted. RINSE effectively smoothed out most of these problems and the resulting broadcast pictures were considerably improved.

The marathon also showed us where improvements could be made — in particular the time taken for RINSE to lock onto the incoming video needed to be much faster. It also showed that simple sync re-insertion cannot cure all synchroniser problems. Strong multipath signals caused by reflections from buildings, or extremely noisy video, can still break up the picture. Further work has shown that, by making a simple modification to the synchroniser itself to enable it to use *external syncs* (directly from RINSE rather than via sync re-insertion), it will pass *any* video signal transparently for many seconds of severe degradation.

Since the London Marathon, RINSE has been tested at several other OBs in order to assess its suitability in

BBC Research Department

Laboratory images showing: (left) freeze-frame when standard synchronism is used, and (right) a stable picture when RINSE is added different environments. These have included the Woburn golf tournament, where one-man radio-cameras were used, and the recent British Grand Prix which featured in-car cameras. More recently, RINSE was used with a one-man radio-camera on *Top of the Pops*.

Satellite Links

Although RINSE was developed for OB-type applications which use FM vision links, the techniques are equally applicable to satellite links which are also FM and operate at a similar frequency. The main difference in the channel characteristics between an OB microwave link and satellite link is the way the noise varies over time. An OB link is likely to be noise-free for most of the time, but may suffer occasional bursts of severe noise when the direct path is obstructed. A satellite link on the other hand is likely to suffer from a fixed noise level if the carrier-to-noise ratio is insufficient, due to inadequate dish size, dish mis-alignment, or rain fading. RINSE copes very well with severe degradation lasting for a few seconds, but it will also "clean up" less severe continuous noise.

As can be seen from the "before and after" shots, a previously-unusable signal can be fully recovered leaving a properly synchronised (but noisy) picture. In a sports OB environment, RINSE will simply prevent synchroniser failure and maximise the available pictures. However, in the world of news and current affairs, being able to recover noisy pictures may allow an important satellite-linked news story to be broadcast in spite of difficult circumstances.

Further developments

There are currently three single RINSE units in existence and these are being evaluated at various OBs. However, discussions have begun with Phil Layton of Development Department with a view to manufacturing RINSE in multi-channel versions. Outside broadcast events rarely use just a single mobile vision link and so the aim is to provide a triple or quad channel RINSE in a compact 1-U rack.

* * * * *

Thanks go to Dave Jennings and Dave Humphries of Tel OBs at Kendal Avenue for their assistance and advice, and to Dave Woof and Adrian Bower from Research Department Workshops for building the additional prototype units in time for the London Marathon.

Richard Evans
RF Systems Section
Research Department

Telecommunications

Re-engineering the national PCM network

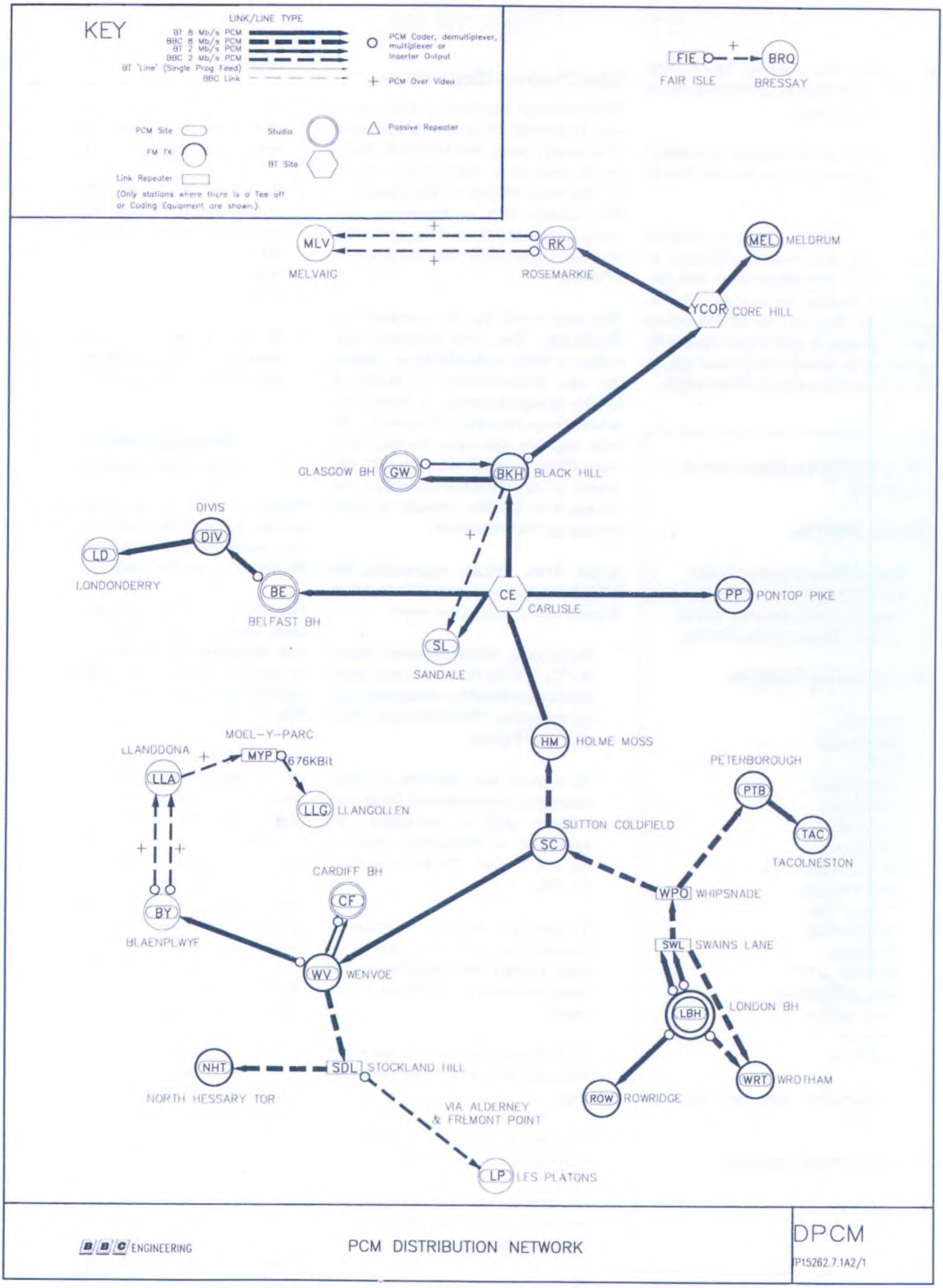
The BBC's national PCM distribution system — which carries all the BBC's Network and Regional Radio networks from the studios to the transmitters — has recently been replaced using the latest* Mk II NICAM *equipment. Keith Hayler and Russell Inman take up the story ...

Some twenty years ago the BBC took its first major step in the now widespread field of digital audio telecomms with the introduction of the 13-channel "Linear" PCM system. (The term "Linear" when applied to PCM systems means no companding). This system allowed the distribution of thirteen channels of broadcast-quality audio and a data signalling channel to the expanding number of VHF and MF Network Radio transmitters via a network of video links. The advantage of this technique was that there were no cumulative distortion mechanisms; effectively the decoded audio quality at Rosemarkie in northern Scotland was the same as that at Wrotham in Kent.

In the early 80s, the NICAM system (now familiar in its stereo-TV guise) was developed. Through the use of a companding technique it was now possible to convey six broadcast-quality channels in a 2 Mbit/s bitstream, with provision for data channels. In order to meet increasing Radio network demands, a re-engineering project was initiated which;

- converted the basic 6 Mbit/s "vision" bearer to the new CCITT 8 Mbit/s standard.

continued on page 16 ...



Map showing national PCM distribution network

- mapped the existing linear PCM onto the lower three tributaries of the new stream.

- provided an additional 6-channel NICAM distribution on the fourth tributary.

This late-1980s project formed Phase 1 of the overall proposal to convert the distribution to full 24-channel NICAM standard, as described in *Eng Inf* No 29 (Summer 1987). Phases 2 and 3 have just been completed in a major co-phased project which forms the subject of this article.

Mk II NICAM equipment was installed at:

Studio Centres

Belfast Broadcasting House
Cardiff Broadcasting House
Glasgow Broadcasting House
London Broadcasting House

Transmitting Stations

Blackhill
Blaenplwyf
Divis
Holme Moss
Llanddona
Londonderry
Meldrum
North Hessory Tor
Peterborough
Pontop Pike
Rosemarkie
Rowridge
Sandale
Sutton Coldfield
Tacolneston
Wenvoe
Wrotham

Re-engineering work was carried out at:

Transmitting Stations

Alderney
Les Platons

Table 1: BBC PCM sites involved in the PCM re-engineering project

The Project Objectives

The primary objective of the project was to provide a distribution system that would meet the Network Radio audio and data distribution needs for the next 20 years. The decline of the linear PCM equipment, now some 20 years in service, provided further impetus for the replacement scheme.

The key word for the project was *flexibility*. The PCM network provides a very cost-effective system for the distribution of Network Radio programmes, a relatively static requirement. However, the PCM capacity can also be used as a cost-effective equivalent to BT provision of contribution circuits, providing it is flexible enough to meet changing requirements.

Apart from simply upgrading the UK's PCM system to Mk II NICAM, other objectives of the project were:

- ☐ To provide NICAM-decoded audio for R1 FM services at some main stations still fed by temporary off-air reception: Peterborough, Divis and Les Platons.

- ☐ To provide new facilities to meet emerging requirements from production staff; in particular, the provision of dedicated channels for the London Travel variant of R1 FM.

- ☐ To produce revenue savings by transferring material carried on long, rented analogue lines to PCM channels with short, cheaper local ends.

- ☐ To increase the network reliability through improved equipment design.

- ☐ To improve network audio performance (where possible).

- ☐ To provide potential for future network improvements, eg digital access to the NICAM coder.

- ☐ To provide complete distribution for dynamic (ie programme-related) RDS data.

- ☐ To enhance network capacity in the National Regions, previously only served by one channel-pair.

- ☐ To standardise and enhance the NICAM distribution in Wales by introducing NICAM coders at Cardiff BH, with a Megastream circuit into Wenvoe for insertion into the 8 Mbit/s distribution.

- ☐ To ensure greater compatibility with modern telecomms coding and interface standards.

Equipment and Systems

Before we look at the equipment involved in the PCM project, a word or two about the coding systems would be useful to set the scene.

The current PCM system network uses vision circuits for its distribution medium. Physically these may be coaxial "tubes", SHF radio links or optical fibre, provided by either the BBC or BT.

Carried on this vision network is the 8 Mbit/s PCM bitstream. The line-code used is Non-Return to Zero (NRZ). The 8 MBit/s bitstream is made up of four 2 Mbit/s bitstreams called tributaries, each conveying six NICAM channels. The four tributaries are termed E, F, G & H. (This is historical — nobody seems to know the derivation of this nomenclature!). Table 2 shows the Channel Allocations assigned to these four tributaries for the new system.

It is principally at the 2 Mbit/s level where Phases 2/3 of the PCM re-engineering project operated. The 8 Mbit/s NRZ distribution system (resulting from Phase 1) was to remain the same, awaiting the arrival of the Managed Broadcast Network (MBN) in 1994/5. This will require interfacing at the CCITT HDB3 standard. In the meantime, however, the existing 8 Mbit/s NRZ multiplexers were reconditioned as

Tributary	PCM Channel	England	National Regions
E	1 to 6	National Regional Contributions (NRCs)	Regional Networks and Contributions
F	7 to 10	National Regional Contributions (NRCs)	National Regional Contributions (NRCs)
	11 & 12	Radio 1 FM (London)	Radio 1 FM (London)
G	13 to 16	National MF & LF Network Distribution	National MF & LF Network Distribution
	17 & 18	Radio 1 FM Distribution	Radio 1 FM Distribution

Table 2: PCM channel allocations

part of the project to ensure continued reliable operation.

NICAM-3 Equipment

Although Mk II NICAM may be a natural successor to Mk I NICAM, it is by no means an automatic one. Transmission Projects conducted extensive investigations into alternative digital distribution equipment. Devices offering high bit-reduction levels were available but had not reached sufficient maturity to offer the quality required of the national PCM system. Other "conventional" PCM systems were available, but with very limited data signalling. Only Mk II NICAM could offer the required audio capacity, and provide suitable signalling to carry the RDS update traffic. In addition, it provided the AES interfacing facilities which would offer exciting future "digital access" possibilities at studio centres. (The terminology "AES" refers to a common digital interface standard used in audio broadcast equipment, developed by the Audio Engineering Society of America and the EBU).

Development Group designed and prototyped the Mk II NICAM coders and decoders for Transmission. A staggering reduction in physical size was obtained by the ingenious use of CD technology and large-scale integration (LSI) techniques. Most notable is the use of the Philips SAA7220 oversampling filter IC which performs four-times oversampling and error-concealment using interpolation techniques. The resulting I^2S signal is then converted to analogue audio by the Philips TDA1541 DAC chip.

The NICAM compression and expansion is carried out by the same LSI gate-array chip in the coder and decoder. This BBC-developed device can carry out the 10-to-14-bit NICAM-3 companding in either direction, controlled by the logic sense on a single pin! Furthermore, bulky transformers in the analogue output stages were replaced by active balanced drivers, producing not only a big space saving, but also improved audio performance. With this kind of artifice, the resulting coders and decoders materialised as twelve channels (two independent 6-channel, 2 Mbit/s blocks) in one 6-U crate; a function previously taken up by six 4-U racks (one bay's worth!) of Mk I NICAM.

For large-scale manufacture, Transmission contracted RE UK Ltd to provide the coders and decoders, manufacturing under licence from Development Group.

Studio Centre Systems

As far as the PCM project was concerned, there were two similar but subtly different studio requirements. Firstly, twenty-four channels of coding were required at London BH, with attendant 2-to-8 Mbit/s multiplexing. Of course, this would have to be duplicated, but it was to be a distributed system; the two active coding systems were not only to go in different rooms, but were to be on different floors! Secondly, in the Regions, six channels of duplicated coding was required to assemble a Regional tributary. Here the duplicated systems had to be housed in the same bay.

The goal was to design a coder bay which could lend itself to both applications. Working to a Transmission Project's specification, Development Group manufactured seven coder bays. Both variants of the bay contain NICAM coders and data combiners (to assemble the Transmitter Control and RDS data). At London an 8 Mbit/s multiplexer is included whilst the "Regional" variant contains a bit-stream changeover rack to provide a single selected output.

At London BH, Radio Projects installed the two coder systems (known as the 'X' and 'Y' systems) either of which can source the entire UK PCM network. A coder bay, monitoring & control, and audio processor bays (the latter two developed by Radio Projects) were installed in each of the Apparatus Rooms. A third transportable system was also made available.

A major development also implemented as part of the project was the introduction of new FM processors. The evaluation and subsequent installation was carried out by Production Resources Radio. Orban 8200 devices were chosen, incorporating twelve digital signal processing chips, and very flexible user-defined processing parameters. These remarkable devices act as the transmission limiters (limiting the peak deviation of the FM transmitters), whilst enacting considerable compression/processing if required. It is due to the labours of the Orban 8200s that Radio 1 FM have achieved their goal of being the loudest station on the dial! Remarkably, the same device can handle Radio 3 FM with kid-gloves, applying minimal compression to gently coerce the lower levels into audibility for less-than-ideal listening environments. The best measure of its success is the widespread acclaim from Radio production staff across all four networks.

The next major technical step forward will be the imminent digital interfacing between these Orban 8200s and the Mk II NICAM at AES level. Once implemented, the door will be open to an entirely-digital distribution system for the network radio services — from studio to transmitter — with analogue making its first appearance at the NICAM DAC on the transmitting stations. On the MF/LF services, new processors have also been installed, the devices here being the Orban 9000 series.

In the Regions, Radio Projects installed coder bays at Glasgow BH and Cardiff BH, whilst the installation at Belfast BH was carried out by Transmission. A Coder System Controller, based on a Programme Logic Controller (PLC), was developed to "manage" the entire Regional PCM coding/multiplexing system. New audio processors (Orban 4000 series) for the Regional FM networks have also been installed.

Transmitting Station Systems

At the transmitting stations, it was necessary to provide up to twenty-four channels of decoding capacity, as required. These decoders had to be duplicated to provide the required availability for the BBC's radio services. Changeover systems were required to select a single output for onward distribution to LF/MF transmitters or studio centres. Further, for flexibility the system was to have the capacity to house the NICAM data splitters which recover the transmitter control and RDS update data.

To meet these differing requirements all functions are set by plug-in configuration cards. In this way, all thirty-seven decoder bays were made to be identical, with obvious advantages to manufacturing efficiency and operational maintenance. This also enabled the same bay to meet studio requirements at London BH and the Regional centres. Any future channel re-allocations can be effected by small changes to the configuration cards, negating the need for messy wiring modifications.

The decoder bays were manufactured for Transmission Projects by Despro Electronics Ltd. At their premises, the decoders from RE UK Ltd were integrated with the completed bay, and the entire decoder system tested before being shipped to the BBC sites.

At the transmitting stations, the Mk II NICAM decoder systems had to be installed alongside the existing systems, prior to network changeover. This presented a considerable space problem which was solved by replacing the existing Mk I NICAM decoder bays with their Mk II successors at the time of installation, and so some Mk II NICAM decoders became operational on Tributary H well before the national network changeover.

Some remaining network Mk I coders and decoders at Alderney and Llangollen also had to be modified to work at the new coded level and sampling standard.

Enhancements were also made at the FM transmitting stations to improve the system integrity:

* A complete "digits-to-rf" comparison loop was enacted
* A PLC was installed to manage the numerous additional fault indications
* A system of programme source recognition was implemented, to prevent radiation of incorrect programme material through mis-routeing of tributaries
* Key parts of the 8 Mbit/s distribution system were upgraded, in particular the demultiplexer

Installations at the transmitting stations began in June 1992, carried out by staff from Communications & Control Section of Transmission.

Network Changeover

So, by May 93, we were ready to transfer to Mk II NICAM at all twenty-six PCM locations. All that remained was to convert the UK from one system to the other — and without the listener noticing!

From the beginning of the project, the network changeover had been the subject of a great deal of thought and office debate. The prime considerations were the constraints of Radio; firstly, no loss of service on any network (day or night) and secondly, no more than a few seconds use of the mono Re-Broadcast Standby (RBS).

The two alternatives were daunting! Either the whole country would have to be converted in one go, or in a series of self-contained phases. A "one-shot" operation was ruled out on logistical grounds. (Just imagine trying to reverse the whole operation because of a hitch at one site!). On the other hand the phased operation had its attractions — it allowed a steady and methodical approach — but it also bore its own problems. For a start, it would require both the existing and new coder systems to run simultaneously at London BH throughout the changeover period. Also, a means of transporting the new bitstream to strategic "inject" points throughout the UK would need to be found. Radio Projects reckoned that it was practical to run two coding systems simultaneously; meanwhile Transmission had devised a plan to carry the new bitstream on temporary circuits. The phased operation won the day!

The changeover was divided into six phases; Rowridge, Scotland, North-East England, Northern Ireland & North England, South & Central England, and Wales & South-West England (including the Channel Isles). The new bitstream was inserted at the key PCM node in each of these regions, replacing the existing bitstream from London. So, for example, at Blackhill the bitstream feed into Scotland was replaced by a temporary feed direct from the new coders at London BH.

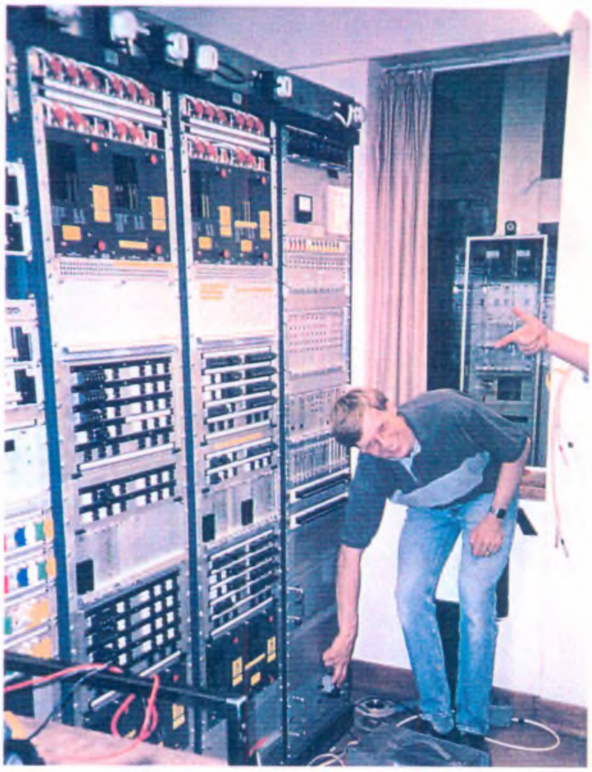
Temporary vision circuits were used to carry the new bitstream to the inject points. BT Protection Circuits (Prots) could not offer sufficient security to carry the BBC's entire radio distribution for up to three days at a time, so Regional Contribution vision circuits were used. These are permanently-rented vision circuits which are used to transfer material from London to the Regions. Much-appreciated co-operation from staff at Television Centre, Glasgow, Manchester, Cardiff and Southampton allowed us the exclusive use of these circuits, with the PCM project paying for BT circuits to convey the displaced contributions. One big proviso was that we were clear of these by the start of Wimbledon! What would happen should a major news story break was the sort of thing nightmares are made of!

A series of comprehensive tests was carried out prior to the network changeover, to check that the PCM could be carried on the modern BT vision circuit plant. Two weeks were spent weaving through the obstacles thrown up by the modern technology of digital vision codecs (with their unrelenting affinity for sync pulses). And in Scotland, finger-nails became bitten short, waiting for the provision by BT of a critical new vision circuit between Glasgow and Black Hill.

There were also more subtle considerations to take on board. The interaction of the LF transmitters causing interference (in the "mush-area") had to be considered when the two different coding systems (with different transit delays) were in operation during the network changeover. The R4 LF time-pips had to be advanced at London BH by 13 ms to ensure that with the increased transit delay of NICAM over the linear PCM, they were radiated from Droitwich at the correct time.

With all this in place, Phase 1 began on 25th May. By restricting this phase to one site (Rowridge) it was possible — by surreptitious use of an additional feed and a duplicated transmission system — to achieve a seamless transition to the new standard. On 26th May, the new coder system at London BH became live for the first time.

The next Phases presented far greater logistical problems. Because the actual changeover to the new feed took place at a key inject point, all sites "downstream" had to convert simultaneously — a so-called "crash" changeover. To co-ordinate this, the redundant Radio 3 MF PCM channel was commandeered. It was possible for any team member to access this channel by telephone, and hence a valuable "talkback" facility was obtained (a little ingenuity was also required to ensure that this vital channel was duplicated on the Mk II NICAM so that it did not die with the linear PCM!) The actual "crash" changeovers were made to be as "slick" as possible. Once again the duplicated system came into its own — allowing modification, line-up and configuration to take place off-line, with a subsequent changeover into service.



Russell Inman, Transmission

Keith Hayler switches off the last linear PCM decoder in the UK at Wenvoe – 0400 hours on 12th June 1993

In Manchester, special arrangements had to be made to divert the PCM route through the studio centre for a period of five days. (Normally, the PCM only passes through BT Manchester on its way north). This involved considerable assistance from BBC Manchester Communications and from the BT National Switching Centre in Manchester. By carrying out this diversion, it allowed us to intercept the network, substituting the new bitstream (delivered to Manchester BH on a contribution circuit) as required.

At each stage, at the appointed hour (around 1.30 am), a coordinated changeover was initiated. Existing NICAM-fed services suffered little more than a momentary digital mute, whilst Radio 1 FM transferred itself! (As the linear PCM decoders conveying Radio 1 failed, the Radio 1 Mk II NICAM decoders sprung into life and the control system reacted accordingly and on perfect cue). Ongoing MF, LF and contributions were handled similarly.

So, with most listeners experiencing nothing more than a short mute, Mk II NICAM crept into service in three-day steps throughout the UK. Eventually, in the early hours of Saturday 12th June, the linear PCM coders at London BH came out of service, and at Wenvoe, the last linear PCM decoder in the UK decoded its final bit.

So there it is — a new PCM system which will see the BBC through the implementation of new distribution systems such as the MBN and digital PTO circuits, and well into the next century until DAB makes its mark. For the project team, it's a bit like Boxing Day — the big day awaited for so long has come and gone! And what of the linear PCM? Well, currently the Science Museum is expressing quite a strong interest in displaying a codec pair, so some of us in years to come might be able to show the children and say "*I turned that off!*" (or on!). I guess one day we might well see a Mk II NICAM bay sat next to it, and somebody else will be writing the *Eng Inf* article!

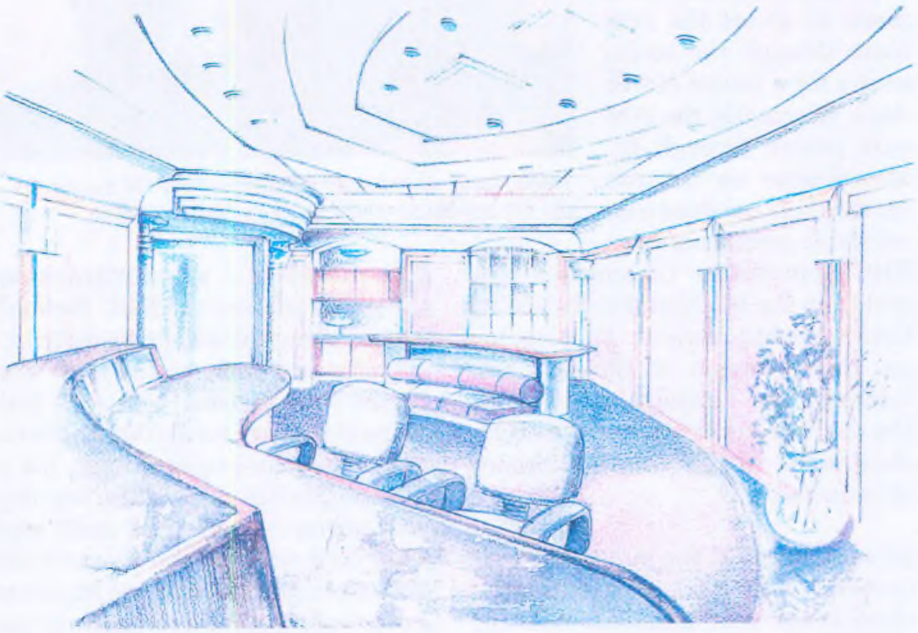
The PCM re-engineering project was led by Transmission Projects, working with Radio Projects and Production Resources Radio.

Russell Inman, Project Engineer
Comms & Control Section
Transmission Projects

Keith Hayler, Snr Project Engineer
Comms & Control Section
Transmission Projects

New edit suites for Glasgow and the OUPC

Two new digital VT edit suites have recently entered service in the BBC — using differing digital technologies. The new suite in Glasgow, which is described here by Ian Gilchrist, uses *serial-component* ***technology while the new OUPC suite, described on page 22 by Peter Duxbury, is based on*** *serial-composite* ***technology.***



Dugald Findlay's design-stage impressions of how the finished suite in Glasgow would look

The first *serial-component* digital VT edit suite in the BBC has just opened in Glasgow. It replaces a second-hand Electra editing suite installed in 1988 — one of the first to be produced by the BBC when it was installed in Edit B at Television Centre during 1978.

The limited space available in the old VT9 at Glasgow was a frequent source of concern to staff using this very claustrophobic area. The new control room is now three times larger, giving ample space for editing and production personnel, as well as the associated equipment.

This new area will be of particular benefit to Presentation in the making of trails. However, Music and Arts, Drama, Religion, Comedy and Sport, among other programme genres, will also benefit from the transparent multi-layered recording and effects achievable in the digital domain.

A small team from Resources Scotland — led by Bill Jarrard, the Project Manager from TE & PS — was set up in December 1992 to specify the building and electronic design detail.

Interior Design

Firstly, a building specification for the new suite was produced. It was to be finished to a high standard of interior design, leaving ample space for production staff to work and monitor the edit session progress.


BBC Glasgow

General view of the finished VT edit suite in Glasgow

The design team, which included Dugald Findlay from BBC Scotland's Scenic Design Department, were tasked with the job of converting the existing Q-Lock area into BBC Scotland's premier edit suite, with aspects of interior design exceeding that found in external facilities. The design mirrors detail in the old reception which is adjacent to the new area. Dugald's drawings, shown on page 20, illustrate how the completed area was envisaged during the interior design process.

The building contract, including the air-conditioning and electrical installation work, was awarded to JAG Building Engineering Services Ltd. This company — formed by ex-BBC BES staff — currently undertakes all building maintenance work for BBC Scotland.

Technical installation

The central focus of the control room is the editing and control desk. Comments were invited from editing and production staff after viewing a cardboard mock-up of the desk produced by Graham Blair, the VT Editor attached to the project. The final design was produced by TE & PS and was constructed by Lund and Halsey Ltd as part of the installation contract.

Videotape machines and other equipment have been installed in the vacated VT9 apparatus area and will subsequently be moved into a shared machine room to be constructed as part of a proposed redevelopment of the adjacent VT10. At that stage, the VTRs will be visible from the edit control desk. The system has been designed to allow recording and transmission from the machine room.

Currently four Betacam SP and one Sony BVH-3000 1" video tape recorders are being used. However, by the end of this year the suite will feature three component digital machines, together with two Betacam SPs and the 1" VTR.

Following a specification produced by Bill Jarrard, the technical installation contract was awarded to Television Systems Ltd.

The main items of equipment are:

Abekas A83 Vision Mixer

The edit suite operation centres on the use of an Abekas A83 digital component, 32-input, 2-mix/effects, reassignable vision mixer, believed to be the first in BBC use. This unit has many useful features including a time line facility which enables the edit controller to "jog" the mixer through a programmed series of effects as though it were a VTR. The A83 has a unique status monitor which displays each element used in the construction of composite multi-layered images.

The A83 also has the ability, via the Abekas LINC control protocol, to share facilities with and control other equipment implementing the same protocol. This means that two control panels could share a single equipment frame; for instance, each taking control of a mix/effects bank.

Abekas A57 DVE

The Abekas A57 digital effects unit (DVE) was chosen as it integrates very closely with the A83 vision mixer. It can be inserted into many alternative paths of the A83 vision system and can be controlled by the mixer to the extent that its control panel is virtually not required. The A57 is a single-channel device with input keying, enabling double-sided page turns etc. Possible effects include 3-D glints and highlights, oil drop, colour correction and de-focus.

Aston Motif character generator

This character generator is becoming the standard in Glasgow, as other Motifs have already been installed in the Electronic Graphics area. The unit installed in VT9 has parallel-component digital outputs.

Sony BVE 9100 edit controller

The Sony 9100 edit controller, with its advanced operating software, has been installed to control all VTRs, the vision mixer and DVE, and several items of sound equipment.

Audio System

The audio system is analogue, based around an Amek BCIII 16-channel, four stereo output bus mixer, customised to BBC Glasgow specifications. The mixer is complemented by outboard compressor/limiters, reverb and delay equipment, DAT and CD machines, a solid-state audio recorder and parametric equalisers. Finally, AES/EBU digital audio inputs and outputs have been brought out to jackfields to allow for cloning of tapes.

Iain Gilchrist
Project & Maintenance Manager
Production Facilities
Scotland

The machine room of the new VT edit suite at Milton Keynes

OUPC

OUPC

The installation at Milton Keynes is the BBC's first *composite* digital VT edit suite and copy area. The project was prompted by the need to replace the original 1" C-format edit suite and to upgrade the copying area, both of which went into service with the original BBC installation in 1981. The other original edit suite at the OUPC had already been updated to component analogue in 1991, based on Betacam SP.

The options

Some difficult decisions had to be made, given the accelerating rate of change in broadcast VT and routeing signal formats. Should the major VT format be analogue component, digital composite or digital component? ... Should the video routeing system be analogue composite, analogue component, parallel digital or serial digital, in either composite or component? ... How far should digital audio or even the capability for future widescreen development be incorporated? The many options were perplexing.

However, at the end of the day, the most important aspect was that it should be cost-effective and appropriate to the Open University's needs.

The choice

A decision on the basis of the system had to be made when initial planning started in February 1993. Taking into account, (i) the ruggedness and repeatability of digital processing, (ii) the choice of digital composite D3 as the Network transmission VT format, and (iii) the state of development, the cost of commercially available equipment and the budget available — the decision was made to opt for a *serial-composite* digital video system. Routeing for AES/EBU digital audio was also to be included.

The editing VT machines were to be D3 format — to provide compatibility with Television Centre — which would allow archiving and re-editing of core programme material on proven hardware. Existing C-format tapes would also be compatible with a composite system.

The choice of composite digital was made possible by the timely release by FOR-A of the PAL version of the VGV DX120 vision mixer, at a competitive price. The option of component digital was not justified at the time, on the grounds of cost or proven product availability.

Routeing system

The area had to work not only with D3 machines but also with existing analogue machines. A multilevel routeing system was therefore chosen, to allow any signal to be routed without having to provide a large number of AD and DA converters. This also had the benefit of providing diversity through the matrix for digital devices, and the ability to have analogue monitoring of any device. The matrix had not only to handle routeing for the new edit suite, but also for an adjacent multiformat copying area. By having one matrix only, maximum flexibility in the allocation of resources between the two areas has been provided.

The system chosen was based on the recently-released Probel TM24 series, which allows analogue and digital routeing in a standard modular series of frames. The configuration is based on seven individual levels, each of either 24 x 24 or 24 x 12. The levels are analogue video, two stereo levels of analogue audio, timecode, serial digital video and two levels of AES/EBU digital audio. The system is controlled by a combination of traditional button-per-crosspoint panels and by two PCs running Procion AV-Workbench windows-based software for flexible multilevel XY routeing and status display.

The digital video routeing system is based on parallel outputs from D3 machines which feed the signals via serialisers onto modified MUSA jackfields and into the Probel matrix. A similar path is used in the reverse process back to the D3 machines via deserialisers. All routeing is in 10-bit form and the matrix is selectable to composite or component formats and capable of transmitting data rates of 360 Mbit/s. The system allows for future upgrading to enhanced component widescreen routeing if ever needed. For the composite routeing, a data rate of 177 Mbit/s is being used which places much less stringent demands on the system.

The new facility also has to interface with an existing Graphics area, based on component signal distribution. To obtain maximum signal interchange quality, an Innovision all-digital coder for converting CCIR 601 signals to digital PAL is being used, together with a Questech 2202 all-digital decoder for decoding from digital PAL back to CCIR 601.

The system at present is working with a Questech Charisma. Expansion of the system will eventually allow digital interchange between the OUPC's Questech SSVR, Quantel Series V Paintbox, Aston Captions and Mac/PC-based graphics and multimedia systems.

Equipment and installation

The edit suite and digital copying area has a complement of five D3 machines, a C-format machine and a Betacam SP. A multi-format copying area — including three Betacam SPs, another C-format machine and various U-matic and VHS machines — has also been incorporated.

The area is split into a machine room with provision for ten full-height equipment bays, and an edit suite control room. There are further plans for a control room for copying operations and monitoring. All VTs are contained in the machine room, which minimises the distraction of machine noise in the control room, unlike previous VT suites at the OUPC where machines were included in the control room.

Continued from page 23

The edit suite control room has been designed with the new HSE *Display Screen Equipment* regulations in mind, with particular attention being paid to the ergonomics of the main operation position, lighting and background noise levels. The control desk houses the VDUs and keyboards for a Panasonic AU-A950 edit controller, Questech Charisma, Questech SSVR, Aston Caption and the routeing matrix XY control station.

Vision mixing is accomplished with the VGV DX120 10-input digital composite mixer, with additional wipe patterns provided as an external key signal by a Cox T8 mixer. A Glensound GSTX14C 16-input stereo analogue audio mixer, with control from the AU-A950 editor, is provided in the edit suite. More complex audio mixing is undertaken in the OUPC's AMS Logic 1 audio dubbing area and transferred back in digital form via the AES/EBU routeing matrix onto either D3 or R-DAT.

Picture monitoring is via a stack of two 20" colour and seven 15" monochrome monitors. Waveform monitoring is accomplished via a Hamlet Videoscope which displays the video waveform and vectors, together with audio level and phase.

The new area was created out of three existing VT cubicles; VTs 4, 5 and 6. A new partition was created between VTs 5 and 6 to form an enlarged control room. The remaining area of VT4 and VT5 forms the combined machine room. The opportunity was taken to refurbish the wall coverings, ceiling grid, lighting, electrical wiring and carpeting of the control room. This work was undertaken locally by OUPC staff while the project and technical installation were managed by TE & PS. The contract for the core of the technical installation was awarded to Gee Broadcast Systems Ltd, with additional installation in the copy area undertaken locally by OUPC staff.

The area entered service in September 1993 and provides the OUPC with up-to-date technical equipment in a flexible and ergonomic arrangement. The area is able to cope with future developments and yet meets the present requirement of producing 160 programmes a year for the Open University in the most cost-effective manner.

The project owes its success to the help, ideas and cooperation of all members of the project team, including staff from the OUPC and TE & PS.

Peter Duxbury, Project Manager
Post Production Systems
TE & PS

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The control room of the new VT edit suite at Milton Keynes

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