No.20 - Spring 1985 **The Quarterly for BBC Engineering Staff** Please Circulate

BBC 1 - Bright New World

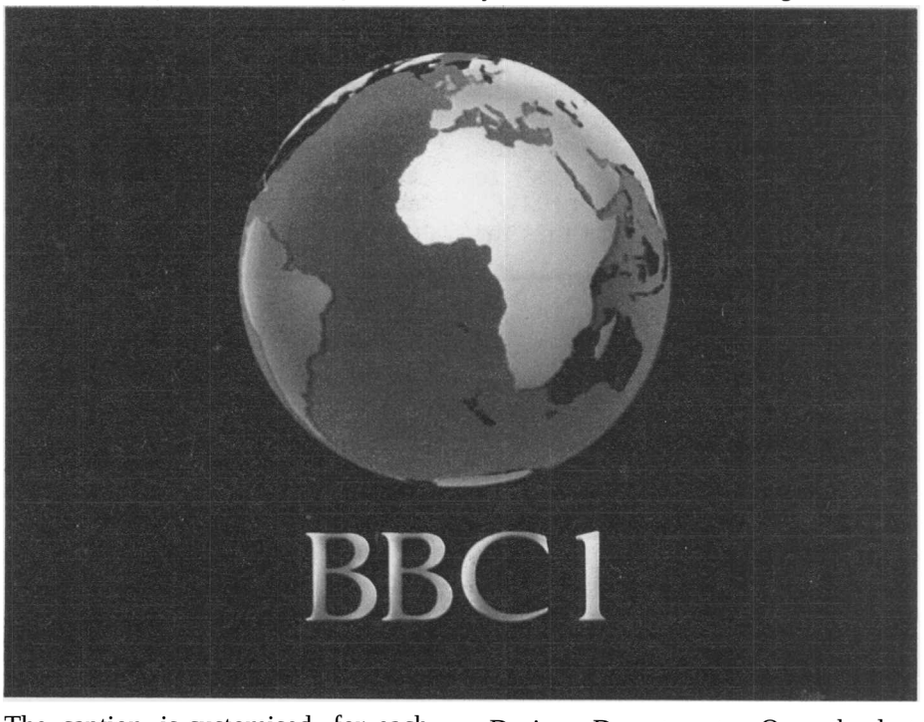
Recently many viewers will have noticed a new look to BBC 1. For many years the channel logo has been the familiar 'rotating world', generated from a mechanical model. Originally this was produced by a remotely controlled camera, affectionately known as Noddy, which was also used for the old mechanical clock and fault captions. Most of Noddy's functions have been replaced by electronic generators, but the World was still being produced by a caption scanner, followed by a colour synthesiser and PAL coder. This required regular maintenance, and alignment of the video processing to produce consistent results.

On February 18th a new Symbol was introduced. The generating equipment is all electronic, using the latest digital techniques. Some digitally generated pictures suffer from an effect known as 'aliassing'; this is most noticable on sloping lines and circles as small steps, which show the graphic being made up of discrete lines. The new equipment is fully 'anti-aliassed' on both the logo and the captions, which substantially improves the overall quality.

By using internal frame stores there is no restriction on the colours, which can be properly shaded. Since the colour information is internally stored there is no need for an external synthesiser or clipper, thus reducing both day-to-day and long-term variations. All National and Regional Centres which opt-out of BBC I have been provided with their own equipment whose outputs, apart from their customised caption, are all identical and of consistent quality.

Descrip tion

The symbol generated by the equipment is a rotating image of the world with a caption displayed beneath. The image is larger than its predecessor, and there is no reflecting mirror, but the detail and accuracy are much greater.



The caption is customised for each of the various regions.

The symbol of the world comprises three coloured parts. A gold shell, which is painted black on the inside, with a shaded blue disc behind it. The sea areas are etched away, leaving the land masses highlighted in gold on the outer surface, and black on the inner surface. Where the shell is completely transparent, that is where there is sea on the front and back, then the shaded blue disc is seen. The outside is highlighted to make it appear as though it is lit by a spotlight above tlte viewer.

Design

Graphic Design at Television Centre undertook the artistic design of the symbol. Clearly this had to be done in very close conjunction with the engineers in Designs Department. Over the last few years, with the design of several electronic graphic devices, a good relationship has developed between the two disciplines. While neither party fully understands the restrictions and principles of the other, each now has a good grasp. of one anothers limitations. Interestingly this even transcends the use of jargon.

Designs Department developed the principles of the system. The most important part of this was the data compression format

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Editorial

Do you cringe when you hear disc-jockeys refer to "97.5 FM" or "1548 kHz medium-wave"? (It is almost as infuriating as hearing ten pence referred to as ten pee!) These "station idents" as they are known, are intended to tell the audience which station they are listening to should they have tuned-in by chance. But they are, to say the least, contradictory, since 1548 kHz refers to frequency and not wavelength; similarly 97.5 refers to the VHF band and not to the modulation system. For those whose notes at Wood Norton have long since gathered dust in the attic, the wavelength in metres equals 300,000 divided by the frequency in kilohertz; thus 1548 kHz equals a wavelength of about 194 metres. The correct phrases, from an engineer's point of view, are therefore "97.5 MHz VHF and 1548 kHz medium frequency". However, research has shown that very few radio receivers (or should I call them sets?) have tuning dials marked "VHF and MF"; they are far more likely to be marked "FM and AM or MW". Therefore it makes sense that the disc-jockeys and presenters should use phrases that listeners are more familiar with.

Brian Marsden (left) from GEC McMichael, and ADE, Charles Sandbank sign a licence agreement that allows GEC McMichael to manufacture and market the CD3M/546 digital PAL decoder

I~ an attempt to persuade more hsteners to use Band 11, BBC Radio has tried to formalize this situatio~, by sug~~s~ing that the phr~s~ VHF-F~ 1S used, thus aVOldmg a con~'hct between engin-e~rs and the hsten~rs. .Eventually e1ther VHF or FM w1ll become normal as the listeners become accustomed to the phraseology, and the alternative phrase will be dropped. Sadly for the engineers, it is likely that "FM" will be adopted, and your editor will be in a permanent state of cringe!

Incidently, in technical writ-ings it is right and proper to use VHF MF LF and HF when refer;ing t~ frequencies, and FM, AM, PCM, DPSK etc when referring to modulation systems.

There are no prizes for guessing which service might carry a signal via NICAM 3/PCM, FM, and DPSK with C-MAC E-MAC D2-MAC, or B-MAC in Band VI: Answers on the back of a 500 pee note to my office please!

Alan Lafferty

The Cost of *ITV*

The following article from Corporate Publicity provides some useful facts when discussing the BBC's finances:

Figures provided by MEAL, the market research organisation, to the 'Did You See ?' programme on the financing of broadcasting (Sunday 10 February) show in detail the amounts paid by consumers towards ITV and Channel 4 through the shopping basket.

Out of a basket of everyday goods which cost a total of £6.20, the following amounts go towards the cost of television advertising:

Chocolate	200 g	1.74 P
Crisps	150 g	0.84 p
Cereal	150 g	2.75 p
Tea Bags	80	1.81 p
Cat Food	415 g	0.56 p
Soap	142 g	1.43p
Toothpaste	175 ml	8.28 p
Stockcu bes	24	5.27 p
Deodorant	150 p	8.91 p

Total cost of products £6.20 31.59p to TV advertising costs

MEAL reports that the most heavily advertised group of products are baby care items. A box of disposable nappies costing £3.25 contains in its price 47.61p for television advertising - 14.6% of its price.

The price of a family car (1.6HL) includes £24.40 for television advertising.

All prices provided by MEAL include an allowance for airtime discounts and for agency commission'.

Transmitters Opened

The following uhf transmitters have opened since January:

Upper Soudley	Glos
Occom be Valley	Devon
Cheselbourne	Dorset
Bidston	Merseyside
St. Albans	Herts
Stokein teignhead	Devon
Inverness	Highland
Gellifendigaid	Mid. Glam
Tregynon	Powys

The following vhf transmitters have opened or changed:

Ludlow	Salop
Brougher Mtn.	Co. Fermanagh
Lame	Co. Antrim

The following local radio transmitter has changed:

Les Touillets	Guernsey Cl

TV 36
Camera Cable

One of the necessary parts of a television studio is the camera and lens, and a lot of time is spent maintaining and lining them up before use. In the last few years however, one of the weak links in the chain has been the multi-core camera cable, now known as TV36, that connects the camera to the studio control rooms. With recent modifications it is hoped that the problems associated with the cable and its terminating connector will be resolved.

For non tv-studio engineers it is perhaps worth considering what the cable does, and what the problems were. As the name suggests, the cable has thirty-six inner core conductors carrying the camera picture outputs, camera controls, talk-back and intercom, syncs etc. between the studio or OB and production control areas. A cross-section through the cable shows its complexity.

The cables first came into widespread service with the Link 110 camera, and came complete with termina ting connectors at each end. These could be straight entry or angled entry connectors depending on their application.

Two problems came to light; the drain wire, a solid conductor, kept snapping every few inches; the symptoms being a shower of bits of conductor falling out of the cable when it was opened up. Secondly the clamps at the rear of the connector were inadeq ua te and the compression ring lasted only about a month before becoming too tired for further use.

So the BBC turned to a different ~upplier, and a different set of problems emerged. These cables had all the same colour insulation (white) on the inner conductors and sadly little attention was given to the allocation of conductor functions or pin layout. Thus syncs could run next to talk-back circuits, resul ting in a permanent buzz on the cameraman's headphones. This problem was particularly evident on the Philips LDK series cameras.

All TV36 cable up to this date was designed for use with baseband frequencies, and it could ha.ve a poor return loss when multIp~ex signals up to 27 MHz were bemg carried. Slight differences between manufacturers' designs resulted in connectors that did not mate, although some of the clamping arrangements were better. However, clamping still caused trouble on the studio floor - the cable would frequently be pulled out of the clamp when the camera moved, and the clamp came off on the studio catherine wheel. The original studio floor cables came covered in neoprene which ripped off if the cables became trapped under the camera pedestal wheels. Although the neoprene was flexible and quiet when moved on the studio floor, it was "sticky" and picked up dirt. An extra wire, sometimes carrying power to camera lamps, was wrapped round it to lift it out of the dirt. Polyurethene was tried as a sheath instead, but this stiffened the cable and had the nasty habit of producing loud squeaks in the middle of productions, although it proved satisfactory for use on OBs, and for wall mounted cables in studios.

So, in 1979, a BBC specification for TV36 type cable was produced, this being coded PIF36/1M. Initially this specification called for three versions, A, B, and C (rubber, polyurethane and pvc sheaths respectively). The resulting cables were free of earlier problems of return loss, colour coding of cores, and the lie of the cable. After further development a single cable, the 'D' version, with an overall diameter of 17.5 mm, sheathed in Arctic grade pvc, was produced. This improved the flexibility and avoided the 'squeak' problem which occurred on some studio floors with the polyurethane sheathed cable. It was also thick enough to prevent it going under pedestal guards. The 'D' version became, and remains, the standard TV36 camera cable for both studio and OB use.

However, cable clamping was still a problem as under severe conditions, the original compression ring clamps deformed the cable evenly all around the ring, leaving it free to move slightly. Eventually the wires of the outer wire braiding snapped off their anchorage, and the inner wires broke off the connector pins: the evidence of this starting to happen was felt when the connector clamps could be turned slightly on the cable end. SCPD produced a clamping wedge as an interim solution which was inserted into the clamping shell and held the cable firm. This worked by flattening the cable slightly, but the whole clamping assembly then tended to unscrew from the body of the connector.

The wedge modification works well if the clamp assembly

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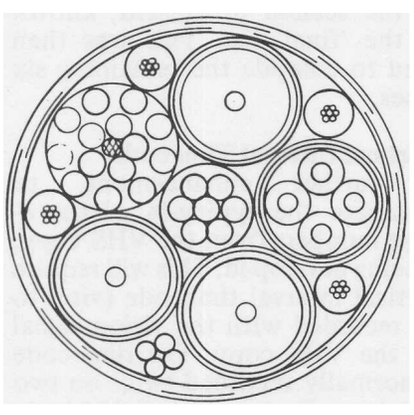
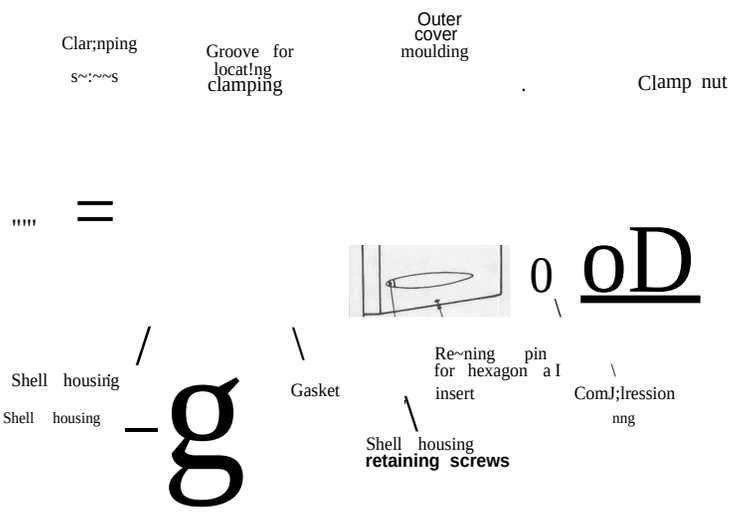


Cable cross-section seen from socket end



Improved Videotape Editing

Soon after the introduction of EBD time and control code (time-code) it became apparent that there were two levels of vt editing. Whereas the day-to-day requirements of actuality and sports programmes could be met by a two-machine edit system, the more complex drama and light entertainment productions required a three-machine set-up (two playback, one edit).

Current examples of these systems, both designed by Designs Department are known as ELECTRA and EDITRACE.

The Electra system is designed to control one edit and up to three playback vtrs on an edit-by-edit basis. Previously the internal data storage handled one edit sequence. However, this facility has been extended now that external data storage has been added. Data logging equipment known as ELECTRALOG (RD3/501) has been installed in the main videotape edit suites at TV Centre. The eq uipmen t provides automatic logging of all the edit decision points (8-digi t timecode values) and associated data for the Electra (RD4/509) videotape edit control systems.

The equipment includes two control-panel modules which are fitted to existing panels in the edit suite, a bought-in DEC LSI1I/23 computer supplied by Dnit-C of Worthing, a vdu with many built-in display features, and an interface panel between the computer and Electra. The data is logged on a 3'l2-inch floppy disc as the edit session progresses so that, at the end of the session, a complete list is held on disc. If, at a later stage, re-editing of the programme is req uired, the disc can be used to load edit data into Electra to give rapid re-location of edits.

The DEC LSI 11/23 *computer*

Edit List in Sypher

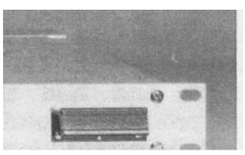
It is also proposed to use the disc in the Sypher sound dubbing suite, where the programme sound of the eqited videotape is improved by adding background effects, music, or inserting alternative material, and generally tidying up the sound which may only have been rough edited at the videotape edit stage. Much of the sound work in Sypher is linked to the vision edit points and the associated time code points of the original material. If this data can be transferred directly from the disc to the audio-machine synchronisers, then time is saved by not having to type this data in. This proposal is now being progressed and a working system should be in service next year.

Off-line Input to ELECTRALOG

ELECTRALOG will also accept data in the form of a serial data-stream containing the time code edit points which have been compiled from a VHS viewing copy of the original recording. The VHS copy has an 8-digit time-of-day timecode 'burnt-in' to the picture when the original recording is made. This is used to identify the edit points by reviewing the VHS tape, and, using the slow mode and 'still-frame', to allow precise time code values to be logged. More recently some editors have used the BBC Microcomputer to log these timecode values, and using a suitable program, an edit list is compiled which can then be printed out. However, by extending the Microcomputer program, it can also be used to send the edit list, in serial data form, directly to ELECTRALOG. This work has recently been completed and the first programme to use 'uploading' from the BBC Microcomputer to ELECTRALOG was the compilation of the test picture sequence, fur fue EBD, of ~and~d~ converted hd tv tests. Seven identical tapes had to be compiled from original material for distribution to the EBD members without using an intermediate dub. Much time was saved by using an edit list compiled on the BBC Micro. This was loaded into ELECTRALOG and the first tape edited. Several new edit points were added during the session as well as changes to the original list. ELECTRALOG built up a new list as the session progressed, known as the 'final' list. This was then used to compile the remaining six tapes.

Vertical Interval Timecode

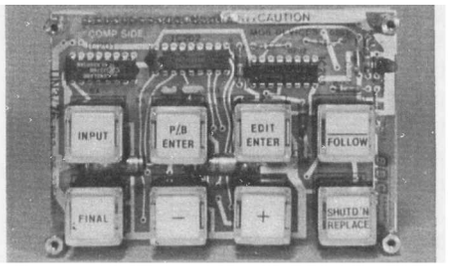
A further enhancement, to eliminate the typing-in of the 8-digit numbers from the VHS copy, is being developed. This will require vertical interval timecode (vitc) to be recorded with the vision signal on the VHS copy. The time-code is normally recorded twice on two television lines in each field blanking period. As well as the time information within the code, there are eight 4-bit blocks of 'user bits' which could be used to carry other



The Electralog interface unit

information such as the spool number. A vitc converter (CD4Sj 418) has been developed to insert vitc and 'burnt-in' timecode characters onto the vision signal when the recording is made on VHS. It decodes the input feed of longitudinal time code (carrying the time-of-day) which is distributed round the studio complex.

A special vitc reader (CD3Sj 549) will send decoded vitc in serial data form to the BBC Microcomputer used to compile the edit list. Using still-frame mode on the VHS machine, a single key operation on the Microcomputer



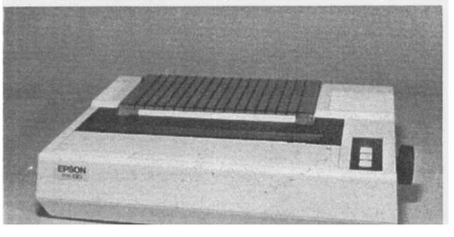
The editors control panel

will log the time code value from the VHS.

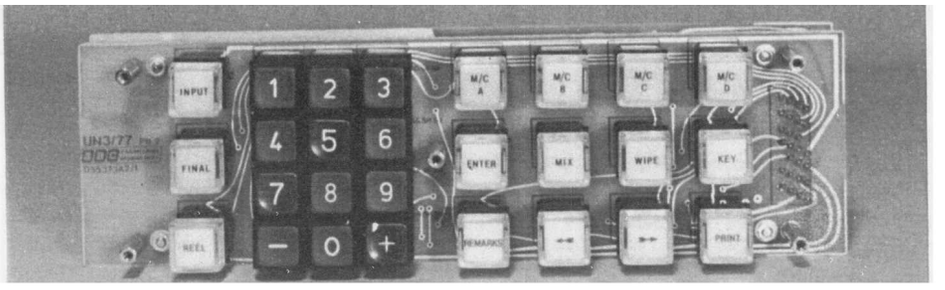
If the VHS copy is edited in an off-line edit suite, the vitc will be carried through to the edit tape. Several generations of editing can be carried out, and, by reading the vitc from the edited tape, an edit list, including spool numbers, could be automatically compiled on the Microcomputer by detecting the vitc time discontinuities.

Logging in the Studio

As the output from the studio is recorded onto the C-format machine, time-of-day longitudinal time code is also recorded on track three so that sequences and events in the programme can be accurately located for editing. The timing of



The video printer



The playback control panel

the sequences is also logged in the studio, as recording takes place, by noting time-of-day against the script. Durations of items are timed using a stop watch. For some years now a trial has been taking place in some studios using a timecode reader with integral LED display and stopwatch facility to ease this task. A specification has now been agreed, and a new unit will be developed based on a micro-processor which will then be installed in all studios.

Special Effects Compact Disc

BBC Radio has released a compact disc of sound effects for in-house use. The disc is a 'pilot' for evaluation by the sound effects service.

In radio and television, a 100,000 discs are issued on loan annually via the Sound Effects Centre. Each year a number of new releases are added to the collection to keep it up to date. At present, the BBC uses 7-inch 33 rpm discs for its stereo recordings, with up to seven minutes material on each side. Through the audition processes, and normal studio wear and tear, the surface quality deteriorates and the life of the record is short.

The Compact Disc is an attractive alternative in terms of the economics of the sound effects service. One CD can have more than an hour's worth of material - four times as much as a 7-inch disc - with a longer life, and a bonus in terms of quality.

The Sound Effects CD has been pressed by NIMBUS RECORDS, the only UK manufacturing plant. Digital equipment was used to make new digital recordings for three quarters of the playing time of the disc. The material was assembled in-house and digitally edited on to a U-matic cassette. The remaining playing time was taken up with new stereo and binaural recordings which would normally have gone on to a 7-inch disc.

The new CD features a range of effects, to allow for as much experimentation as possible. There are a number of backgrounds such as sea wash, rivers and city skyline, especially useful in CD quality, as well as new recordings of bicycles, dentistry, babies and natural history subjects. There are also some percussive 'spot' effects which are usually difficult to put on to an analogue disc.

It will be some time before the sound effects service can obtain enough feedback on the CD to make detailed plans for the future. They will be relying htfavily on the responses of people involved in programme sound, in both Radio and Television. Although there is at present only a limited choice of suitable players for CD reproduction, two studios in Broadcasting House have been equipped.

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ERRATUM

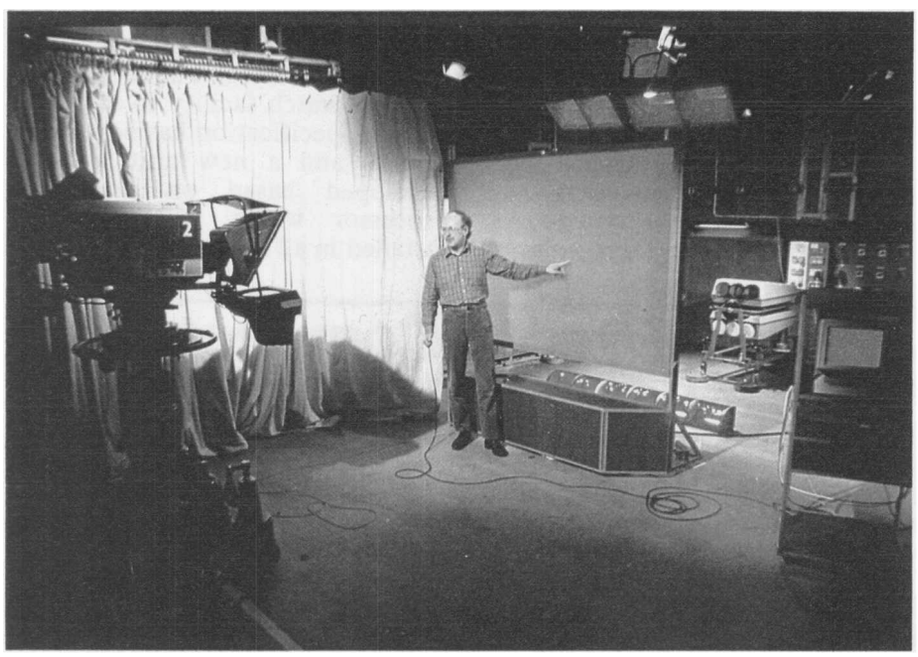
The credit for the photographs on the back page of 'Eng Inf'number 19 was wrongly attributed to John Flewitt. The credit should have been given to David Bruce Johnson of SCPD.

Our apologies for any embarrassment caused.

Animated Graphics for Nf5

Introduction

BBC Television's new Weather computer system, allows the weathermen to construct high quality graphic sequences that describe how the weather is changing over the United Kingdom. The system, developed in-house by the Computer Graphics Workshop, uses the latest techniques in computer graphics to both prepare and display tv weather bulletins from data products produced by the Meteorological Office computer centre at Bracknell.



Weatherman Michael Fish rehearses in the studio. The Macintosh terminal (right), is controlled by the switch in Michael's right hand

All material produced by the computer system is presented using a uniq ue electronic blackboard. This new studio technique allows the wea thermen to be in vision simultaneously with the graphics, and also lets them both see, and control, their animation sequences during the broadcast. The design of the familiar BBC Weather symbols has been improved, and wherever possible, all new map and satellite grids have been cleverly designed to relate to each other. The two graphic designers on the project have also been able to take full advantage of the latest computer techniques in digital typography and cartography.

The system has taken just over one year to develop and builds heavily on software experience gained by the Computer Graphics Workshop on the general election and other similar projects. The BBC end or the system uses an Apple Macintosh XL microcomputer configured as a Weather workstation. This controls software running on a Digital Equipmen t VAX 11/750 minicom pu ter. The VAX in turn controls a Quantel 700 I graphic terminal which generates the anima tion seq uences.

The bulk of the data, i.e. satellite images, forecast data products and weather statistics, etc. are sent from the Met Office computer to the VAX computer over British Telecom Kilostream circuits. This processing proceeds independently of other production work on the VAX system. The Quantel graphic facilities are augmented by a Jupiter 7 framestore which assists in the processing of satellite pictures.

BBC Computer system

The computer system at Television Centre uses a Digital Equipment VAX /1/750 minicomputer with 2M byte main memory, linked to two Apple Macintosh XL micros with IMbyte memory each. The software running in these computers allo'ws weather data to be received automatically from Bracknell and also lets the weathermen plan and view material.

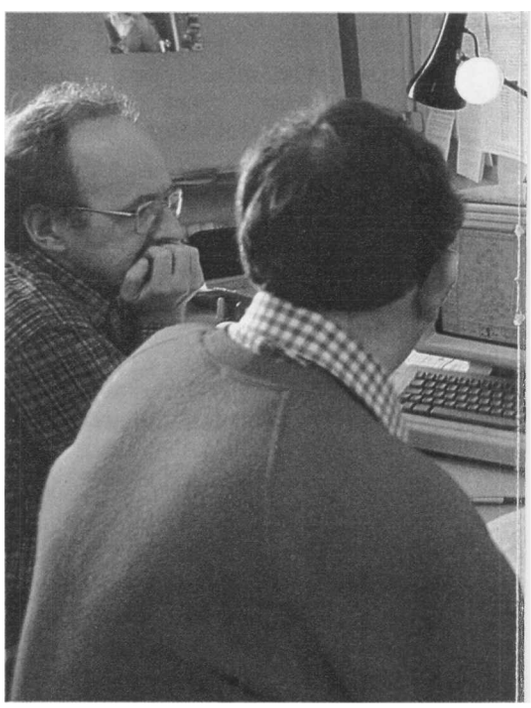
When enough material has been assembled, the video frames that constitute the final bulletin are stored on the integral 160Mbyte Winchester disc that forms part of the Quantel display subsystem. These frames are broadcast live from the Quantel which is controlled by the weatherman in the studio using a second Macintosh XL.

Weather workstation

The initial brief for the system designer required that the system be capable of one-man operation by the weathermen. It was realised at an early stage in the project that this would probably represent the greatest challenge to the software development team.

Various man-machine interfaces were evaluated and tested, including graphic tablets and joysticks, but the best method was found to be a "mouse". At that stage the only easily available system with good interactive graphic facilities was the Apple Lisa, now appropriately renamed the Macintosh XL.

The implementation of this specialised user interface for the weather system represents a major step forward in man machine interfaces in the BBC. It allows the weathermen to see and edit a graphic representation of all the digital weather products, the satellite image sequences, and an updated version of the familiar



fan McCaskill and Michael Fish llse the mOl for the midday forecast

~w TV Weather System

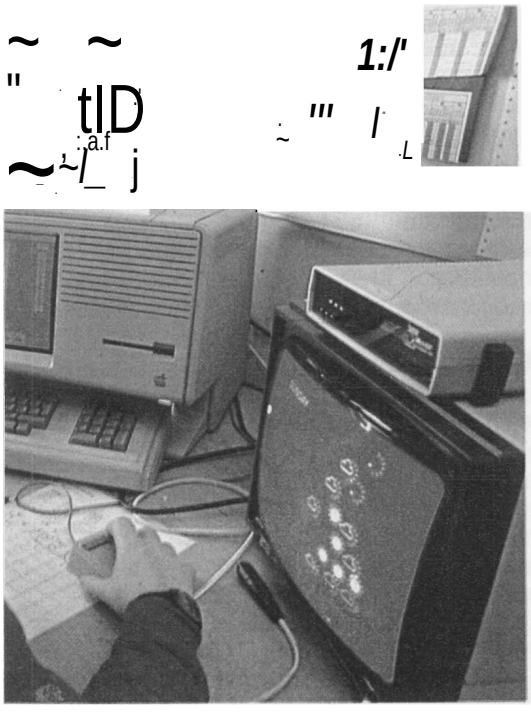
sym bol chart.

Operation of the system involves viewing various graphic menus, pointing with the mouse d riven cursor, and selecting the desired object or command. For example, when the symbol chart is being prepared, the Macintosh displays a set of iconic representations of clouds, sunshine, snow, rain and hail symbols.

By selecting these symbols and placing them on the appropriate map background a complete chart layout is defined. When the time comes to make up the full symbol chart, the Macintosh sends a list of the chosen symbols and their position to the VAX which instructs the Quantel what to do. This operation is very speedy and if need be the Weathermen can make up a sequence of symbol charts which can themselves form a short animation sequence.

Similar techniques have also been implemented to help edit the positions of highs and lows on the isobaric charts, and to allow the weathermen to draw warm, cold and occluded fronts.

Since a nother part of the brief demanded that the format of each day's bulletin would be flexible, an interactive sequence editing facility has also been provided using a "filmstrip" representation of the complete bulletin.



:lse to select and place symbols

Graphic displays and studio operation

All of the images and graphics are assem b led in the Quan tel 700 I display sub-system. This sub-system is a Motorola 68000 micro in which the low level graphics software runs. The micro also controls two broadcast quality framestores, a local 160Mbyte Winchester disc which stores pictures, as well as communicating to the VAX.

Almost all of the graphic output techniques used within the project were originally developed by the Workshop for use within real-time projects such as the General Election, 1984 European and US Elections, 1984 Olympics, the Money Programme, and Odd One Out. All of these have a requirement for high quality text and/or maps whose layout and design can be predicted well in advance.

The system heavily exploits the unique facilities for mixing between framestores to animate multiple satellite images and the forecast products.

The studio presentation by which the weatherman delivers his bulletin is completely new. The techniq ue is a hybrid one, relying on both colour separation overlay (cso), and video rear projection.

The compu ter graphics are projected onto a screen approximately the same size that viewers are familiar with. This image is tinted blue by spilling some blue light onto the rear of the screen. This allows the weatherman to stand in front of the screen and see a degraded version of the full colour image. The man can therefore point and gesture to the visuals in a way which hitherto was very difficult with cso.

The camera viewing this scene is locked-off, and sees the wea therman against the blue-background. The viewer at home, however. sees the weatherman in full colour in front of what appear to be full colour weather charts. The weatherman controls the whole show through one push button and can therefore interact wi th the graphics even though they may be animating.

Photographed "off-the-tube ", how the presenter and graphics fit together

Bracknell Computer Data

The BBC is the first UK broadcaster to subscribe to the new digital weather product service offered by the Meteorological Office. This service relies on one of the most powerful computers in Europe, a Control Data Cyber 205, located at Bracknell.

The Bracknell system sends three types of data to Television Centre: satellite images: forecast frames for various weather phenomena: statistics on rainfall and sunshine for the previous

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New World - continued from page 1

for storing the map of the world at all angles. The hardware development included EPROM based frame-stores, and digital processing of the video. Software had to be written for the departmental VAX-Il computer for validating and processing the data into a suitable form for direct programming into memory.

A third group in the project was Computer Graphics. They have been extensively involved in- past projects, and for the BBC 1 symbol they wrote large amounts of software, especially to generate the compressed data for each view of the world. This processing and the transferring of data between their Quantel and VAX-ll computer took a long time and was mostly run over weekends, but the time had to be carefully chosen so as not to interfere with election coverage in 1983 and later the Olympic games.

Computer Graphics also organised some early feasibility studies to evaluate the graphic principles. In particular this showed that a 3D effect could be obtained even with an 'infinity' view.

The digital standard used is that specified by the EBU for a digital parallel interface. While the device has only analogue outputs, to suit present installations, the EBU specification defines the required sampling rates and levels for luminance and chrominance. A further advantage is that the Quantel Paintbox handles data in a form quite close, but not identical, to this format.

To produce the overall effect two full frame-stores are used. One is the foreground store which holds the highlighted gold shell, and the other is the background store for the shaded blue disc and the captions. These stores hold only a single frame, and there is no restriction on their content. They are full colour and can display any picture produced by the Quantel Paintbox. These stores are generally known as the 'fixed' memory.

The main store of the system is known as the 'sequence' memory. This holds the data for the map of the world for each of the 600 fields that are displayed. This data is compressed by a coding system which combines the benefits of traditional run-length coding, with the advantages of pixel definitions. There is physical space for up to 7.5 Mbytes of memory, although the addressing can access up to 16 Mbytes. For this application a field of data is stored in less than 8 kbytes of memory space, as opposed to over 400 kbytes for a full field store.

Software

The starting point for the sequence data was a purchased data-base of a Mercator's projection map of the world. This was edited by Computer Graphics to remove all political boundaries, and transferred from their VAX-ll computer into the Quantel Paintbox. This was used for a 2: 1 size reduction which incorporated the anti-aliassing algorithms. The data was then transferred back to the VAX for encoding into the Designs Department data compression format.

The two sets of fixed data, the gold shell for the foreground and the blue disc with caption for the background, were 'drawn' on the paintbox. This data is properly anti-aliassed at source and was also transferred to their VAX-I1. Further processing ensures that no degradation occurs.

Both the fixed and sequence data was transferred from Computer Graphics to Design Department on magnetic tape, using the internal post! This proved to be an extremely efficient method of data interchange, far exceeding the earlier methods of paper tape and floppy disks.

Hard ware

The memory structure is similar to that used for the recently introduced digital Test Card F generator (see Eng Inf No 18), but each card can hold more data, and can be a part of a larger data-base. The EPROMs used are 27128 16 kbyte devices, although the memory card can take 27256 and even 27512 devices as, and when, they become available. When fully populated with 27128s each card holds 0.5 Mbytes.

The controller unit has a 24-bit sequence address bus giving access to 16 Mbytes, but the equipment has space for only 7.5 Mbytes, and is fitted for 5 Mbytes. The controller also addresses the fixed memory through a 19-bit address bus. This memory uses identical cards to the sequence memory and four are in parallel. A result of this is that the customising for each region affects only the data on two cards in the system. In fact, since only the caption is different for each, only 16 EPROMs are specialised.

The controller also decodes the sequence data from its highly compressed format into a usable 13.5 MHz data stream, and distributes timing information to the rest of the system. Timing control is useful, since it can eliminate the need for external synchronising. This equipment's ou tpu t can be varied from over *6ps* early to over *3ps* late relative to the mixed syncs input reference.

Digital multipliers are used to key the map onto the foreground and background data streams. These are full 8 x 8 bit devices, and correct scaling is incorporated to ensure unity gain where necessary. The two keys are processed to prevent any excess amplitude after combining.

The two data streams are added digitally, before being blanked. Normally digital blanking needs to be shaped to conform to PAL system I, but since all the signals are generated internally, correct shaping is naturally included within the data. (In any case the start and end of all lines are black.)

A new, triple-video, analogue-to-digital converter has been designed to provide the YUV outputs and an analogue matrix used for two sets of RGB outputs. Both these units employ close tolerance components to minimise drift, and hence regular alignment. A test waveform is included within the system for checking output levels and matrix accuracy.

The system also includes a large power supplier, based on a commercial unit, and a BBC designed clock generator which is common with other digital equipments.

Manufacturing

The detailed design of the system began in early 1984, with the requirement that the new symbol should be ready to go on air by 1st January 1985. This included the slight complication that not only London, but also eleven regions had to have their equipments delivered and installed well before Christmas.

Taking a certain amount of risk, some manufacturing had to be initiated before the prototype was fully operative. This partic-