ENG INF

The quarterly for BBC engineering, technical and operational staff

AUTUMN 1992 No. 50

R. D. DEMONSTRATIONS

John Barrett, RD

Comparative off-screen photos of (top) the experimental analogue 625-line PAL transmission from Crystal Palace, showing multipath and other propagation distortions, and (below) the superior picture quality of the experimental 30 Mbit/s digital 625-line transmission (see page 2)

Research Department recently opened its doors to visitors from both inside and outside the BBC, to demonstrate some of the key projects currently undertaken by the department. The event was judged to be a great success, with some 620 people from industry, government and the media visiting Kingswood Warren during the four days.

Continued on page 2...

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ENG INF

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As ***Eng Inf*** is an internal BBC magazine, it would be appreciated if no reference was made to it in articles, magazines, etc, published outside the BBC.

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Stories for the Spring 1993 edition should be forwarded to the editor by Friday 12th February, 1993.

As we now have PC facilities, your word-processed text may be sent in on a 3½-inch diskette.

DO Practice Handbook

A new edition of the *Drawing Office Practice Handbook* is now available from Engineering Training Department at Wood Norton.

Last revised in 1975, the handbook has been prepared by a working party of the Drawing Office Liaison Group, and is provided primarily to give guidance to engineering drawing offices within the BBC. It is also available to other areas that have the need to prepare engineering drawings on an infrequent basis. This revised edition contains updated sections plus new information relating to the generation of drawings using CAD techniques.

Copies may be obtained from:
the Distribution Unit
at Wood Norton (ext 318)
at a cost of £20

...Continued from page 1

The demonstrations were chosen to illustrate the wide range of work that is done at Kingswood, covering television and radio both in the studio and at the transmitter.

Six areas of work were on display:-

- Low bit-rate digital HDTV
- Digital Audio Broadcasting (DAB)
- Enhanced studio PAL
- Cordless OB cameras
- Optical routeing of digital television signals
- Control room acoustics

The digital HDTV demonstration proved to be very topical, as it included the results of some very recent BBC tests of a high bit-rate modem produced by Thomson CSF/LER of France. The system successfully transmitted 60Mbit/s of data within a standard uhf 8MHz television channel. When used in combination with techniques presently being developed for video compression, the system would in principle be able to transmit two HDTV programmes.

For the tests, a 30Mbit/s digital 625-line vision signal was combined with a similar rate of pseudo random data and transmitted at 50W erp from the Crystal Palace mast. The signal was successfully received at Kingswood and at a number of other test sites in south London and Surrey. During the HDTV demonstration, visitors were shown a video tape recording which compared the superior picture quality of the digital signal to a conventional analogue PAL signal, transmitted over the same uhf link (see photos on page 1).

Henry Price
H.E.I.D.

Transmitter News

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

New TV relays

Borve	Outer Hebrides
Clovenfords	Borders
Elland	West Yorkshire
Honiton	Devon
Lees	Gtr Manchester
Maentwrog	Gwynedd
Preston	Dorset
Queslett	West Midlands
Trebanog	Mid Glamorgan

In addition, the Seagry Court relay at Swindon has had its antenna modified, to improve coverage.

Addition of Nicam Stereo

Durris (BBC2)	Aberdeenshire

New FM Stations

Combe Martin	Devon
Ness of Lewis	Outer Hebrides

Radio 1 on FM

Keighley	West Yorkshire

Radios 1 and 4 on FM

Penifiler	Isle of Skye
Skriaig	Isle of Skye

Frequency changes affecting Radios 2, 3 and/or Scotland have also taken place at these stations.

Local Radio MW Closures

Shrewsbury (756 kHz)	R. Shropshire

DEVELOPMENT GROUP
New Title, New Roles

Following the reorganisation of Design & Equipment Department announced in March '92, Development Group assumed its new title from 1st November. Three broadly-based sections will cover work on ***control systems***, ***studios*** — principally digital audio and video — and all aspects of ***transmission*** including ancillary services.

Apart from offering design and consultancy services, the Group includes prototype services, outside contracts and test staff to support small-batch manufacture and repeat orders for existing designs, with full warranty and repair cover. Development Group will remain at Avenue House until the new accommodation at Kingswood Warren is ready at the end of 1993.

Reporting to Phil Laven, CER&D, the Group is headed by John Astle, together with Section Heads — David Bradshaw, David King and John Sykes — and Business & Quality Manager, Peter Gregory.

NETWORK RADIO
Drama Studio MV6

Mike Taylor and Simon Cooke describe Maida Vale's new drama studio: Suite 6.

Maida Vale — a former skating rink dating back to approximately 1910 — was acquired by the BBC and converted into rehearsal and recording studios during the 1930s. Today, it houses seven production studios, The Radiophonic Workshop and accommodation for support staff.

For some while, MV6 had been an under-utilised music studio and it was decided to refurbish it completely as a new drama studio to complement MV7 — London's principal Radio drama studio.

John Walsom, RHWL

General view of the new cubicle

Architecture

The production and operational principles which had already been established for the White City drama suites — by consultant architects, Renton Howard Wood Levin — were adopted for MV6 as far as possible, within the limitation and restrictions of the existing space. The ideas collected by the BBC Drama Studio Study Group, during their tour of comparable facilities at the time of the Langham Project, have also been incorporated.

Effective communication between the cast and the director was considered to be very important, as was good visibility into as many of the acoustic spaces as possible.

Studio 6 therefore provides a range of interlinked acoustic environments, including a dead room with an anechoic acoustic trap for outdoor and distance perspectives. A substantial live area with a curtain partition provides the main acting area with a kitchen and telephone booth. Effects stairs to a new studio balcony lead to a new green room. A number of variable acoustic panels are incorporated, while various types of openable doors allow great flexibility when planning studio sets. This arrangement also provides good communications between the different environments in which the action proceeds physically as well as acoustically.

John Walsom, RHWL

The upstairs green room

A new cubicle has been cut into the rear corner of the studio, utilising existing available corridor space. It provides three-window visual communication with the main part of the studio. The loudspeaker and vision monitoring have been incorporated into the architecture of the observation windows and the plan form of the cubicle has been designed to suit the preferred 'front-to-back' arrangement of operator, production area and sound effects sub-mixer area. Lack of coloration, and stable and accurate stereo imaging, were prime objectives for the monitoring. This has led to an irregular octagonal-shaped control room with near parallel sides and a symmetrical plan.

– MAIDA VALE 6 –

Technical equipment

Some early consideration was given to transferring the existing mixing console from Studio B11 in Broadcasting House. However it was eventually decided that it would not meet the operational and production needs of the new studio. The B11 console was a development of the general-purpose series of desks designed in the late 1970s, and was never entirely satisfactory or adequate for the needs of Radio Drama. A considerable amount of time was wasted in the studio whilst rearrangement of the cubicle facilities took place.

It was thus decided to install a modern sound desk offering a larger number of channels, greater flexibility and with the option of setting up scenes or whole production requirements and recalling when necessary. This is a particularly important feature if the studio is to be used for extended times on different productions in parallel. Early consideration was therefore given — by Radio Projects, Studio Operations and Drama Department — to the AMS Virtual Console System, the SSL 5000, the Neve 'V' series and the SSL 6000 consoles. After very careful analysis, the AMS Virtual Console System was chosen.

This console offers the ability to store the settings of all the controls and recall and reset them immediately. All the controls are assignable so, unlike a conventional desk with controls for every function associated with every channel, this desk has two sets of controls which may be assigned to perform the functions of channel fader, group fader or master fader. This allows the operator to set up the studio with microphones plugged up in a number of areas for different scenes, and to place the controls for the microphones being used at any particular time in the most convenient position.

The studio is also equipped with a wide range of sound reproduction devices including grams, samplers, CD, tape and DAT machines. These are generally used for playing in sound effects and atmospheres, and are premixed by the 'grams operator' at the rear of the cubicle. Because of the large number of record sources available, a small router has been installed to allow any desk output, or repro device to be recorded on any machine. Visual monitoring has been provided to those areas of the studio which are not directly visible from the cubicle, and comprehensive talkback facilities are provided to all studio areas.

John Walsom, RHWI

Main active areas and control room, with stairs to the green room

Other facilities provided include DAT editing on a Sony PCM7000 series system; optical disc recording and editing on an Akai DD1000 recorder; and a telephone effects unit which allows eavesdropping on either side of the conversation in addition to providing all the standard rings and tones.

Mike Taylor, Hd. of Proj. Man.
and Simon Cooke, Proj. Eng.
Radio Projects

TRAINING

Manager's Technical Awareness Workshop

Roger Harste describes a three-day internal course which has been designed to show managers how radio and tv programmes are made.

The Technical Operations environment can be a bewildering place for those not working in it. There are *dollies* and *moles*, *booms* and *fishpoles*, *pans* and *crabs* — things that sound as if they should have no place in a studio. Then, in true BBC fashion, there are a whole host of abbreviations, such as PPM, LS, MCUs, PFL, CMCCR, etc. The list seems to be endless.

Many non-technical staff find themselves dealing with this new language and wish to understand what goes on in a studio. The demand for a general awareness course has been obvious for some while so, in the true spirit of enterprise, Engineering and Technical Operations Recruitment (EngTOR) has developed a three-day course called the *Manager's Technical Awareness Workshop*.

Sound is a natural place to start. Using lecturers at Radio Training and at Radio Studio Operations Training, the first session has course members working in the role of Studio Managers and presenters, compiling a straightforward Radio programme. It brings home what it's really like to work under the pressure of the red light.

Having survived the day in Radio, the second day is spent with Television Training at Elstree. No gentle introduction here but straight into recording on location — the set of *Albert Square* to be exact. There has been many an arm groaning under the weight of a fishpole, several pans that were not quite focused and many cold people awaiting a

reviving cup of coffee. It's quite a relief to move into the studio. Here, course members put together a programme, performing many different roles, from director to presenter, vision mixer to camera operator, tape operator to boom operator.

The final session — with Post Production Training — forms a natural conclusion to the programme-making chain, and to the workshop. It provides a chance to experience computer-assisted editing at first hand, as well as an opportunity to view the superb facilities available in Stage V at Television Centre. Seeing equipment such as D3 and Sypher in use gives course members a new awareness of the complexities of good post production.

The Workshop has more than achieved its aim to make those who attend aware of the work of Technical Operators. People from areas as diverse as Occupational Health, Scheduling units and Personnel have found the course both enjoyable and beneficial. "Brilliant", "very informative", "great fun", — these are some of the accolades that we have received. A great success all round!

By the way, if you are still not sure what moles, crabs and fishpoles have to do with broadcasting, then maybe you too should consider coming on the Workshop!

For Further Details Contact:
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EngTOR, Room 3368, White City
Tel: White City (07) 25774

EQUAL OPPORTUNITIES

Engineering agrees six action points

The Engineering Directorate ***Equal Opportunities Group*** — chaired by Phil Laven, Chief Engineer Research & Development — has met twice and, at their second meeting on 12 October 1992, agreed six action points which were subsequently endorsed as Engineering Division policy by the Director of Engineering's management team on 16 November. The points, which are listed below, are "*a positive start to the work of the group*", says Phil Laven. "*The under-representation of women in BBC engineering posts is particularly difficult to address since women are under-represented generally throughout industry and amongst those following technical courses. This is far from an easy time to remedy any form of under-representation, but this should not deter us from doing all we can to ensure our working practices do not discriminate, however unintentionally, against women, members of ethnic minorities, people with disabilities, or any other group.*"

- Equal opportunity issues arising from management decisions should be fully considered by the management team concerned as part of the decision making process.

- A target date of **December 1992** for managers and other staff to attend a Fair Selection training workshop has been confirmed — after this date only those who have previously attended the course should be involved in the recruitment and selection process.

- A target date of **December 1994** has similarly been set for managers and staff to attend the Disability Awareness Training course.

- The importance and use of person specifications in the recruitment and selection process should be reinforced by senior managers. In future, jobs should not be advertised without a current person specification having been prepared in advance and its use recorded.

- Greater use should be made by all departments of positive equal opportunity statements in job adverts (whether internal or external) to encourage under-represented groups to apply for positions with Engineering directorate. The following statement should be used in all future job adverts:

  "BBC Engineering welcomes applications from women, ethnic minorities and people with disabilities as they are presently under-represented. Appointments will be made on merit."

- Greater encouragement, practical support and assistance should be given by departments to enable staff to make use of the flexible working arrangements permitted by the BBC.

Charles Hope, EID

EID's leaflets are in such demand, we've now opened a shop! Do you know its NGR? A small prize will be sent to whoever is first to submit the correct answer to six figures

NETWORK TELEVISION

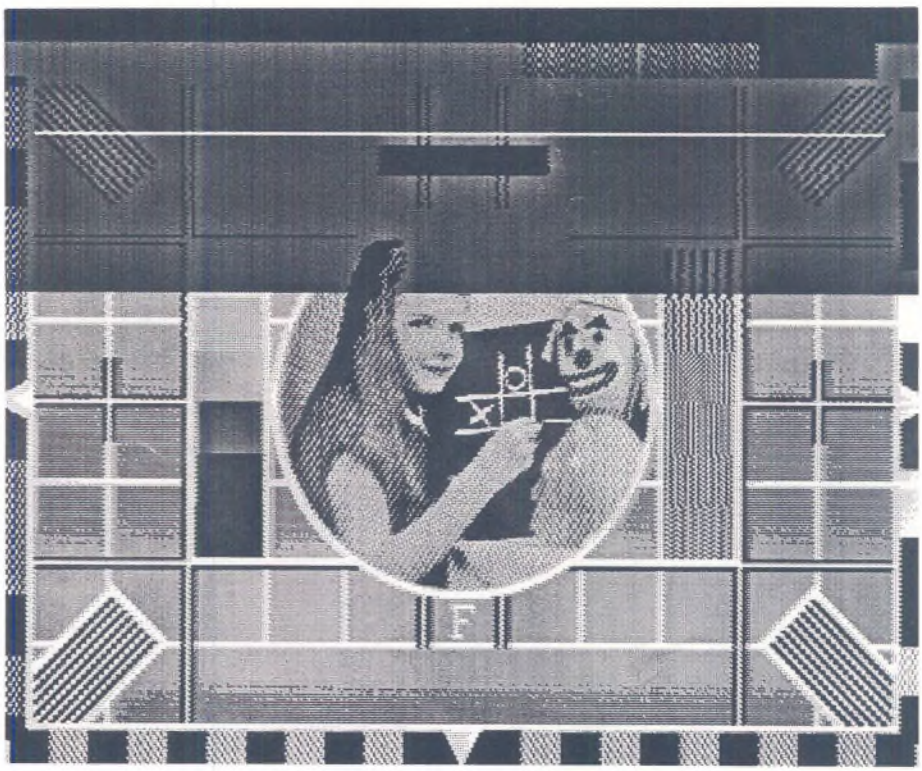
The *Hot Lips 2* system

Tim Voore describes the *Hot Lips 2* system which was used during a Ghana-London satellite linkup for *Songs of Praise*, to measure the sound-to-vision relative delay on the transmission path.

Due to different transmission path lengths, the *sound* and *vision* components of a television signal may not arrive at their destination at the same time — leading to disturbing 'lip-sync' errors. Back in 1981, Technical Investigations at Television Centre designed a unit which could easily measure this relative delay — caused mainly by multiple passes of the TV signals through video synchronisers.

More recently the incidence of lip-sync problems has increased, due to an escalation in the use of digital equipment such as vision synchronisers, video effects units and sound information compression systems — all of which have significant processing delays. Last year, following a reappraisal of the old 1981 equipment, Sound Operations commissioned Technical Investigations and Evaluations (TIE) to produce an updated version. A prototype unit was to be ready for field trial at the Winter Olympic Games in Albertville, France.

The system, nicknamed *Hot Lips 2*, is analogous to the 'clapperboard' method used by film crews to establish vision/sound coincidence. The system consists of two units, a *sender* and a *receiver*.



Technical Investigators

Vision test pulse superimposed on suppressed video

The sender

The sender takes in a feed of composite coded video. During approximately the top third of the active picture period, the maximum video excursion is limited to about 200 mV (clear of the colour burst). Vision test pulses — consisting of two adjacent lines of peak white on line 60 (field 1) and line 373 (field 2) — are added to the suppressed video, using a non-additive mixing technique.

Synchronously with the vision pulse on field 1, a dual-tone encoded burst of sound is generated. This burst is repeated every three seconds, giving a maximum delay measurement range of one second, with unambiguous indication of whether sound or vision leads. The resolution is ± 1 mS of the delay reading, more than adequate for lip-sync purposes. Although the accuracy is not good enough for stereo phasing, it will however bring the compensating delays sufficiently close for phasing to be achieved easily.

The sender unit is portable and battery powered, giving up to 5 hours of continuous use from two alkaline 9 volt batteries.

The receiver

The receiver is housed in a 1 U rack and consists of a processing card, to extract the received test pulses, and a digital stopwatch module which measures the relative delay between them.

This simple system is very versatile, possessing the following advantages:

- ☐ As the test signals do not differ from the normal analogue signals expected to pass through the system under test, no problems should arise whatever the hardware encountered in the transmission path.
- ☐ No additional synchronising information needs to be sent in order to determine whether sound or vision leads, provided there is a known maximum limit to the range of delay to be measured.
- ☐ The equipment can be used with 525/625 NTSC/PAL/SECAM signals, without any standards switching being required, either in the sender or receiver.
- ☐ Overall equipment costs can be kept low, as the sender can be replaced with a videotape recording of the vision and sound test signals.

The Ghana OB

The 1st March edition of *Songs of Praise* was made as a joint venture between the BBC and the Ghana Broadcasting Corporation, to help celebrate the 35th anniversary of the independence of Ghana and her membership of the Commonwealth. The programme took place from Bristol Cathedral and Fete, in Ghana, using a satellite link-up to unite Christians in Ghana and the UK. The diagram opposite shows how the signals were routed.

An important aspect of this programme was to show the congregation in Bristol and Fete singing in synchronism. Either congregation would be required to lead the singing, with the other congregation joining in, getting their cues from monitor screens and PA. These two situations however were not identical as now explained:

If Ghana led the singing, then the approximate 0.25 second delay — due to one satellite hop — was not important as the Bristol congregation could time themselves to it. However, when Bristol led, then Ghana received the sound and vision approx 0.25 seconds late, sang in time to it, and London received it delayed by yet another 0.25 seconds. The two sources — Bristol and Ghana — were now approx 0.5 seconds out of sync, with Bristol leading. In order to be able to 'mix' these signals, with the illusion of synchronous singing, it was necessary to delay the transmission sound and vision from Bristol, by approx 0.5 seconds.

The aforementioned problem was compounded by the fact that singing in synchronism to vision and sound cues was far from easy, being affected by such things as the size of the choir, the dimensions of the cathedral, the positioning of the PA, etc.

Past experience with similar 'time warp' situations, such as the Gulf War link, had shown that setting the compensating delays required for sound/vision synchronism was difficult and wasteful of valuable satellite line-up time. *Hot Lips 2* had already had a successful field trial during the Winter Olympics from Albertville, and it was believed that the system would provide a positive contribution to the Ghana OB.

As well as measuring the delays of the transmission paths, the *Hot Lips* equipment would be used to measure the processing delay of the Charisma, and to set accurately the Questech long vision delay.

For the Ghana OB, all the compensating delays were located in Presentation Area B at Television Centre, which was the technical centre of operations. Bristol had one sender unit. Pres B also had a sender together with the latest prototype receiver and, as a backup, the updated original receiver.

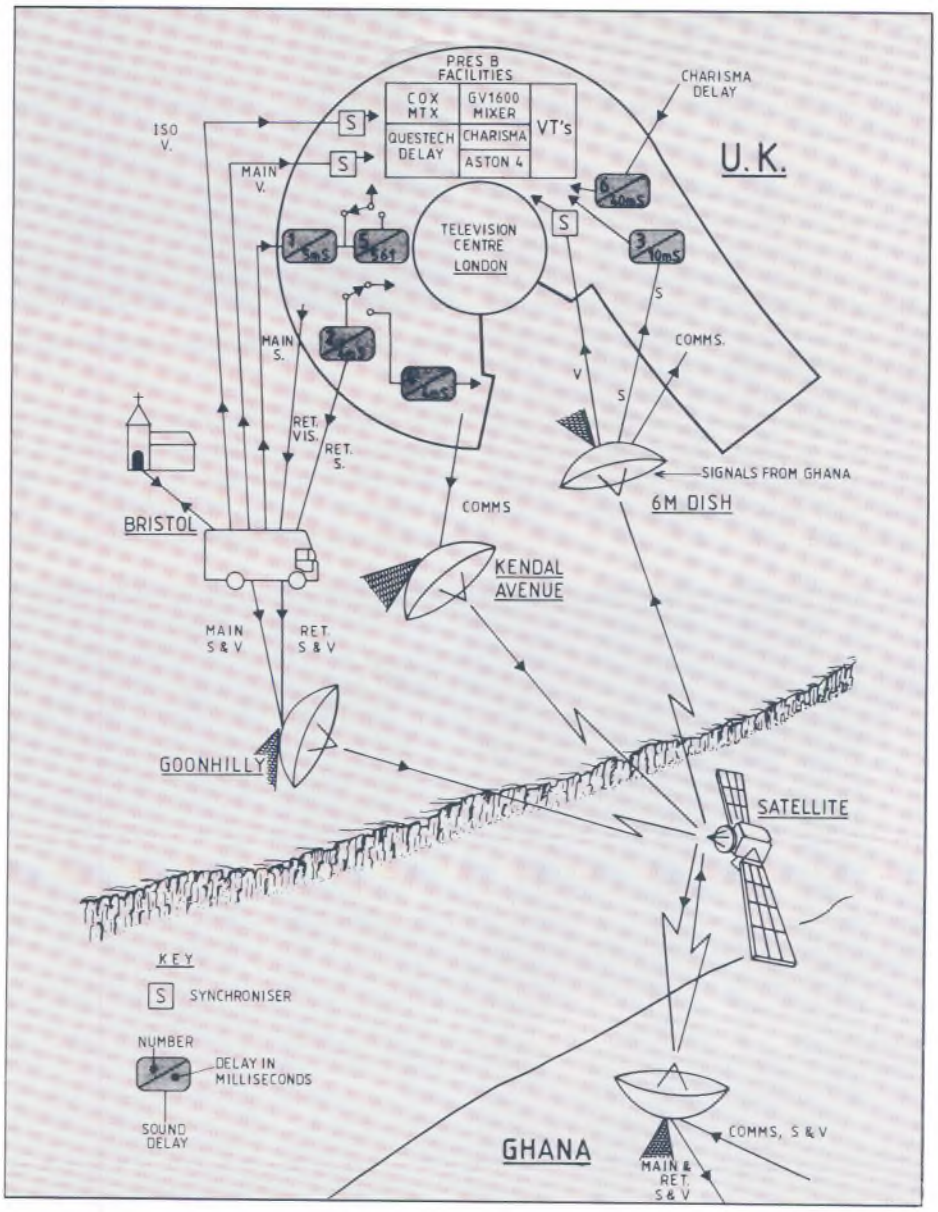
The Ghana team took with them a one hour Betacam SP video recording of the signals generated by a sender. This programme was the most complex ever likely to be encountered, and thus would show up any weakness in the system at this relatively early stage in its development. In the event, the success of using recorded test signals over a long satellite link meant that overall equipment costs were kept down by reducing the number of senders required.

The use of *Hot Lips 2* significantly reduced the time required to set up the sound/vision compensating delays. Because of its speed of operation, we were able to re-check the measurements on the day of transmission, which provided a confidence check. It also enabled us to deal with changes resulting from signal routeing differences compared with those of the previous day; it was very easy to do a 'self check', which proved of great value on the occasions when we had signal routeing difficulties.

As it was possible to say with confidence that the compensating delays had been set correctly, the cause of any lack of sound/vision synchronism could be identified easily. Had there not been this confidence, it could well be that incorrect remedial action may have been taken.

Subsequent to the Ghana OB, this equipment was used in Barcelona during the Olympic Games, when setting up the international routes. It also performed a valuable service on a day-to-day basis in determining the compensating delay required for use with the remote free-running 'Olympic Village' camera, which came up with a random delay each time it was powered up.

Tim Voore
Technical Investigations Engineer
Network Television



Simplified signal routeing for the Ghana OB

BROADCASTING HOUSE

Fit for another 60 years!

In this concluding look at BH – celebrating its sixtieth anniversary this year – George Crowe outlines the changes to the building which have taken place since 1945.

BH survived the 1939-45 war with a certain amount of superficial damage, but remained largely intact. There then followed a period of austerity which characterised the late forties and early fifties. Priority was given to sorting out some of the acoustic problems of the war-time studios and to re-equipping the control rooms, most of which were fitted with the legendary OBA/8 amplifier and its associated mixer. The result was the Type A equipment, still felt by many to represent the peak of valve amplifier design. The equipment was of course designed and built by BBC Engineers — not out of choice, but out of necessity. There was simply no alternative.

BBC Photo Library

1959: The Portland Place frontage of BH and the new extension

Prior to the war, an extension had been planned for the north side of BH and some excavation work had already started. When war broke out, the so-called 'stronghold' was built on part of this site, to house an emergency control room, with studios and transmitters for vital services. Its roof was protected by huge concrete blocks, which were later removed to allow the construction of the extension to begin. The stronghold itself still exists, and is used mainly for storage.

The fledgling Television Service absorbed much of the capital which was available after the war so, when it came to building BH Extension (BHX), it was necessary to enter into a leasing agreement with the Prudential Insurance Company. While the initial plans for the extension had followed the same architectural style as BH itself, the 'Pru' wanted something which could be separated from BH — in case the BBC went out of business! The result is the familiar H-block, designed to provide lots of individual cellular offices, and miles of corridor walls.

BBC Photo Library

1940: Bomb damage in the Council Chamber

Although designed primarily as an office block, the new extension housed seven general-purpose studios, two small talks studios, several recording and editing areas, and two well-equipped drama studios in the basement. The latter were built as completely separate structures, mounted on flexible rubber pads, in a (not fully-sucessful) attempt to keep out the noise of the underground trains. Completing the technical facilities were a new control room and continuity suites on the first floor (replacing the war-time Control Room which had hurriedly been relocated in the sub-basement).

By the early sixties, therefore, Radio was comfortably located in BH and the

BBC Photo Library

1945: The "stronghold" adjacent to Duchess Street

new extension, with a few departments in Egton House, 16 Langham Street and Yalding House. *The Light Programme* was based in Aeolian Hall, in Bond Street, although all its transmissions originated from BH.

This happy state of affairs did not last for long. It was disturbed by three main factors:-

- network expansion: *Broadcasting in the Seventies*
- increased News coverage, with much more actuality
- the New Broadcasting Centre projects

Network Expansion

Up until the late sixties, there were three Radio networks: the Home Service, the Light Programme and the Third Programme. They comprised studio-based live programmes, live OBs or programmes pre-recorded on tape and played back from a continuity suite, in which the announcer controlled the network, linked the programmes and generally kept everything in order. Four continuities were built, one for each network and a spare.

However, two significant developments upset this tidy state of affairs. Radio 1 — twenty-five years old this year — went on the air with *disc jockeys*, not announcers, and they wanted more than one! Radio 2 slowly followed and it soon became apparent that four continuities were not enough. The solution was to convert the 'mixer suite' — designed to handle complex OBs — into two continuities. Then there were six. This was satisfactory for a while, but then the networks began to split their vhf and mw/lw services — Radio 3 to accommodate cricket, Radio 2 to carry sport, and Radio 4 to broadcast educational programmes.

This, together with the urgent need to re-introduce a spare suite, caused three new continuities to be built on the first floor east wing. In 1983, Radio 1 moved its main operation to two new suites in Egton House, next to the production offices.

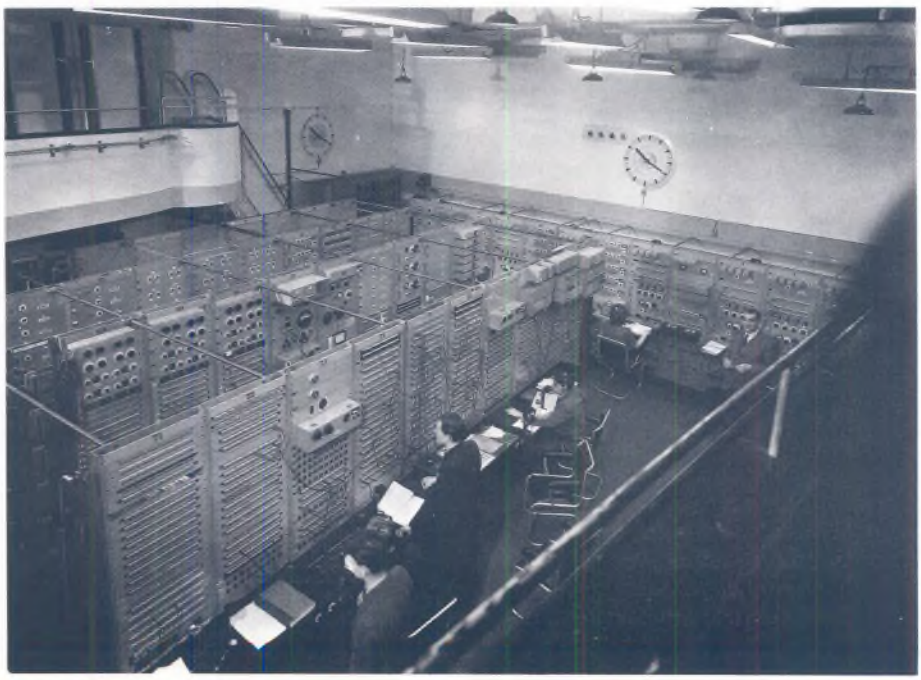
Asbestos

Above the control room and the six continuity suites lay the main air-conditioning supply duct, lined with *that* substance: asbestos. We had to get it out — without closing the area — but it took a long time to complete; it was not until the Radio 5 suite had been finished in 1990 that the last trace of the affected ductwork could be removed. This long and complex sequence of projects was carried out without any loss of transmission.

The trend way from the continuity of the fifties and sixties, towards the transmission suite of today has continued. Radio 2 will complete its move into a purpose-designed suite this year; Radio 5 went on-air in 1990 from brand new dedicated facilities, and Radio 3 is currently making worrying noises!

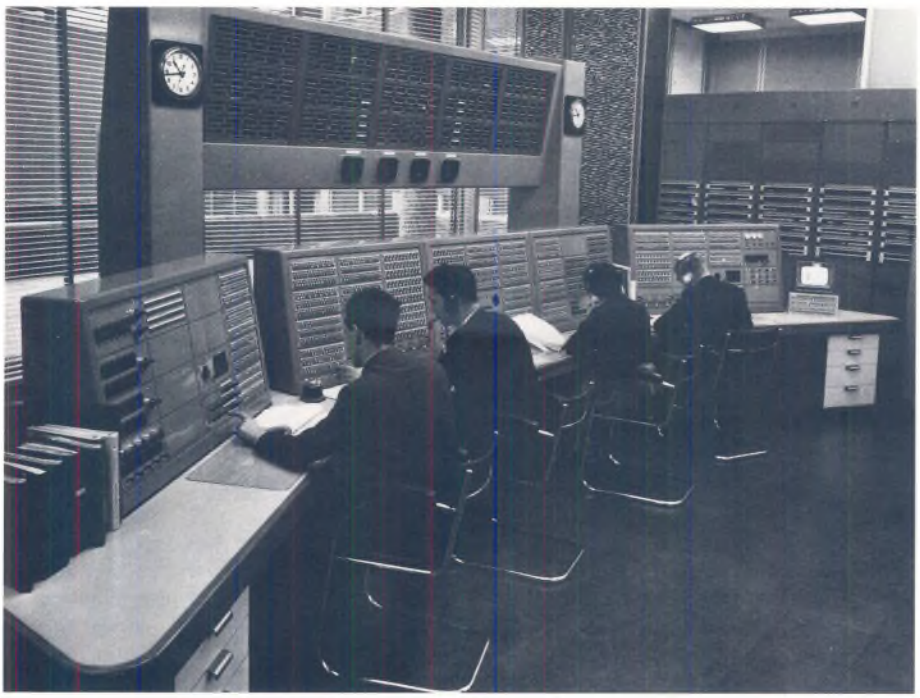
News Developments

The News Bulletin of the early sixties consisted mainly of the newsreader's voice. There was a limited amount of recorded actuality but no remote correspondents, and certainly no broadcast telephone reports — the Post Office wouldn't allow it! As a result, the technical facilities were very simple. The newsroom, at that time located in Egton House, was little more than a room full



BBC Photo Library

1946: The Central Control Room in BH



BBC Photo Library

1961: The Sound Control Room in BH Extension

of desks, telephones and typewriters. News bulletins, confined mainly to the Home Service, were read from one of the Egton House studios.

With the opening of BHX, the opportunity was taken to move the Newsroom to the BH site. But the extension had been designed mainly for cellular office accommodation, while the newsroom needs a large open plan area with studios leading off it. The resulting compromise can be seen today on the third floor, which has recently been refitted by Radio Projects to enable it to last a few more years.

Finding more adjacent studio accommodation for News became a real problem. The answer was to build on to the back of BH itself, starting at ground level and going up as far as the fifth floor. This allowed 3B, 3K, 4A and 4B to be built.

Initially, it was necessary to demolish the original BH boiler house chimney which stood on the site. This was the first appearance in BH of the now-familiar diamond saw (and drill) which, being relatively quiet, has saved us a fortune in 'stop knocking' delays over the years. However, the hammer and chisel was not banished completely. With the site being adjacent to the Concert Hall, the demolition contract specifically prohibited noisy work during the Wednesday Lunchtime Concert. Unfortunately, one day, one of the workmen wanted to go home early so he hammered his way through his lunch hour. The result was that the conductor stopped the live concert and walked out in a rage!

New Broadcasting Centre(s)

While these News studios were being built, a lot of strategic thinking was going into the longterm accommodation requirements of Radio.

The intention in the early 70s was that Radio should move to join Television at White City. The favoured site was on the opposite side of Wood Lane to TC. A considerable amount of early planning work was done, but the scheme foundered when the Board decided against the "Broadcasting Ghetto".

In the early 80s, Aubrey Singer (then MDNR) and George Howard (then the Chairman) put a lot of drive behind the need to rehouse Radio. The Governors accepted the report of a cross-directorate working party which concluded that "there was no real alternative to redevelopment on the Langham site". A limited architectural competition took place, and was won by Foster Associates. The resulting design, although beset by all sorts of technical problems, took up the whole of the Langham site and would have been a stunning piece of architecture.

But it was not to be. Once again, thoughts turned west when the White City statium site was bought. The intention was to build first the Corporate HQ, quickly followed by a Radio Centre. This plan was modified with the appearance of the News & Current Affairs directorate, and Radio was placed third in the queue. The project was finally cancelled at the time of *Funding the Future* in 1989 when it became clear that the benefits did not match the enormous costs.

BBC Photo Library

1963: The control cubicle of Studio B15 in BH Extension

All this caused planning blight on BH — we had intended to vacate it by the early 90s, so most of the refurbishment work stopped in the mid 80s. No work at all had been done on the *building infrastructure* since it had been built, and only now are we beginning to catch up on the backlog.

When it became clear that the future of Radio lay in BH, and not on a new site, we began to work out what had to be done to enable us to occupy the building indefinitely. Most other organisations would have decided that such a major refit of a building could only be done with substantial portions of the site vacated. We thought about that — but not for too long, because the problems of a temporary decant are immense. The decision was thus taken to carry out a refit with the occupants still in place, vacating only small areas at a time.

'Project Topdeck', only recently completed, saw the complete refurbishment of the top three floors. It also laid the foundations of a new heating, cooling, electrical and communications infrastructure which will spread throughout the building over the next few years. We now have a reliable electrical intake, and sufficient standby power to keep us on the air. There is a lot still to do, but we are well on our way to achieving a new building inside the old shell.

This year, BH is sixty years old. It is a tribute to its designers and builders that it has been in continuous use for broadcasting throughout that period. We now anticipate its occupation for a further sixty years, at least.

George Crowe
H.R.D.E.R.

VIDEO FORMATS

Part 1: analogue formats

In this two-part article, Dave Bowd discusses the evolution of video recording formats, starting here with *analogue* formats.

Broadcasters have been using video recorders for over thirty-two years. Throughout this period the techniques and the equipment used for recording have been subject to almost continuous change.

BBC Photo Library

1966: An Ampex VR2000 quadruplex videotape channel at TC

Quadruplex

For the first twenty years, *quadruplex* in its various forms was the dominant format. Initially, interchange between the early recorders was difficult, but these problems were steadily overcome. Physical cut-editing techniques were developed to enable some post production to be carried out. A great deal of patience was required to get the desired effect but those skilled in the art could produce remarkable results.

Improved servo techniques were developed which enabled both electronic editing and quasi-synchronous operation. Electronic editing removed the need to physically cut the tape but did not initially provide the flexibility to allow rehearsal or moves of the edit point. These facilities soon were added, either by the use of a burst of tone on the cue track, or by counting control-track pulses.

Electronic *time-base correction* using analogue techniques was developed, initially for monochrome, allowing truly reliable synchronous operation for the first time. This was closely followed by full colour operation. Colour had been possible prior to this, but only by using non-phased techniques similar in some respects to those used in current domestic VCRs.

Editing techniques were refined by the use of a *frame identifying time-code* recorded on the cue track. Initially a number of competing time-codes were proposed but the SMPTE and EBU were able to standardise on the current 80-bit code. Once this technique was introduced it rapidly took over,

providing for the first time the ability to synchronise the replay and record machines to provide the truly frame-accurate editing that we take for granted today.

Throughout this period, head and tape technology had continually progressed, allowing development of the format and improving video performance to keep up with requirements. The original *Low-Band FM* standards were replaced with *High-Band* and, in the late days of the format, with *Super High-Band* which included half speed, two good quality audio tracks and a pilot frequency to provide better control of time-base errors and colour banding. This latter development did not however achieve any significant market penetration.

One area where the quadruplex format could not meet production requirements was in providing still, slow and fast motion pictures. An experimental mechanical intermittent tape-transport arrangement, used in conjunction with a magnetic disc still store, was used with a quadruplex recorder. This was not a very satisfactory solution and eventually Ampex produced a special hard disc recorder, recording on both sides of two discs to meet this need.

Helical Scan

Although the quadruplex recorder was dominant during this period, other developments were in hand. During the late sixties, a large number of recorders were developed using the *helical scan* technique. Models were developed using half-inch, three-quarter-inch, one-inch and even two-inch tape. These used two-headed 180 degree Omega wrap, one-headed Alpha wrap and single-headed Omega wrap techniques. Initially, the performance of these was not to anything like broadcast standards, but they were used for off-line viewing and edit point decision-making. The ability to 'burn-in' time-code numbers to identify the frame uniquely was of course advantageous to this activity.

As tape and video head technology improved, the performance of these machines steadily improved to be acceptable for monochrome broadcast use, and a number of such machines were used by the BBC at its smaller regional sites. The machines tried in this role were the Ampex 7803 and the IVC 961.

With further improvements, colour also became possible and the same sites were converted to colour. The performance of this equipment was marginal however and further breakthroughs were required.

These breakthroughs came in two separate areas. The first was the development of wider-range time-base correctors, to correct the larger off-tape base errors from the early helical scan recorders.

The second was the development of a technique first used by Ampex, which enabled the replay head to more accurately track over the long tracks used by this type of recorder, using a video head micro-positioning servo. Ampex called this *AST* (automatic scan tracking), but alternative names are used by other manufacturers. More importantly, this facility provided — for the first time from a VTR — improved pictures in shuttle, and broadcast quality still, slow and limited fast motion capability.

The first machine with this feature, the VPR1 came from Ampex and appeared almost at the same time as a machine from Sony which did not have AST, but had an additional record head so that it could record the vertical interval at the bottom of the tape. The SMPTE supported by the EBU opposed the appearance of two similar but incompatible formats and after much discussion a compromise format, the *C-Format*, was agreed. The wish to record the full vertical interval was more USA-based, and a European alternative of a fourth audio track was developed so that Europeans had the option of either recording the vertical interval or a fourth audio track.

Up to this time most helical scan machines recorded one field-per-track but two broadcast formats used segmented formats recording only 52 lines-per-helical-track. The first of these was the IVC 9000, which was developed in the early seventies. This used two-inch tape and offered higher FM frequencies than quadruplex, giving a superior moire performance, and provided three audio tracks in addition to a time-code track. The company did not have the resources to solve some of its early difficulties and the machine's large size limited its applications.

A later format known as *B-Format* made by Bosch used one-inch tape and was much more successful. It appeared in advance of format 'C' and in some ways had a technically superior performance. However, its slow motion facilities were rather limited since it relied on intermittent tape motion in a similar way to the early quadruplex experiments, and its pictures in shuttle were also poorer than those from C-Format. Significant sales were made, particularly on the continent of Europe, and it is still in use today.

The C-Format, with its excellent post production features, has reigned for composite recording during the past ten years. However, it is now becoming obsolescent as its performance is becoming inadequate for today's complex post production operations.

Early cassette formats

The same head and tape improvements that gave broadcast machines their improved performance were also available for the rapidly developing non-broadcast market. Here the need was for low-cost easy-to-use machines with low tape costs.

By the early seventies two cassette formats had been developed, the *U-Matic* format from Sony, and the Philips *VCR*. The latter has of course been superseded by the *Betamax* and *VHS* formats.

As the use of the U-Matic became more widespread, battery-operated portable equipment became available. Experiments began in the USA using this equipment with battery-operated television cameras to replace the film cameras used for television news gathering. This avoided the delay due to film processing and offered some hope of reducing high film stock costs.

The experiments were a success and were repeated in Europe. However U-Matic had a very marginal performance for 625-line operation and was soon replaced by a further development, the *U-Matic H* format. This format provided a performance adequate for most news and some current affairs purposes. The portable equipment was light enough for this type of use, and both record-replay and record-only versions became available. The use of cassettes enabled straightforward handling of stories and quick and easy changing of cassettes, even in adverse conditions. Although JVC made some of this

equipment, Sony really dominated the market place.

Component recording formats

By the early eighties, a demand was growing in the USA for a combined camera and recorder. The relatively large U-Matic cassette was not very suitable for this and manufacturers looked at designs based on the two dominant domestic cassette formats, the Betamax and the VHS. RCA was the first in the field with a camcorder known as *Hawkeye* which recorded the luminance on one helical track and B-Y and R-Y on a separate adjacent track. This used VHS cassettes and provided a playing time of up to twenty minutes.

Although this was initially marketed by RCA and later also by Ampex, it was actually manufactured by Panasonic and became known as the 'M' format. The FM frequency multiplex techniques used to record the colour difference signals were better suited to the unequal bandwidths of the NTSC colour difference signals, than the equal wider-bandwidth signals required for 625-line use.

Sony introduced a camcorder using the Betamax cassette which they called *Betacam*. This used time-division-multiplex techniques to record the colour difference signals which worked adequately with 625-line signals.

At about the same time, Bosch introduced a similar system using quarter-inch tape, but recording line alternate colour difference signals, time-division-multiplexed with the luminance signals. This format was known initially as *Lineplex* and later as *Quartercam*.

All the above formats had the necessary studio record-edit machines.

The presence of these similar non-compatible formats caused the SMPTE and the EBU to make strenuous efforts to create a common format but these were not successful. The EBU therefore developed with the manufacturers a common Y, R-Y, B-Y interconnection standard called *EBU10*. It is still in use and has enabled analogue component equipment to be interconnected easily.

However, it was soon apparent that the Betacam system had a clearly superior performance for 625-line/50Hz use, and the other formats were withdrawn.

These early component recorders had a somewhat limited luminance and colour difference bandwidth but had a significantly improved colour noise performance compared to the U-Matic H format which was a colour-under system. Users therefore began a change-over to Betacam.

The development of metal particle tape enabled a higher performance capability, and Panasonic took the opportunity to completely re-engineer their 'M' format to provide wider bandwidths, a longer playing time (90 minutes) for studio machines and to add two FM audio tracks in addition to the two longitudinal audio tracks. This new format — *MII* — gave a significantly improved performance. Sony reacted quickly to this challenge, creating a similarly improved format known as *Betacam SP*. This latter format has now largely replaced the standard Betacam equipment although most Betacam SP equipment can also work in the standard Betacam mode with non-metal particle tapes.

The performance from these improved formats makes them suitable for a wide range of broadcast purposes. Both formats have options for the addition of two-track PCM audio and the ability to provide outputs compatible with digital interfaces. A recent Betacam model provides only digital input and output interfaces.

Due to market rather than engineering considerations, Betacam SP has established itself as the dominant format in Europe and offers camcorders, portable recorders and a wide range of studio recorders to suit almost every possible application.

The MII format is still available with a similar range of equipment to Betacam SP. Both are in widespread use in the USA and Japan.

Dave Bowd
Head of Post Production Systems
Television Eng. & Project Services
Network Television

Analogue Video Formats

Format	*Signal System **	*Scanning Method*	*No of Heads*	*Head/Tape Speed (m/s)*	*Tape Type #*	*Coercivity (Oersteds)*	*Width (mm)*	*Thickness (μm)*	*Max Record Time (mins)*	*Peak White (MHz)*	*Manufacturers*
Quadruplex	Composite S	Transverse	4	41.27	FeO	280	50.8	38.0	20	9.3	RCA, Ampex
B-Format	Composite S	Helical	2	24.0	CMO/CrO_2	650	25.4	30.0	120	8.9	BTS
C-Format	Composite N	Helical	6	21.39	CMO	650	25.4	28.0	191	8.9	Sony, Ampex, Thomson
U-Matic	Composite Y/C	Helical	2 or 4	8.54	CMO	650	19.0	27.0	60	6.4	Sony, JVC
U-Matic H	Composite Y/C	Helical	4	8.54	CMO	650	19.0	27.0	60	6.4	Sony, JVC
Betacam	Y, R-Y, B-Y	Helical	10	5.75	CMO	650	12.65	25.0	110	6.4	Sony +
Betacam SP	Y, R-Y, B-Y	Helical	12	5.75	MP	1500	12.65	25.0	110	8.8	Sony, Ampex, Thomson, BTS
MII	Y, R-Y, B-Y	Helical	10	5.9	MP	1500	12.65	14.0	97	9.2	Panasonic, JVC

* S = Segmented, N = Non-segmented, Y = Luminance, C = Chrominance, R = Red, B = Blue
\# FeO = Ferric Oxide, CMO = Cobalt Modified Oxide, CrO_2 = Chrome Dioxide, MP = Metal Particle

TELECOMMUNICATIONS
Part 3: the White City scheme

Nigel Adams describes the telecommunications facilities which have been installed at White City.

Have you been involved in an office move or a reorganisation recently? For perhaps more than 50% of you, the answer is likely to be yes, in which case an important question that you probably asked at the time was: "what will happen to my computer?"

We all need information. Nowadays, we depend heavily on the telephone, the fax machine, the local computer network, the data communications links to other computers, etc. And these all need to be properly looked after when a major move or reorganisation takes place. One such move in recent times has been that of Central and West London staff into the new White City building.

Mike Meyer, EID

White City basking in early-morning spring sunshine

When first planned, it was intended that White City would provide accommodation for the Board of Management, Engineering Division, the Central directorates and the Schools and Education departments. A great deal of preparation and planning resulted in a full specification for the building being drawn up. Subsequently, a 'design and build' contract was awarded to Balfour Beatty and a number of BBC project teams were set up to plan and prepare the building for final occupation.

Transmission Engineering Department (TED) was responsible for providing the communications facilities — both inside the building and to the outside world, including other BBC buildings. The department was asked to provide facilities that would serve the White City building and the corporation for the next fifty years, and was tasked with the organisation and transfer of some 38 existing networks and computer systems to the new building.

Internal network

What was required was a building-wide network that could be shaped and tailored to grow with the requirements of the Corporation over the next fifty years. Unfortunately, wiring and network schemes used at the time had a typical life span of just two to three years before they had to be altered significantly or even completely replaced. Thus, a conventional scheme was out of the question.

The network had to be as flexible as the telephone network but should be capable of supporting Ethernet speeds as well as the RS232-based schemes in wide use at that time. The only technology that could cater for this type of building-wide scheme was a *broadband cable* system and the decision was taken to include such a network in the original specification of the building — basically to provide links between departments.

As *flexible* broadband technology would be far too expensive to install on a per-user basis, work would still need to be done after the building had been completed; namely, the cabling up of the incoming computer systems — in all their different flavours and configurations. A survey was thus carried out by TED to assess the building's final wiring details.

Two costing exercises were then carried out. The first examined the conventional approach whereby individual schemes would be prepared for each computer system. The second exercise used what was then a new development — the use of so-called *saturated* or *structured cabling* systems. The conclusion was that, although structured wiring systems would be more expensive initially, they would rapidly become more economic within a few years.

Structured Cabling

Having decided to install a structured cabling system at White City, the design goal was to provide two unscreened twisted pair (UTP) cables to every desk. This cabling could then be used to carry information in any form to the person sitting at the desk. If different information was required, the system could be re-configured to carry the new information without installing new cables under the floor.

Structured wiring consists of cabling from every desk to cabinets (or bays in BBC parlance) that allow electronic hubs or concentrators to be mounted. In White City there are between five and six of these cabinets on each floor of the building. The cabinets themselves are linked together using a number of fibre pairs and in some cases, additional UTP cables.

The original broadband cable, specified seven years ago, is used as the building's network backbone to carry traffic between departments, possibly situated on different floors. It also provides controlled access to other corporate facilities and networks such as the Oslan network, the Television Data Network and to other regional networks.

All the computer networks in White City use structured wiring — there are no proprietary cabling systems anywhere in the building — and in each department, the cabling philosophy is identical. As an example, the diagram shows the second floor of the building. The upper part shows the distribution of the departments on that floor, while the lower part shows the whereabouts of the cabinets.

Each department has its own private and individual network(s); on this floor alone, there are four major PC networks, five Macintosh networks, a minicomputer system and numerous standalone computers which themselves make use of the structured cabling to share printers. Although there are more networks than cabinets, and some networks cover an area served by more than one cabinet, each is totally separate from the others. However, networks can be linked, at the request of the department, using fibre links or via the building backbone.

If the 1985 list of departments bound for White City is analysed, you will very quickly see that what was planned for in those days is totally different in 1992. Indeed, the 'churn rate' — a measure of how peoples' offices are moved or reorganised — is already 40% per year, even though the building is not yet two years old! This proves that the decision to install a structured system has been more than justified; TED has frequently had to re-structure plans and schedules, often at short notice, to cope with changes to the list of occupants and their IT requirements.

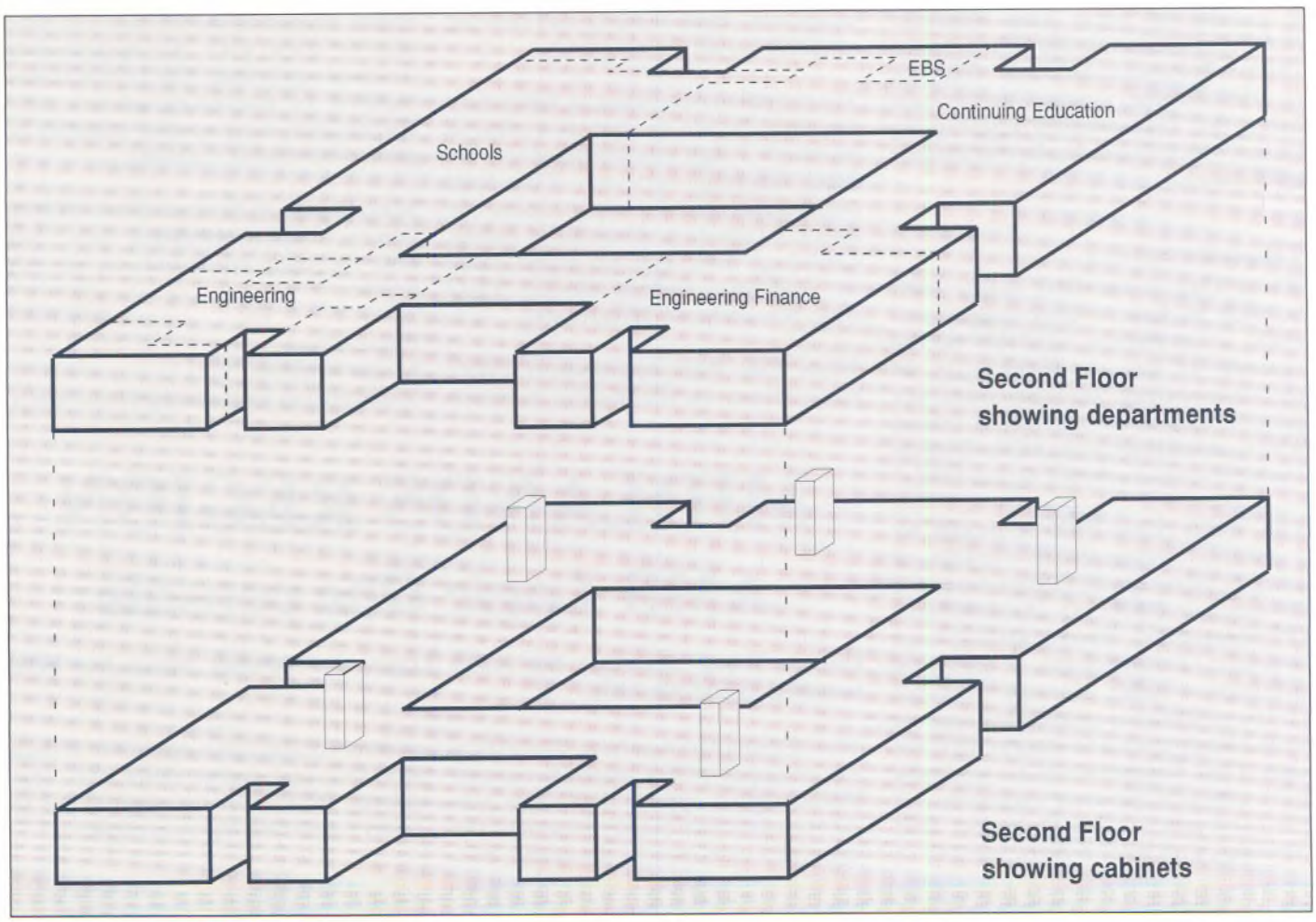
Network management

A full network management system has been installed at White City to look after the UTP cabling, and the network equipment located in the cabinets. (With the agreement of departments, it can also supervise key elements of individual networks, such as the servers or printers).

By maintaining a constant vigil on the complete system (without prying), operators can be warned if, for example, part of the network has developed a fault, or that another part is running close to full capacity. When fully operational, the system will allow TED to offer proactive support to its clients, perhaps warning them that they have problems before a catastrophe occurs. The system might also be used to model networks as a tool to planning them in the future.

External connections

The Digital Telecommunications Network (DTN) — featured in the previous edition of *Eng Inf* — connects White City to the rest of the BBC's sites in London and the Regions. This relies on a mixture of BT and Mercury



Plan of second floor at White City

2 Mbit/s circuits while, for backup purposes, a 10 Mbit/s laser link has been installed between White City and Television Centre. There are also some 64 kbit/s Kilostream circuits between White City and the mainframe computer centre at Sulgrave House, as well as connections to the corporate X.25 packet-switched network and the Starmaster asynchronous data network.

In order to provide easy access to these services, the White City building has been fully cabled with data sockets alongside the telephone sockets. Thus, each floor box has a black data socket and a white telephone socket, with different keying to prevent accidental interchanging. These are cabled back to their own distribution frames and from there they can be connected to the Voice Switch or the data network equipment as required. The black data sockets can work at up to 128 kbit/sec to anywhere in the building. By this method, interconnections between local computer systems are provided, as well as connections between individual terminals or clusters of terminals and the mainframe computer centre at Sulgrave House.

A number of Local Area Networks (LANs) at White City are linked via the Digital Telecommunications Network to other external systems, an example being the Transmission Engineering system which is linked to its counterpart at Warwick.

Telephone services

White City is the first major BBC building to have a large fully-digital PBX — a Philips SOPHO S2500 system. It has the capability of accommodating several times the present number of extensions (about 2,500) and of supporting all the features available from a modern digital PBX.

The White City PBX is linked by 2 Mbit/s circuits (each capable of carrying thirty speech or data channels) to similar PBXs at Westminster (Parliamentary Broadcasting) and Warwick (Transmission). A high-level protocol — Inter Message Protocol (IMP) — is used to create what appears to be a single system to users at the three sites. Thus, features which are normally only available between extensions on the same site — Call Diversion, Call Transfer, Call Back if Busy, Identity of the Caller (with a suitable telephone), etc — are available between the three sites. (As older PBXs on the BBC network are replaced with modern equipment, these features will become available across the network).

The extension numbering at White City has been chosen as part of a plan to introduce 5 digit numbering across the BBC internal network. This will remove the need for access codes for internal calls (e.g. 01-xxxx if calling LBH from TVC say); no access codes are used when dialling between White City, Warwick and Westminster.

White City PBX can support ISDN connections to the public network which give near-instantaneous dial-up digital paths that can be used for voice and/or data with the appropriate terminal equipment. The system is also capable of providing ad-hoc data connections using special adaptors in place of telephone handsets.

Many thanks to Norman Hitch, Martin Davies, Stephen Redburn and Chris Bell for their contributions to this article.

Nigel Adams
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Transmission Engineering Department

Telecommunications and Business Systems (TBS)

When the White City project started some seven years ago, the provision of telephony and communications facilities was dealt with by the Telecommunications Section of TED, which later became Telecomm Network Section (TNS). The structured cabling system and networking facilities were dealt with by Inf Tech Eng, which later became Comms and Business Systems Section (CBSS).

However, as of 1st August this year, Transmission department has amalgamated its data communications, telephony and business systems expertise into one team called *Telecommunications and Business Systems* (TBS) — ensuring no overlap or re-inventing of the wheel.

TBS offers a 'one-stop shop' which provides a comprehensive and competitive service — covering all network projects involving information technology and voice traffic — to Business Units and to the corporate BBC. It offers a single point of contact and a team with the range of experience and skills to advise on and implement any telecommunications and business systems requirements in the BBC.

TBS provides not only project management — interfacing with the customer's own expert teams and sections — but also offers full systems support, with a negotiable service level agreement.

The section is based at Warwick and has offices in White City and Woodlands. The parent department — Transmission Engineering — is currently undergoing the introduction of Quality Assurance procedures, and is working towards accreditation under BS5750 by the end of this year.

Further information on TBS can be obtained from:
Nick Davies on Warwick (07) 16800.

MIDLANDS REGION

AMS *Logic One* console

Declan Wood describes the AMS *Logic One* console which has been installed at Pebble Mill.

When Pebble Mill was built, Studio One was equipped with a mono 24-channel BBC-designed Type D desk. This provided an excellent facility to go with the renowned acoustics of the studio but, unfortunately, after 20 years of regular use the desk had become unreliable. When Studio One came up for refurbishment in the late 1980s, a number of both analogue and digital desks were considered: the decision was made to buy an AMS *Logic One* digital console.

The Logic One is a semi-assignable digital console which works in conjunction with an 8-track digital recorder/

editor known as the *Audiofile Plus*. Although the Audiofile Plus will operate as a stand-alone unit, the desk cannot operate without it.

In May 1990 the Type D was removed — due to its unreliability — and was temporarily replaced with an outside broadcast Amek desk and a Glensound output unit. At the end of that year, the studio's Artists' Room was equipped with a Glensound outside broadcast de-rig kit, to allow production to continue in the studio whilst work began on the refurbishment of the cublicle.

The old PO-style junction blocks were replaced and all connections into, out of and within Studio One were made via Krone blocks — 135 in total. Two new bays (44U high) were mounted against the cubicle wall. The cubicle, corridor and adjacent Presenters Studio (M1) were completely redecorated with Fabitrak acoustic wall-covering, and re-carpeted with antistatic carpet tiles.

The Logic One consists of a central processing rack, an input/output sub-frame, two mic/line input units and the desk control surface. The Audiofile Plus is made up of a processing racks, a disc storage pack and a control surface.

Most of the bay-mounted equipment contains cooling fans which are acoustically noisy, thus preventing their installation within any of the operational areas. The only available location for these units was some distance away, in the old piano storeroom. A section of this room was partitioned off to contain two 44U-high bays and all the relevant equipment. Over 40 metres of trunking had to be installed to carry the cabling between the cubicle and the equipment racks. However, the mic/line units were installed within the cubicle bays to minimise the distance that low-level signals would have to travel. This enabled analogue inserts to be hard-wired, thus saving on Logic One hardware.

The Logic One is heavily software based, using transputers and digital signal processing devices to manipulate the audio. A 20 Mbit/s data link carries the information which passes between the desk and the equipment racks some 40 metres away.

Being semi-assignable, the Logic One does not have separate inputs and outputs for each channel, group and main. Instead, it has a number of input and output devices (hardware interfaces) which must be assigned. The Studio One installation has eight analogue stereo microphone or line-capable inputs, one analogue line input, eight analogue stereo outputs, four stereo AES/EBU digital inputs and outputs, and four stereo digital inputs to, and outputs from, the Audiofile Plus. Stereo inputs and outputs can be split and used for mono channels, if required.

The configuration of the Logic One can be altered by the operator using the relevant menu on the Audiofile Plus. It is possible to assign any of the following items to any of the twelve channels, two groups or one main:

- ☐ Input: stereo (AB, AB wide or MS) or mono
- ☐ Up to four bands of equalisers, all 20 Hz to 20 kHz (high-shelf, low-shelf or Bell), -24 to +24 dB
- ☐ Up to two filters, both 20 Hz to 20 kHz (high-pass or low-pass) with 6, 12, 18 or 24 dB-per-octave slopes
- ☐ A selection of full dynamics, including compressor-limiter, expander, gate and dynamic side-chain equalisation
- ☐ Output: stereo (AB, AB wide or MS) or mono

Each adjustment of the above can be recorded and automatically recalled along with the position of the linear-motor moving faders. This facility means that the automation of all of the desk controls can be locked to either audio or video timecode. The only restriction to the facilities available to each channel, group and main is the amount of processing available. At present, there is not enough processing power to provide all units with full facilities but this could be made possible if additional hardware was purchased. Nevertheless, it is unlikely that full facilities would ever be required in every channel, group and main of this particular installation.

There are two further Audiofile Plus devices within the Radio complex at Pebble Mill. The equipment racks associated with one of these have been installed within Studio One's new equipment room, and it is planned to relocate the remaining edit suite's equipment racks there in the near future — effectively creating a central processing area. It will then be possible to record eight tracks of audio onto the Logic One's Audiofile Plus and, using one of the other two machines, to off-line edit the recorded material, thus leaving the studio free for new recordings.

The Logic One is primarily a post-production desk. Although it possesses an impressive array of equalisation and dynamic capabilities, as well as full automation, it has no broadcast facilities. Thus, a separate Broadcast Interface pod provides all the monitoring, talkback and transmission switching required of a live broadcast desk.

The installation of the Logic One has provided Pebble Mill with a modern digital facility, suitable both as a broadcast studio for its regular Radio 3 concerts, and as an in-house and commercial CD mastering and editing facility.

Declan Wood, Project Leader
Studio One Refurbishment
Pebble Mill

Pebble Mill

The AMS Logic One console in Studio One at Pebble Mill

ELECTRONIC GRAPHICS

Part 4: animation techniques

Mike Winston describes the electronic techniques available for producing animations.

Animation is the process of producing a number of individual still frames such that, when viewed sequentially, they create the illusion of movement.

The best known form of this technique is cartoon films, where the separate frames are built up from hand-drawn cells and photographed on a rostrum camera. By using camera movements, multiple exposures and film lab optical effects etc, complex results can be produced. Similar results can be achieved using an *electronic* camera, with vision mixers and keyers etc, but the artwork still has to be made by hand.

Alternatively, animations can be created *all-electronically* using a number of different methods:

Peter Lane, Graphic Design

2-D Animation

Painting systems are a useful tool for drawing individual animation cells and so it is not surprising that most systems also provide some means to animate them. The Quantel Paintbox, for example, has a system for limited-area animation:

> A background picture, which remains fixed, is stored in one frame store. In a separate frame store, individual cells with key signals are drawn side by side. These two frame stores are then combined by a keyer which acts only on part of the picture (the animation window). By offsetting the memory addresses to the animation store during frame blanking, each cell can be made to appear in turn through the window. The sequence can be cycled to provide continuous movement, such as a rotating logo.
>
> The three pictures opposite illustrate the components used to produce the logo which is featured on snow reports for skiing. The flag rotates to reveal the country's map on the back.

This technique is used extensively in NCA-type work to animate maps, diagrams etc. However, on the Paintbox, it is fundamentally limited by the fact that all the cells have to fit side by side into one frame store. This means there is a trade-off between how large the animation area can be and how many different cells it can use.

Animation derived from cells in this way (physical or electronic) is two dimensional. Of course, the artist can draw in perspective and create a three dimensional scene, but once the artwork is drawn, it is not possible to change the viewpoint. The artwork remains flat and so, for example, the camera cannot look behind a cartoon character!

Another animation technique known as *colour cycling* can be used on 8-bit painting systems with a colour look-up table. As described in Part 2, this table is effectively an area of RAM — the byte stored in each pixel is used to address the RAM and the data stored there represents the actual colour required. Every pixel in the picture must address one of the 256 locations in the table, and changing the contents of the table can radically alter the appearance of the picture. Changing every entry in the table only requires writing into 256 different addresses — a task that can be completed during frame blanking — so real time animation over the whole picture is possible.

Colour cycling is limited but can produce surprisingly effective results on diagrammatic pictures with limited colours. A typical application is the 'travelling dotted line' type of effect used on the ITV weather forecast.

3-D Animation

To create genuine 3-D animation, the original artwork itself must be three dimensional. One way to do this is to build a model and move the camera around it. Such a system is known as a *motion control rig* and these are used in the film and TV industry for special effects. Some of the larger ones can handle very large objects but they are very expensive and bulky.

A more practical way is to use a computer and work with a mathematically-represented model.

3-D Computer Animation

Creating a 3-D animation needs three separate processes:

1. Model building

By using a drawing tablet or mouse, a model is created and stored in 3-D

co-ordinate form. Various techniques are used such as:

Polygen mesh The surface of every object is divided into flat polygons (usually triangles). Quick to build, versatile, and easy to edit. Curved surfaces are a problem as they need many small polygons to look smooth, although surface shading in the rendering process can disguise this shortcoming.

Patch modelling The surface of every object is made up from small patches with elastic surfaces. These can be pulled into shape using imaginary strings on the surface (control points). Produces much better curved surfaces but is more difficult to edit. Latest system is called NURBS (non Uniform Rational B-Splines).

Solid modelling — builds up the model from a series of solid primitives such as cuboids, prisms, cylinders, cones, spheres etc. Has the advantage that models have solidity which makes it easier to avoid physical impossibilities (objects intersecting each other). Good for simple objects but very tedious to create complex shapes. Main application is the modelling of mechanical components.

The Polygon method was very popular but is now only used on low-end systems. As a result of the demand for sophisticated modelling systems in the manufacturing and design industry, patch modellers are now the norm.

When complete, all the model information is stored as a list of 3-D co-ordinates and parameters in a data file. Most computer animation systems can also import data files from CAD systems such as Autocad.

2. Motion planning

This stage defines how each part of the model, and the camera viewpoint will move. It also allows several light sources to be described in intensity, colour, etc and moved around the scene. It is usually possible to preview the motion in 'wire frame' mode.

3. Rendering

This process creates individual picture frames using the model and motion data files Usually the result is a faster scanned image which in our case will be 720 x 576 (or 768 x 576) pixels. Rendering must allow for hidden surface removal and surface shading effects (matt, shiny, specular, diffuse, etc) and usually allows 2-D textures or images to be mapped onto the 3-D surfaces (Texture Mapping).

Various algorithms have been devised. Of these, *ray tracing* probably produces the most realistic result but requires a great deal of computation. Ray paths are traced from the view point around the model through a number of reflections and refractions. Objects themselves can even be transparent. Another technique called *radiosity* works by tracing rays in the other direction but requires even more computation.

Note that only at the rendering stage is the scanning standard specified. Thus, the same scene can be rendered in different resolutions for different requirements.

The sequence of pictures (on the back page) illustrates the modelling and rendering of a chess set using the Alias/Iris equipment in the Computer Graphics Workshop.

The three stages in producing a finished animation put very different demands on the computer hardware and software.

Modelling and motion planning are very interactive processes and the software must respond in a user-friendly way. The success or failure of the system depends on this. The computing power required is relatively modest but special geometry hardware is needed to produce quick wire frame drawing on the screen.

Rendering is the complete opposite, needing no operator input but as much computing power as possible. This is why PC-based systems can be acceptable for modelling but very slow to produce the final result.

In order to improve rendering time, the work stations used have special hardware to speed up the number crunching, but complex scenes can still take many minutes-per-frame to render. Equipment is often left to do this overnight. This has led to a further stage of highly specialised hardware, built solely for rendering and used as an add-on to the workstations (Rendering Engines).

A number of different companies have written 3-D software packages, eg:

Alias Research
Parallax
Soft Image
Symbolics
Thomson Digital Image (TDI)
Vertigo
Wavefront

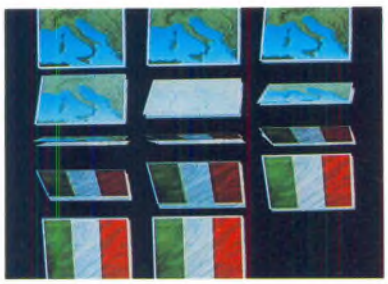
These packages run on a variety of workstations, the most popular being the Iris range made by Silicon Graphics.

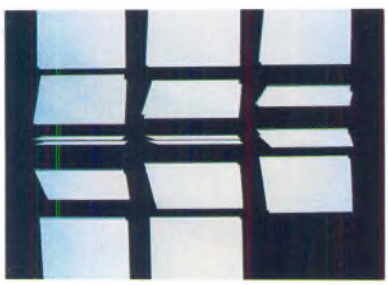
The BBC Computer Graphics Workshop uses Alias software on an Iris workstation.

News and Current Affairs use four Vertigo systems running on a variety of Iris workstations. One of these uses high performance graphics hardware with a broadcast-format frame buffer and is able to do simple rendering in real time.

There is sometimes confusion between computer animation and Digital Video Effects (DVE). The fundamental difference is that in computer animation, the picture are generated internally, whereas DVEs merely rearrange pictures fed into them. This is why computer animation can take hours, but DVEs can achieve superficially similar effects in real time.

continued overleaf....





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Top and middle: the animation frame store containing eight cells and their associated keys

Bottom: the animation keyed onto a background picture. The overall effect is the flag rotating to reveal the map on the back

...continued from previous page

Another source of confusion is the reference to 3-D DVE effects. Modern DVEs can move pictures around in 3-D space but the picture itself remains two dimensional, ie it has no depth. Turning it edge on makes it vanish. The term *2½-D* has been coined to more accurately describe this.

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Photographs shown below:

a: The outline of a pawn is drawn — shown blue. The red points are control vertices used to adjust the shape of each part of the curve.

b: The complete pawn is created by rotating the outline through 360°. This screen shows 4 views (front, side, top, perspective) and a spotlight has been defined, shown by the green arrow.

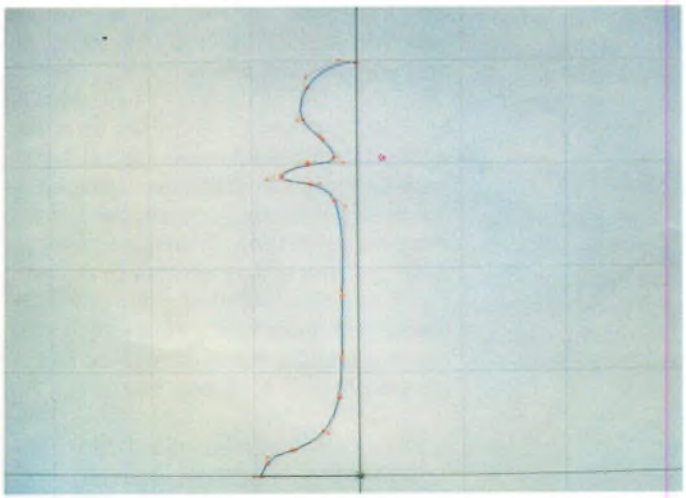
c: The pawn partly filled in by the "Quick Renderer". This simplified process gives a good idea of the final effect much more quickly than the full rendering process.

d: A fully rendered image. The spotlight has been coloured yellow and the pawn given a specular surface characteristic.

e: As above, but a wood texture has been mapped onto the surface.

f: The pawn has been replicated 16 times and placed on a board, modelled by 64 thin squares side by side. A marble texture has been mapped onto the surface and white ambient lighting added to fill in the shadows.

a



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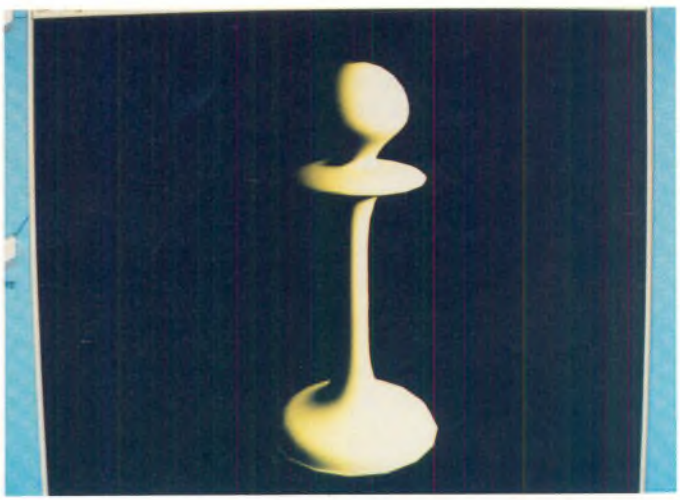
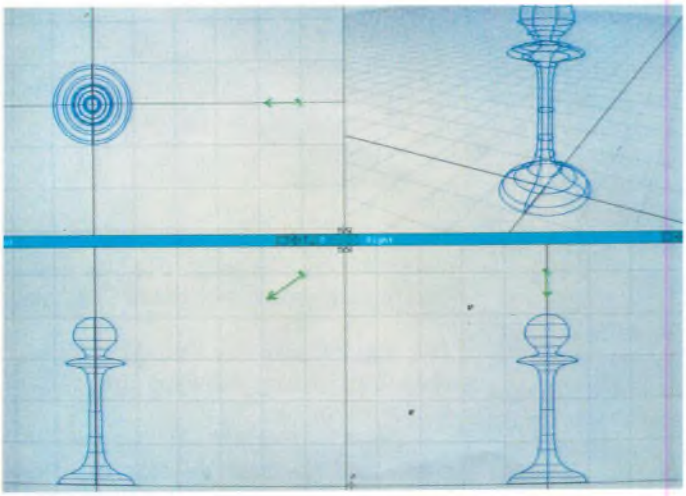


b



e

c

f

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