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ABSTRACT

A sequel to the booklet "A Review of the Different Types of Instructional Materials Available to Teachers and Lecturers," this booklet begins by looking at ways in which video materials can be used in different instructional situations, i.e., mass instruction, individualized learning, and group learning. The basic principles of television picture production and videorecording are then discussed, and the basic equipment needed to produce video materials is examined. Guidelines and techniques for planning and producing a video program conclude the booklet, and an annotated list of four items recommended for further reading is provided. (MES)

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How to Produce Video Materials

Introduction

In this booklet, we will take a detailed look at one of the most useful audio-visual aids available to the modern teacher or lecturer – *video*. Video has already made a considerable impact on instructional methodology, and shows every sign of becoming even more important if the price of the associated equipment continues to fall in real terms. Indeed, since the appearance of low-cost colour television cameras in the mid-1970's and inexpensive domestic-quality videocassette recorders in the early 1980's, video production has become one of the major 'growth industries' in many educational institutions.

As in earlier booklets on specific instructional media, we will begin by taking a general look at how video materials can be used in the different types of teaching/learning situation that are identified in booklet number 2 in the series "A guide to the selection of instructional methods". Next, we will discuss the basic principles of television picture production and videorecording and examine the equipment that is needed to produce video materials. Finally, we will show how to set about planning and producing an actual programme.

How video materials can be used in different teaching/learning situations

It is probably true to say that video materials can be used in virtually any type of instructional situation, either to provide illustrative or supportive material or as the vehicle by which an exposition or instructional sequence is presented. Nor is its use limited – as is sometimes erroneously supposed – to situations where it is necessary to show movement, since video can be used for presenting visual material of *all* types (although it is, of course, best suited to demonstrating motion of various sorts). Let us now see how it can be used in the three broad classes of instructional situation that were identified in "A guide to the selection of instructional methods" – *mass instruction*, *individualised learning* and *group learning*.

Mass instruction

Here, video materials have three main roles. First, they can be used to provide illustrative, background and other supportive material for use within the context of conventional expository instruction. Video materials are ideally suited for this purpose, and are, of course,

particularly useful in situations where motion of some sort has to be demonstrated. Such 'moving visual inserts' can range from full-length programmes lasting for half an hour or more down to short clips or single-concept sequences lasting only a few tens of seconds.

Second, video materials can be used to provide self-contained mediated expositions that take the place of a conventional lecture or taught lesson on a given topic. When employed in this way, the medium is not necessarily restricted to showing scenes that incorporate movement, but can be used to present any material that has a strong visual component. Sequences of still pictures, for example, can often be shown just as effectively within the context of a video presentation as in a tape-slide programme. All types of video materials can be used in this 'mediated lesson' role, including externally-produced video programmes, broadcast television programmes (either off-air or recorded) and 'home produced' video presentations designed for specific purposes.

Third, video materials can be used as vehicles with which learners can interact in the context of a mass-instructional situation. The use of a closed-circuit television system to record drama, role-playing exercises, debates, etc. for subsequent discussion and analysis by a class are typical examples.

Individualised learning

Video materials are ideally suited for use in individualised learning situations, either on their own or within the context of an *interactive video* system (see booklet number 18 in this series - "How to produce computer-based learning materials" - for detailed information about such systems). When used on their own, such materials are probably best suited to a straightforward expository role, although the advent of interactive video should enable them to be built into a much wider range of instructional situations than has been possible up to now.

Group learning

Here, there are two main ways in which video materials can be used, namely, in a supportive role (providing visual material for illustrative, background information or extension purposes) and as a vehicle with or through which the participants have to interact (e.g. in role-play, simulations and microteaching). The video medium has already proved to be ideal for the latter role, and early evidence suggests that interactive video may prove to be even more useful in many situations.

The basic principles of video recording and editing

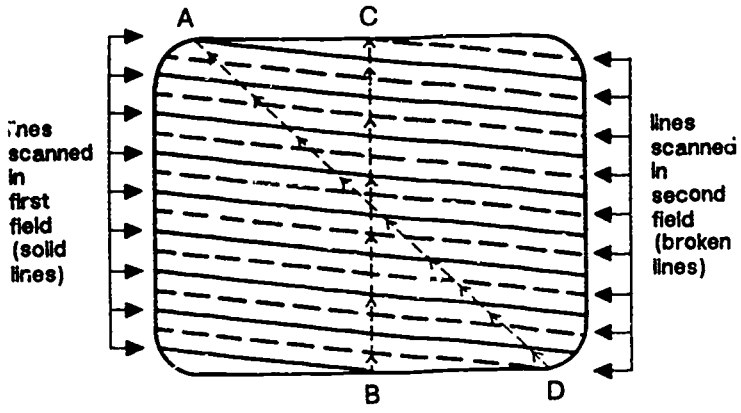
How television pictures are produced

Motion pictures and television both create an illusion of movement by presenting the eye with a rapid sequence of still images, each slightly different from the previous one. Because of the phenomenon of *persistence of vision* (whereby the retina of the eye retains a particular image for some time after the stimulus that produced it is withdrawn), the human brain interprets such a sequence of images as a continuously-changing system (similar to that which it is used to 'seeing' in the real world) provided that the images are presented at a rate greater than roughly 15 per second. In the case of motion pictures, the images are usually presented at 18 frames per second in silent films and 24 frames per second in sound films. In the case of television, the picture is changed either 25 or 30 times a second (25 in the UK and other countries where the mains frequency is 50 Hz and 30 in the USA and other countries where it is 60 Hz).

In the case of television, each separate *frame* of the picture is built up in a series of horizontal lines, British television pictures consisting of 625 such lines and American pictures 525. In order to reduce flicker, a system known as *interlaced scanning* is employed. In this system, which is shown schematically (in greatly simplified form) in figure 1, a complete scan of the picture is carried out in two stages, or *fields*, with alternate lines (the solid ones in the figure) first being scanned in succession, after which the scanning process is repeated for the remaining lines (the broken ones in the figure). In the British 625 line system, the scanning of the first field begins at A (the start of line 1) and ends at B (half way along line 313); the scanning of the second field starts at C, beginning by completing line 313 and finishing at D (the end of line 625), after which the scanning process starts again at A. In the American 525 line system, the scanning process is similar, with the transition between the two fields of a frame taking place half way along line 263. In both systems, the field scanning rate is equal to the mains frequency, something that is necessary for technical reasons. Thus, in Britain, the scanning rate is 50 fields (25 frames) a second, while in America it is 60 fields (30 frames) a second.

In a television camera, a system of lenses is used to produce an optical image of the scene being recorded on a mosaic of photoconductive or photoemissive cells. This is then scanned by an electronic beam, producing an electrical signal that varies in strength according to the intensity of the light falling on that part of the mosaic. In a colour television camera, three separate scanning processes take place, one for each of the three primary colours used in colour television (red, green and blue).

Figure 1: the principle of interlaced scanning

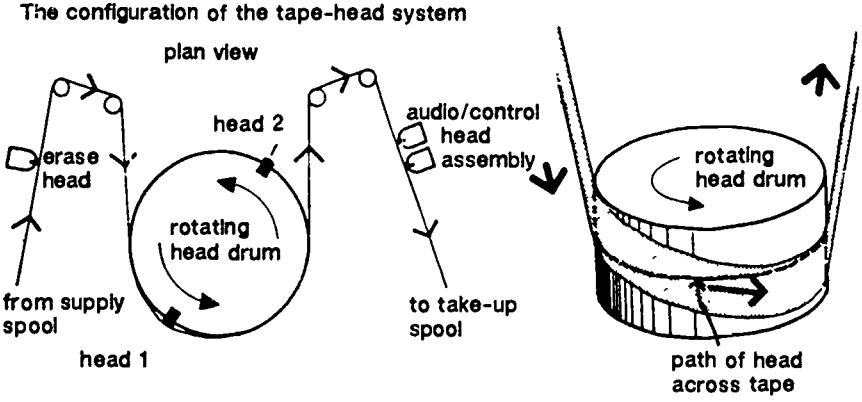


In a television receiver or monitor, the opposite process take place, the fluorescent rear surface of the screen being scanned by an electron beam that builds up the picture line by line. In a colour set, three separate scanning systems are again used – one for each of the primary colours – with a special perforated mask being used to ensure that each colour beam strikes the correct parts of the screen.

How television pictures are recorded

A television signal consists of three basic components, namely a high-frequency signal carrying the picture information, a synchronising signal that controls the scanning process by which this information is converted into a sequence of fields and frames, and an audio signal that carries the sound. The latter two signals can be recorded on magnetic tape in the conventional manner, namely, by using stationary heads to produce tracks running along the length of the tape, but it is not possible to record the picture signal in this way because of the extremely high frequencies that it contains (up to five megahertz). The maximum frequency that a tape recording system can handle is proportional to the speed at which the tape moves past the head and inversely proportional to the head gap width. Even using the smallest head gaps that are technically possible, it would be necessary to employ tape speeds of several hundred inches per second in order to record the picture components of television signals in the conventional way, something that is clearly not practicable. Fortunately, this problem can be overcome by employing a rotating head support system that moves the video head(s) rapidly across the tape as it travels through the machine. In most of the videorecorders used for instructional purposes, some form of *helical scan* system is used. Here, the tape is wound round a

cylindrical drum in a manner similar to that shown in figure 2, a drum that rotates at high speed within the loop of moving tape. In the U-wrap system shown in the figure (the configuration used in most videocassette recorders) the drum carries two heads, diametrically opposite one another. Thus, as the drum revolves, these execute a series of parallel scans across the tape as it moves round the drum. The video signal is thus recorded in a discontinuous series of stripes, which can be joined up electronically to produce a continuous signal when the tape is replayed.



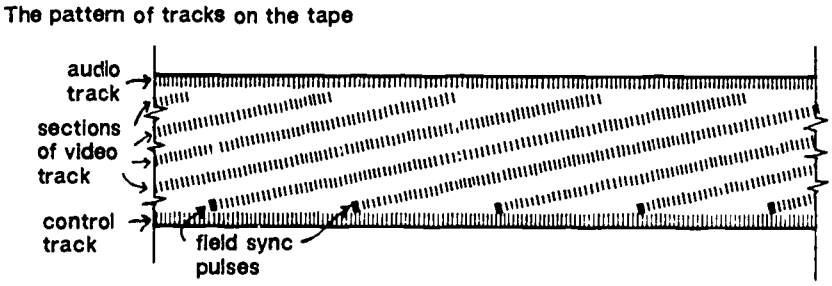


Figure 2: the principle of helical-scan videotape recording using the U-wrap tape configuration

These diagonal video tracks take up the entire width of the tape except for narrow strips at the top and bottom edges, which are used to carry the audio and control signals in the form of conventional tracks. With a twin-head U-wrap system of the type shown in Figure 2, the head drum rotates 25 times a second when recording 625 line pictures and 30 times a second when recording 525 line pictures. Thus, in each case, one complete frame is recorded during each revolution, with each frame corresponding to two segments of video

track on the tape – one for each of the two fields that compose it. As shown in the lower part of the figure, the start of the track segment representing each field is labelled with a *field synchronising pulse*; these pulses enable the separate segments of the video signal to be properly integrated during the playback process.

When the tape is played back, the tape moves through the machine in exactly the same way, the video signal being read off the tape by the rotating video heads, the audio signal by the audio head and the control signal by the control track head. The latter is used to synchronise the movement of the tape with the rotation of the video head so that the intermittent video track is scanned in the correct way.

The different videotape formats

Like photographic film, videotape is available in a range of widths, in this case, 2", 1", $^3/_4$", $^1/_2$" and $^1/_4$". Of these different widths, however, only two are widely used in instructional television work, namely $^3/_4$" and $^1/_2$", with the latter being by far the most popular type. The two largest sizes of tapes are only used when the work has to be of broadcast standard, while the smallest is only used with a single small non-standardised type of video recorder.

Half-inch videotape is available both in open-reels (for use with open-reel *videotape recorders* (VTR's) similar to open-reel audiotape machines) and in sealed cassettes (for use with *videocassette recorders* (VCR's), which are again similar to their audiotape counterparts). The two most widely used $^1/_2$" video cassette formats are *VHS* and *Betamax*, both of which are primarily designed for domestic use but are perfectly adequate for most educational and training purposes.

Three-quarter inch videotape is used when higher quality is required, and is again available both in open-reel and cassette form. The most widely used $^3/_4$" video-cassette format is *U-matic*, which is available in two forms, namely, *standard* or *low-band U-matic* and *high-band U-matic*. As its name suggests, the latter has an extended bandwidth compared with the standard form, and thus produces higher quality results; it is, however, *considerably* more expensive to work with.

The equipment needed for producing video materials

At one time, practically all instructional television work was carried out using *monochrome* (i.e. *black and white*) equipment, since (a) colour equipment was prohibitively expensive in comparison, and (b)

research had shown that monochrome television was just as effective as colour television for most instructional purposes. Since the mid 1970's, however, colour equipment has become steadily cheaper in real terms, with the result that it has achieved progressively wider use. Indeed, virtually all television equipment now being purchased for educational or training purposes is of this type, with the result that black and white instructional television is, to all intents and purposes, obsolete. The one exception is time-lapse video recording, which is still largely carried out in monochrome, but this too will no doubt 'go coloured' in due course.

The basic equipment needed for video work

All that is needed to carry out simple video work of the 'record-and-playback' type is a *television camera*, a compatible *videocassette recorder*, and a *television monitor* that is capable of handling the signals from the recorder. If your work is to be carried out in a fixed location (e.g. recording of interviews or small-group activities in a classroom) a basic tripod-mounted camera and an ordinary domestic-quality videocassette recorder will probably be perfectly adequate. If you intend to shoot material in a variety of locations, however, or intend to work out of doors, then a 'portapack' system of the type shown in figure 3 would probably be more suitable. The system shown consists of a shoulder-held colour camera connected to a shoulder-slung U-matic videocassette recorder powered by re-chargeable batteries. Such a system enables material to be shot under virtually any conditions where the light level is reasonable.

A basic VHS portapack can be obtained for roughly £1000*, although it is possible to pay a great deal more. A semi-professional U-matic system like the one shown in figure 3 costs roughly £5000, although it is again possible to pay much more than this depending on the quality required.

* All prices given in this booklet are those that prevailed in 1987.

Additional equipment needed for video editing

The main limitation of a single camera - single video-recorder set-up of the type just described is that it does not allow editing of material to take place - apart from crude 'editing-in-the-camera' carried out by shooting sequences in a pre-planned order, using the 'pause' control on the system to prevent picture break-up between shots. Such a procedure is hardly ever used for serious work, however, because of its inflexibility.

Figure 3: a 'portapack' video system

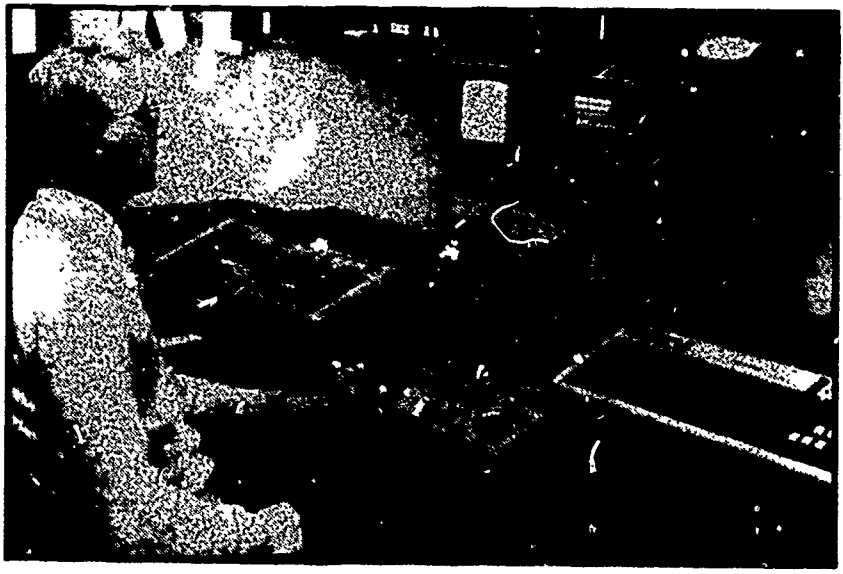
Unlike audiotape editing, which can be carried out either by cutting and rejoining the tape or by dubbing from one tape onto another, videotape editing can only be carried out by electronic means. The reason for this should be self-evident from figure 2, which shows the complicated overlapping track patterns by which a television signal is recorded on videotape. All videotape editing thus requires the use of at least two videorecorders – one to play back the original material and one to record this on the edited tape.

The simplest way to carry out editing of video material is 'crash editing' – dubbing material directly from one videotape recorder to another by feeding the output of the 'playback' machine straight into the 'record' machine. Such editing can be carried out using any two compatible videorecorders, but almost invariably gives rise to picture break-up between sequences due to the stopping and starting of the machines, thus causing various forms of noise and distortion to appear. Crash editing is therefore totally unsuitable for producing a high-quality finished product.

The only way to overcome the above problems is to make use of a custom-designed *videotape editing suite* consisting of two compatible videorecorders of reasonably high quality linked by a central control unit. A basic VHS editing suite can be obtained for roughly £5000, and a basic U-matic suite for roughly £8000, although it is again possible to pay a great deal more. A typical editing suite (a U-matic editing suite in this case) is shown in figure 4.

A whole range of ancillary items of equipment can be a.ded to a basic videotape editing suite of the type shown in figure 4, two of the most useful being a *time-base corrector* and a *caption generator* (also known as a *video typewriter*). A *time base corrector* is an electronic system that stabilises the video signals being processed by the system, thus enabling a much higher quality of edited material to be produced.The price of such systems starts at around £3000, although it is possible to pay well over £10,000 for a more sophisticated version.

Figure 4: a U-Matic videotape editing suite



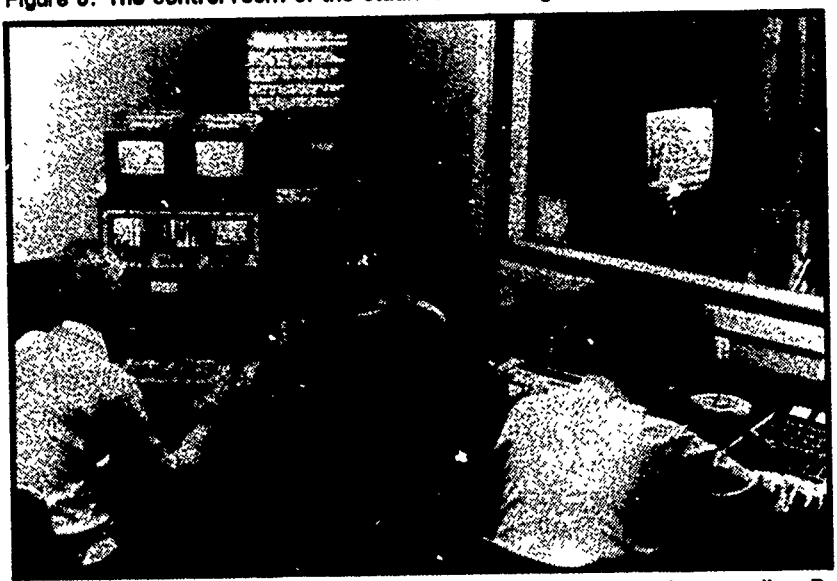
A *caption generator* is a keyboard device that enables captions and other alphanumeric materials to be added to a television picture by feeding them directly into the video signal. A basic caption generator can be obtained for around £2000, although it is again possible to pay a great deal more. It is also possible to convert an ordinary microcomputer (such as a BBC micro) into a caption generator by carrying out a simple conversion and purchasing suitable software and ancillary equipment. In this way, it possible to acquire a perfectly adequate caption generator system for around £1000.

Setting up a television studio

Although it is perfectly possible to produce excellent instructional video materials using the equipment described above (a single 'portapack' camera/recorder system plus an editing suite), the range of materials that can be produced and the range of activities that can be carried out is obviously greatly increased in you have

Figure 5: A typical college television studio

Figure 6: The control room of the studio shown in figure 5



access to a properly-appointed multi-camera television studio. By using an existing room, a makeshift three-camera colour TV studio can be set up and equipped for roughly £12000 (£6000 for the cameras and tripods and £6000 for the ancillary equipment (vision mixer, camera control units, monitors, sound equipment, videorecorder, lights etc.). It is, of course, possible to spend a great

deal more that this for a fully-equipped custom-built studio with a separate control room. If a new building is being planned or an existing building is being re-furbished, this is probably the best time to set up such a facility, since the cost may well then be obtainable as part of the overall capital sum assigned to the project rather than having to be pleaded for separately. Typical college studio facilities are shown in figures 5 and 6 – a three-camera full-colour studio with a well-equipped control room.

How to design and produce video materials

Planning a video programme

The starting point in planning a video programme should be the realisation that there is a definite need for moving visual material of this type in a particular instructional situation – either in a supportive role or as the main vehicle for instruction – and that no suitable material is already available.

Once a decision has been reached to produce such a programme, the next step should be to draw up a rough overall plan, outlining its content and basic structure. This should then be converted into a more detailed plan, in which the visual and narrative contents of the different sections are specified. This can be done in a number of ways, e.g. by producing a *storyboard* (a series of sketches of the different shots or visual elements of the programme with information about the sound content given alongside each) or a *shooting script* (a sequence of detailed verbal descriptions of the different shots together with information about the accompanying sound content, as before). Detailed guidance on how to carry out this work can be found in the books listed in the 'Further Reading' section at the end of the booklet.

Whichever method is used to draw up the detailed plan for the programme, the following general guidelines should be borne in mind:

- Limit the *content* of the programme. Remember that the viewer will only have one chance to understand what is being covered, and cannot ask questions. Thus, if you try to cover too much material, or introduce too much detail, some (or all!) of your audience may well become confused or 'get lost'. If this happens, the material obviously has little chance of achieving its design objectives.

- Make sure that the programme has a definite *structure*, and that this structure is made clear to the viewers by making appropri-

ate use of 'signposts and links' – either in visual or in verbal form. Failure to do this can again lead to confusion and consequent failure of the material to achieve its objectives.

- Try to keep to a 'linear' argument in each section of the programme, avoiding the temptation to go off on diversions or digressions. These can again lead to confusion in a mediated presentation, since the presenter is not in direct touch with his audience and thus has no means of gauging whether they are following his argument and taking appropriate steps if they are not.

- Remember that television is essentially a *visual* medium, in which the narrative should play a supportive rather than a central role. (If this is not the case, you are probably using the wrong medium to present your material.) Thus, when planning a video programme, you should *think visual* at all times, building the programme round the sequence of picutures that you decide to incorporate rather than simply using the pictures to support a mediated lecture, as is usually the case with a tape-slide programme (see booklet on "How to produce linked audio and still visual materials").

- Also remember that television is a *moving* visual medium, so that any video material produced should generally incorporate *motion* of some sort. (If it does not, then you are again probably using the wrong medium). Note that such motion can be produced either by movement of the actual subject material or by movement of the camera, change of camera angle, etc. during shooting or editing, as we will see later.

- Try to keep the visual treatment of the subject matter straightforward and simple, avoiding 'artistic' or 'gimmicky' shots. These simply distract the viewer from the *content* of the programme, so that the 'medium' gets in the way of the 'message' – a fatal weakness in any mediated instruction system.

- Make sure that you get the 'continuity' right, so that the shots follow one another in logical order. For example, if your programme shows an actual situation (e.g. a process or a machine) together with a schematic diagram of the same thing, try to match them up as closely as possible so that the viewer can relate the diagram to the situation that it is supposed to represent. Something that moves from right to left in the former, for example, should move in the same direction in the latter, otherwise viewer confusion will almost certainly result.

The different types of shot that can be used in a video programme

Let us now take a brief look at the different visual 'building bricks' that can be used to construct a video programme, i.e. the different types of *shot*.

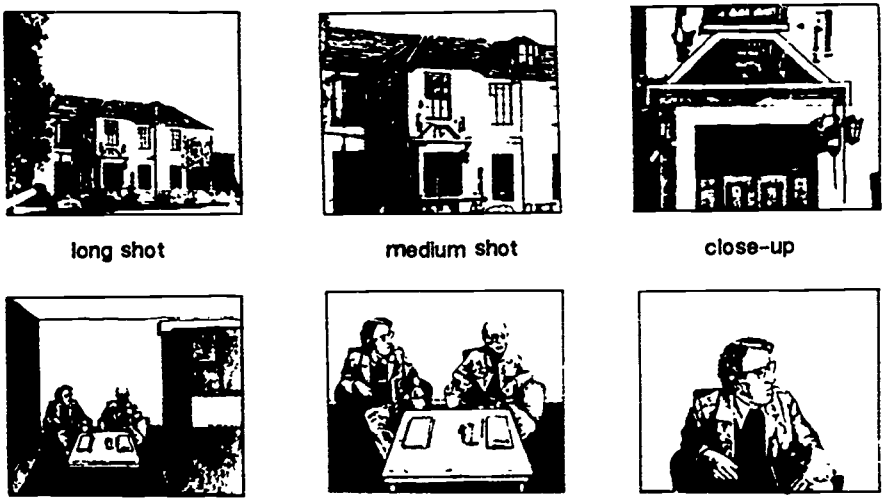
The three basic types of shot

In all video work, three basic types of shot should form the bulk of most sequences. These are:

- The *long shot* (LS), which provides a general view of the subject taken from such a distance that the subject is seen in the context of the background or setting in which it is located at the time.
- The *medium shot* (MS), which provides a closer view of the subject, eliminating most of the background details.
- The *close-up* (CU), which provides an even closer view of the subject or a specific part thereof, excluding everything else from view.

These three types of shot are illustrated in figure 7.

Figure 7: the three basic types of shot used in video work



long shot | medium shot | close-up

Note that the terms 'long shot', 'medium shot' and 'close up' do not imply that they should should be taken from any specific distance, since this will depend entirely on the nature of the subject being shot.

A 'long shot', for example, can be taken from several hundred yards in the case of a large building and from a few feet in the case of a piece of equipment of relatively small size. Also, different cameramen can interpret the terms in different ways, so that what is a medium shot to one may well be a close-up to another. It is also possible to use shots intermediate between the three basic types (e.g. a *medium close-up* (MCU), which is half way between a *medium shot* and a *close-up*), or shots which lie beyond the normal LS-MS-CU sequence (e.g. an *extreme long shot* (ELS) or *extreme close-up* (ECU) – see figures 8 and 9).

Figure 8: an extreme long shot

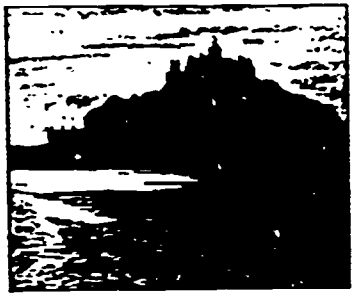
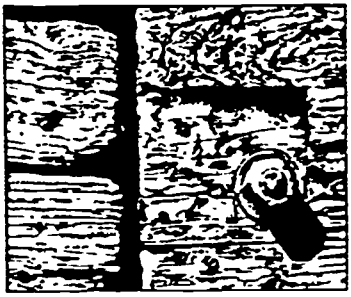


Figure 9: an extreme close-up



Moving camera shots

As we saw above, it is possible to introduce a sense of movement into a video sequence by moving the camera or changing the effective distance or angle of viewing during shooting. Some of the main options available include the following

- *Zooming* – where the apparent distance from which the scene is shot is increased (*zooming out*) or decreased (*zooming in*) during the actual shooting by using a *zoom lens* and varying its focal length in a continuous manner (not to be confused with *dollying*).
- *Panning* – where the camera is rotated about a vertical axis during the shot, thus causing its effective field of view to sweep across the scene being shot (not to be confused with *crabbing*).
- *Tilting* – where the camera is rotated about a horizontal axis at right angles to the direction of shooting during the shot, thus causing the subject to be scanned in a vertical direction.
- *Dollying* (or *tracking*) – moving the camera towards or away from the subject during the shot.

- *Crabbing* (or *trucking*) – moving the camera along a line at right angles to the direction of shooting during the shot.

Angle and position shots

Another way of introducing special effects or variety into a video sequence is to use different camera angles. Some of the possibilities are again listed below:

- *High-angle shots* – where the camera is above normal eye level, looking down on the subject (this effectively places the subject in an 'inferior' position, reducing its size and slowing down any motion that it may possess).
- *Low-angle shots* – where the camera is below normal eye level, looking up at the subject (this places the subject in a dominant position, exaggerating its height and speeding up any movement).
- *Subjective shots* – where the camera shoots 'over the shoulder' of the person carrying out the operation being filmed or recorded, thus giving the impression of seeing the operation from that person's point of view (in most shots, the camera views the scene from the point of view of an objective observer).

Producing a video programme

When it comes to the actual production of a video programme, the procedure used will depend on a number of factors, including:

- the video format in which you will be working (U-matic, VHS, etc);
- the method of recording the associated sound (if any);
- whether the material is to be recorded in a studio or on location;
- the detail in which the shooting sequence has been pre-planned;
- the method of editing that is going to be employed.

Two basic approaches can be adopted. The first is to draw up a highly detailed shooting script for the programme and then to carry out the actual shooting in a multi-camera studio, so that the material can be shot sequentially, using a video mixer to 'edit' the programme as the shooting proceeds. This requires meticulous planning, however, and, even then, will probably not 'come off' at the first attempt, so that several re-takes of the entire programme may well be necessary. The second method is to use a single

portable camera to record the various shots non-sequentially, and then to edit the material into its final continuity using suitable electronic editing facilities. This is probably the most convenient method of producing the majority of instructional video materials.

Further Reading

1. *Video in Education and Training*, by M J McInnes; Focal Press Ltd., London; 1980. (An excellent practical guide to the use of video equipment and the planning and production of video programmes – highly recommended.)

2. *The Practice of ETV*, by T Gibson; Hutchison Educational Ltd., London; 1970. (Still an excellent handbook for anyone who has to use television for instructional purposes despite being somewhat dated.)

3. *Television for the Teacher*, by F Kinross; Hamish Hamilton Ltd., London; 1968. (Another extremely useful handbook on the use of television in education, despite being somewhat dated from a technical point of view.)

4. *Video – A Guide to the Use of Portable Video Equipment*, by R W Rowatt; Scottish Council for Educational Technology, Glasgow; 1980. (An inexpensive booklet that offers a number of extremely useful hints to users of such equipment.)