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A SURVEY OF VIDEO-TAPE EDITING

THE PRESENT SITUATION

Having progressed from the razor blade to the minicomputer in about fifteen years, video-tape editing remains a major growth area in television programme production. Each year demand seems to outpace the available facilities and new systems appear, widening the programme-making options.

Several channels of development have progressed together to make this possible. The signal systems of v.t.r's and the tape itself have improved enormously, so that multi-generation recording is entirely feasible; the v.t.r servo systems are now sufficiently stable and accurate to cover the rapid changes between replay and recording which are essential for electronic editing; add to this the evolution of cheap minicomputers and digital circuits and it becomes possible to control and synchronize groups of recorders, perform complex sound and vision edits, and take over the arithmetic involved – for example in calculating the exact duration of a programme made up of numerous short segments. These parallel developments have been exploited successfully in a wide range of editing systems and the question now is not so much what is technically possible, but which system one should choose to meet particular programme requirements in the most effective and economical way.

This question may well have to be extended to include the programme origination equipment, taking account of the opportunities offered by modern colour cameras, special effects mixers, chromakey, and the video disc with its picture freeze, slow motion and animation facilities. In some cases programme producers have found the totally electronic system preferable to the use of colour film notwithstanding the high capital cost involved. The final choice of system, however, is very much a matter of individual circumstances and varies widely from one organization to another depending on the programme requirements and the existing staff and facilities. There is no single system which is ideal for everyone, and while new and in many respects attractive systems appear, the older systems also continue in use.

It is not possible in a brief survey to discuss the various systems offered by different manufacturers; this information can generally be found in the technical press and at the major international broadcasting conventions. An examination of the principles involved, however, is certainly useful, and it is instructive to consider the various possibilities in order of increasing complexity.

CUT EDITING

The earliest and, in principle, simplest method was 'cut' or 'physical' editing and even now many tapes are edited in this way. Figure 1 shows a cut-edit being made with a typical microscope splicer.

The system has some advantages. Only one v.t.r is needed, the tape remains first generation, and if a section has to be removed from a programme tape it is quicker to cut it out than re-record. To offset this it is tedious, there is no room for second thoughts, there is some risk to the original material, there is a possibility of drop-outs and disturbances at the joins, particularly when these have been run many times, and the suitability of the tape for re-use is correspondingly reduced. Also the sound and

Fig.1 Cut editing – the earliest system, but still widely used.

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picture are 0·6 seconds apart so that one cannot choose the best editing point for both sound and vision with re-recording that particular part of the sound track.

ELECTRONIC EDITING

The need to cut the tape can be avoided if the recording v.t.r is made to switch instantaneously between the replay and recording modes, without visible picture or sound disturbances. Devices to achieve this, such as the Ampex 'Electronic Editor' and the R.C.A 'Electronic Splicer' have been marketed for many years and are now commonplace. For most applications it is also necessary to control, and to alter if necessary, the precise point at which the edit is made. This is achieved by devices such as the Ampex 'Editec', which record a pulse on the cue track to define the editing point.

A number of options then arise. It is possible to use a single v.t.r and assemble a complete continuous programme in sections. This system has some applications, including animation, but it is not very popular for studio recording because it puts an extra load on the director and the artistes. Even a small 'fluff' means a complete retake of that sequence and, since all the takes must be in the right order, each must be completed satisfactorily before the programme can continue. There is the small advantage that the tape remains first generation and that no further editing is needed provided that the completed programme duration is correct, but this is not always easy to achieve and the tape may finally have to be cut-edited after all. The more common technique is electronic dub-editing, in which editing is carried out in the course of re-recording the programme. This requires a minimum of two v.t.r's, where the editing is limited to cuts between sequences; if mixing, or special effects are required, two or more replay machines are necessary, bringing the minimum up to three v.t.r's. Dub-editing is very commonly used and it has the advantage that edits can be rehearsed and modified as necessary; also studio sequences need not be recorded in the correct order and doubtful sequences can be repeated at the end of the original recording, if studio time permits.

The method so far described is somewhat rudimentary because there is no precise control over the replay v.t.r's during run-up. In practice the tapes are started from a given point marked on the tape in ink and the run-up time is generally sufficiently consistent to present no serious problem. The process is tedious however and would clearly benefit from some form of automatic control. Time code provides the answer.

TIME CODE

For many years it was realized that there would be great advantages in recording some form of time code on v.t.r's to identify individual frames, and a number of systems were developed using different codes. The main stimulus occurred however with the introduction of the SMPTE code, which is now effectively the industry standard. It contains 80 bits of binary information coded as bi-phase mark, is capable of being recorded on the v.t.r cue track and uniquely identifies each television picture over a 24-hour period in terms of hours, minutes, seconds and frames. The use of this code opens up many possibilities. If the time-code generator is made to operate in real time, any logging of timings during television productions in studios or on outside broadcasts against a local clock corresponds directly with the time code on the tape. This is much simpler than using the normal v.t.r timer because this operates in elapsed time and changes its relationship to real time whenever there is a break in recording. Also, during electronic dub-editing the time code can be used in conjunction with suitable editing equipment to maintain precise control over the transport systems of both the record and replay v.t.r's and to define sound and vision editing points.

The time code also makes it possible, given suitable equipment, to synchronize v.t.r's and sound recorders. This can be advantageous for sound dubbing or when stereo or specially high-quality sound are required. Also, if a multi-track sound recorder can be synchronized to either a quadruplex or a helical scan v.t.r, the sound dubbing can be carried out separately using the helical scan v.t.r, with a useful economy in quadruplex v.t.r time.

Time code also offers a means of bridging the gap between video tape and film. For example, where foreign language dubbing is necessary, the v.t.r sound and picture together with the time code can be transferred to a monochrome kinescope and, after dubbing, the sound can be transferred back synchronously to the master tape. Similar techniques can be used, if required, to allow intermediate editing of the v.t.r picture on film before the final programme tape is assembled.

THE INTRODUCTION OF TIME-CODE EDITING

When installing time-code equipment, the first essential is clearly a time-code generator, and if this always operates in real time it can feed all the v.t.r's on the station. The only condition is that the generator and the sources being recorded must be referred to the same sub-carrier generator and pulse chain.

The next step is to fit time-code readers to those v.t.r's on which tapes with time code are to be viewed or edited. The time code may be displayed on nixie tubes or, if character generators are included, it may be superimposed on the picture, in which case it can be viewed at any remote point.

Now comes the choice of the time-code editing system. The simplest arrangement must control two v.t.r's, one for replay and one for editing, and it must provide control of the two transport systems and the editing mode (sound and vision, vision only, etc). The tapes on the replay machine will already have time code recorded on them; the clean tape on the editing machine also requires time code, preferably in elapsed time, and this must either be pre-recorded or built-up during editing using a separate

time-code generator with slaving facilities.

We can begin by recording the normal leader on the editing v.t.r with time code, if not already present, as a synchronizing reference. The approximate time-code addresses for the start and finish of each sequence will already have been logged, and we can go on to feed in the addresses for the first sequence, causing the replay v.t.r to locate and play it. The system must have one or more keyboards for feeding in these addresses, simple memories to store the addresses and a means of altering them to achieve the exact timings required. The start and stop times for the editing v.t.r must also be keyed in, and the system must be able to reverse, park and run-up both v.t.r's in precise synchronism. It must allow rehearsal of edits and it should reject any instructions which would produce non-colour-synchronous edits.

Systems of this type can be extended to control additional play-in sources, sound recorders and special effects mixers. Figure 2 shows a typical system in operation at the BBC Television Centre. This is permanently installed with two v.t.r's (the second machine is out of view to the left), but can control a third v.t.r or a video disc, or a number of sound recorders in a simple but flexible arrangement.

Because their memories are small, systems of this type can only retain the instructions for the latest edit. This is quite adequate for many purposes, but if it is necessary to go back and alter an earlier edit all the succeeding edits must be remade with no means of recalling the decisions previously reached. If this limitation is unacceptable the next step is to introduce a larger memory and a minicomputer. Many further systems then become possible, all exploiting the computer's considerable flexibility in different ways.

The computer will certainly be required to undertake all routine calculations and to reject instructions which are demonstrably wrong. Information provided by the computer will generally be conveyed page by page on a television visual display unit; it will cover details of the programme, the tapes used, the number of v.t.r's, the sequence numbers and their time-code addresses, the

Fig.2 Time-code editing at the BBC Television Centre.

Fig.3 CMX editing at the Rank Video Laboratory, London.

editing options selected and the resulting programme duration. Also, because the system logic is written into a computer programme, instead of being wired-in, it can be changed if experience or new requirements make this desirable.

The computer may go further and assume a dominant role in the non-creative aspects of the operation, by indicating to the editor the successive decisions and instructions required from him. At this stage the editor may still convey information and instructions by means of keyboards and manual controls, but there is now the alternative of the light pen, which when used with a visual display unit can control many of the required operations.

The larger memory and minicomputer also allow previously determined editing decisions to be fed in rapidly, for example, from punched paper tape; this information may then be used for either operator-controlled or automatic assembly depending on the complexity of the system. In either case we are led to the next stage of the discussions, which is 'off-line' editing.

OFF-LINE EDITING

In its simplest form, off-line editing requires only a small monochrome helical-scan v.t.r costing a few hundred pounds. While a programme is being recorded on the master v.t.r's a simultaneous copy is made on the helical-scan recorder; the producer then plays this copy as often as necessary to choose his takes and the approximate editing points. The ability of helical-scan v.t.r's to display a still frame is particularly helpful, and if time code is used and superimposed on the picture the address of each editing point can easily be logged. The use of a monochrome reduced-bandwidth picture presents no real problem and the simplicity and small size of the equipment allows it to be used in offices and production areas. The producer attends the subsequent editing session on the master tapes with a clear view of what is needed; the programme benefits and v.t.r time is minimized.

This simple system is also valuable for news reports on long conferences. The proceedings are continuously recorded on the master v.t.r's and helical-scan recorders; the helical-scan tapes are reviewed on another machine while recording continues, to choose the items to be included and their duration. By the end of the conference the make-up of the programme is settled and the editing of the master tapes can go ahead rapidly.

The limitations of this simple off-line system are the need for manual logging of the numerous time-code addresses and the mental calculations of the sequence durations; also it is not always possible to choose editing points for the desired aesthetic effect without being able to rehearse the complete edits in both vision and sound. The first two limitations could be eased considerably by a simple calculator with print-out facilities. The third limitation can only be removed by using two helical-scan recorders with some form of time-code editing control system; this is certainly possible but the order of cost is greatly increased and the advantages have to be considered in relation to this.

Off-line editing may be developed much further by incorporating disc-packs, as in the CMX600 system shown in figure 3. Once the programme material has been loaded into the discs any frame is immediately accessible without the need for spooling backwards and forwards; also inspection of successive frames near the editing point is a simple matter.

With this system it is possible to rehearse sound and vision edits with a flexibility not available even on film and to record the editing decisions, this record being subsequently used for automatic assembly of the programme using the master tapes and v.t.r's.

The limitations of this type of system are the high capital cost of the equipment, the time required and additional cost of transferring the original programme into the disc-packs. On the other hand there can be a considerable saving in time on the master v.t.r's and the assembly can be undertaken when they are not required for other purposes. Clearly this type of system is most likely to be attractive when a programme requires a very considerable amount of complex editing.

THE FUTURE

The present array of editing systems is already impressive and new systems are continually being developed. Taking account of the numerous different approaches which are possible the future will no doubt reveal some interesting new possibilities. Certainly anything which would reduce the capital cost of editing systems and the associated v.t.r's would be a great help in extending the use of video-tape editing; meanwhile most users will find some system among the many choices available to meet their particular requirements.