Engineering Committee Report

Approaches to Videodisc-Based Editing

By Stanley D. Becker and Larry S. Spangler

Optical videodiscs offer many benefits for editing applications. Their interactive capability provides nearly instant access to 30-minute segments of video with two channels of audio. Videodisc players deliver frame-accurate freeze-frame, slow motion, and reverse motion and are cost-effective and reliable. In addition, recent advances in both DRAW disc development and edit system hardware have made the utilization of videodiscs for editing purposes more practical than ever before. This article describes two approaches currently in use.

A survey report submitted by members of the Study Group on Applications of Optical Disc Technology for Production Use in Motion Pictures and Television (N15.10)

The SMPTE Study Group on Applications of Optical Videodiscs for Production Use in Motion Pictures and Television (N15.10) has been exploring several areas of videodisc technology that relate directly to motion-picture and television production. One such area is the documentation of existing practices in the field of videodisc-based editing. Two of these methods are described below.

Production Flow Examples — Method 1

Project Requirements for Material Originated on 24 Frame/sec Film to Be Released on Film

The post-production flow for this type of project is shown in Fig. 1. The only deviations from conventional film preparation procedure are the following.

1. *Editorial.* Log, mark, and assemble film to be transferred via telecine. On the film roll* one indexed frame at each key number discontinuity must be identified. Identify the frame with grease pencil and log the edge number and code number on the transfer log.

2. *Telecine.* Transfer film roll to ¾-in. or 1-in. videotape. The tape reel must have continuous and increasing SMPTE time code and be formatted per Fig. 2. The telecine operator must record the approximate time code of each assemble edit.** Disc frame cues need not be inserted if disc production is done on a DRAW Disc Recording System.

3. *Disc Production.* Prior to disc production, the disc production operator will examine each edit point and record the SMPTE time code frame number of the *A*-type frame closest to the indexed frame after the edit. This time will then be entered into the action point table of the videodisc recorder's encoder/generator to force the new 3/2 pulldown sequence,† as we will require 3/2 (i.e. 24 frame/sec) discs.

4. *Logging.* On the off-line logger, scan through the disc and enter the following information for each scene and take:

a. Scene and take number
b. Material involved (picture only, sound only, or picture with sync sound)
c. Description of scene
d. Laser disc references to the scene and take
e. Film source references to the scene and take

The system must know the media for final conformation, for example, 24 frames/sec, 35mm. When the logging and editing are complete, assembly lists and negative cut lists must be outputted for final conformation.

Project Requirements for Material Originated on 24 Frame/sec Film to Be Released on Film and Videotape

Project requirements for this configuration are the most complex due to the difference in frame rates of film and video. In order for film to be edited electronically, the optical image must be converted to a video signal. This conversion is done on a telecine, the output of which is recorded on videotape. Film is normally shot at 24 frames/sec and video runs at approximately 30 frames/sec. In the transfer process, this discrepancy is resolved by scanning every other film frame three times instead of the normal two field scans, which make up the frame of a television picture. This 3/2 pulldown technique results in the generation of 60 fields of video from 24 frames (1 sec) of film.

The 3/2 conversion technique, however, does introduce a problem: Two of every five video frames will consist of fields that contain information from two different film frames. The resulting effect is that images displayed in freeze frame will appear to flicker between pictures from two different film frames. Another effect is that the editor may select this artificial frame as an edit (splice) point, causing an edit ambiguity. The obvious solution is to identify and give still frame access to only those fields on which each complete film frame begins.

Notations

A video frame is always a field 1/field 2 sequence, and is in sync with time code; indeed the time code defines the video frame. The picture frame, however, does not have to be in

*A 30-min film roll is most desirable as no edits need be made at telecine transfer.

**Not required if automatic cue inserter is used.

†Not required if automatic cue inserter is used.

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sync with the video frames. With 3/2 pulldown, the picture frames alternate between being two video fields long and three video fields long.

The 3/2 sequence creates four types of picture frames, called *A, B, C,* and *D.*

- The *A* frame is a f1/f2 picture frame.
- The *B* frame is a f1/f2/f1 picture frame.
- The *C* frame is a f2/f1 picture frame.
- The *D* frame is a f2/f1/f2 picture frame.

It follows that 2/2 field 1 pulldown is a series of *A* frames, and 2/2 field 2 pulldown is a series of *C* frames. The *ABCD* picture frame sequence is ten video fields long (five video frames), always starting with a f1/f2 picture frame (the *A* frame). Every five video frames the *ABCD* sequence repeats. Therefore, if the video frame time code for picture frame *A* was :10, then the next *A* frame would occur at video frame time code :15, then :20, then :25, then :00, and so on (assuming non-drop frame time code is used). If the video frame time code for picture frame *A* was :11, then the next *A* frame would occur at video frame time code :16, then :21, then :26, then :01, and so on. A similar story exists for when the *A* frame starts at :12 to :14 frames.

In all there are five ways that time code can be related to 3/2 pulldown. These will be denoted by the position of the *A* frame for a particular 3/2 sequence. The position will be denoted as $A = 0$, $A = 1$, $A = 2$, $A = 3$, or $A = 4$. The number corresponds to units of the time code frames value. Note that if the *A* frame was found to be at a frames time code of :25, the correct notation would be $A = 0$.

The post-production flow for this type of project is shown in Fig. 3. The editor will log, mark, and assemble film to be transferred via telecine. On the film roll[††] one indexed frame at each key number discontinuity must be identified (Fig. 4). Identify the frames with grease pencil (or punch if negative) and log the edge number and code number on the transfer log.

At the transfer facility, the film roll is transferred to ¾-in. or 1-in. videotape. The tape reel must have continuous and increasing SMPTE time

[††]A 30-min film roll is most desirable as no edits need be made at telecine transfer.

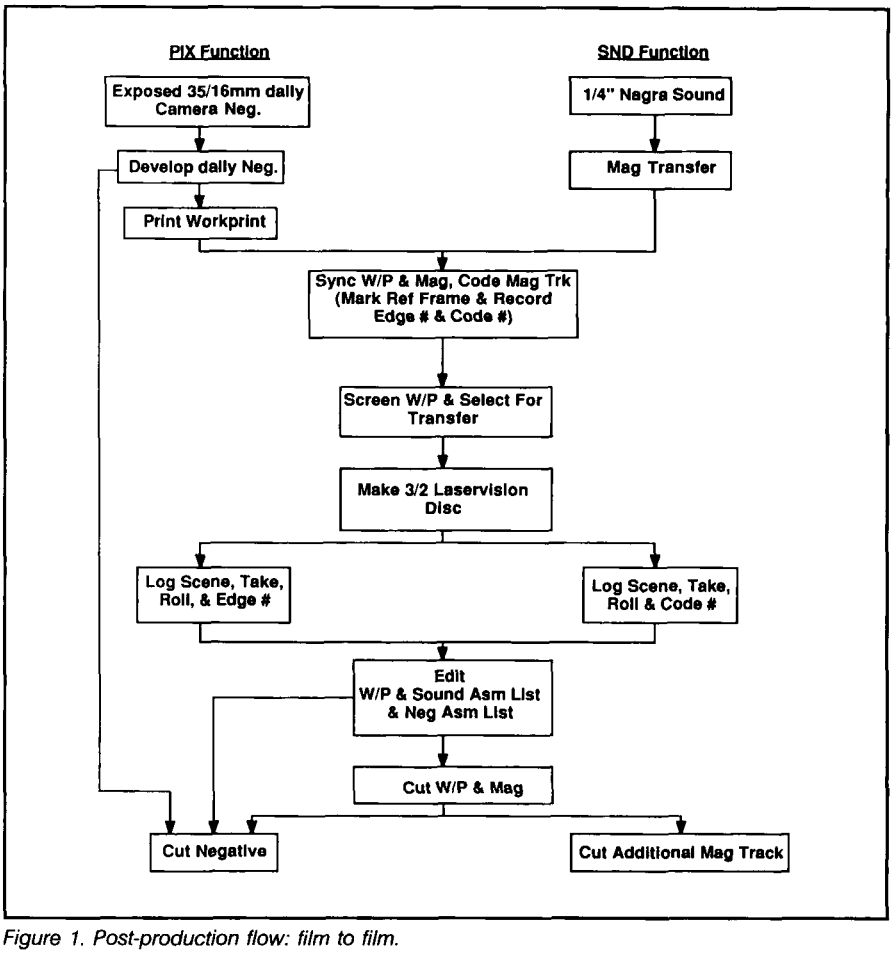

Figure 1. Post-production flow: film to film.

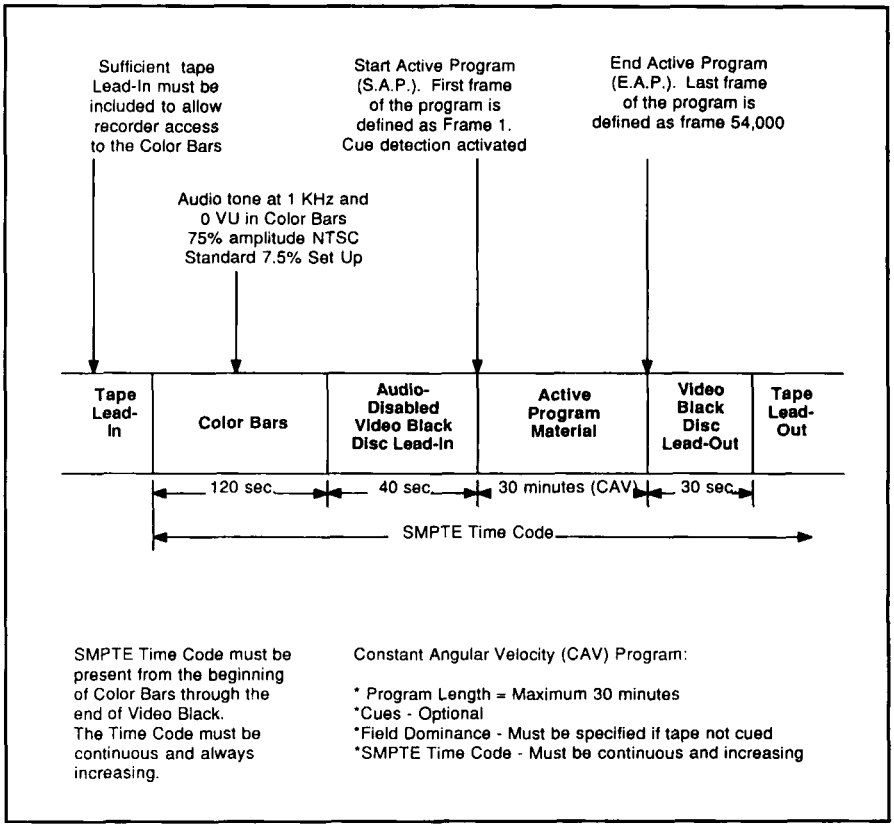

Figure 2. Format for videotapes to be used in videodisc recording.

code and be formatted as shown in Fig. 2. The telecine operator will record the approximate time code of each assemble edit.

Prior to disc production, the disc production operator will examine each edit point and record the SMPTE time code frame number of the *A*-type frame closest to the indexed frame after the edit (Fig. 4). This time will then be entered into the action point table of the videodisc recorder's encoder/generator for a new pulldown sequence. The SMPTE time code number of the indexed frame and frame type will also be entered into the transfer log.

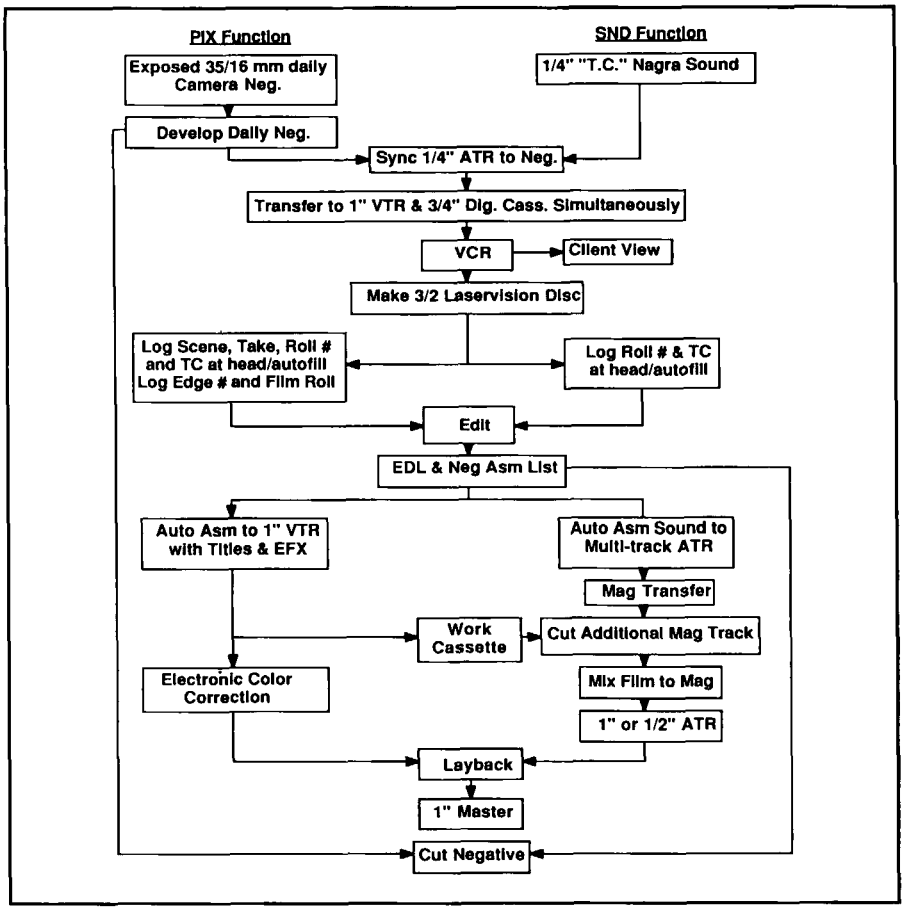

Figure 3. Post-production flow: film to tape and film with ¼-in. ATR (T.C.) interlock transfer, film mix, and electronic color correction.

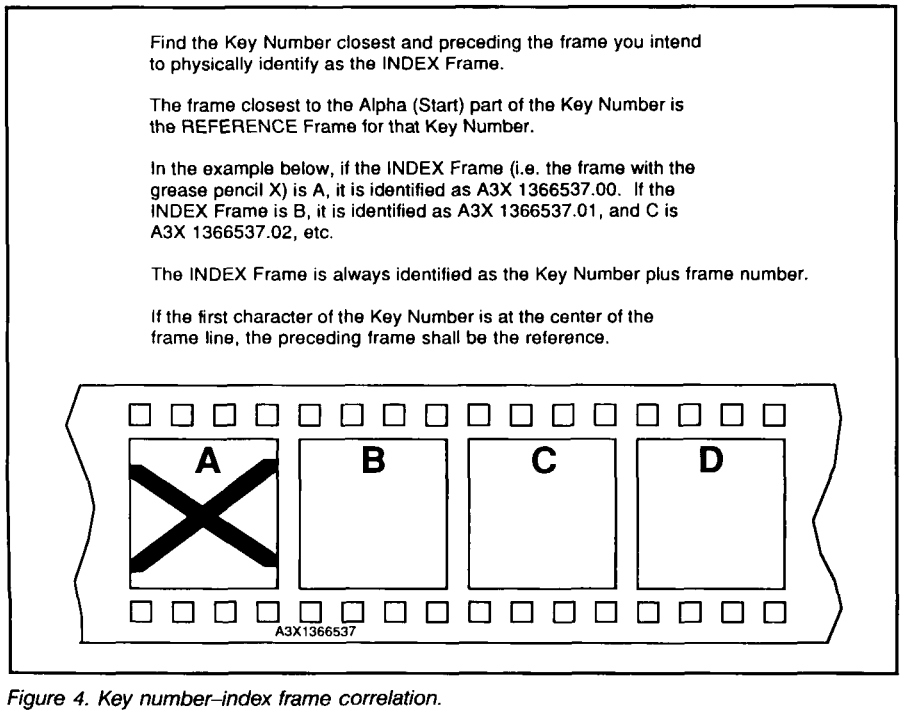

Figure 4. Key number–index frame correlation.

If an automated transfer system that can force an *A* scan at the edit point is available, manual identification can be avoided. The assembly starts with the first edit at :00 frames of time code. At the end of the film material the VTR is "bumped out" of record. The In time of the next edit is an over-record set at a SMPTE time code of :00 frames, or any multiple of 5 (e.g. 05, 10, 15, etc.). Since all In edits *A* scan and the time code sequence is maintained, the videotape has a contiguous *ABCD* sequence and only one action point is required for the 3/2 disc. Furthermore, only one time code need be logged at the disc editor.

The two different frame rates for film and video evoke some additional requirements. The first is the conversion of disc addresses prepared in the 3/2 mode to editorially frame accurate SMPTE time code addresses. The second problem is one of duration. If every edit of a completed production happened to have an odd number of film frames and the first film frame of each edit happened to be a three field scan, each video edit would run about 8.3 msec longer than the equivalent cut film edit. A run time error of 1 sec could be accumulated in approximately 120 edits. These problems are avoided by a proprietary algorithm for film frame-to-SMPTE conversion. The result is all video edits will match film edits ± 1 field and the cumulative run time error will never exceed 1 TV field.

Another run time error is due to the fact that the color video rate is 29.97 frames/sec. When transfer occurs, each 1 sec (24 frames) of film is scanned by 30 frames of color video (33.366 msec/frame). This will introduce a 0.1% error in run time between the projected film and video versions.

Correction of this error would be necessary if a sound track that had been prepared in synchronization with a videotape picture needed to be utilized with a film-conformed picture. Resynchronization of such a sound track can be achieved by laying

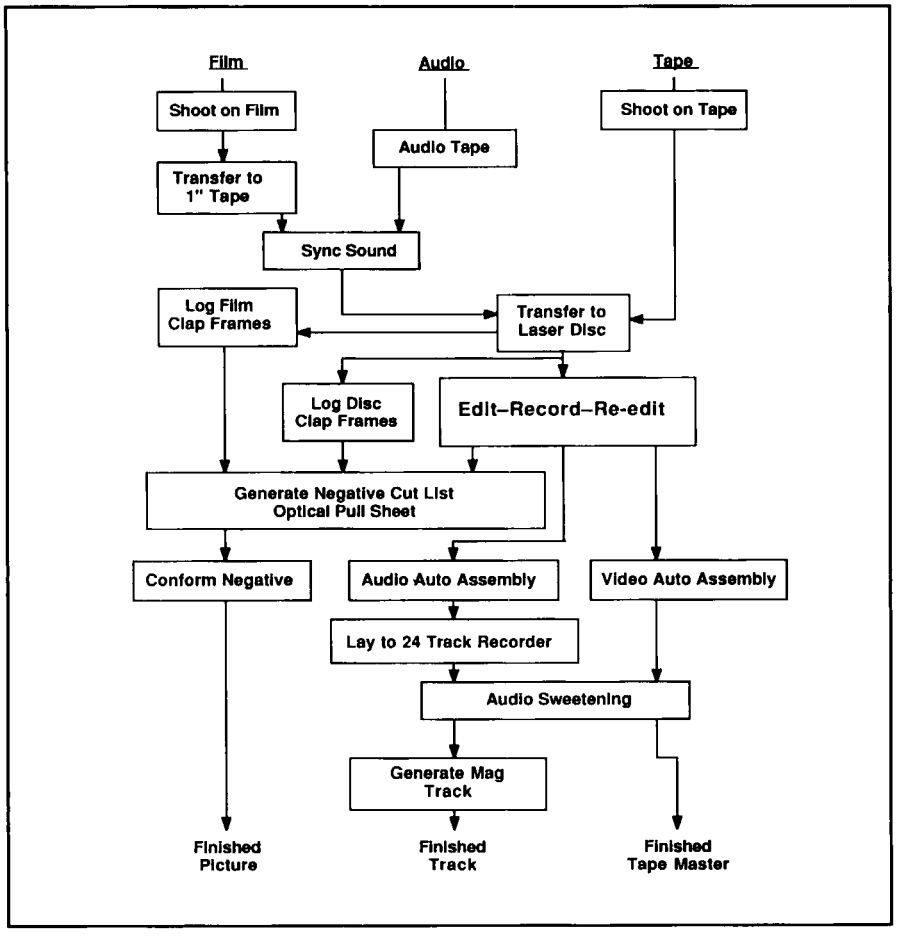

Figure 5. Electronic post-production.

down a 59.97-Hz pilot tone on the ATR, which would then be used to adjust the ATR's speed during the transfer to mag film. All off-line editors share the same fundamental problem; that is, to accurately transfer the edit decision information to conform the final release media. The random access disc editor provides an environment to not only off-line videotape projects, but film projects with release requirements for both tape and film.

Production Flow Examples – Method 2

The post-production flow charts for both film-original and video-original projects are shown in Fig. 5.

1. Shoot Film or Videotape

Film: Single or multiple cameras. Audio is recorded on a Nagra ¼-in. or on a ½-in. 4-track audio deck with SMPTE time code.

Videotape: 1-in. format and multiple cameras are generally utilized. Steps 2 and 3 below are skipped, as these 1-in. tapes are transferred directly to 2/2 pulldown recordable laser videodiscs.

2. Dailies/Telecine

After processing, film is transferred to 1-in. videotape. Normal 3/2 procedures are utilized for 24 frame/sec film transfers.

3. Audio Sync Dailies

Audio from the ½-in. 4-track source is synced with and laid down on the 1-in. film transfer reels. This audio generally consists of two channels of program audio plus the SMPTE code from the ½-in. source. If the show was shot with multiple cameras, audio can be synced to all the video source reels simultaneously.

4. Videodiscs

The 1-in. videotapes are then transferred to recordable laser videodiscs. SMPTE time code is encoded on the discs as a superset of the normal Laservision Philips code. This superset currently includes SMPTE code, disc identification information, and six alpha-numeric characters for camera identification. The SMPTE time code does not have to be continuous or sequential. The videodiscs are encoded for 2/2 format so they will reflect exactly the source tape reels, even if the original source material is film. This does not create a problem if the final release media is to be videotape. If the final product is to be film, a computer program is utilized in conjunction with a logging process to correlate film clap frames with disc frame numbers, and then create a negative cutter's list of edge numbers after the disc edit process. This list is then used to conform the negative and produce the finished picture.

5. Disc Editing

Editing is done using the videodiscs. The Philips code superset encoded during disc recording is automatically recovered by the dual-headed disc players, thus eliminating a manual logging step usually necessary to correlate scene and take starts with SMPTE time code. The finished products of this step are an edit decision list on a 3½-in. floppy disk, and a ¾-in. master for use as a reference source for on-line auto-assembly. A hard-copy edit list printout is also provided.

6. Auto Assembly

For video release, the 1-in. is auto assembled using the floppy disk created during the disc editing session. Titles, effects, and electronic color correction are also completed during this step. If audio was originated on ¼-in. or ½-in. tape, the floppy disk list can be used to auto assemble a ½-in. audio master from the original source reels. This audio can be used with a ¾-in. video dupe with visible code for sweetening and other audio post production.

7. Audio Layback

After audio post-production and sweetening, the completed audio is laid back on the 1-in. video master for tape release, or used to generate a Mag track for projects that finish in film.

Other areas being investigated by this study group include developing recommendations for standards concerning the creation and interchangeability of optical discs used for editing purposes, and for the formulation of a format for encoding editing-related data that will allow conforming to film or video original material.