

Edit List Management

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As the number of computerized videotape editing systems increases, editors have to deal ever more with numbers which provide the instructions for the automated assembly (on a workprint or intermediate tape) of a number of scenes or edits coming from diverse original tapes. These numbers, or assembly instructions, form a list of a quite complex nature. In dealing with a huge quantity of numbers, errors can easily be made. After describing first the characteristics of the basic edit list line, a number of frequently occurring errors, their remedies, and general edit instructions are described, such as over-recordings, the use of tracking edits, instructions for optical effects, instructions for wipes, and the matting of titles and keys. Editing is an aesthetic activity, and the relation of the editor as an artist to the computer which is to follow his instructions is analyzed briefly. The conclusion is reached that great care must be exercised in setting up an edit list. Rules for efficient performance in this endeavor are given.

If there is one phase of videotape editing that is most confusing and least understood, it is the strange phenomenon known as "edit list management." Computer-assisted videotape editing in any form deals exclusively with time code and frame numbers and managing these numbers is a problem that editors are faced with every day. These numbers usually appear in the form of a well-organized edit list (sometimes called a "menu") either as a computer-produced hard copy or on a cathode ray display screen. They are the principal means to control, correct, document, and memorize the videotape editing process.

There are several good computer-assisted editing systems in use today and each has been designed to provide what the manufacturer believes will fill the need at one particular level in the marketplace. Some systems are obviously more complex than others and thus take more time to learn how to operate. Editors tend to develop a preference for a particular system because they feel comfortable with it, but no matter how familiar an editor may get with an editing system, edit list errors do occur.

The author has been involved in one form or other of videotape editing since 1957 and for two decades has been observing tape editors in their work. He has carried out, over the years, editing on many different types of editing systems. Time code editing did not become available until 1967, and not until early 1972 did editors really concern themselves with edit list problems. The reason for this was that prior to 1972 no way of storing time code information in memory was available. Once information storage became available, it was realized that in order to repeat or locate a given edit on videotape a means of retrieval would be necessary. Interfacing a teletype reader and paper tape perforator to a computer editing system was a simple and inexpensive way of storing editing data for future use. The punched tape thus generated could be read into a teletype terminal at a later date yield-

ing an edit list in the form of a paper printout containing all edit information stored on the tape.

Even though edit storage on paper tape is still quite popular today, the large number of edits on tape limits its usefulness: the sheer size of a punched tape may make it difficult to load it into many reader units interfaced with editing systems. Paper tape storage of edit data is gradually being replaced by a storage device with a much greater storage capability known as a "floppy disk." Such a magnetically coated flexible disk, about the size of a 45 rpm record, can store more than 3000 edits on each side. It is relatively inexpensive and may be used over and over.

Dealing with Numbers

Some editors are able to manipulate frame identification numbers with great ease and with comparatively few edit list errors. Generally though, "flying fingers do not an editor make." Three major reasons that edit list errors occur are: (1) the editor is inexperienced or not familiar with the system he is using; (2) the editor does not understand the relationship between the code numbers and their effect on the edit list; (3) the editor may keyboard too fast and may not verify the data as they are entered, leading later on to extra work and frustration.

The last omission may cause many errors that tend to compound themselves. In most cases, it takes more effort to correct these compound errors later on than would be needed to do the checking. It takes only a few seconds to check each entry during the keyboarding operation, especially when working from an already created list. Repairing or correcting erroneous numbers in an already completed edit list always takes longer and becomes more difficult as the editor becomes fatigued. One must always remember that the computer and its memory will store only the information that the editor feeds it, and that includes the editor's errors. (The acronym GIGO, for garbage-

in/garbage-out, that computer people use is apt.)

Describing an Edit

Table I illustrates an example of a typical edit entry in an edit list.

The entry 001 in column *a* is the *sequential edit (or event) number*. It "increments" by one for each consecutive edit entered. At the end of the list, it gives the total of edits in that list. This number is continuously updated as edits are added to or inserted in the edit list.

The entry 63 in column *b* is the *original reel number* associated with this edit. Each edit must be assigned an original reel number to allow the system to locate the proper source material. It should be noted that some older editing systems are only able to handle up to 63 reel numbers. Newer systems will handle up to 999 original reel numbers.

The entry *B D* in column *c* identifies the *edit mode* and the *type of transition*. The first letter indicates what edit mode the system is set for. The second letter indicates the type of transition desired.

Three *edit modes* are generally possible. The letter *B* indicates a "both-cut" edit, meaning that both the video and the audio will be cut and changed simultaneously. The letter *V* indicates that the edit which is to be previewed and recorded on the work-tape (workprint) applies to the video (the picture) only, leaving the audio intact. The letter *A*, finally, indicates that the edit applies to the audio (the sound) only, leaving the video intact.

To indicate the *type of transition* desired, four different letters are generally used in the second position in column *c*. The letter *C* indicates a straight or direct cut that will produce an abrupt transition from one scene to the next. The letter *D* indicates a dissolve (superimposed fade-in and fade-out). If the letter *W* appears in this position, a wipe is indicated, i.e. a transition that crosses the screen in any desired direction with a visible hard, soft, or bordered edge. Finally, if the letter *K* is indicated, this means use of a key. Keys are used to matte one signal on top of another one, without any of the background bleeding through. There are several kinds of keys such as "chroma key" that must be dealt with in editing, but this paper will not describe all the many possibilities in this area.

The three digits in column *d*, 030 in Table I, indicate the *duration of the transition* (its length) in frames, in our example a both-cut dissolve of 30 frames duration is indicated. Up to 999 frames (about 33 s)

Table I. Typical edit entry on an edit list.

| a | b | c | d | e | f | g | h |
|-----|----|-----|-----|------------------------|-------------------------|-----------------------|------------------------|
| 001 | 63 | B D | 030 | Play-In 12:11:45:00 | Play-Out 12:11:55:00 | Rec-In 01:00:00:00 | Rec-Out 01:00:10:00 |

A contribution received first on 9 March 1978 and in final form on 2 May 1979 from Arthur Schneider, Electronic Video Industries, Inc., 2800 West Olive Ave., Burbank, CA 91505. Copyright © 1979 by the Society of Motion Picture and Television Engineers, Inc.

maximum duration for any transition may be entered with the system illustrated. A 000 entry or no entry at all in column *d* indicates, of course, a direct cut of type *C*. Transitions of type *D*, *W*, or *K* must always be accompanied by the corresponding duration entry in column *d*.

Columns *e* and *f* indicate the extension of the useful action. The head entry in column *e*, reading Play-In, indicates the start of the useful action, and the numbers underneath it indicate where exactly the first frame of the useful action is located on the original source reel (reel 63 in our example). It is the 00 frame found exactly at the time code location 12 h, 11 min, 45 s, 00 frames, on that reel. In similar fashion, the Play-Out heading in column *f* indicates and identifies to the exact frame the end of the useful action. Note that in our example the useful action has a length of exactly 10 s and zero frames. On the basis of these data, the editor now knows exactly the source and location of the original scene material, and in the event of changes becoming necessary, the material may be located easily.

The last two columns, *g* and *h* respectively, with headings which signify Record-In and Record-Out, define where on the edited worktape the original material has been re-recorded. Here, Record-In defines the first frame of the re-recorded action and Record-Out defines the last frame of the re-recorded action. (One must be aware that there is a significant difference between useful action and re-recorded action. The useful action is that part of an original scene [or take] selected by the director or the editor for final program use. The re-recorded action is the selected portion as re-recorded on the worktape. While both have exactly the same duration, the useful action on the source tape [original recording or master tape] may be preceded and followed by additional scenic action, but the action recorded on the worktape shows no action beyond its extremes.)

We must add here that the method most often used in videotape editing is known as "transfer editing" where material from the source tape is transferred to (re-recorded on) another tape (a worktape or intermediate tape) by an electronic copying process. The duration of the edit is found by subtracting the Play-Out from the Play-In time, or the Record-Out from the Record-In time, because the record difference and the play difference must be equal.

Edit List Errors

Now let us discuss some of the typical edit list errors that may prevent the proper, correct, and efficient conforming of frame-identifying edit list numbers. The term conforming, also called *auto-assembly*, refers to the important operation of matching the information created in a specific editing session to identical information usually found on a master tape. To put it another way, conforming means matching the sequence of edits made in a workprint to the diverse

Table II. Example of an over-recording left in an edit list.

| | | | | | | | |
|-----|----|---|---|-------------|-------------|-------------|-------------|
| 001 | 63 | B | C | 12:11:45:00 | 12:11:55:00 | 01:00:00:00 | 01:00:10:00 |
| 002 | 45 | B | C | 09:44:15:00 | 09:44:30:00 | 01:00:05:00 | 01:00:20:00 |

Table III. Example of correctly timed consecutive edits in a list.

| | | | | | | | |
|-----|----|---|---|-------------|-------------|-------------|-------------|
| 001 | 63 | B | C | 12:11:45:00 | 12:11:50:00 | 01:00:00:00 | 01:00:05:00 |
| 002 | 45 | B | C | 09:44:15:00 | 09:44:30:00 | 01:00:05:00 | 01:00:20:00 |

original source materials on a frame-for-frame basis.

Much of today's videotape editing is done off-line because the average hourly charge for on-line editing is about three times that of off-line editing. In off-line editing, a workprint is created instead of editing directly on the final 2-in tape, and we must try to minimize edit list errors for a number of reasons:

1. Errors may make the editor feel frustrated with his tools and undermine the confidence needed to edit efficiently.

2. The producer/director may feel that the system he is working with does not provide the necessary flexibility.

3. If the editor does not deliver a "clean" edit list prior to conforming or auto-assembly, needless delays are the result. They are caused in part by an excessive number of reel changes and by redundant recordings that waste time and money.

4. If frequent errors occur, film people that could be potential users of videotape will not have the necessary confidence in this type of electronic editing.

It should be noted that some systems have the ability to clean the edit list during the editing process. The editor may also take advantage of a variety of commercially available list-cleanup programs. These programs generally provide the following features:

1. They remove over-recordings (a term to be explained later) so that the audio/video edits are joined in a consecutive manner.

2. They rearrange edits in the list by Record-In times so that the automatic assembly can proceed in an orderly fashion. This is of particular importance because out-of-sequence editing at a later date is a common practice among videotape editors, and changes are usually made after the program has been edited in continuity.

3. They will renumber all edits in consecutive order and generate a second set of numbers that relate to the original sequence of edits.

4. They will position the separate video and audio edits in proper relation in the edit list, based on their Record-In times, no matter where in the list the edit was actually inserted.

5. They trace reel number and edit information through several versions of the edited workprint and correctly relate it to the final edited material.

Over-Recordings

A frequent error is over-recording (on-top-recording). Specifically, this occurs when excess material at the end of a scene that is to be shortened remains in the edit list and is eventually covered up by recording new material on top of it. Leaving the excess material in the edit list reduces the efficiency of any auto-assembly. Table II is a typical example of over-recording in an edit list.

Note that the Record-Out time of edit 001 is five seconds longer than the Record-In time of edit 002. This is an example of a short over-record, but in many cases it may amount to several minutes of extra material for each edit. In auto-assembly, such excess material is first recorded needlessly, then re-winding takes place, and finally the new scene is recorded over the excess material; all of this will accumulate a considerable amount of time at the end of an editing session. To prevent the accumulation of such excessive auto-assembly time, the Record-Out time of edit 001 must be shortened to match the Record-In time of edit 002. This will make these two edits consecutive in their record times. After cleaning up the list, it should look as shown in Table III.

Another example of a frequent error is that of two consecutive both-cuts straddled by a video insert, which has been added after the initial editing (Fig. 1). The sequence of transfer recordings is as follows: Scene "A" is recorded followed by scene "B" followed by scene "C." Table IV illustrates the corresponding edit list entries. This example shows the relation of the video insert

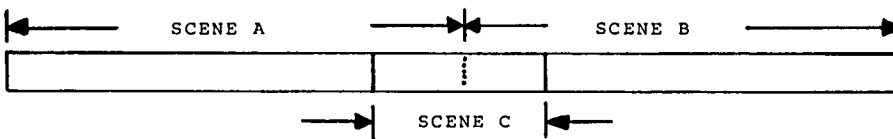


Fig. 1. Schematic of a video insert, straddling two both-cuts.

Table IV. Example of an insert straddling two both-cuts.

| | | | | | | | |
|-----|-----|---|---|-------------|-------------|-------------|-------------|
| 001 | 023 | B | C | 12:00:15:00 | 12:00:30:00 | 01:00:00:00 | 01:00:15:00 |
| 002 | 017 | B | C | 08:25:10:00 | 08:25:20:00 | 01:00:15:00 | 01:00:25:00 |
| 003 | 009 | V | C | 10:00:40:00 | 10:00:43:00 | 01:00:14:00 | 01:00:17:00 |

Table V. Example of a tracking edit.

| | | | | | | | |
|-----|-----|---|---|-------------|-------------|-------------|-------------|
| 004 | 003 | A | C | 05:01:13:24 | 05:01:13:24 | 01:00:44:01 | 01:00:44:01 |
|-----|-----|---|---|-------------|-------------|-------------|-------------|

Table VI. Example of the use of a tracking edit.

| | | | | | | | |
|-----|-----|---|---|-------------|-------------|-------------|-------------|
| 001 | 003 | B | C | 05:01:03:24 | 05:01:33:24 | 01:00:34:01 | 01:01:04:01 |
| 002 | 025 | V | C | 17:08:00:29 | 17:08:04:28 | 01:00:40:15 | 01:00:44:14 |
| 003 | 030 | V | C | 14:10:12:00 | 14:10:15:10 | 01:00:54:14 | 01:00:57:24 |
| 004 | 003 | A | C | 05:01:13:24 | 05:01:13:24 | 01:00:44:01 | 01:00:44:01 |
| 005 | 099 | A | D | 000 | 10:11:22:17 | 10:11:42:25 | 01:00:44:01 |

Table VII. Example of a split edit delaying video.

| | | | | | | | |
|-----|-----|---|---|-------------|-------------|-------------|-------------|
| 001 | 015 | B | C | 11:00:10:00 | 11:00:20:00 | 01:00:00:00 | 01:00:10:00 |
| 002 | 008 | A | C | 07:00:01:00 | 07:00:03:00 | 01:00:08:00 | 01:00:10:00 |
| 003 | 008 | B | C | 07:00:03:00 | 07:00:15:00 | 01:00:10:00 | 01:00:22:00 |

Table VIII. Example of a split edit delaying audio.

| | | | | | | | |
|-----|-----|---|---|-------------|-------------|-------------|-------------|
| 001 | 015 | B | C | 11:00:10:00 | 11:00:20:00 | 01:00:00:00 | 01:00:10:00 |
| 002 | 008 | V | C | 07:00:01:00 | 07:00:03:00 | 01:00:08:00 | 01:00:10:00 |
| 003 | 008 | B | C | 07:00:03:00 | 07:00:15:00 | 01:00:10:00 | 01:00:22:00 |

(scene "C") to the both-cuts (scenes "A" and "B") in the list. Assembly of edits 001, 002, and 003 (representing scenes "A," "B," and "C" respectively) must be done exactly in the order indicated on the list. If edit 003 were assembled before edit 002 (which is possible because its Record-In time is earlier than the Record-In time of edit 002) an error would result. Edit 002 would then be assembled (transferred) in the last place and would cut off the second half of the video insert (edit 003), because the recording of its both-cut will erase anything in the path of the both-cut. The procedure described applies to audio inserts just as it does to video inserts.

Tracking Edits

Another day-to-day procedure is that of including so-called "tracking edits" in the edit list. A tracking edit is a nonrecorded, redundant edit as shown in Table V. Note that its Play-In and Play-Out, as well as the Record-In and Record-Out, times are identical and thus have a zero duration. The only purpose of the tracking edit is to provide synchronizing information for the computer, enabling it to locate the play and record times corresponding to a given edit. This is necessary for synchronizing the play and record times involved in creating an effect such as a wipe, dissolve, fade, or key. All these optical effects require tracking edits.

In addition, tracking edits must be in-

cluded in the edit list when the record times of consecutive effects are separated by one or more audio or video edits not relating directly to the previous event. Tracking edits contain the Play-Out and Record-Out times of the specific edit in the list from where one wishes to start a given optical effect. It should be noted, however, that no tracking edits are required between straight cuts.

In sum, the tracking edit is used only to identify a specific frame that is electronically spliced on to the next consecutive frame which indicates the beginning of an optical effect. Tracking edits are not recorded by the system and are only needed for bookkeeping purposes.

Table VI shows another example of the use of a tracking edit. If the tracking edit was not included in this list, it would not assemble properly. This group of edits provides the editor with a means of adding narration (contained in edit 005) as well as two video inserts (edits 002 and 003) to the master scene (edit 001). Let us analyze this list.

Edit 001 is a both-cut and is the master scene for all that follows. As noted, edits 002 and 003 are video inserts that replace, on a frame-for-frame basis, the corresponding frames of the master scene. Edit 002 starts near the beginning of the master scene, while edit 003 goes in 10 s after edit 002 stops. The tracking edit 004, which in this case applies to the audio only, is used as a reference edit and is not recorded. Its purpose is to track the audio from edit 001, the

Table IX. Erroneous dissolve instructions in an edit list.

| | | | | | | | |
|-----|-----|---|---|-------------|-------------|-------------|-------------|
| 001 | 296 | B | C | 07:08:08:00 | 07:08:18:00 | 01:00:00:00 | 01:00:10:00 |
| 002 | 345 | B | C | 090 | 12:15:20:00 | 12:15:22:00 | 01:00:10:00 |

Table X. Edit list instructions for a fade to black (fade-out).

| | | | | | | | |
|-----|-----|---|---|-------------|-------------|-------------|-------------|
| 001 | 023 | B | C | 14:59:10:20 | 15:00:01:20 | 01:00:00:00 | 01:00:51:00 |
| 002 | BL | B | D | 090 | 00:00:00:00 | 00:00:03:00 | 01:00:51:00 |

Table XI. Example of a fade with time added at its end.

| | | | | | | | |
|-----|-----|---|---|-------------|-------------|-------------|-------------|
| 001 | 023 | B | C | 14:59:10:20 | 15:00:01:00 | 01:00:00:00 | 01:00:51:00 |
| 002 | BL | B | D | 090 | 00:00:00:00 | 00:01:03:00 | 01:01:54:00 |

master scene, up to frame 01:00:44:01, synchronizing it with the original material being recorded and mixing it from that frame on with the new audio from edit 005, the narration. Note that the audio dissolve duration of 000 frames for edit 005 is merely a means of running the two audio sources together. Because the dissolve duration is zero, no automatic mix of audio will actually take place. The actual mix of audio that must be done, however, is carried out by the editor, using a non-computer-controlled audio mixer. This allows him to balance the mix of the two audio sources to his liking. Note also that the Record-Out time of edit 005, the narration, comes later than the Record-Out time of edit 001, the master scene. This means that the narration will continue over subsequent edits.

Split Edits

An often-used transition to anticipate the picture or sound of an incoming edit is known by several names such as a "split edit," an "L-cut," an "off-set," or a "stagger cut." This type of effect may also be used at the end of an edit to perform the same function.

In the edit decision list, it appears as a two-line event, as shown in lines 002 and 003 in Table VII. Here, edit 001 is a both-cut with a duration of 10 s. Edit 002, which is from a different source reel (008), is an audio cut that has a Record-In time 2 s earlier than the Record-Out time of edit 001. The duration of edit 002 is 2 s. Edit 003 is a matching both-cut. That is, the Play-Out time and the Record-Out time of edit 002 are the same as the Play-In and Record-In times of edit 003. One will notice that edit 003 has the same reel number as edit 002, as well as the same Play-In and Record/In times as the out times of edit 002. But in this case, the mode and transition type are indicated in the list as a both-cut (B C).

What this really indicates is that 2 s before the end of edit 001 an audio edit is made having a duration of 2 s, thereby starting the sound from reel 008 before the picture of reel 015 ends. In order to continue the sound and switch to the picture of reel 008, a matching both-cut is made. Approach to this type of edit may be made by either delaying the video (Table VII) or delaying the audio (Table VIII).

List errors may occur if the end of the audio or video insert does not coincide in time with the end of the previous edit, leaving a gap or cutting off a portion of the previous edit.

Many of the new computer-assisted editing systems have the ability to preview and record this type of transition in a single pass if the software and the hardware are compatible. Older systems must create this transition in a two-pass configuration by first previewing the audio or video portion, then recording it, then previewing and recording the both-cut in a separate pass, to see whether the aesthetic condition has been met.

Optical Effects

Another type of edit list error frequently occurs in the generation of optical effects, such as wipes, fades, dissolves, and title keys. Table IX shows such a common error. Here, a duration for a dissolve has been created that is longer than the duration of the edit itself. Hence, the edit will not assemble properly. The edit list shows a dissolve of 90 TV frames (3 s), but the edit duration is only 60 frames (2 s). Therefore, the dissolve will be upcut (cut short) by 30 frames (1 s). The problem may be solved by either extending edit 002 by at least 30 frames (1 s) to 12:15:23:00 Play-Out time, (adding also one second to the Record-Out time), or shortening the dissolve duration to 60 frames (2 s) or less. The basic rule is that, when indicating a duration for any effect, one must make sure that the duration of the edit must be equal to or greater than the duration of the effect.

A fade to black (fade-out), which is really a dissolve to black, is indicated as shown in Table X. Here, the length of the dissolve equals the duration of the edit. Note the letters *BL* in column *b* (the second column). They stand for the "black" necessary to achieve the desired effect, which amounts to fading to black for the picture and to silence in the sound, according to the *BD* (both-dissolve) instruction in the list.

If the editor should wish to add 1 min to the end of the fade in a single pass, the edit would look as shown in Table XI. In that case, the 90 frames of the dissolve duration are added to the 1 min of black leader, making the total Play-Out time 00:01:03:00. This minute is, of course, also added to the Record-Out time. It may be useful to remember here that, although the edit list gives all edit durations in the time code format (hours, minutes, seconds, and frames), all effects durations are displayed in frames only.

Creating Wipes

Wipes are a slightly different problem. All the rules explained still apply, but the editor must also indicate to the system which particular wipe pattern he desires. A typical wipe instruction is displayed in Table XII. Here, the edit list display looks basically the same as for a dissolve or fade. But the addition of a wipe-pattern number is essential for proper conforming through a computer-assisted editing system. In column *c* (the third column) of this table the number 12 does *not* indicate duration, but is read out by the system in conjunction with the instruction *W* as "wipe pattern No. 12," one of many selectable patterns usually available on video switchers.

Titles

Our final explanation concerns the matting of titles, also known as "keys." In general, keys are letters or other artwork, matted on top of a background scene, without the background image bleeding through the letters or foreground material. Again, the general rules for effects duration apply,

Table XII. Edit list instructions for execution of a wipe.

| | | | | | | | | |
|-----|-----|---|---|-----|-------------|-------------|-------------|-------------|
| 001 | 123 | B | C | | 11:23:11:00 | 11:23:21:00 | 01:00:00:00 | 01:00:10:00 |
| 002 | 456 | B | W | 012 | 10:09:00:00 | 10:09:10:00 | 01:00:10:00 | 01:00:20:00 |

Table XIII. Edit list instructions for the matting of titles or keys.

| | | | | | | | | |
|-----|-----|---|---|-----|-------------|-------------|-------------|-------------|
| 007 | 017 | B | C | | 15:00:43:00 | 15:00:44:00 | 01:00:53:00 | 01:00:54:00 |
| 007 | 017 | B | K | B | 15:00:44:00 | 15:00:53:00 | 01:00:54:00 | 01:01:03:02 |
| 007 | 021 | B | K | 030 | 12:00:23:00 | 12:00:23:00 | 01:00:54:00 | 01:00:54:00 |

but in this special case special handling in the edit list is required (Table XIII).

There are three event lines in the list concerning the key effect, and they carry the same event number in column *a*. The first line identifies the background source. The second line indicates at which point of the background material the effect will start. It picks up on the frame next to the Play-Out time of the previous edit line, as indicated by the same source reel number, 017, which becomes the background from here on. To achieve this, the second line contains the instruction *BKB*, meaning "both-key background." The third line contains a new reel number, 021, namely that of the foreground letters, and the system sees this as the "both-key" foreground material. It has a duration of 30 frames which tells the system that the artwork will fade up (come to full strength) in the 30 frames indicated by the time code.

The cue "both" is used here because, although the key affects only the picture, both picture and sound may continue as background information. Note also that line three actually describes the tracking edit for the onset of the key.

The complexity of the key signal and of the various combinations that may be achieved requires a more detailed explanation than this paper is prepared to deal with. However, the example provided displays graphically the possibilities that may cause edit list errors. One must always carefully consult the operating manual of the specific video editing system to be used. It will provide detailed information concerning instructions for keys and how to integrate them into the editing list.

One important point to consider in computerized video editing is that unexpected edit list errors may occur when power "glitches" enter the computer-assisted system, causing it to store erroneous data in its memory. Thus, unwanted data may appear if power transients are not suppressed. They may be caused if someone in the building operates equipment that interferes with the editing system. The remedy consists in the installation of an appropriate voltage protection device. The cost is low, and users of computerized editing systems are wise to avail themselves of this protection.

User Concepts

Editing is an aesthetic activity and it should not be necessary to go through a series of complicated keyboarding steps just to make a simple edit. Some computer-assisted editing systems tend to make the edi-

tor feel in need of an engineering degree in order to make an edit. An intimidating system is often to blame for edit list errors.

Editors should not be required to "talk" to the computer before beginning to edit. At present, it is often difficult — except for the most experienced editors — to communicate with some of the editing systems. Some manufacturers, however, are now coming to the rescue of the tape editor with new models that communicate in a very considerate fashion.

Some of the new models offer a "dedicated" keyboard which provides the editor with all the editorial functions at his fingertips. On such keyboards, each editorial function is assigned to a specific key. This facilitates a much faster, easier, and safer way to edit videotape, because the editor can select the desired function, and push a key to carry it out. This is important for efficient edit list management. In these systems, virtually no dialogue between the computer and the editor is required, and the number of editorial mistakes is greatly reduced. Today's technology can design editing systems that will considerably simplify the editor's task. The clue is to build systems that allow the editor to think more about the aesthetics of editing and less about the actual mechanics of performing the edit. Editing systems must be designed for editors.

Conclusions

Videotape editors have a need for careful edit list management. It is too late when, during auto-assembly, the editor finds a major error which may throw off the show timing to the point where auto-assembly must be stopped to fix the mistake. This is not only time-consuming but costly in dollars.

In many cases, after building the workprint, the editor may not have the time to "proof" his edit list by assembling a new confirming workprint from the completed list before proceeding to auto-assembly. Therefore, it is most important that list errors be caught before they can be compounded. This observation may sound redundant, but it only takes a little extra time to prevent errors at their point of origin.

To minimize list errors, the editor should scan the list for possible discrepancies before punching out the edit list, that is storing it on paper tape or on a floppy disk. He should remove all over-recordings, duplicate edits, and check to see that record times do not leave "holes" in the edit list. All fades, wipes, and dissolves must include a

"zero-length" tracking edit ahead of each effect.

We have intended to bring to the surface only some of the problems encountered in today's computerized editing. Probably, a book could be written about problems editors have to face as they build their edit lists.

To sum it up, edit list management is not as difficult as it may appear. Four most im-

portant factors must always be remembered: (1) the editor must thoroughly know the system he is working with; (2) he must understand the relationship of the instruction numbers in the list to the edits they will produce; (3) he must never be in too much of a hurry; and (4) finally, he must check and make sure that all edits in the completed list are listed by consecutive record times. If the

system in use is not capable of reordering edits in the list by record times, the list must be submitted to a firm that provides software for the "cleanup" of edit lists. Such a service is normally provided at a small cost and will yield a well-organized list, ready for auto-assembly. Edit list management is not difficult if time and care are applied.

Effects of Aspheric Surfaces on Optical Performance and Their Application to Lenses for 35mm Cinematography

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The practical use of aspheric surfaces in optical devices, such as parabolic mirrors or illuminating condensers, is well-known. Technical problems in the design and manufacture of such surfaces had to be overcome before the incorporation of aspheric surfaces into the construction of high precision optics, such as camera lenses for motion pictures and television, could be attempted. An overview of the performance of aspheric surfaces is given, and their limitations are mentioned. Spherical aberration, distortion, and astigmatism can be controlled by their use. The introduction of an aspheric surface into the design of a lens produces two types of effects: direct effects permit controlling of a specific aberration, and indirect or secondary effects may allow for the simultaneous control of another aberration. Greater lens compactness and reduction of the number of required lens elements may result. Three fundamental parameters for the measurement and evaluation of an aspheric surface are explained. A short description of various possible grinding and polishing methods is given. The accuracy of the surfaces obtained can be measured by the use of interference fringes or by means of a feeler in combination with a laser. Canon designed their first aspheric lens in 1971. It is shown that the aspheric design reduces aberration fringes, gives greater freedom from flare, and improves contrast. A series of four aspheric high speed lenses for motion-picture use was created. Some details of their design and construction, including the "floating" focusing mechanism, are mentioned. A Class III Scientific or Technical Award from the Academy of Motion Picture Arts and Sciences resulted from this technological achievement.

The use of aspheric surfaces to improve the performance of optical systems has long been known and there have been a number of cases where such surfaces have been used in practical applications. We may cite as an example of their use in high performance systems, parabolic mirrors used in astronomical observation systems and as an example for low precision systems, aspheric condenser lenses. However, for many years aspheric surfaces were not practically applied to high precision optical systems such as camera lenses for still photography, motion pictures, and television. Technical problems in both design and production limited the use of aspheric surfaces in optical products like these, but advances in production engineering and also in computer-aided design technology have gradually removed these restraints, and several new objectives in which aspheric surfaces are used are now available.

This contribution was received in August 1975. We regret the inordinate amount of time taken to get it reviewed, edited, and published. The authors are Jiro Mukai, Yoshiya Matsui, and Isao Harumoto, Canon Inc., Optical Research Division, 30-2 Shimaruko 3-Chome, Ohta-Ku, Tokyo 144, Japan. Copyright © 1979 by the Society of Motion Picture and Television Engineers, Inc.

Effects of Aspheric Surfaces and Their Limitations (Problems in Design Technology)

As is described below, processing of aspheric surfaces is much more difficult than that of spherical surfaces and therefore involves higher cost. The increased cost limits the number of aspheric surfaces which may be used in any given optical product to only one or two. This makes the design of aspheric optical systems more difficult than that of conventional spherical systems. First, the designer must determine which of the surfaces in the system will be most effective in aspheric form, and then he must endeavor to make the improvements gained by the use of an aspheric surface worth the cost. It is obvious from these considerations that one must know for which purpose an aspheric surface can be quite effective and for which purposes it is ineffective. This is of basic importance for any decision on whether or not an aspheric surface should be used in an optical system. Aspects of lens performance which can be improved by the use of aspheric surfaces are the following.

1. The image formation of a specific point in the focal plane can be made free from aberration. (Correction of spherical

aberration in a parabolic mirror is an example.)

2. A specific aberration curve can be controlled as desired. (An example of this is the control of distortion in a retrofocus lens.)

3. The surface has different sagittal and meridional curvatures for an off-axis pencil of rays. This facilitates the control of astigmatism.

However, an aspheric surface is ineffective with regard to the control of the following parameters.

1. Dimensional characteristics of an optical system such as focal length and back focal distance.

2. Petzval curvature.

3. Primary chromatic aberrations such as longitudinal and lateral chromatic aberration of the first order.

The application of aspheric surfaces with these characteristics in an optical system will produce direct and indirect effects. By direct effect, we mean the improvement of aberration which can be expected by the introduction of an aspheric surface specifically for the purpose. By indirect effects, we mean certain secondary effects which can be attained simultaneously with the direct effect. The following is an example of indirect effects.

When an aspheric surface is applied to control the distortion present in a wide angle lens of the inverted telephoto-lens type, improvements in other aberrations can sometimes be obtained at the same time. In some other cases, greater compactness of the overall system or a reduction in the number of lens elements can be attained together with the correction of aberrations.

When designing an aspherical optical system, it is difficult for a designer to determine in advance which of the various surfaces will be most effective by giving it an aspheric shape. Thus, the initial investigation must cover a much broader range than required for conventional optical systems. This is the major reason why the design of aspheric optical systems is difficult. Existing computer-aided design technology is a powerful tool for surmounting this diffi-