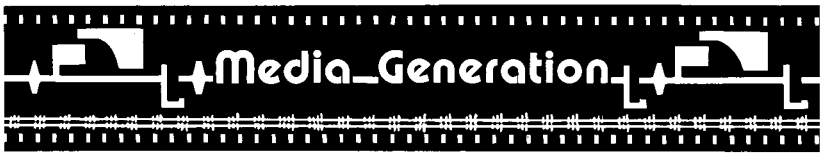

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FILM TIME CODE

John Bishop
MEDIA GENERATION

Regardless of how you shoot, or what kind of system you use for creative editing, two problems face every filmmaker -- synching double system sound before you edit, and conforming the original sound and negative (or video transfer) with absolute frame accuracy after editing. In conventional 16mm production, the audio tapes are resolved to 16mm fullcoat magnetic film and manually synchronized to the picture by slate marks (a beep on the sound track and a corresponding light flash on the film) at the head or tail of each take. A productive day of shooting can require days in the editing room to sync before you can begin cutting. Logs made during synching are often needed to locate specific sound bits prior to sound mixing, and the proper negative rolls for pulling opticals and ultimately cutting the negative.

Imagine the nightmare in the editing room from the footage generated by a typical rock concert of the 1960s shot with six cameras. Then imagine a concert shot with six cameras in 1993 --

The concert is about to begin. An assistant carries a master clock the size of a pocket calculator over to the audio recorder and uses it to jam sync (set the internal clock) on the recorder's time code generator. He then walks over to each film camera and does the same to their time code generators. The music starts and thousands of feet of film roll through the cameras -- no slates, no beep lights, no time code displays. Small Hi-8 VCRs on the camera operators' belts record the output of each camera's video assist, a color, flicker-free images that carries the time code for each frame in the vertical interval (VITC). After the concert, the Hi-8 tapes are loaded into a non-linear editing system and automatically logged. The producers have a rough cut ready to look at before the film negative is back from the lab. The program will be fine cut on the non-linear system without ever making a workprint, transferring and syncing the sound, edge numbering the cutting copies, or manually logging all the relationships. The negative will be cut from a frame accurate list produced by the editing computer. This is something that can happen today with off the shelf technology. It is made possible by two types of digital information recorded on the film edge: Keycode and film time code.

Keycode:

Latent edge code is printed every six inches between sprocket holes on camera stock during manufacturing. These numbers print through on the workprint. Negative cutters use the latent edge code to match the AB rolls to the cut workprint. Kodak developed Keycode, a bar code that duplicates the latent edge code numbers in a machine readable form. This makes it possible to log the latent code by computer, either on the editing bench or when the negative or print is transferred to video. By recording the Keycode as part of the video, it is possible to get a

frame accurate negative cutting list from edited videotape. This has opened the convenience of video and non-linear editing to people shooting and finishing in film. Keycode is now on all Eastman camera films, and on 35mm Agfa and Fuji films (and will soon be on Agfa and Fuji 16mm film). (Rather than patent Keycode, Kodak opted to get it accepted as an industry wide SMPTE standard for all film manufacturers.)

Keycode comes on every roll of film, whether you use it or not, and many software packages exploit it. While it solves the big problem of keeping track of your negative, dithering back and forth between film edge numbers and video time code on edit decision lists (EDLs), and conforming negative to workprint; Keycode does not help with synchronizing sound.

Film Time Code:

SMPTE time code for video and audio tape was standardized twenty years ago and is the cornerstone of video editing and audio sweetening. It is a stream of digital information that encodes the hour, minute, second, and frame of each frame of video (or the exact time referent position of an audio tape). By reading this code, computers can control the movement and position of the tape. It is also handy for logging tape contents. Additional information such as date or roll number can be recorded in the "user bits" part of the code. To record time coded audio for film, you need a time code equipped Nagra (model IV-STC or a converted IV-S) or DAT recorder (Fostex PD-2 or Stellavox Stelladat), or a multi-track recorder with one track devoted to time code.

SMPTE time code is used in film production for referencing double system audio to film. The usual procedure is to jam sync a "smart slate" (e.g. Denecke TS-1) to the Nagra clock. The smart slate displays the time code on a bright LED display which the camera photographs at the head of each shot. In the telecine room, you sync by visually matching the time code in the picture to the time code readout of the tape player.

Another use of a smart slate is to display the time code of a piece of audio tape as it is played back. In a rock video, for example, the photography is done to the playback of the song. If the time code on the slate is displaying the time code on the audio tape, it is easy to find where that shot slips into the song.

In 1984, Jean-Pierre Beauviala and his engineers at Aaton in Grenoble developed the first method of putting time code on film as it is exposed, a system now in its third generation. The original idea (which pre-dated the smart slate and the Nagra IV-STC) was to print human readable real time on the film edge, and record a real time reference on the Nagra which was transferred to the fullcoat audio. A special printer read the magnetic time code and printed numbers on the edge of the fullcoat. In effect, you got your workprint and fullcoat back from the lab with the ink edge numbers already in place. Synching was done by matching the numbers. This system was not widely implemented, and today the only American lab that can print time code on fullcoat is DuArt in New York.

The current version assumes that sound is recorded with SMPTE time code. In the film gate of the camera, two frames before the aperture in 16mm, a line of seven red LEDs writes a

checkerboard code in the space between sprocket holes on the film edge as the film moves, much the way a dot matrix printer works. This shows up as green on the negative or red on a print. There is a checkerboard between every frame except for those reserved for human readable characters (a holdover from Aaton's original system). Because the code is written in the film gate, after the loop, loop length is not critical. The checkerboard identifies the frame, in machine readable form, by hour, minute, second and frame. The real time on the Nagra's time code will match the real time on the corresponding frame of film. Additional information such as date, roll number, and camera number is distributed over a sequence of checkerboards and can be recovered on playback. The checkerboards organize information differently than SMPTE time code, but SMPTE is decoded when the checkerboard codes are read. Aaton code is currently available on 16mm and 35mm Aaton and 35mm Panavision cameras, and can be retrofitted to 35mm Moviecams and 35mm Arriflex BL-4 and 535 cameras.

Arriflex introduced a non-compatible time code on their 16mm SR-3 and 35mm 535 cameras in 1992. It uses red LEDs to print a bar code on the film edge and requires a different reader on the telecine or sync block. The Arriflex time code is pure SMPTE for machine use and does not write any alphanumeric characters. The LED array is ahead of the loop, so loop length is critical when loading. Otherwise, its operation is similar to Aaton.

So, how do you shoot with time code?

"Shooting with time code is easy to do, and a simple elegant concept that is accomplished with some incredibly complicated hardware and software engineering," said Wynn Bowers at Panavision as he handed me a sheaf of technical information. You can shoot by just following the instructions provided by Aaton, Panavision, Arriflex, Nagra, and other purveyors of time code equipment. However, for a more complete understanding of what is going on, he recommends reading USING TIME CODE IN THE REAL WORLD II by Jim Tanebaum (available from Sound Recording Services, 8827 Lookout Mountain Ave., Los Angeles, CA 90046 for $19.95 plus tax and $5.00 shipping).

Before you start, figure out how you are going to edit and post-produce so that you know for certain that the systems and standards that you use in shooting will be available at your lab, video house, telecine, and negative cutter, and compatible with your equipment and method of creative editing. It has to be talked through, checked and possibly tested. This is particularly important when you will be using different facilities at each step or editing on low-end video systems.

On location, the first order of business is to set the proper frame rate on the camera and time code protocol on the recorder. (There are eight protocols, each designed for particular circumstances.) For the American production environment (24 frames per second (fps) film rate and 29.97 fps NTSC video), both Aaton and Panavision recommend shooting film at *24 fps* and setting the Nagra time code generator to *30 fps non-drop* mode. This combination will always work. (You can also shoot at *30 fps* on the camera and *30 fps non-drop* on the Nagra, but only when you are transferring the film to video at 30 fps, as is sometimes done when video is the exclusive end product.) Other combinations are also possible, and some mismatches are not fatal. However, if you perceive the need to use a creative combination, then run a test. Marianne

Exbrayat at Aaton des Autres said, "The only problems we encounter, are when people try unusual frame rates. For example, they need a shot of someone talking in front of a computer screen and they try to match the computer frame rate which can be anywhere from 20 to 120 fps. They should call us first, or run a test."

The internal clocks on the Nagra and camera(s) have to be set to the same time. This can be done by setting the time and date on the Nagra and plugging its time code output into the time code socket on the camera. It takes a few seconds for the Nagra to jam sync the camera clock. You can also use an independent master clock such as Aaton's Origin C+ to jam sync both the camera and recorder. (With some older Aaton cameras, the time has to be jammed in ASCII form rather than pure SMPTE, and you have to use a device such as Origin C+.) Using a discrete master clock can simplify things on a complicated shoot, because it can go to a camera, recorder, or smart slate, so you don't have to bring everything to one spot. The Origin C+ will also check the clocks in all the equipment to determine if they are drifting, and rejam if necessary. The clocks should be checked and rejammed every three hours.

That's it. Now you are ready to shoot with unprecedented freedom. Time code dispenses with slates; the camera no longer has to swing over to the sound recordist at the head or tail of each take to get a sight-sound reference mark (beep light, clapboard, time code display) to use for synching. This can save 5-20 seconds per shot which adds up to an extra minute or so of usable film per roll. Not hunting for slates also makes the film crew less conspicuous which is a boon in documentary shooting. And these real time numbers provide the spine of a log that is referent to the actual time and sequence in which they were shot. Aaton is developing a notebook computer (SCRIPT-h) with an internal time code generator that organizes notes by the time code. It is for use by the script supervisor (on a feature) or writer/producer (on a documentary).

The 16mm Aatons were designed from the ground up for documentary use, and the time code system is no exception. Most discussions of high-end video post for film assume that your pockets are as deep as George Lucas', and that you slate every take at the head with a written and spoken scene and take number, and that these are carefully recorded in camera reports, sound reports, and script supervisor notes. In the real world of documentary filmmaking, camera roll numbers get labeled out of sequence. Most slates are tail slates. Instead of a clapboard or even a beep light, often a tap on the mike is the only slate. Within a single sound roll, magazines get swapped to make use of high speed or pushed film as the subject moves from outdoors to indoors. It is often rough and tumble shooting where it is more important to get the shots and keep moving than to observe the rituals of the film set. At $450 an hour for transfer, it is insane to try synching such free form gleanings in the telecine, the cost of a workprint is incidental by comparison. (With a visible time code slate, and good logging in the field, you can sync quickly enough in transfer to come in under the cost of workprinting and synching film style.) With time-code on the film, however, the process is automated. Aaton estimates a 30% savings over manual synching in the telecine. You can shoot real documentary and still save money.

Larry Andrick at Foto-Kem Lab described the process. The film, either the negative or a print, is put up on the telecine, and the audio tape on a Nagra that is set up to chase the time code coming from the telecine. If the audio tape is close to the correct position when they encounter a

new take, it syncs within a few seconds. If the tape is cued to the head, and the spot is at the end of the roll, it takes longer. Once you have sync, the operator punches a key to lock the telecine, audio recorder, and video recorder together. Then you back up to the head of the shot and start recording.

But what if you want to end up with a cut negative? Or what if this was only a utility transfer to 3/4" of all your footage, because you plan to go back to the original after editing and retransfer, with meticulous color correction, the smaller amount of film that will actually be in the program? This is where it gets complicated and the computer's ability to maintain the links between many interrelated sets of numbers comes into play.

The tape coming off the telecine will have its own time code (which may or may not be the same as the film time code, depending on how it is set up). This tape will be related to a specific sound and camera roll, the time code on the audio tape, the time code on the film, and the Keycode on the film. It is also this tape, or a copy of this tape, which you will be editing. So when you are finished and ready to cut negative, or retransfer selected takes, or sweeten the sound, the time code on this tape will be the link that will get you back to the exact frames.

There are several software/hardware packages used by telecine suites to tie all this information together into a database. Foto-Kem, for example, has both Evertz Keylog System which captures Keycode and relates it to video time code and the time code on the audio tapes, and Aaton Keylink which reads film time code as well. Other facilities could feed directly into Excaliber, OSC/R, or some other software.

Keylink is a PC based system which places the film/audio time code, the Keycode, and the video tape time code into three lines of *vertical interval time code* (VITC) on the video tape. Additional data tags are in the user bit area to link with the database. The VITC is copied every time the tape is copied, so as you edit, this critical data stays with the program. And when you input the video into a non-linear editing system, the VITC information is decoded and becomes part of the critical information tracked by the system. Keylink will also insert up to eleven windows of data over the video image for making a window dub.

(Every video frame is composed of 525 vertical scans, the first 21 of which are deep black and not shown on the picture tube. Data such as close-captioning, VITS & VIR quality control codes, and VITC -- the Vertical Interval Time Code relevant to this article -- can be recorded in this *vertical interval*. The advantage of VITC over the more commonly used *longitudinal time code* (LTC) which is recorded as an audio track, is that the VITC is copied when the video is copied and serves as a reference back to the source even after several generations.)

In addition to the time codes and Keycode, Keylink logs film, audio, and video reel numbers, frame rates of film and audio code, scene and take numbers, notes made on SCRIPT-h, notes typed by the colorist during the transfer, particular configurations in the telecine suite, the format and gauge of the film, and other data. At the end of the transfer session, you get a print out of the events giving a concise account of each take including scene and take number, sound and camera roll numbers, in and out points in film time code, video time code, and Keycode, and

notes from the keyboard or SCRIPT-h. You also get a floppy disc with the entire database in one of two forms; AatonBase which is highly compressed but can be directly input to some editing systems (Avid, Lightworks), or FLEX/ASCII for use by other systems. If you are familiar with database mechanics, you can incorporate the information into your own application on a standard database program.

Keylink is not a database manager for tracking an edit, as much as it is a way of extracting and organizing the information that comes together in a transfer. There are other databases designed to track every frame of film and video through the most arcane and Byzantine productions without slipping a single frame. Keylink will directly pour into FilmLab Excalibur. An automatic interface with The Adelaide Work's OSC/R, the software used to track the 3000 elements and hundreds of hours of 16mm and 35 footage that went into TRUTH OR DARE, is being developed.

OSC/R and Excalibur are sophisticated, expensive programs that keep track of the whole library, and provide dead accurate cut lists for negatives or EDLs for finishing regardless of whether the edit was done in film, video, non-linear, or a combination. If you have a million dollar production, or a ten part series, these are the tools to have. And if you have a pretty good budget, you may work with negative cutters and labs that have these programs.

But some of us work at a more modest level. Maybe you can shoot with time code and get a transfer done with all the information in the VITC and the AatonBase, but then go way off line and edit VHS window dubs on a backspace editor in a friend's garage. This puts you back to logging eight digits in and eight digits out by hand for each edit. Aaton, has another trick up its sleeve. Sorter2 is software (with add on boards) for a PC that will read VITC from an edited tape (down five generations), link the user bit tags to the AatonBase from Keylink, and generate EDLs, negative cut lists, and even sound cut lists for sweetening. So you can take your edited VHS tape to a facility with Sorter 2, and they will extract the EDL/cut list for you in the time it takes to play the program.

If you go this route, it is important to test on the equipment you are actually using. Marianne Exbrayat at Aaton de Autres told me that some 3/4" and consumer equipment head switches out of the standard part of the vertical interval and in so doing, obliterates the VITC. And if you lose that time code, you have lost the glue that holds it all together. There are 21 lines of vertical interval, however, and with testing you can find a place to insert VITC where it will be compatible with your equipment.

By now it should be clear that time code and Keycode are great time and tedium savers, as is non-linear editing. On limited budgets, however, documentary filmmakers can often afford a lot more time than money. I have a non-time code Aaton and a Steenbeck and on a typical production, if I have $1000 in my pocket, I'd shoot a few more rolls of film that will go up on the screen before I'd pay for convenient technology. It may take longer, but often the thinking time allowed by the slower pace of film editing is more valuable on an unscripted documentary than dollar-a-breath instant editing on a rented Avid.

What does this actually cost?

The scenario that began this piece is possible only with the very latest Aaton XTRprod camera and video assist (which costs about as much as a condo in a really good part of Encino). In addition you need a time code Nagra or DAT (one year's net for a dedicated documentary filmmaker), and a non-linear editor (Mercedes and BMW are also nice machines). If you are doing ten camera coverage of a one night concert, you'd be crazy not to rent the equipment and do it in time code. But what about a modest personal film, twenty rolls, a few interviews, a few events, five shooting days? Here is a comparison based on typical rental rates and paying $25 for labor.

	SLATES/ CUT FILM		**TIME CODE/ NON-LINEAR**	
camera rental	any good one	1650.00	time-code	2325.00
audio recorder	Nagra kit	500.00	Nagra TC kit	750.00
filmstock	20 rolls	2140.00	20 rolls	2140.00
film processing		1100.00		1100.00
workprint		1850.00		
audio to fullcoat		600.00		
synching		1000.00		
edge coding		350.00		
video transfer				2000.00
edit equipment	flatbed 1 month	600.00	Avid 1 week	1300.00
edit labor	160 hours	4000.00	40 hours	1000.00
	TOTAL	13790.00	TOTAL	10615.00

OK, I'm convinced! You can save almost $3200 shooting and editing this simple film by using time code and non-linear editing. In fact you can save about $5000 if you record the videotap with VITC directly to Hi-8 and don't do telecine rushes. So if anybody out there wants to hire me for a big project, just give me the money you will save and I'll buy the latest Aaton.

[I'd like to thank Marianne Exbrayat at Aaton des Autres, Wynn Bowers at Panavision, James Shaw at The Adelaide Works, and Larry Andrick at Foto-Kem for their time and help in elucidating the hands-on side of time code. And Arriflex, FilmLab, Cinema Products, Kodak, Fuji, and Agfa for providing written materials.]

Citation—
Film Time Code. **International Documentary**, October 1993.