

# Adcenter Documentary

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# Selected Text

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## Writing, Directing, and Producing Documentary Films and Videos

By Alan Rosenthal

Revised Edition

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An internationally renowned documentary filmmaker with more than sixty films to his credit, including the Peabody Award-winning *Out of the Ashes*, Rosenthal has written the first book to address the realities involved in the making of a documentary. Rather than dealing with theory or hardware, Rosenthal tackles the day-to-day problems from initial concept through distribution. Simply and clearly, Rosenthal explains how to write, direct, and produce the new documentary, whether film or video. He emphasizes the research and writing of the documentary, from approach and structure through interviewing, narration writing, and the complexities of editing. This emphasis makes his book unique.

Alan Rosenthal is a documentary filmmaker, teacher, and author acting in Israel, Britain, and the United States. His films have appeared on such American networks as CBS, PBS/WNET, and ABC, and on Dutch and Israeli television. He teaches at the Hebrew University, Jerusalem.

# The Adcenter Documentary Process

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## A Brief Outline

- The team is selected
- We meet
- Roles are assigned
- We discuss project, top to bottom
- We meet
- The Producer meets with Andrea to discuss money
- You continue to develop final list of contacts
- You prioritize each person's relevance to the story
- Based on the availability of the most significant participant or participants, you begin to define your shooting period
- We continue to meet and discuss timing of proposed shoot
- You continue to pursue these individuals until you have locked down a specific interview time and location or until you are certain you will not be able to meet with them.
- Immediately upon finalizing your interview schedule, begin planning (not BOOKING) your travel (see Travel section);
- Confirm with team members all travel options; get a consensus
- DISCUSS YOUR TRAVEL PLANS WITH YOUR PROFESSORS
- Confirm travel plans with reservations
- You revise the story, as much as possible, based on final list of participants
- You begin to develop questions for each participant; you research each participant
- You learn how to use the camera and lights and microphones
- You learn how to log footage into Script-It
- You watch documentaries and learn about documentary styles
- You confirm one week in advance ALL appointments
- You find someone at each agency as your contact person (perhaps your participant's assistant or a Creative Department assistant) and ask for their assistance in getting proper shooting locations within the agency
- You get clear directions to every place you're going
- You practice setting up the equipment and interviewing people
- One week before you leave
- Reserve all camera/lighting/sound equipment
- Research locations; think about cover footage
- Two days before you leave
- Check-out all equipment and do a complete run-through with all team members present
- Travel
- Shoot
- Have participant sign release form for inclusion in project
- Keep a journal of questions asked, questions needed, tape numbers and interviewees per tape (including timecodes for each)
- Get copies of all spots from respective owners
- Have agency sign release form for copyrighted material
- Protect your tapes
- Return, check-in equipment
- Review footage
- Transcribe footage (relevant shots only) using Script-It software, marking exactly the start and stop times for all shots, and indicating interviewee and topic of answer
- Print out all logged shots; keep separate shot log for cover footage

- Assemble script by piecing together story from existing shots; script must be no longer than 40 minutes
- Using Script-It, finalize script
- Begin matching cover footage to script
- Export Edit Decision List for narrative
- Export Edit Decision List for cover footage
- Make preliminary music picks with team
- Digitize music onto Public drive or Jaz cartridge
- Begin Edit
- Edit Decision List is imported into Avid
- Avid digitizes footage based on timecode entered by user; all footage for documentary is now in the Avid and the edit can begin
- We edit the story
- We add cover footage
- We add sound and music
- All graphics for the project are developed and executed, including title, transitions and credit design
- Credits list is developed
- Production company name and graphics are developed
- We continue to edit the story; final documentary must be no longer than 22 minutes, including title and credits and production company propaganda
- When the story is completely edited, with all components in place, we adjust color and sound levels
- We output a master tape

# Adcenter Documentary Roles

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## Producer

Responsible for everything. What doesn't get done by anybody else, the Producer has to make sure gets done. All in all, the Producer is the parent of the documentary. The Producer is the taskmaster, as well. He or she will be responsible for making sure deadlines are met, contacts are available, materials are ready – everything. Also, typically the Producer handles travel responsibilities.

The project does not belong to the Producer, however. The documentary is the result of every team members' efforts. And everybody has an equal amount input – provided they offer an equal amount of effort.

The Producer is also responsible for money. (See separate sheet detailing financial responsibilities.)

## Writer

The writing process for an Adcenter documentary is different on every documentary. The most visible writing assignment is often the narration, including the introduction to the documentary and any intermediate narration that is necessary to move the story along, or to provide information that is not given in interviews. However, writers are often employed to help craft the basic outline of the documentary once all the footage is gathered. Because it is virtually impossible to script a documentary before shooting begins, the process of finding the story within the captured interviews is critically important to the development of the documentary. The tactics writers use to develop a piece of copy can be useful in helping to assemble a linear, coherent, interesting story from seemingly disparate information.

## Research/Fact Finding

A documentary begins with an idea and matures into a visualized story through a relatively linear process. There isn't necessarily any magic to it. The difference between "a" documentary and a "great" documentary is a combination of elements, but it begins with research. There are few — very few — instances where a single individual can command our interest and attention for 15 or 30 minutes on film. For better or worse, we're accustomed to movies (and TV) being fast paced and visually rich. The mix of interviewees, information provided, supporting visuals and graphics, all combine to create an interesting, compelling story.

## Camera/Lighting

Responsible for a complete and thorough understanding of the camera and lighting equipment. Responsible for managing tape stock, batteries, light bulbs, and everything else related to the camera.

## Art Direction

Responsible for the look and feel of the final product. Should develop and execute all graphics for the documentary, including Title and Credit design, design of any Transitions used in the documentary, design of Nameplates for documentary subjects, the composition of Camera

Setups and Lighting (with the Camera/Lighting operator), and anything else graphically oriented about the project.

## Editor

This person is responsible for the integrity and continuity of the story. While it's impossible to "script" a documentary prior to shooting, it is very possible to have a thorough understanding of the story before the fact. As the project proceeds, from pre-production through shooting through editing, the Story Supervisor is responsible for having a clear and immediate understanding of what the story has become.

You might imagine that you are going to get specific information from your interviewees, and on that assumption you may think your story is heading in a certain direction. However, if none of your subjects discusses a portion of your story, intentionally or unintentionally, you must be able to be prepared to get that information from the next person interviewed, or be able to reform your story around the material you actually have.

Thus, the Story Supervisor must know at all times exactly what information is needed, what information is procured, and what the story has become as a result.

# Story Supervisor

# Sundance Film Festival: Documentaries Get Top Billing

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<http://www.nytimes.com/yr/mo/day/news/arts/sundance-film.html>

January 26, 1999

By BERNARD WEINRAUB

PARK CITY, Utah -- Forget feature films. The 15th annual Sundance Film Festival, the nation's premier showcase of independent movies, has been dominated by an avalanche of first-rate documentaries this time around.

While such movies as "Sex, Lies and Videotape," "The Usual Suspects," "Shine" "Central Station" and "The Brothers McMullen" have been introduced here in years past, this time documentaries are the focal point -- and the strongest films -- of the packed festival in this snowy Wasatch Mountain ski resort.

"This year is probably the strongest year we've had in terms of documentaries," said Geoffrey Gilmore, the director for programming. "They're much more about the subcultures of America, more about the realities of American life than in previous years. For whatever reason, they're less personal than in previous years. The concentration is on subject, on content, rather than the personal prism of the filmmaker."

Implicit in his comments and those of numerous producers, distributors and filmmakers is that the feature films presented here in recent years have often been overpromoted, and stumbled at the box office. One top independent film executive characterized the feature films shown so far as "typically Sundance: very earnest, a bit downbeat, with production values and performances that seem strong."

Though often overlooked, documentaries have sometimes been the high point of the festival: "Hoop Dreams" "Crumb," "Unzipped" and "When We Were Kings" were first presented here. On Friday night there was a virtual mob scene at the first screening of "American Pimp," an exploration of the world of pimps and prostitutes by Allen and Albert Hughes, twin 26-year-old filmmakers whose previous successes include such features as "Menace II Society" and "Dead Presidents."

Sitting in a fast-food restaurant on Main Street here on Sunday afternoon, the brothers said the movie began as a conventional feature. While researching it, however, they changed their minds. "We kept saying, 'Why don't we use these real people: they're 10 times more interesting than anything we could have made up,'" said Allen Hughes. "It was a freeing experience. There's that feeling, 'I couldn't make this up even if I tried. Why not just go for reality?'"

The proliferation of documentaries seems a result of several factors, including a realization among filmmakers in an arduous fund-raising environment that a few outposts on broadcast and cable television are potentially fertile grounds for documentaries. Several documentary filmmakers cited important support in particular from HBO and the "American Masters" series on PBS.

"The television universe had just brought greater interest in documentaries," said Freida Lee Mock, an Academy- and Emmy-winning documentarian whose newest film, with Terry Sanders, her husband, is "Return With Honor," an account of the ordeal and heroism of American pilots who were held as prisoners of war in North Vietnam.

"Just getting into documentaries is not as hard as feature films," she said. "The bar is not as high in terms of the budgets; the process is more open to women, to younger people, to older people. It's a more democratic entryway into the filmmaking world."

The documentaries being presented here, some of which will probably be shown later this year at movie theaters, on PBS or on HBO, deal with an almost startling array of themes. On Sunday night the 1,300-seat Eccles Theater was packed for the premiere of "Death: The Rise and Fall of Fred A. Leuchter Jr.," a bleak documentary by Errol Morris ("Thin Blue Line," "Fast, Cheap and Out of Control") about an "execution technologist," Fred A. Leuchter Jr., who works on execution devices and is involved in the Holocaust denial movement.

Morris, 50, who lives in Cambridge, Mass., and earns his living mostly making television commercials, said he first read about Leuchter in a front-page article in The New York Times in 1990. "I've always wanted to make a movie about the Holocaust, but not a traditional movie," Morris said. "This provided a way for me into the story that was quite unique."

Why are documentaries so significant at Sundance now? "It's the possibility of telling stories that would not be told otherwise," Morris said. "Telling stories involving real people, involving a connection to the real world, which is very powerful." He shrugged. "Look at so many Hollywood films. They are devoid of any intellectual ambition."

The festival program also includes Chuck Workman's documentary "The Source," an exploration of the Beat Generation; Paolo di Floro's "Speaking in Strings," a portrait of the violinist Nadja Salerno-Sonnenberg; Nanette Burstein and Brett Morgan's "On the Ropes," about three Brooklyn boxers; "American Hollow," about an Appalachian family, made by Rory Kennedy (a daughter of Robert F. Kennedy); Michael Epstein's "Hitchcock, Selznick and the End of Hollywood"; Barbara Sonneborn's "Regret to Inform," about American and Vietnamese war widows; Stanley Nelson's "Black Press: Soldiers Without Swords," about the ascent of black-owned newspapers, and Chris Smith's "American Movie," about the travails of a low-budget filmmaker, Mark Borchardt.

Certainly the glitziest documentary is "Get Bruce," about Bruce Vilanch, a madcap and campy writer for Bette Midler, Robin Williams, Whoopi Goldberg, Billy Crystal, Roseanne and numerous other stars who are featured in the film. Vilanch also writes for the Academy Awards and other awards shows.

Vilanch, interviewed in a hotel coffee shop here, said he was approached two years ago by the producer Andrew J. Kuehn after the success of "Unzipped," the movie about the fashion designer Isaac Mizrahi.

"It made him think that it would be wonderful to do a movie about another flamboyant queen," said Vilanch. So Kuehn got his directory of flamboyant queens and got to the V's before someone said yes. And that was I." Vilanch said he was initially concerned. "If it doesn't work out it's a career killer," he said.



All of which is not to say that feature films have been overlooked at Sundance. Robert Redford, the festival's patriarch, indicated that he was a bit worried that feature films had in recent years turned almost mainstream.

"They were more accomplished and less rough-edged," Redford said. "If that's the way the current independent community is going -- more mainstream -- so be it. But we want to make sure that space is open to the next batch of independent filmmakers who are not as mainstream."

So far, the feature films that have caused the most stir at this year's festival are decidedly mainstream. Guy Ritchie's "Lock, Stock and Two Smoking Barrels," already a big hit in England, is a funny and wicked tale about young Londoners who get involved with local thugs. A much-anticipated film to be shown on Tuesday is Allison Anders's "Sugar Town," about the music scene in Los Angeles, with a cast that includes Ally Sheedy and Rosanna Arquette.

A third film that has already caused something of a bidding war among distributors is Mark Illsley's "Happy, Texas," with the actors William H. Macy, Steve Zahn and Jeremy Northam. It is a comedy about two men who escape from a West Texas chain gang and masquerade as a gay couple hired to direct a local beauty pageant.

Nonetheless, documentaries seem to be gathering the most attention. "There are no rules about documentaries: that's the best thing," said Workman, whose film "The Source" deals with such Beat Generation figures as Allen Ginsberg and Ken Kesey. "It's often very personal. There's no formulaic ritual. The only danger, really, is that they become so popular that studios will get involved and tell you how to do it."

# Working in a Digital Video Edit Suite

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Working with an editor in an editing suite can be a creatively rewarding experience. Your vision begins to take shape, and through an ongoing process of experimentation and exploration you may find that you leave the suite with a better product than you anticipated.

An Avid is a powerful tool for assembling an array of materials into a motion-based project. But an Avid is not a tool for paring down scores and scores of information. An Avid is best used to polish a select group of materials into the best possible arrangement.

Preparation is paramount – even more so than in the process of producing a print ad or radio campaign. Much of the work required to make an edit session go smoothly can be – and should be – performed by the creative team well before the session begins. All materials used in the spot should be readily available to the editor, and at a minimum a script, storyboard or timeline should be provided as a reference to the project.

## Adcenter specifics

### **Scheduling**

The Adcenter's Avid is in high demand, especially in the second semester of each year. In each spring semester, approximately 10 thirty-second television spots will be produced on this equipment, as well as four documentaries (15 to 20 minutes each). Other projects like the Speaker Series, Adcenter promotional materials and the Adcenter television show (13th & Main) are edited on this one computer.

For your television spots and documentaries, you will be given a time allotment that is sufficient for the completion of your work. Because most days have a scheduled project, it will not be practical (or possible) to change this date.

A calendar will be posted on the door of the Avid room for sign up and scheduling information.

Please do not interrupt an editing session in progress. If the Do Not Disturb sign is posted on the door, do not disturb. If it is imperative that you speak with someone in the room, call extension 110 from the Lab telephone or the Lobby telephone.

### **Be on time**

Because the availability to the equipment is limited, and because it is typically not possible to extend the schedule, it is important to meet scheduled editing times. If you are an hour late, the total time available for your project is reduced by an hour.

## Pre-edit preparation

You should schedule a meeting with the editor 48 hours before your session. The purpose of this meeting is to discuss the project and your goals for the session. Please provide a typed list of materials used in the project. This should include the number of videotapes (including the names as indicated on the label on the front of the tape), any audio used in the project (and the type of media on which it will be supplied – S-VHS tape, VHS tape, Beta tape, CD, cassette), graphics (the number of graphics and type – name supers, section headlines, etc., and the format in which they will be supplied), and a final version of the credits for the project, sorted by time and by page or sequence.

A typical list might look like this:

<b>Media</b>	<b>Format</b>	<b>Title</b>	<b>Use</b>
video	s-vhs tape	Hayden 1	various; see script
video	s-vhs tape	sanfran 1	various; see script
music	cd	talking heads	track 2; 00:00-01:00
music	cd	auto sound effects	track 3; entire track
music	cassette	voice over	take 2; in pt at ± 3:25
graphics	pict	intro seq 01.pict	intro section
<i>note: there are 60 files in this sequence, numbered intro seq01-61.pict</i>			
graphics	pict	apple logo.pict	on nameplates throughout
ad	4x5 trans	lisa ad	product section
ad	print ad	apple2e ad	product section
fonts	floppy disk	chicago font	on intro graphics

You'll also have to provide a complete script when the edit begins, indicating exactly which materials go where and for how long.

# How I Best Work

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## Decision-making responsibility

Generally, I want one or two people to be the primary decision-makers for the edit. If I have a question or idea, I want to be able to communicate with the people who have the most comprehensive vision for the project, as well as the person able to make quick and final decisions.

However, since it is not practical for the primary decision-makers to be in the room at all times, it is necessary that all people involved in an editing session have the authority to make decisions on the project. Further, these decisions will be binding. I will not erase three or four hours of work because team members who were not in the room do not agree with a decision made by a team member who was present in the edit.

The surest way to prevent creative conflicts is for everyone participating in the edit to have a clear vision of the project. This is only possible if the team reaches a creative consensus before the edit begins.

## Beginning a project.

At the onset of a project, I will ask the team (or the lead contacts) to discuss the project with me, sharing the results of the creative consensus – the desired style, the feeling and the tone. Also, I need to understand the exact goal of the project, which may sound oversimplified. But I'm not requesting, "a documentary on the Apple 1984 spot." I want, "a fast-paced overview of the Apple 1984 spot that links the advertisement to the success that Apple found in the mid- to late-1980s. The documentary will have a 1980s theme, with an emphasis on the geek culture that arose from the personal computer explosion in that decade. It will be cut fast and aggressively, no dissolves. Just fast hard cuts."

Whatever the goal, tone or style, I need to understand exactly what the team hopes to accomplish.

## Scheduling team members.

We will need to develop a schedule of who will be in the edit suite when. While most of the time, team members will be needed in the suite, I will periodically need to perform some computer-related tasks that do not require participation.

## Bring an open mind to the edit.

Rarely does a project leave an edit exactly the way the creators envisioned it. Good ideas are not proprietary. Everybody in the edit can add something to the project.

# Working with the Adcenter's Editor

## Your stuff

Please do not leave anything in the editing room that is not essential to the production of your project. Over the course of a documentary it's easy to accumulate a mountain of materials. Only those materials that are necessary should remain in my office. This means tapes, CDs, notebooks, papers, books, print ads, jackets, book bags, photos, or anything else. I will make sure you have space for your documentary-related things.

## Food

It's OK to eat in my office, but as soon as you're done discard all food containers in the trash can in the matt room – NOT in my trash can. And – clean up your mess if you make one. On a personal note: I do not collect small soy sauce containers or restaurant-style sugar packages or tiny coffee creamers. I also don't covet pens or straws or used to-go cup lids. Please, throw it away or take it with you.

## Computers; Workspace

The computer at my desk is not available. Feel free to bring a laptop to my office if you need to work. You can connect to the server if you need. Also, please do not clutter the workspace with personal materials.

## The phone

The phone in the editing room is not for personal calls.

# Equipment Checklist

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**CAMERA CASE**

- Camera (1)
- Battery
- AC Adaptor
- Adaptor cord
- Lens cap
- S-Video cable

**LIGHT KIT, MEDIUM**

- Lights (3)
- Light stands (3)
- Wire cages (3)
- AC cords (3)
- Umbrellas (3)
- Spare bulbs (3)

**MONITOR**

- Monitor (1)
- Monitor AC cord (1)
- S-Video cable (1)

### **LAVALIER MIC KIT**

- Microphone & cord (1)
- Clip (1)
- Windscreen (1)
- Battery, AA (1 spare)

### **HANDHELD MIC**

- Microphone (1)
- Battery, AA (1)
- XLR to XLR cable, male/female (2)
- XLR to 1/8-inch cable
- Boom pole

### **MISC/DUFFLE**

- Extension Cord, orange 3-prong (1)
- Power strip (2)
- Duct tape (1)
- Batteries, AA (4)



# Shooting Checklist

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Make CERTAIN you perform each of these tasks before shooting every interview

- Camera mode set to MANUAL
- Iris / Shutter set to IRIS
- Manually adjust IRIS setting to accomplish shooting objective
- White balance
- Focus set to MANUAL (MF in viewfinder)
- Zoom in, focus camera (use monitor)
- Audio check
- Composition / Lighting (use the monitor)
- Advance tape (use built-in search function on camera)
- Record / Pause (REC in the viewfinder)
- Date/Time set to OFF

# Interview Checklist

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## Camera

- Set the white balance each time you turn on the camera. White balancing adjusts the camera's CCD chip to the ambient light temperature, and will generally prevent people from appearing too green, yellow or pink on tape
- Set the camera to Manual Mode (M) on the dial. Turn off Autofocus, which is located on the lens.
- Adjust exposure by changing the Aperature setting — NOT shutter speed.
- Charge all batteries the night before the shoot
- Make sure the Date/Time function is turned off. If not, you'll get the date and time on your footage, and it's impossible to remove it.
- When using the more expensive tripod (the black one), always use the built-in level to make sure the camera will be square with the ground. When using the silver tripods, adjust the level visually. Try to keep the top of the camera square with the horizon.
- Always connect the camera to a monitor. The monitor will give you the best representation of focus, white balance and composition.
- To properly focus, zoom in as close as possible on your subject, focus the camera, and then zoom out to the desired focal length. The camera will stay in focus through the zoom range.
- Always use a tripod – no exceptions.
- Shooting with the zoom lens set to wide will mask more shakiness (from hand-held operation) than shooting zoomed in. With the camera at maximum zoom you will see the smallest motion from the camera.
- When interviewing with two cameras, establish a camera position and lens focal length (zoom) that will allow you to "lock down" one camera. Once this camera is positioned, do not move it. The camera operator should not touch the camera or hold the tripod handle; instead he/she should just watch through the viewfinder (or better, a monitor) to make sure the subject has not moved out of frame. The goal is to have one camera that always captures a steady, in-focus, acceptably framed image. The second camera can move about and experiment, and when that image is better it can be used in editing. However, by locking down one camera you know that you have an acceptable shot for every second of footage.
- Look at the lens surface prior to shooting to be certain there is no dirt, fingerprints, lint, etc. on the lens. If you must clean the lens, use lens cleaning fluid and tissue. If this is not available, use the softest, least abrasive material on hand.

# Interview Checklist, cont.

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## Lighting

- Halogen lights can reach 900° Fahrenheit, do not touch; a fraction of a second can inflict a serious, painful burn. Allow lights at least 10 minutes to cool down before touching.
- Never directly touch a halogen bulb even when it's cool; oil from your finger can cause the bulb to explode when it heats up
- Carry a power strip or two, and an extension cord. The small light kit has ridiculously short electrical cords for the lights. The medium kits have longer cords.
- Do not plug every light into one power strip. You will likely overload the circuit and will trip a breaker in the breaker panel. Many office buildings intentionally hide the breaker panels, so you have to call maintenance to reset the circuit. To be safe, use plugs around the office or facility to distribute the electrical load.
- Make sure the light kit you take to your shoot has extra bulbs.

## Microphones/Audio

- Both lavalier and hand-held microphones are condenser microphones, which means they must have their own power supply. Both models use AA batteries. Have at least twice as many on hand as you intend to use. Purchase the brand that has a power/freshness test on the battery.
- Make absolutely certain that you are capturing audio. Wear headphones with the camera, and watch the audio level meters on the top of the camera.
- Do not place the lavalier microphone immediately under the subject's chin. Although, technically, the mic is closer to the mouth, the sound waves move away from the face in an upward motion. It's best to place the mic about halfway down the chest, if possible.
- Do not make adjustments to a camera while the subject is giving an answer. Always wait until the subject finishes his/her comment.
- The interviewer should always completely finish asking the question before the interviewee responds and then remain silent during the subject's response because it is impossible to remove overlapping voices from a single audio track. No "uh-huh's" or "OK's" or "I see's" during the answer.

# Interview Checklist, cont.

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## Tapes

- You must purchase mini DV (aka mini DVCAM) tapes. These tapes are not widely available. They are available at Circuit City, Best Buy and large electronics stores that carry Digital Video Cameras. Purchase 50 minute tapes; expect to pay around \$15 each.
- When you have filled a tape, or have completed your shooting, flip the copy protection switch that's built in to the tape. Sliding this plastic switch to the opposite side prevents the tape from being recorded over.
- Always know exactly where you are on your tape. When adding footage to a tape that already contains necessary shots, always watch the tape from the camera (in VCR mode) to make absolutely certain you are not going to record over important footage. AND, allow at least 10 seconds to lapse before starting a new shot.
- Always label tapes immediately after (or before) use. Keep in mind that you may use the second half of the tape for another interview, so leave room on the label for additional information. Once an interview is complete, write the timecode information on the label of the tape. This will expedite the process of finding new information on the tape. For example:

Kerry Feuerman 00:00 – 23:56

Joe O'Neill 24:00 – 1:10:32

Voice over 1:10:40 – 1:23:45

# Interview Checklist, cont.

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## Miscellaneous

- Do not interrupt your subject if you think they misinterpreted your question. Allow them to finish, because you can't predict what they might say and it just might be the best quote you get from them. Then, if necessary, re-ask the question and guide the subject toward the answer you're looking for.
- Log footage as you go. Know how many minutes of each subject you have, and on which tape the interview exists.
- Camera operators should be familiar with the questions to be asked, and should as a result be able to anticipate emotional, fervent or heart-felt answers. By anticipating responses, the second camera operator can make use of a slow zoom to add drama to a response or a quick zoom to reinforce surprise or humor.
- Do not hesitate to ask the interviewer to repeat his/her response if you feel that your coverage of the answer or statement was not adequate. By agreeing to an on-camera interview, the subject will probably understand that somethings may need to be re-shot.
- Test everything – camera, microphone, cables, batteries, monitor, tape, lights –several hours before the shoot.
- Never allow your subject to see themselves in the monitor. Their image will invariably make them self-conscious, or will bring out their unsolicited advice on how to set up your shot.
- Be polite when invading a subject's office. Ask before you move anything, and always replace everything.
- Always be diplomatic, considerate and congenial. You are a guest in the subject's office, and they are usually doing you a favor by allowing you to tape them

# Recommended Books for Film and Video Production

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## Lighting for Film and Video

### Matters of Light and Depth, by Ross Lowell

This is an excellent book with a grip truck full of real world advice and experience, written by the inventor of the Lowell light. You might expect it to be specific to his company's lights, but it hardly refers to them at all. Very useful for the low budget and location shooter. Sample from book

### Painting With Light, by John Alton

In the forties, many Hollywood cinematographers, approached their trade as a skilled craft, not an art. Not John Alton. He really means "Painting With Light". THE classic on both technique and philosophy. Written 50 years ago, it primarily refers to the lighting instruments of the time, but the advice is timeless.

### Technique of Lighting for Television and Film, by Gerald Millerson

Another very practical text by Mr. Millerson, Thorough, and covers the differences between the two mediums, including TV studio lighting practices.

## Handbooks

These are books meant to be used for quick reference on the set or in the field.

### The Professional Cameraman's Handbook, by Verne and Sylvia Carlson

THE handbook for camera operators. Extensive detail on all available cameras, including ones that haven't been made in decades, but that you are still likely to run into. Shows how to load the magazine, attach the accessories, etc. Also details the camera assistants responsibilities, and along with Loading room procedures, Slates, Camera Reports and so on.

### Professional Lighting Handbook, by Verne and Sylvia Carlson

Like the camera handbook, this volume details equipment and practices, but of lights and power on the set.

### American Cinematographer Manual, by Rod Ryan

When Hollywood cameramen walk on the set, they always have two things with them-- their light meter, and this manual. Covers camera specs, and pages of tables for Depth of Field, shutter angles, everything!

### American Cinematographer Video Manual, by Frank Beacham

Useful guide to video from lighting to scopes to TBCs. Fits in your hip pocket, but more comfortable in your ditty bag.

### Translation of Film and Video Terms by Verne Carlson

Shooting internationally? These little industry specific dictionaries will help get your message across to your crew or the customs officer. [View sample pages.](#)

# Documentary Evaluation

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HOW COMPLETE WAS THE STORY?

Totally		A few gaps		Left me hanging
1	2	3	4	5

---

WAS THE THEME PREVALENT THROUGHOUT THE DOCUMENTARY?

Theme good				What theme?
1	2	3	4	5

---

WAS THE DOCUMENTARY EDUCATIONAL?

I learned a lot				Huh?
1	2	3	4	5

---

WAS THE DOCUMENTARY ENTERTAINING?

I laughed, I cried		I stayed awake		GI Jane was better
1	2	3	4	5

---

HOW WOULD YOU RATE THE LENGTH OF THE DOCUMENTARY?

Too short		Just right		Too long
1	2	3	4	5

---

DID THE DOC. FEATURE ENOUGH OF THE WORK FROM THE CAMPAIGN?

Needed more		Enough		Too much
1	2	3	4	5

---

RATE THE PROFESSIONALISM OF THE DOCUMENTARY AS A WHOLE?

PBS		Local access channel		Wayne's World
1	2	3	4	5

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OTHER COMMENTS

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# Money

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This page will be updated to reflect 2002 budgets.

# Travel

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From Richmond

# An Introduction to Film Sound

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by Jane Knowles Marshall

<http://filmsound.studienet.org/marshall/>

Though we might think of film as an essentially visual experience, we really cannot afford to underestimate the importance of film sound. A meaningful sound track is often as complicated as the image on the screen. The entire sound track is comprised of three essential ingredients:

- the human voice
- sound effects
- music

These three tracks must be mixed and balanced so as to produce the necessary emphases which in turn create desired effects. Topics which essentially refer to the three previously mentioned tracks are discussed below. They include dialogue, synchronous and asynchronous sound, and music.

## Dialogue

Dialogue authenticates the speaker as an individual or a real person rather than the imaginary creation of a story teller. As is the case with stage drama, dialogue serves to tell the story and expresses feelings and motivations of characters as well. Often with film characterization the audience perceives little or no difference between the character and the actor. Thus, for example, Humphrey Bogart is Sam Spade; film personality and life personality seem to merge. Perhaps this is the case because the very texture of a performer's voice supplies an element of character.

When voice texture fits the performer's physiognomy and gestures, a whole and very realistic persona emerges. The viewer sees not an actor working at his craft, but another human being struggling with life. It is interesting to note that how dialogue is used and the very amount of dialogue used varies widely among films. For example, in the film 2001 little dialogue was evident, and most of what was used was banal. In this way the filmmaker was able to portray the "inadequacy of human responses when compared with the magnificent technology created by man] and the visual beauties of the universe." [2]

The comedy, *Bringing Up Baby*, on the other hand, presents practically non-stop dialogue delivered at break-neck speed. This use of dialogue underscores not only the dizzy quality of the character played by Katharine Hepburn, but also the absurd duality of the film itself and thus its humor. The audience is bounced from gag to gag and conversation to conversation; there is no time for audience reflection. The audience is caught up in a whirlwind of activity in simply managing to follow the plot. This film presents pure escapism - largely due to its frenetic dialogue.

## Synchronous and Asynchronous Sound Effects

Synchronous sound effects are those sounds which are synchronized or matched with what is viewed. For example, if the film portrays a character playing the piano, the sounds of the piano are projected. Synchronous sounds contribute to the realism of film and also help to create a particular atmosphere. For example, the "click" of a door being opened may simply serve to convince the audience that the image portrayed is real, and the audience may only subconsciously note the expected sound. However, if the "click" of an opening door is part of

an ominous action such as a burglary, the sound mixer may call attention to the "click" with an increase in volume; this helps to engage the audience in a moment of suspense.

Asynchronous sound effects are not matched with a visible source of the sound on screen. Such sounds are included so as to provide an appropriate emotional nuance, and they may also add to the realism of the film. For example, a film maker might opt to include the background sound of an ambulance's siren while the foreground sound and image portrays an arguing couple. The asynchronous ambulance siren underscores the psychic injury incurred in the argument; at the same time the noise of the siren adds to the realism of the film by acknowledging the film's (avowed) city setting.

### **Music**

Background music is used to add emotion and rhythm to a film. Usually not meant to be noticeable, it often provides a tone or an emotional attitude toward the story and/or the characters depicted. In addition, background music often foreshadows a change in mood. For example, dissonant music may be used in film to indicate an approaching (but not yet visible) menace or disaster. Background music may aid viewer understanding by linking scenes. For example, a particular musical theme associated with an individual character or situation may be repeated at various points in a film in order to remind the audience of salient motifs or ideas.

Film sound is comprised of conventions and innovations. We have come to expect an acceleration of music during car chases and creaky doors in horror films. Yet, it is important to note as well that sound is often brilliantly conceived. The effects of sound are often largely subtle and often are noted by only our subconscious minds. Yet, it behooves us to foster an awareness of film sound as well as film space so as to truly appreciate a twentieth century art form, the modern film.

2. Thomas Sobochack and Vivian Sobochack, *An Introduction to Film*, p.177.

This is an excerpt from *America in Film and Fiction* original URL:  
<http://130.132.143.21/ynhti/curriculum/units/1988/4/88.04.04.x.html>

This article is a condensed version of several chapters of Sobochack and Sobochack's book, *An Introduction to Film*. The original web site also contains a section about film space.

The URL of this file is:  
<http://filmsound.studienet.org/marshall/>

# Frequently Asked Questions About Film & TV Audio Post-Production

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by Bruce C. Nazarian M.P.S.E.

## **What is Audio Post-Production?**

Audio Post-Production is the process of creating the soundtrack for a visual program of some kind. Ever since silent movies began to talk, filmmakers have been looking to control and improve the quality of the sound of their creation. As soon as creators realized there was a way to control and enhance the sound of their pictures, Audio Post was born, and has been a fact of life ever since. In Television, audio was originally "live", like the visual program it was part of. As TV evolved, and the art form grew to include "videotaped" and "filmed" programming, the need for Audio Post increased. Nowadays, it would be difficult to find any feature film or television show that hasn't been through audio post.

## **What is involved in Audio Post ?**

Audio Post usually consists of several processes. Each different project may need some, or all of these processes in order to be complete. The processes are:

Production Dialogue Editing ADR (Automated Dialogue Replacement - if needed) Sound Effects Editing and Design Foley Recording (human sound effects recorded in sync with picture) Music Composition and Music Editing Mixing (also called re-recording)

## **What does all that mean in English ?**

It's really pretty simple, once you know the breakdown::

Production Dialogue Editing - In order for the production audio recorded on the set or on location to be properly mixed, a Dialogue Editor needs to properly prepare it. This means locating the proper take from the recorded production audio, checking sync (so it actually works with the picture properly), and eliminate extraneous noise so the Mixer has clean dialogue to use during the Mix.

ADR [Automated Dialogue Replacement] - In cases where the production audio is too noisy, or otherwise unusable (bad line reading, airplane fly-by, etc.) the Dialogue Editor will "cue" the line for ADR. This means replacing that line or lines of dialogue using the Automated process of Dialogue Replacement. This process takes place on the ADR Stage, a specialized recording studio where the actor can record lines in sync with the picture.

Once a replacement line of dialogue has been recorded, the Dialogue or ADR Editor will check the sync carefully, editing the take if necessary to precisely match it to the picture, and prepare it for the Mixing Stage. This process is also known as "looping".

Sound Effects Editing and Design - Ever wonder how they made the sound of Darth Vader's helmet breath, or the Empire's Tie Fighters, or that great train wreck sequence from "The Fugitive"? - Sound Effects Editors and Sound Designers are how. The process of adding sound effects (backgrounds like: air, rivers, birds, traffic, and hard effects like: gunshots, door slams, body falls, etc.) has been the domain of sound effects editors for years. Although originally edited using 35mm magnetic film, recent years have seen the development of many different Digital Sound Editing systems. More and more projects are using digital technology because of the efficiency and quality it can bring to sound effects. Sound Designers use digital and

analogue technology to create sound effects that have never been heard before, or to artistically create specific "mood" sounds to complement the director's vision of the visuals.

Foley - Taking its name from Jack Foley, the Hollywood sound effects person generally regarded as the "father" of these effects, Foley effects are sounds that are created by recording human movement in sync with the picture. Different from the environmental backgrounds and hard effects that comprise edited sound effects, Foley effects are sounds like footsteps, prop movement, cloth rustling, etc. The players involved in this process are the Foley Mixer, who records the sounds, and the Foley Walkers who create those sounds. After the Foley Effects are recorded, the Foley Editor will make any slight timing adjustments necessary to ensure that they are exactly in sync with the final picture.

Music Composition - Music for film/TV falls into three general categories: Score, Source and Songs. The Composer is the individual hired with the responsibility to prepare the dramatic underscore. Source music is that music we hear coming from an on screen or off screen device of some kind; some examples are radio source music, phonograph records, TV show themes, when seen on a TV set in the shot, and many other similar variations. Source music may be original, or licensed from a number of libraries that specialize in the creation of "generic" music. Songs may occupy either function, depending on the dramatic intent of the director. Using "Pulp Fiction" as an example, Director Quentin Tarantino hired a Music Supervisor (Karyn Rachtman, FYI) to "score" the picture using period music of the 1970's almost exclusively. Most contemporary films use a combination of score and source music.

Music Editing - The Music Editor assists the Composer in the preparation of the dramatic underscore. Frequently working also with the Music Supervisor the Music Editor will take timings for the Composer, (usually during a spotting session )in order to notate the specific locations in the film where underscore or source music will punctuate the narrative. Once the underscore is recorded, and the source music gathered, the Music Editor will usually be the person who edits or supervises the final synchronization of all music elements prior to the mix.

Mixing (also called Dubbing) - The Mixers have the responsibility of balancing the various elements, i.e., - the Dialogue (and ADR), Music, Sound Effects, and Foley Effects, in the final mix. The Dialogue Mixer, (also called the Lead Mixer or Gaffing Mixer) commands the mixing stage; his partners in the mix are the Effects Mixer and the Music Mixer. On large features, it is not uncommon to have an additional mixer handling just the Foley effects. On huge pictures with tight deadlines, it is possible that several teams of mixers are working simultaneously on numerous stages in order to complete the mix by the release date.

### **Where does post-production begin ?**

If you haven't shot your film yet, it begins before you shoot - by selecting the finest production dialogue mixer you can afford. The little bit extra paid to a great production mixer can save you tenfold later in post-production.

### **What does the production sound mixer do ?**

The production mix team are the individuals charged with recording your live dialogue, in sync with the camera team. The Production Sound Mixer is your most important ally at this stage in the movie's production. Although you will be anxious to complete as many setups as possible during each shooting day, a little extra time given to the sound mixer to allow him to capture scene ambience (called room tone) will pay off handsome dividends later during our dialogue editing. The production mixer will have with him a boom operator, who handles the boom mics, and usually a cable person, who will be in charge of wrangling the audio cables needed to mike the set appropriately. Usually they will record on a Nagra recorder, but digital recordings on Portable Time code DAT machines are becoming more common.

### **We are shooting our film on location...what now ?**

Generally, each day after the completion of the shoot, the production audio rolls will be sent to an audio post house for transfer to "dailies" form. If the film is being edited filmstyle, using 35mm mag audio and film dupes (as opposed to electronically, using an Avid or Lightworks edit system), the production select takes will be transferred to 35mm mag film. This sprocket-based medium will allow the film editor or assistant to sync that day's select film takes with the audio track that corresponds to it.

If the production is being edited electronically, using a computer-based edit system, the options are a bit different. Frequently, a video post house will be engaged during shooting to telecine the selected and printed film takes. In addition, they will transfer the production audio from Nagra or DAT and generally synchronize the dailies onto some form of videotape, for later digitizing into the Avid or Lightworks editing system. Syncing dailies at the video house eliminated the need for the assistant film editor to do it, and allows the assistant to load the editing system instead. An important task to accomplish during the digitizing is for the assistant to correctly log in the dailies time code that is recorded on the Nagra or DAT location tracks. This will allow the EDL (edit decision list) that is created later on to accurately reflect the original time code that was shot with that scene, and allows the audio post house to electronically automate the re-loading of the production dailies, should they need to be replaced.

### **And this goes on all during the filming?**

Yes. Dailies transfers will continue until there are no more dailies coming in, and shooting has wrapped. During this time the editor may also need reprints of previously transferred takes, or prints of previously unprinted takes. They are processed in the same manner.

### **We are done shooting...now what happens?**

Now the real fun begins. The editor has been syncing dailies all during shooting, choosing which scenes should begin to form the final cut. During the next several weeks, the process of editing will continue as the decisions are narrowed down to final choices. It is at this time that the final form of the film begins to take shape. Although the film editor may have been assembling the "editor's cut" during the shooting period, the first formal edit period is generally referred to as the director's cut, and it is when the first full assembly of the film is refined.

### **Do I need Audio Post during editing?**

Well, yes. During the editing you may still need reprints of selected takes or outtakes. The audio post facility will duplicate these for you. But the real job is starting to come into view: the locked cut.

### **What is the locked cut ?**

In short, the final version of the finished film. Although it may receive a small edit here or there in the next few weeks, the film is essentially "locked" into this form.

### **What happens once the cut is locked ?**

Audio Post begins now in earnest. Once the cut has been locked, the film can be spotted for the placement of sound effects and music. The Supervising Sound Editor, the Director and possibly the Film Editor and Composer will gather at one or more spotting sessions to determine the film's audio post needs. "Spotting for music" is the process of viewing the locked cut and deciding where the music score will be, and where the source music will be needed. "Spotting for sound" is the process of determining:

- if and where any dialogue problems may exist, so that ADR can be cued to be recorded
- where sound effects are needed and what kind
- what Foley effects will be needed in the film, and where
- If Sound design (the creation of special sound effects), will also be needed.

### **What actually happens after 'spotting'?**

The real job of audio post has now begun. In the next weeks or months, the sound editors will locate and synchronize all of the sound effects needed in the film. If necessary, they will create Field Recordings of new sound effects needed for the film. The Foley supervisor will cue all of the Foley effects that will be needed; they will be recorded by the Foley Mixer and the Foley Walkers; the ADR supervisor will cue all of the Automated Dialogue Replacement lines that need to be recorded during the ADR sessions, and the Music Editor will begin providing for the needs of the Composer and/or music supervisor. The Dialogue editor(s) will begin preparing the production audio for final mixing, and the ADR editors can commence editing in the ADR lines, once they have been recorded.

### **What happens after spotting ?**

Typically, the next few weeks or months are occupied with sound editing of all types. The Director will be checking on the various aspects of the sound job as time progresses, to be sure that his vision is being realized. Usually, there is provision for one or more "effects reviews" where the effects are listen to and approved. The same goes for Foley, Dialogue, ADR, Sound Design and Music. When everything is completed and approved, the next step is Mixing (also called 'dubbing' or 're-recording').



### **What happens during the mix ?**

During the mix, the edited production dialogue and ADR, sound effects, Foley and Musical elements that will comprise the soundtrack are assembled in their edited form, and balanced by a number of mixers to become the final soundtrack. In New York, single-mixer sessions are more commonplace than in Hollywood, where two-mixer and three-mixer teams are the norm.

The mixers traditionally divide the chores between themselves: the Lead Mixer usually handles dialogue and ADR, and may also handle music in a two-man team. In that case, the Effects mixer will handle sound effects and Foley. In three-man teams, they usually split Dialogue, Effects and Music; sometimes the music mixer handles Foley, sometimes the effects mixer covers it.

To keep the mix from becoming overwhelming, each mixer is actually creating a small set of individual sub-mixes, called STEMS. These mix stems (dialogue, effects, Foley, music, adds, extras, etc) are easier to manipulate and update during the mix.

### **When mixing is done, what then ?**

After the mix is completed and approved, films generally require a last step called Printmastering, that combines the various stems into a final composite soundtrack. When this is completed, an optical or digital sound track can be created for a feature film release print.

It is also usual at this time to run an 'M & E' (which stands for Music and Effects) track. This is essentially the film's soundtrack with the English language dialogue removed. This allows foreign language versions of the project to be dubbed easily, while preserving the original music, sound effects and Foley. During the M & E, effects or Foley that are married to the production dialogue tracks are removed along with the dialogue. To "fully-fill" an M & E for a quality foreign release, those effects and Foley must be replaced.

Television movies usually do not require print masters, unless they have been created using SURROUND SOUND techniques. In most cases, the final stems are combined during a process called LAYBACK, at which time the soundtrack is united with a final edited master videotape for ultimate delivery.

### **What about optical soundtracks ?**

Optical soundtracks (we mentioned them earlier). Almost all of the release formats, including the digital ones have provision for some kind of optical soundtrack, even if only as a backup. The optical soundtrack refers to the two-channel soundtrack that is carried on the optical track of the film release print.

### **How do I get an optical soundtrack ?**

Once your surround sound format has been selected (see the paragraph below for more), you need to order an optical soundtrack negative for the film. In the case of LCRS mixes, a traditional two-channel; Printmaster track is created, and this is sent to an optical sound house for the creation of the optical negative. The optical sound house will record the soundtrack onto 35mm film using a special camera, and some will also develop their own soundtrack masters. Once the optical negative is shot and developed, it can be incorporated into your answer printing process, and a composite answer print containing your complete soundtrack can be printed or "shot" at your film lab. This usually happens during the first or second trial answer print phase.

### **What about: THX - Dolby - Ultra\* Stereo - DTS - SDDS?**

This is a BIG question. This one point alone causes much confusion amongst filmmakers. Please take a moment and read this paragraph carefully. If you need more information after that, please contact either Gnome Productions or Magnolia Studios and we will help you out. First, about THX.

THX [tm] is not something that you DO to your soundtrack, it is just a set of sound reproduction or mixing conditions that optimize the sound of your film's soundtrack in exhibition. Simply put, the THX standards that many dubbing stages and movie theaters adhere to are a way of being certain that "what you mix is what you get", so to speak. You may choose to mix in a stage that is THX certified, and you may not. If you do, your soundtrack should sound reasonably the same in THX theaters all around the world. It is this standardization that THX brings to the filmmaking community.

You may want to visit the THX Web Site for further information. They can be found at <http://www.thx.com/thx/thxmain.html>. To make sense out of the rest of the names, we need to know about Film (and Television) Surround Sound Film sound tracks (and some television ones) go beyond just Left-Right Stereo; there is a Center Channel for the dialogue, and at least one "Surround Sound" channel. The Surround channel is used to project the sound out into the theater, to "surround" the audience. This is to enhance the illusion of being "in the picture". This four-channel format is called LCRS (for the Left, Center, Right and Surround channels that the soundtrack contains).

Although the technical means behind this process is beyond the scope of this discussion, suffice it to say that it works well enough to have become a standard format for release prints for many years. LCRS You've probably already figured out that you cannot reproduce a four-channel soundtrack from a medium that only plays back two tracks. You are very right. In order to reproduce the LCRS soundtrack from a traditional film optical soundtrack (more on opticals later) you need a way to encode the channels....the Matrix The Surround Sound Matrix Encoder (or, how to put FOUR into the space where TWO should go!) The solution is to use an encoding device that can fold the four channels of audio down into the two channels available on the film's optical soundtrack. When the audio tracks have been processed this way, they are labeled Lt/Rt [Left Total/Right Total] in order to distinguish them from ordinary Left/Right Stereo soundtracks.

The Surround Sound Matrix Encoder is a necessary piece of hardware that the audio post house must have available during your film's mix, in order to create the surround soundtrack. The Licensing of Surround Sound formats Now we're really getting into the heart of the matter. Dolby Labs, Ultra-Stereo Labs, DTS (Digital Theater Systems) and Sony [SDDS] all have technologies available for the encoding of film surround soundtracks into film release prints. Although these processes vary somewhat as to their method, they essentially accomplish similar things. Additionally, some of these vendors offer Digital Encoding formats (Dolby Digital, DTS and SDDS currently, and Ultra-Stereo soon to come). The Differences in Surround Sound formats In the most basic form, Theatrical Surround Sound consists of LCRS: Left, Center, Right, and mono Surround. A soundtrack can be encoded into this format by using a Dolby or Ultra-Stereo encoding matrix during the film's Printmastering session. DTS also has a process called DTS Stereo that can create a typical LCRS film soundtrack (check with DTS directly for more on their specific processes...). Surround Sound formats beyond L-C-R-S: Some of the surround sound encoding processes can create different, more complex soundtrack formats; Dolby SR/D and DTS, for example, can create six-track soundtracks for release, and Sony's SDDS is an eight-track format. In the case of six tracks, you get Left, Center, Right, Left Surround, Right Surround and a Sub-woofer channel (for enhanced low-frequency response).

The split surrounds (as they are called) make it possible to move sounds around in the surround speakers, or to use stereo background sounds for even more impressive film soundtracks (Jurassic Park comes to mind, here). And if you heard Jurassic Park in a good THX theater with a DTS Digital soundtrack, you know what the sub-woofers are there for! That T-Rex really gave the sub woofers a run for their money, as well as Jeff Goldblum...Six-track sound reproduction has been with us for a while, since 70mm film releases have had the ability to deliver a six-track soundtrack that was magnetically encoded on the release print. This, unfortunately, was very expensive to produce, and problematic to control quality.

Sony's SDDS (Sony Dynamic Digital Sound) uses an eight-track delivery configuration that adds two speakers in between the Left/Center and Center/Right positions in the front speaker wall. Known variously as InterLeft, InterRight or LeftCenter and RightCenter, these channels allow for additional separation of music, effects and dialogue in the front speaker wall, while preserving the split surround format.

The Differences in Digital Sound delivery methods The three digital systems (Dolby, DTS and SDDS) use proprietary methods to deliver the digital audio to the theater; two of these methods (Dolby, SDDS) encode the digital soundtrack onto the release print. DTS uses a different method, that of encoding a "timing stripe" onto the release print, and synchronizing a digital audio playback from an accompanying CD-ROM that carries the encoded soundtrack. In either case, the digital audio is reproduced in the theater with the same fidelity it was recorded at during the encoding process. This system neatly bypasses the traditional limitations of optical soundtracks: noise, bandwidth limitations, and headroom (transient peak) limits. Soundtracks sound cleaner, clearer and louder as a result. Please don't take this as a condemnation of optical soundtracks. A well-mixed movie can (and they still do) sound great with a well-produced optical soundtrack. To summarize this difficult topic: THX specifies a set of standards that affect how sound is recorded and reproduced in a movie theater. You get the benefits of the THX standard whenever you mix in a THX-certified mixing stage. There is NO additional fee required. You may display the THX logo in your film's credits if you sign a simple one-page form. Dolby Surround is a 4-channel optical surround format; this format is encoded in the optical soundtrack You must license this format from Dolby Labs; There IS a license fee for this service Ultra-Stereo is a 4-channel optical surround format; this format is encoded in the optical soundtrack You must license this format from Ultra-Stereo Labs; There IS a license fee for this service DTS is a 6-channel digitally-encoded surround format; this format is encoded on an external CD-ROM, but the timing and other information in encoded on the film release print; You must license this format from Digital Theater Systems (DTS); There IS a license fee for this service Dolby Digital is a 6-channel digitally-encoded surround format; it is encoded on the film release print; You must license this format from Dolby Labs; There IS a license fee for this service SDDS is an 8-channel digitally-encoded surround format; it is encoded on the film release print; You must license this format from Sony Corporation - SDDS division; There IS a license fee for this service

### **I have got a video project - What's this DVD, AC-3?**

relax - take a breath and we'll walk you through this...It's actually pretty simple;

Surround sound program on video materials are now released in a number of analog AND digital forms...

Straight Left-Right Stereo program is still utilized a lot for Television, and Industrial formats...

VHS Home video releases can be encoded in Dolby Surround (L,C,R,S), just like feature films;

Laserdisc releases have also been using digitally encoded L,C,R,S surround formats, just like VHS

NEW DIGITAL VIDEO RELEASE FORMATS have allowed for new DIGITAL SOUND FORMATS  
AC-3 - is a digitally-encoded surround sound format that is capable of reproducing six tracks of sound  
Ac-3 actually refers to Dolby's Audio Compression 3 format used to compress the data  
DVD releases are also utilizing AC-3 digital sound format as well as traditional Surround Sound

All of these formats can easily be handled or prepared by a knowledgeable sound house.  
Please contact us if you have specific questions that you would like answered...no obligation, of course...

### **My mix sounded great on the mixing stage - but my print isn't in sync!**

Well, we didn't say this would be EASY, just that we could help take some of the mystery out of it for you...You should IMMEDIATELY contact your post sound house and tell them what you've experienced. The Sound Supervisor on your show should be willing to take some time and help you sort this out. In the meantime, here's a few things that you can check on:

Some likely possibilities:

(1) If the Final Mix Printmaster has been transferred or copied, be sure the copy was done correctly. We have had experiences where a perfectly fine Printmaster was thrown out of sync because a copy was made first, and the optical shot from the copy;

(2) If the soundtrack DRIFTS from being in sync to gradually being more and more OUT of sync during the reel, suspect this possibility: If the Printmaster is on Multitrack tape, the SMPTE code on the tape could cause the optical soundtrack to drift in speed; If you mixed to VIDEO TAPE, a slight difference between 29.97 frame code and 30.00 frame code could throw you out of sync by many frames over 1000 film feet. If the soundtrack was shot on Mag, a mistake in running the film chain at video speed could cause the Mag to be "offspeed", just like the Multitrack tape example above;

(3) If the Mag Printmaster was in sync when you reviewed the final mix, check to be sure the film lab didn't accidentally "misprint" the soundtrack by moving the optical negative a perf or two, or a frame or two when they married it to the picture. This can easily happen IF THE HEAD POP or TAIL POP is not EXACTLY CORRECT on your final Printmaster.

(4) If you printmastered in 2000-foot film reels, and FOR ANY REASON these reels were then separated and rejoined later, this poses a prime opportunity for sync to slip. If the beginning of a 2000 foot reel is in sync, and the last 1000 feet is suddenly (and consistently) out of sync until the end of the reel, suspect this phenomenon immediately.

(5) If one or two shots suddenly are out of sync but were IN sync when you mixed, ask yourself this: did you mix from an Avid or Lightworks (or other electronic edit system) output? If so, it's possible the film negative was not cut to the exact same shot length as the electronic output; Have you verified the length of all optical effects? If you have inserted optical effects, they may not have been counted exactly right, and you may have gained (or lost) a perf or frame or two in the effect; either way, your soundtrack will lose sync right then and there, and STAY out of

sync for the rest of the reel (unless another optical effect error magically puts it back in sync again!)

(6) Finally, when all else fails, it is remotely possible that the optical negative might be offspeed. A quick call to the optical sound house will help them verify this for you.

**My foreign distributor says I need an "Emenee" to make a sale ?**

Actually, it's an "M and E" or "M&E". This element comprises the "MUSIC and EFFECTS" elements of your original soundtrack, with ALL of the English language dialogue and Walla removed to allow for foreign language dubbing. In most contemporary post sound packages, an "M&E" is allowed for in the original bid. This process requires preparation during the original sound editing, as well as some additional Foley coverage that might NOT be needed for a straight domestic release. If you NEED an M&E, be sure that you tell your post sound house that UP FRONT. It WILL add some dollars to your post bid, but you WILL want it, if you are to have any possibility of a foreign release or sale at all. Preparing this element NOW will buy you plenty of "peace of mind" later on. The M&E can be on Mag, on DA-88, on DAT, or on almost any format that can be synchronized. It DOES NOT need to be converted to an Optical soundtrack form at this time...only later, when a new foreign Printmaster is created after the foreign language has been added to it.

**Do I need to know about the academy rolloff ?**

Well, although it is a holdover from film sound's infancy, we need to be aware of it, since it does have some relevance in certain circumstances. The academy rolloff is a specific frequency response curve that is used in dubbing stages to simulate the effect that the old-time optical soundtrack would have on the frequency of the final soundtrack. With advances in technology in today's film industry, its use is diminishing, although it has been used on mono theatrical trailers to this day.

**How do I get more info about Surround Sound Licensing?**

It would be best to consult the various vendors themselves...

THX can be reached at <http://www.thx.com/thx/thxmain.html>, or in San Rafael, CA through 415-662-1800

Dolby Labs can be reached at <http://www.dolby.com>, or locally in L.A. at 213-845-1880

Digital Theater Systems can be reached at <http://www.dtstech.com>, or locally in L.A. at 818-706-3525

Sony Corporation maintains a web page at <http://www.sony.com>

Ultra-Stereo Labs can be reached directly by telephone at: 818-609-7405

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President Gnome Digital Post Magnolia Studios

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# Film Sound Glossary

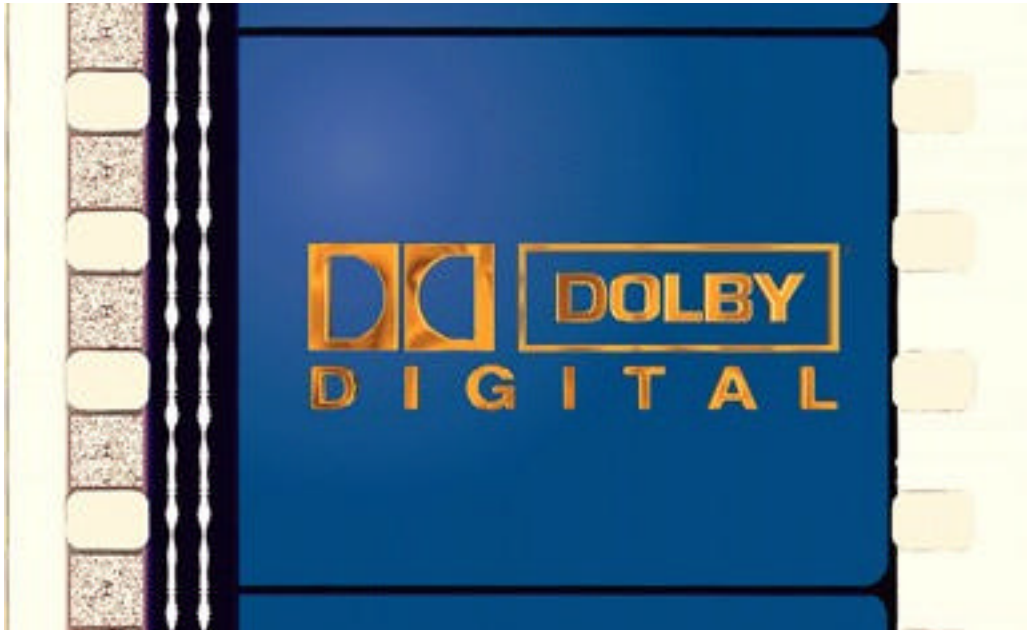
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## Dolby Film Laboratories

**Acoustics** -- The characteristics, such as how sound is reflected and absorbed, that acoustically differentiate one environment from another, such as a living room from a concert hall.

**Ambiance** -- Low level sounds that set a mood or suggest the character of a particular place.

**Analog vs. digital** -- The difference between analog and digital sound is explained best in terms of the analog and digital soundtracks on the Dolby Digital print shown in Figure 1.



The width of the analog soundtrack varies in a way that is directly analogous to the varying soundwaves of the original sound. All analog formats have an equivalent varying parameter, such as the strength of the magnetic field on recording tape, or the side-to-side swings of the groove on a phonograph record. When played back, the varying width of the track is translated to a varying electrical voltage which ultimately causes the theatre's loudspeakers cones to move back and forth to recreate the original sound.

With a digital optical soundtrack, points along the soundwaves of the original sound are assigned a numeric (or digital) value, which are represented as tiny dots on the track. These values can also be recorded as magnetic pulses on tape, or as microscopic pits on CDs. When a digital track is played back, the numeric values are converted to the varying electrical voltage needed to drive the speakers.

Digital sound can be of very high quality, and resistant to wear and tear. Without sophisticated techniques such as the Dolby AC-3 process used on Dolby Digital prints, however, it takes much more space to record or transmit digital sound than analog.

**Atmospheres** -- Low level background sounds, such as wind or traffic noise, which add to the reality of a scene. These sounds are sometimes recorded separately at a shooting location, creating what is called a wild track for mixing into the soundtrack later.

**Dolby AC-3** -- The multichannel coding technology used on Dolby Digital films soundtracks and the new Dolby Digital (Surround AC-3) laser discs, by the upcoming US High Definition TV system, by the new DVD, and in numerous cable and satellite applications.

**Dolby noise reduction** -- Complementary (record-play) signal processing systems developed by Dolby Laboratories to reduce the noise inherent in recording media without affecting the sound being recorded. Dolby A-type noise reduction is the original professional Dolby system and is used on Dolby movie soundtracks, while the Dolby B-type, C-type, and new S-type systems are for consumer formats such as the audio cassette.

**Dolby Stereo** -- Dolby Laboratories' original motion picture system, wherein Dolby A-type noise reduction was used in the recording and playback of movie soundtracks. Dolby Stereo represents 4 channels of sound (see the definition of Stereo below) with Dolby recording equipment used to combine the four channels used in the studio into 2 channels for placement on the film, and then Dolby playback equipment used to convert the 2 tracks on the film back into 4 channels of sound in the cinema. Today the term has come to represent an umbrella term for Dolby film sound technologies.

**Dolby SR (spectral recording)** -- The most powerful analog Dolby system, used for the analog soundtracks on all Dolby Digital prints and on many analog-only releases as well. It not only provides greater noise reduction than the original Dolby A-type system, but also permits recording a wider frequency range, particularly at high signal levels.

**Dolby SR•D** -- The term the film industry uses to identify 35 mm release prints containing both an analog Dolby Stereo SR ("SR") and Dolby Digital ("D") optical soundtracks. The term is sometimes misused to identify just the Dolby Digital format or presentations.

**Dolby Digital** -- The multichannel digital format used in cinemas and in consumer delivery systems such as home theatre (including laser discs), HDTV and DVD. The format uses Dolby's AC-3 audio compression technology to derive the required digital audio bit streams.

**Dolby Surround** -- The home surround-sound format derived from Dolby Stereo film sound.

**Dolby Pro Logic** -- The more advanced form of Dolby Surround that not only recovers the surround information from encoded program material, but also adds a center channel to keep dialogue and center effects firmly positioned on the television screen. Pro Logic permits a wider listening/viewing area, provides better channel separation, and gives more accurate sonic perspectives.

**Dubbing theatre** -- A special theatre equipped for mixing film soundtracks. The sound systems in dubbing theatres where Dolby soundtracks are mixed and in Dolby-equipped cinemas are calibrated to the same standards. This helps make it possible for audiences to hear the sound the director heard—and intended—when the soundtrack was mixed.

**Dynamic range** -- The range between the loudest and softest sounds a sound format or system can reproduce properly.

**Effects** -- Sound effects, i.e., the non-musical elements on a soundtrack other than dialogue.

**Foley** -- The art of recreating incidental sound effects, such as footsteps or rustling clothes, in sync with the picture. Named after one of its first practitioners.



**Magnetic soundtrack** -- Narrow stripes of oxide material (similar to the coating on recording tape) that are added to a developed release print, then recorded in real time with the film's sound. For playback in the theatre, projectors are equipped with magnetic heads like those on a tape recorder. Introduced in the 1950s to provide stereo sound in the cinema, magnetic offers very high sound quality. The prints themselves and theatre maintenance are costly, however, so today there is just only one magnetic format remains, six-track 70 mm.

**Mix** -- The blend of dialogue, music, and effects which comprises a film's soundtrack. Also, when used as a verb, the process of assembling and balancing these elements electronically, thereby creating the final soundtrack.

**Optical recorder** -- The machine that transforms a completed mix on magnetic tape into an optical soundtrack. It creates a photographic negative of the optical track, which is combined ("married") with a negative of the picture to create a release print (see Printer).

**Optical soundtrack** -- A photographic strip adjacent to the picture on a 35 mm movie print, varying in some way with the variations in sound (see Figure 1). Analog optical soundtracks vary in width, while digital optical soundtracks have patterns of dots (see Analog vs. digital and Variable area). Because optical soundtracks are printed at high speed at the same time as the picture, the release prints are economical, as opposed to magnetic prints whose soundtracks are recorded in real time as a separate step.

As the film is pulled through the projector's soundhead, a narrow light beam passes through the moving soundtrack, which causes the intensity of the beam to vary. The varying light falls on a sensor to create electrical signals for the theatre's loudspeakers to convert back to sound.

**Printer** -- A machine that exposes raw film stock to negatives of the movie's soundtrack and picture, at speeds up to twenty times faster than film is projected, to create a release print. The rapid, simultaneous printing of sound and picture contributes significantly to the relatively low cost of 35 mm optical release prints (see Optical soundtrack).

**Release print** -- The actual film played in the theatre. A release print consists of reels approximately 20 minutes long which are played consecutively without interruption either by alternating between two projectors, or by splicing the individual reels together into one large reel called a platter. Prints are played at 24 frames per second and prints are recorded at 16 frames per foot.

**Stereo** -- Sound recording and reproduction by more than one (mono) channel. In home music reproduction, "stereo" means two channels (left and right). In the film industry, however, "stereo" is understood to include a surround channel. Proper movie stereo also has a center channel to keep on-screen dialogue centered for viewers seated off to the sides. Thus Dolby-format stereo film presentations comprise at least four channels, with left, center, and right speakers behind the screen, and surround speakers at the rear and sides of the auditorium. Other so-called "stereo" presentations, however, may consist of no more than a single mono speaker behind the screen with some surround speakers at the back.

Since "stereo" came to mean two channel sound in the home, this is why Dolby's film sound technology could be identified simply as Dolby Stereo for the film industry, and why a new term, Dolby Surround, was needed to identify multichannel home sound reproduction.

**Subwoofer** -- A loudspeaker dedicated to reproducing the very low bass. Dolby Digital and 70 mm magnetic soundtracks provide separate bass effects channels specifically for playback over subwoofers

**Surround sound** -- The reproduction of ambience, atmospheres, and occasional special effects recorded on one or more dedicated channels, and played through speakers placed along the sides and rear of the auditorium to surround the audience.

**THX** -- A trademark licensed to movie theatres and manufacturers of home theatre products, identifying compliance with the performance parameters of Lucasfilm Ltd. for commercial and home theatre sound systems. Unlike Dolby's focus on soundtrack formats and processes, THX develops standards for the playback environment, regardless of film format. THX-certified theatres use professional Dolby cinema processors for playing Dolby soundtracks (which is why both logos can appear on the same theatre marquees), and all THX-licensed home theatre systems are based on Dolby Pro Logic Surround decoding.

**Time Link** -- A high-quality, yet economical, digital audio delay technology developed by Dolby Laboratories and used in some Dolby Surround decoders.

**Variable area** -- The technical term for the analog optical soundtrack whose width varies with the sound. A Dolby analog optical soundtrack sometimes is referred to as an SVA track, for "stereo variable area." Another type of optical track, variable density, was tried at an earlier time, which varied in photographic shading with the sound, rather than in width.

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# Star Wars: a new sound

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by Robert Cashill

Ben Burtt returns to the Jedi to blast the trilogy's audio into hyperspace for 90s audiences

When Ben Burtt picked up his undergraduate degree in physics from the University of Southern California, he dreamed of joining the space program. In 1975, he did. But not NASA's.

"George Lucas, the writer/director, asked Gary Kurtz, the producer, to find a student somewhere who didn't cost very much to go out and collect sound for the film they were developing," says Burtt, who cobbled movies together as a hobby and received a scholarship to study at USC Film School when one of them won an award. "Gary called USC and said, 'Do you have any prospective Walter Murches there?' And they recommended me, because I did have a great interest in sound. Most students wanted to be writers and directors, not sound people."

Burtt had no idea that the film Lucas and Kurtz were a year away from shooting, Star Wars, would catapult all associated with it into the front ranks of the Hollywood stratosphere. But, as he finished up his master's degree, he had an inkling that his first brush with Tinseltown would be a memorable one. "Gary said, 'We have a character called a Wookiee, and we'd like to create a voice for it--can you work on it?'" And I said, 'Okay.' I didn't know what that was, but at my next meeting with them, they showed me a wall of Ralph McQuarrie's conceptual art for the film, and I was completely knocked out. I said, 'All my life I've wanted to see, let alone work on, a film like this.' I loved Flash Gordon and other serials, and westerns. I immediately saw the potential of what they wanted to do."

With a 1/4" mono Nagra tape recorder and a microphone supplied by his new bosses, Burtt went into the field to round up sounds for a melange of creatures and mechanical effects called for in the script. "They went off and shot the movie, and I traveled around to zoos doing animals, and factories and airports doing various kinds of airplanes and jets, and out to army bases to record machine gun fire," he recalls. "One time I went to Marineland down in Long Beach, CA, to record a walrus for a possible Wookiee effect. Its pool had been drained for cleaning--the walrus was stranded at the bottom, moaning--and that was the sound! Finds like this made me realize that there would be a lot of adventures to be had in sound and sound collecting."

There would be indeed. At the age of 27, Burtt collected his first Academy Award, a special achievement honor for the alien, creature and robot voices in Star Wars, the movie that blasted the film medium into hyperspace. Seen today, its credits read like a who's who of top industry personnel, including Don MacDougall, Ray West, Bob Minkler and Derek Ball, who collected their own Oscars for the sound design of the movie.

If you've been anywhere near the orbit of North America this year, chances are you revisited Star Wars and its companions, The Empire Strikes Back and Return of the Jedi, and seen those credits writ large once again on the big screen. International engagements are also reintroducing the Star Wars trilogy, freshened with newly-created CGI effects and soundtracks, to audiences eagerly awaiting the next batch of films, which are scheduled to lift off in 1999. The re-release of the movies gave Burtt, who supervised the sonic redesigns, a chance to revisit his youth, and fix it, too.

In the 20 years since Star Wars, Burttt has added three more Oscars to his shelf (for sound effects editing on Raiders of the Lost Ark, E.T.: The Extraterrestrial, and Indiana Jones and the Last Crusade), and a total of seven nominations. By the time this issue goes to press, he may have copped another win, for his direction of the Imax film Special Effects in 1996. Burttt worked full-time for Lucasfilm until 1990, and has since freelanced, with Imax (on films like Blue Planet and The Dream is Alive) but also for his old Jedi master, for whom he directed episodes of TV's Young Indiana Jones Chronicles.

When The Force came calling again two years back, Burttt and a staff of 10 hunkered down for months of 12-hour days at the Skywalker Ranch in Northern California, to reinvigorate the sound of Star Wars for contemporary movie theatre technologies. The film was the first ever recorded for Dolby stereo, but the introduction of digital formats like DTS and SDDS left Star Wars, and its sequels, sounding comparatively tin-eared in the 1990s.

With his varied, and bustling career, Burttt doesn't go on many sonic expeditions these days. But his first order of business on the revised Special Edition trilogy was to create new "Huttese" dialogue for the surprise appearance of Jabba the Hutt in Star Wars, create a squishy sound for his movements (a garbage can stuffed with wet towels did the trick), then piece the scene together with the animators. 'We've never given credit to the performer who does that voice, whose pitch is lowered with a harmonizer," he laughs. "I like Jabba just to be Jabba. But I can tell you that my 12-year-old son, Ben, is in a Jawa costume for the new scene at Mos Eisley. All three of my kids have adjusted to what Dad does for a living; they're used to me dragging them out to work and recording them when they had colds or flus if I needed a beastly sound."

The restoration of the Star Wars films was a family affair for Lucasfilm personnel, many of whom had worked on the films originally. The movies had been upgraded to THX home theatre standards for video-cassette and laserdisc earlier in the decade, "but we had to take those restorations much further for movie theatres."

A priority goal was to bring out from the original mix other "beastly sounds," as well as music cues, dialogue, and effects, that Lucas wanted to highlight this time around in the trilogy. "There were three different mixes of Star Wars that were on exhibition in its original release that we had done at different times," Burttt explains. "One was a Dolby Stereo, for the 40 US theatres equipped for it at that time, one was a six-track 70mm version, and another was a conventional mono. Because you had to perform the mix over again for each one, you would do things differently, just by chance, and also by design. George would have a new idea, and we'd change a lot of dialogue, or we'd add something. There were actually a few places where special effects shots were added to the negative after we finished the mix; there are laser bolts that we'd never cut sound for, and a few spaceships, because those shots came in so late they didn't get any sound put to them. There are some minor flaws like that, nothing that really affected the story--Star Wars was the first major film I had ever worked on doing the sound, so I was thrilled by almost anything that came out of the mix--but they nagged me."

Lucas and Burttt and his team prepared lists of changes and, "using our 20-year-old notes, and our memories of what we wanted in the first place," went about amending the soundtrack. "We created the surrounds all over again, so that we could take advantage of the split surrounds that we now have. We were able to extend the high- and low-frequency material, as it can be played back in theatres now, so we could add more subwoofer to the rumbling spaceships or explosions, and attain a higher fidelity in the music and so on."

As is his usual practice, Lucas gave Burttt a free hand to make his enhancements, with input as the restorations progressed. The one requirement was to add to, but not alter, the much loved adventures. "A lot of sounds in movies nowadays are just a lot of noise, with nothing standing out with any sort of real character," he says. "In looking at Star Wars, we were amazed at how articulate the final space battle was, years later. We didn't do a lot to change that, except adding subwoofer material to the explosions. Where we had spaceships flying past the camera, we added the sound of them continuing into the surround speakers; we brought the sound off the screen and into the room more than the original movie. There was an attempt to spatially envelop the audience, but there is a limit to what you can hear and what will work."

Propelling Star Wars into the 1990s meant relocating original sound elements from the 1970s--not an easy task. "Star Wars required a tremendous amount of work, because the quality of a lot of the recordings was marginal, and some of them had not withstood the test of time, and we just managed to get them to sort of work," Burttt says. "Archivally, the film was not well-organized. Everything had been kept in a Skywalker Ranch warehouse, but some of it was thrown into piles and we had to do a bit of digging. There was a great number of people, including myself, getting dirty as they crawled around the archives, up on shelves and under boxes, reading old faded labels. We did manage to find everything, but it was a trial."

The other two films required less spadework, reflecting in part the vastly improved fortunes of the Lucas empire post-Star Wars. "Not only had we learned a lot from doing the first film, but when we went around to do Empire, we were more prepared to handle the duplication and mixing processes. By the time we did Jedi we had our own facility in Northern California, so we had more control over the quality of the sound than we ever had. Both were much better inventoried on digital storage mediums--you could practically send strangers into the vaults to find things--and, technically, each one of the tracks got to be a higher-fidelity recording and ultimately, a better mix," Burttt says. "On Star Wars, everything--music, dialogue, effects--was combined into one master recording. You had to undo it and make changes with surgical precision. But on Jedi, we had separated stems: Music was separately recorded from dialogue and from effects, so if we wanted to change something independency of one of the other elements, we could do it."

The renewed films were edited with Pro Tools [R] digital audio workstations (DAWs) from Digidesign. "We took our original sound elements and digitized them, then put them into the Pro Tools to do any editing we wanted to do. Because all the tracks for Star Wars were on magnetic film from the old days, we had to do a lot of cutting and splicing of film, not the editing and manipulation of today. Some elements we didn't put into the computer; some we just used as film elements." The original 35mm music transfers, for example, were recut on a Moviola, "because we wanted to go back to the original recordings where we could to save generations and preserve the original feeling of John Williams' scores."

A master mix, in the 5.1 format ("which has all the different channels you could have") was generated for each film. Consultants from SDDS, DTS, and Dolby Digital then helped monitor and adjust the mix for each specific format. Eventually, it's showtime, preferably in a theatre that meets Lucasfilm's rigid THX standards for sound delivery, as more and more do. "In the studio, in 1977, it sounded great, but chances were 1-in-50 that it would sound that good in a theatre at that time. It was exciting for all of us to re-release the films to theatres now, as we knew we could have a much greater chance of the sound playing a larger role in the presentation of the film."

Burt is pleased that part of the Star Wars legacy was to revolutionize film sound. "I hadn't worked in stereo; I hadn't worked in DOLBY," he says of his own tribulations as a rookie Luke Skywalker in cinema audio. "We were working with experienced mixers and sound editors in Hollywood, and they had very little stereo experience and no Dolby noise reduction experience, either, so we were all learning. But what we ultimately achieved shook things up tremendously. Suddenly people saw a whole new area of creativity that had been laying fallow, and now Hollywood could have a fresh new playground to be creative in."

Much has changed, but some things have stayed the same, as Burt prepares for preproduction of the new Star Wars films, and develops an IMAX film about the mystery and excitement of sound. "Y still have my Nagra," he laughs. "It's a completely reliable piece of equipment that refuses to break down. I'll continue to use it until someone arrests me."

Skip Lievsay, partner in C5 Inc., a New York sound production company for motion pictures, eschews the currently trendy title "sound designer." Sometimes directors ask him to take it because, as he says, "I think there's a certain perception that if you have a sound designer, the sound is something special." But he feels that it is important to understand and respect the heritage of the term. "People like Walter Murch on *The Conversation* and *Apocalypse Now*, and Ben Burt on *Star Wars*, had a really huge input and impact on the movies," says Lievsay. "Next time I work on *Star Wars*, I'll consider taking the credit, but until that day I'm happy with supervising sound editor."

Yet that is no small thing--as supervising sound editor, Lievsay is responsible for more or less all of a movie's post production audio track, including sound effects, dialogue editing, Foley recording, and final mix. Only the music is left in other hands. What the sound editor is typically given is a picture with periodically inaudible dialogue, inadequate audio accompaniment to everything from footfalls to gunshots, and zero atmosphere. "The majority of the work is fairly subtle, mostly atmospheric stuff like footsteps and traffic sounds," says Lievsay. "It's just providing an overall sense of realism."

Then there are the more elaborate projects, movies that require "non-literal" sounds. Such a project is Barry Sonnenfeld's *Men in Black*, the film Lievsay is working on this spring, and which Columbia Pictures will release in July. The futuristic story is of two government agents, played by Tommy Lee Jones and Will Smith, who track and contain illegal aliens--in this case, the unearthly kind. As Lievsay and other C5 employees work on the soundtrack using the latest in digital editing technology, Industrial Light & Magic is completing the \$90-million movie's digital imagery. "We have aliens and saucers and spaceships and these huge beasts in the end," said the sound editor in February. "We've been making sound effects, two of us full-time, for four months, and we have another three months to go. It's our biggest project ever--when we started working, there were 75 or 100 things we had to create that were totally non-literal."

Not that the company wasn't ready. Since starting C5 in 1989, Lievsay and his co-founders Ron Bochar, Philip Stockton, and Bruce Pross have aggressively overseen the transition from linear to digital technology. In its two-floor midtown Manhattan headquarters, the company has integrated the capabilities of Synclavier RAM-based samplers, which make digital recordings by converting analog audio into data representing frequency and volume, and Avid platforms, which use a Mac interface to store the data in a file folder and reproduce the sounds along with picture.

With this technology, the sound editor says, "You can change the speed data is played back, you can play back several pitches at the same time, or you can bring back two samples at a

very, very close pitch. The beauty of it is that you can have several samples, and you can edit them together." At any of 30 workstations, ranging from small monitors to big-screen editing suites, the data can be called up by name--"jet takeoff" or "elephant roar," for example--and combined, sequenced, and matched to picture, with the assistance of Avid Audio Vision or Sonic Solutions software.

"It's a workstation kind of world," says Lievsay of his company. "This is a major advancement--picture and track together on one machine. In New York, a couple of years ago, many people were still working on magnetic film, and in one year, we completely changed to workstations." Ironically, though most of the major sound editing work for Hollywood features is done in California, Lievsay says the changeover there has been far slower. "People on the West Coast have invested in magnetic gear and they don't want to switch," he says. "Most of them still work on Moviolas."

Lievsay remembers well what that was like. When he was cutting the Coen Brothers' *Raising Arizona*, for example, "I took recordings on 1/4" tape, locked the door at Sound One for three weeks, and produced all the sound effects. I would take the mags and mix them together on a two-line recorder, transferring all the sound and building piles scene by scene. I gave the piles to the editors, and they built them into reels. In New York at the time, there were few sound houses the way there are in California. I would get a job, hire my crew, and rent spaces. I saw that it would be much more efficient to have my own gear, so I bought some dubbers and tape machines and stuff like that, and would lug it to whatever room I was editing in. The reason we made this company was to have this gear in the hands of the editors, so we could compile our stuff ourselves."

Sound editing was not a craft Lievsay came to directly. Aspirations to being an architect fell by the wayside in recession-afflicted 1970s New York, but a friend got him a job as an assistant on a low-budget feature. "I worked on the movie from the very beginning to the very end, every part of it," he recalls. "I also worked on the editing, and got a very good overall feel of what that was all about. We edited at a rental house that no longer exists, and I worked there for a while doing TV versions of United Artists films and *Saturday Night Live* commercial parodies. And I made a rather shrewd assessment of the possibilities--there was far more work for sound editors than there was for picture editors. Picture editors tend to be a force of one over a long period; sound editors tend to be a force of a dozen over a short period."

In the early 80s, Lievsay had the great fortune to hook up with the tyro filmmaking brothers Joel and Ethan Coen on their first feature, *Blood Simple*. That low-budget thriller went on to play at the New York Film Festival, enjoy a healthy commercial run, and attract the attention of Martin Scorsese, who hired Lievsay to supervise sound editing on his movie *After Hours*. Both Scorsese and the Coens became regular clients, helping the sound editor to compile credits like *GoodFellas*, *The Age of Innocence*, and *Casino* for the former, and *Miller's Crossing*, *Barton Fink*, and *Fargo* for the latter. "Those two contacts just kind of legitimized everything," he says. Lievsay has also supervised most of Spike Lee's movies, and worked repeatedly with such directors as John Sayles, Jonathan Demme, and Sonnenfeld, who started out as cinematographer on the Coen Brothers' films. Other recent credits have included Al Pacino's *Looking for Richard* and Danny De Vito's *Matilda*.

Lievsay's partners have their own consistent clients. Bochar has worked regularly on Alan J. Pakula films, including this spring's *The Devil's Own*, Sidney Lumet films, such as the upcoming *Night Falls on Manhattan*, and Barbet Schroeder projects, like the upcoming *Desperate Measures*. Stockton has basically taken over the John Sayles account, supervising

sound editing on *The Secret of Roan Inish* and *Lone Star*, upcoming projects include Ang Lee's *The Ice Storm*. As for Pross, he acts as Foley supervisor and mixer on all of C5's assignments.

"On a lot of the movies we've done since we moved down here," says Lievsay, "I actually don't edit that much anymore." What he has done is concentrate on his specialty--"hand-made" sounds. He defines this as "finding sounds, compiling them, manipulating them, using a lot of sounds to combine together to make textures." The non-literal realm is where he finds his greatest stimulation. "Whether it's a pitch or a texture or a certain perception, like a rumble, I find that by manipulating the sound and mixing it with other sounds, you can create something out of nothing. The challenge is to make that association--you've got to look somewhere in a dark corner."

A case in point is *Barton Fink*, which epitomizes what Lievsay calls the "immersed in a fishtank" quality of the Coen Brothers' movies. In one scene, the title character, a serious New York writer adrift in 1940s Hollywood, is watching a wrestling picture to gain pointers for a script assignment. "The camera is intercutting between tracking shots pushing in on John Turturro. and pushing in on the black-and-white dailies of two men in a ring, throwing each other on the mat," says the sound editor. "We started off with just the whirring, clicking sound of the projector, and then we started to add sound effects. We found an ore-crushing machine which has this grumbling, churning sound--I was thinking of his stomach, actually. As we got closer, I started to add things for the mat--at first, ordinary things, then crashes, and as we got to the climax, I added a recording of a chainsaw at a low frequency, so it sort of grew out of the ore-crushing sound. We also heightened the actors, so that when it gets to their close-ups, they're just roaring.

"At the end of the scene, it cuts to a pullback on the typewriter back at Barton's hotel," Lievsay continues. "I took a European steam train whistle, which is very high-pitched, and at the last blast of this shriek, everything sort of dies away to the typewriter and the music." When Barton later blacks out, the combination of the train whistle and chainsaw become an audio motif.

Where do these sounds come from? Commercial CD libraries are a major source, along with C5's ever-growing library of sounds and material that is passed around through a network of sound editors and recordists. "I'm working on a scene now for *Men in Black* in which a huge spaceship crashes into the Unisphere in Flushing Park, crashes to earth, and skids to a stop in front of Tommy Lee Jones and Will Smith," says Lievsay. "It's a huge sequence we produced a tremendous amount of material for. I pulled a lot of crashing stuff out of the commercial libraries, and one of my editor friends in San Francisco had done some other pictures that had big metal smashing sounds, so he pulled some stuff from those."

Compilation is key. For the main spaceship in *Men in Black*, says Lievsay, "I took a bunch of recordings of servo sounds--a jet takeoff, big motors from various recordings, some from libraries, some I recorded, some I got from a friend who loaned me his whole library. All those together make a nice combination of motor sounds. We wanted to de-emphasize the airplane sound and go more with an almost 50s sci-fi sound; it's a matter of just finding all the elements and combining them, finding the right size and texture." And then, aided by the digital equipment, manipulating them properly. The Synclavier can create an explosion, for example, out of two cannon sounds slightly varied in duration. "You start them at the same point, and they gradually get a little bit out of sync," says Lievsay. "The longer the wave, the lower the frequency, the more it has to be out of sync to have that effect."



Such creative experimentation is necessary, because scheduling an explosion to record is rarely practical. More mundane elements--cars, shootouts, city sounds--are easier to obtain as needed, though New York is not the ideal spot to do so. "Most films we work on are urban films, but a lot of it is done in California, because recording around here is very difficult," says Lievsay. "There are few places you could go where you wouldn't be in somebody's flight path. But each movie we record new city atmosphere material for, and we just go out and stand on the street."

For the more creative non-literal sounds in *Men in Black*, different avenues have been explored. The monster at the end, for example, is a work in progress, with recordings of lion and elephant roars, other animal sounds, and human vocalizations being compiled, mixed, and manipulated to achieve the "organic" effect desired by Sonnenfeld. Even more challenging is alien dialogue, which was shot on-set with actors speaking English, but is being redubbed and subtitled in the final mix. "There are people in LA who specialize in making vocalizations, creating lexicon and lingo," says Lievsay. "I assume they do it just for the movies; I can't imagine what other purpose there would be. We ship them out material, they carefully calculate the way the mouths move, and come up with a new sort of phrasing--another language, basically."

This is essentially a more complicated version of an audio post requirement on any movie, automated dialogue replacement (ADR). Another standard task, whether for movies about screenwriters, gumshoes, or aliens, is Foley editing, which fills in the aural blanks left by live recording of footsteps, doors opening and closing, prop handling, and so on. "I give the Foley artists notes that describe what we want them to record, and they use their own judgment based on years of experience to decide what the sound should be," says Lievsay. "Footsteps are usually obvious, once you figure out what the surface is and what kind of shoe it is."

C5's Foley stage is a cluttered affair, stocked with everything from shoes and varied surfaces to rocking horses and bedsprings. Foley editor Pross says it all came from "nearby flea markets, cleaning out our closets, raiding dumpsters. We've been picking up garbage for seven years. And usually when a new prop comes in, whether the movie calls for it or not, within a day or two, we manage to use it.'

After all of the elements are compiled, the picture is edited, and the sound effects are coordinated with the composer's contributions. The last stage of the process is the final mix, which Lievsay usually supervises at a facility like Sound One, or occasionally in California. With the addition of C5's newest mixing suite, which integrates a 16-track Avid Audio Vision with a fully automated 112-input Otari console, even that stage can sometimes be accomplished onsite.

"We're at a happy point now where we can produce quality work quickly, and where we don't really have any technological drawbacks," concludes Lievsay. Nevertheless, he is always looking toward the next innovation. "This is our fourth generation of editing platform," he says of the Avid. "I think the next generation will be much cheaper, much faster, and able to do a lot more. I'm looking forward to taking all these workstations and throwing them away when the new thing comes around, whatever it is."

# Editing: A Primer

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URL: <http://www.loop.com/~chaskes/edit.html#Film Editing>

## Film Editing Home Page

Let me introduce myself: I'm Michael Chaskes, a Los Angeles-based freelance film editor (for more about me, visit my home page, Michael's Cutting Room). Several years ago, I noticed that there weren't many web pages which are devoted exclusively to the art of film editing, and so I created this page to provide some basic information and links. Since then, I'm happy to report that a bounty of editing-related pages have sprung up, and you'll find links to many of them below.

Since I started this page in 1996 (how the time does fly!), many of you have written to say hello to me. Thanks! And if you wrote a while ago and still haven't heard back from me... well, my sincerest apologies. My life has taken some interesting turns this year, and as a result, my e-mail responses have fallen (and will probably remain) several months in arrears. I'm reading your letters as I receive them, but replies may yet be a while in coming. Thanks for your patience, and I expect to get around to replying... one of these days. (NOTE: Regrettably, I cannot promise lengthy replies of any sort, particularly to technical questions about the editing process, interview questions about myself, or advice on film schools and editing careers. I love to write on all of these subjects, but alas, time simply does not permit. Your technical questions will be much better addressed if you follow the links at the bottom of this page and/or read some of the suggested books. And for all who'd like to know how I've gotten to where I am now--wherever that may be--please visit my home page (URL above) and/or read my journal.) I can be reached at [chaskes@loop.com](mailto:chaskes@loop.com).

If you haven't already seen it, I commend to you Loren Miller's insightful short treatise on motion in movies, which he graciously allowed me to reprint below.

There are also a few new links below. I'd love to add more reader contributions. From the outset, this page has contained a standing request for readers to submit material or links that are relevant to film editing. I've received lots of link suggestions (and added most of them), but very little actual writing. Your film-editing articles, tips, insights, and stories would add to this page's liveliness and value... so send 'em in! (Of course, all reprinted work will be duly credited to its author(s).) And naturally, please keep sending those links too.

Thanks for your visits, and I look forward to hearing from you.

# What Is Film Editing?

Or, "You mean it doesn't come out of the camera looking like that?"

A common misconception about filmmaking is that the director shoots only what film s/he needs, and that what is seen onscreen is more or less everything that the director shot. In most cases, nothing could be further from the truth.

Ordinarily, a director shoots vast amounts of "coverage"--that is, raw footage from which the film will be constructed. For any given scene, the director will frequently shoot a minimum of three "setups" or "angles"--that is, views on the scene that vary from each other in terms of focal length, camera position, amount or type of camera motion, etc.

For instance, for a simple two-character dialogue scene, typical coverage might include a long shot (both characters visible along with their environment), a two-shot (both characters facing each other, visible from head down to shoulders or waist), over-the-shoulder shots (close shots of each character, with the shoulder and back of the head of the other character visible in foreground), and close-ups (head and shoulders, or just the head, of one character only). The director will often shoot the whole scene, in its entirety--not just the portions s/he expects to use--from each of these angles. Further, the director will often shoot and print more than one "take" of each angle, in order to get the best possible acting and technical performances or to explore alternative interpretations of the material. When all is said and done, the director will probably have shot between 10 and 20 times as much footage as will ultimately be seen in the finished film.

The "dailies" or "rushes" (the film "straight out of the camera," after it's been developed, printed, and synched with the production sound) look nothing like a finished film. The dailies-watching experience consists of seeing the same script material performed over and over again, in long takes without a single cut except when the camera has been stopped and re-started, seen a few times in a row from one angle, then a few times in a row from another, and then another. Clearly, this material has a long way to go before anyone will pay to see it!

This is where the film editor comes in. Rather than being the person who simply "takes out the bad parts," the editor "puts together the good parts." In fact, s/he puts together everything. The editor attends dailies screenings and takes notes from the director on which takes the director prefers, and if the director has any particular scheme in mind for how a scene should be put together.

Then the editor actually begins to assemble the movie, scene by scene. S/he will often spend some time looking at the footage again, getting to know it as well as possible. Then s/he will choose and mark sections of one take or another that s/he wants to use. Finally, s/he will begin to cut the selected pieces of film together. There will be many false starts along the way, as the editor looks at the scene coming together and decides whether it's working or not. S/he may ask the opinion of an assistant editor or other trusted associate about the scene. Finally, s/he will put it aside and move on to the next scene.

As the editor cuts, s/he must keep a number of considerations in mind. S/he must look for the best acting performances and technical values (camera motion, lighting, etc.). S/he must make each individual cut as fluid and seamless as possible (except where a more rough-hewn effect is desired). S/he must cut to new and appropriate angles at dramatically proper points in the

scene. And, in the final analysis, s/he must use the material the director has shot to tell the story in as involving and as emotionally charged a way as possible.

# Cutting Film vs. Non-Linear Editing

(Note: For purposes of the following discussion, I will use the Avid Film Composer as a representative non-linear system, since it is the leading system as well as one with which I happen to be familiar.)

In the last several years, a revolution has taken place in film editing. Until recently, virtually all feature films were edited "on film." That is, editors cut actual film--workprint made from camera negative and mag dubbed from original production recordings. They viewed and listened to footage on an upright Moviola or on a flatbed table, marked cut points with grease pencil and Sharpie pen, and made the actual cuts with a splicer and tape.

A few editors preferred to cut film electronically, transferring dailies to videotape and then laboriously assembling a cut by re-recording selected shots from deck to deck in the order desired. This "linear" editing suffered from one major drawback: since no videotape was physically being spliced, the editor was required, upon trimming, extending, or adding a shot anywhere but at the end of the cut material, to re-record all of the cut work that followed the change. Film, on the other hand, still retained a marvelous "non-linear" quality: one could add or extract material anywhere in the cut without affecting the footage that followed it.

Computers facilitated a revolution in the editing room. By modifying home PCs such as the Apple Macintosh or DOS-based computers, Avid, Lightworks, and other companies ushered in the age of Digital Non-Linear editing. Their innovation: making it possible to digitize footage: originally onto optical disks, later onto high-capacity hard drives. Rather than cutting film or re-recording videotape, the editor merely creates files which tell the computer in what sequence to play back which pieces of digitized material. The editor can make changes at any point to any part of the sequence without affecting what follows.

Non-linear has swept the editing world. From studio films to low-budget, even to student filmmaking, everyone seems to be editing on Avid or a competing non-linear system. The president of the Editors Guild wrote in 1996 that film-based editing was dead, and in a recent conversation with a technician at a major Hollywood lab, I was told that 80% of all films they process are telecined for non-linear editing.

And yet, there are still plenty of flatbeds out there, and labs still print dailies on film if you want them to. (Mag stock is beginning to grow scarcer but, to my knowledge, will still be available for some time.) Cutting on film is still possible and still (at least compared to non-linear) relatively inexpensive.

What advantages do digital non-linear systems offer over traditional film-based editing? The first is an enormous savings in time. Cutting film requires endless putting up of rolls, taking down of rolls, shuttling through rolls, rewinding rolls, etc. to find and view footage (or, on a Moviola show, unwinding of shots, viewing shots, re-rolling shots, etc., etc.) When the editor actually wants to make a cut, s/he must physically line up the out point on both the picture and the track to assure sync, make the cut, splice the new shot into the cut, and splice the dailies roll back together to close up the gap. Finally, when the editor wishes to extend a shot, whether by a few frames or a few feet, s/he must find the necessary footage--which might be back in the dailies rolls, hanging from the trim bin, rolled up with unfiled trims or lifts, or (as inevitably happens, particularly during a crunch) completely and mysteriously AWOL.

In non-linear, these problems disappear. The computer can instantly access and display any part of any shot at any time. Shots can be organized and re-organized without physical labor, by simply dragging shots into a new "bin" (the Avid term for a digital file folder). Cuts are made instantly; the editor need only choose an in and out point in the source material and an in or out point in the cut work (or vice versa), click a button, and voila. Extensions or trims can also be made instantly.

A second advantage of non-linear systems is the increased ability to experiment. In film, if an editor wishes to re-cut a scene while retaining the option of returning to the previous version, s/he must make a dupe of the old scene, reconstitute the footage back into the dailies rolls, and recut. This is time-consuming and expensive, results in a large number of splices in the workprint, and requires another reconstitution and re-assembly if the original version is opted for.

In non-linear, the editor simply creates a new file (or "sequence" in Avid parlance) for the alternate cut. Both sequences--the original and the recut--can then be viewed back-to-back if desired. One can theoretically generate any number of versions of a given sequence with no undesirable repercussions.

A third advantage of non-linear systems is the ability to instantly create and view optical effects (such as fades, dissolves, wipes, titles, superimpositions, etc.). In film editing, one marks the workprint with grease pencil where an optical is desired, but the actual appearance of the effect can only be imagined. Later, the required camera negative is pulled so that an optical house may create the actual opticals; if the editor doesn't like an optical, it must be discarded or re-ordered, and the original expense of producing the optical has been wasted.

Non-linear systems will create a viewable effect more or less instantly. Eventually, an optical house will still have to create optical negative with which to strike release prints; but the editor can first play with the effect on the computer until s/he is sure that the effect ordered is in fact wanted.

Non-linear systems also have a number of disadvantages. The first consideration--for low-budget films in particular--is their cost. In Los Angeles, an Avid Film Composer with a relatively modest 18 GB of digital storage can rent for between \$700 and \$1,500 per week, while a flatbed and editing bench setup (including rewinds and splicer) should rent for considerably less. (Of course, editing on film requires full-time work by one or more assistant editors, and in low-budget, their salaries may or may not eat up the remaining difference in cost.)

The second disadvantage is resolution. While some non-linear systems will digitize at "broadcast quality," systems geared toward feature film editing will generally digitize only at fairly low resolutions. At these resolutions, fine detail is lost and the image appears somewhat pixillated. This can make it difficult for an editor to assess the visual quality of a shot which s/he is considering for use in the cut. (Higher resolutions consume more disk storage, which adds extra expense. Avid's Film Composer does not even offer broadcast-quality resolutions, although their Media Composer 8000 and 9000 models do offer both broadcast-quality resolutions and film-cutting capability.)

The third disadvantage of non-linear systems is that one cannot easily view cut material on a movie screen (or even the dailies, for that matter, since--on low-budget films at least--videotapes are frequently telecined directly from negative, and positive workprint is never made). In film-based editing, of course, one can drag one's cut reels down to the screening

room any old time and have a look. In non-linear, even if a production has the budget to print dailies as well as telecining them, assistant editors must output cut lists from the Avid and manually conform the workprint to the editor's work on the Avid. In this way, cut work can be screened in the ordinary manner... but at considerable expense.

A fourth disadvantage is the inevitability of downtime. Catastrophic breakdown of flatbed editors is rare; at most, typically, one might blow a lightbulb, which can be replaced in a moment. Avids, on the other hand, experience a variety of technical problems ranging from software conflicts to hardware incompatibilities to corrupted files to defective cards. Any one of these can stop editing dead in its tracks, and fixing it can in some cases take days. Even though Avids still save editing time in the long run, their occasional prolonged downtimes can cause intense frustration.

Finally, non-linear systems have one last disadvantage. By allowing filmmakers to edit faster than ever before, and with their high rental costs, they are encouraging producers to put fewer and fewer weeks of picture-editing into post-production schedules. This raises a question: just because it's become possible to cut a feature film in five weeks, does that make it desirable? Traditional film editing enforces, through its physicality, a slow and deliberate pace, and produces a happy by-product: plenty of time for editor and director to reflect on the cut. Sometimes it's necessary to walk away from a cut for a little while, then to come back and screen it again with a fresh eye. Reflection over a period of a few months can be good for a film in progress. By encouraging producers to trim down the editing process, non-linear systems are unintentionally causing films to be rushed into picture-lock, whether they're completely ready or not.

For better or worse, non-linear editing is clearly here to stay. How long film-based editing will co-exist with it is anyone's guess. Speaking strictly for myself, I think that the unbelievable speed and ease of non-linear editing more than makes up for its other deficiencies. After one has edited without those once-necessary evils of searching for trims or making one-frame extensions, returning to film-based editing seems like an impossible chore.

But, having returned to the occasional 16mm flatbed project after editing on Avid, I found that it is possible to go back. There are certain tactile pleasures to editing on film which non-linear can't match: the feel of celluloid in your hand as you thread up a flatbed or make a splice, and the satisfying sight of cut material slowly growing in diameter around the take-up core.

Of course, in the end it's all the same. As audiences view the finished film, they won't know by what technique it was edited; they will judge only whether the film touched them, moved them, entertained them, made them think. Putting together pieces of film to elicit these responses is the only thing that matters for the editor, whether s/he works on film, videotape, or non-linear.

# Film Editing Resources on the Net

## Newsgroups

rec.arts.movies.production - deals with all manner of production-related issues, editing included.

rec.arts.movies.tech - primarily for presentation/exhibition-related issues like widescreen formats and theatrical sound; may be of interest.

## Mailing Lists

Editing-L Description: Per list administrator Lee Unkrich, Editing-L is "devoted to discussion of the art and technique of film editing. It is intended as a forum for professional editors, student editors, as well as anyone who is interested in this fascinating, often misunderstood art. The term 'film editing' is meant to include both editing on motion picture film, as well as on all of the current linear and non-linear editing systems. Philosophical discussions are welcomed, as well as specific questions concerning technique. Please, however, restrict discussion of system-specific topics to the various system-specific newsgroups and mailing lists." For Subscription Info: Leave subject line blank; type "info" in body of message. On the Web: Editor Darren Jonassus has begun compiling a Web archive of Editing-L threads; Andy Birkhead has also created an Edit-L FAQ.

Avid-L Description: Forum for Avid users to share tips and answer each other's questions. Avid employees often contribute to the discussions. To Subscribe: type "subscribe avid-l-digest name <e-mail address>" in body of message On the Web: Visit the searchable, rather comprehensive Web archive of Avid-L threads, or Andy Birkhead's Avid-L Compilation FAQ.



# Publications About Editing

Many of these are also available at general bookstores, from specialty shops such as the Samuel French Bookstore, or at online booksellers like Amazon.com.

## Technical Guides

The Film Editing Room Handbook by Norman Hollyn - the best and most readable guide I've seen for assistant/apprentice editors, and a good overview of the feature-film post-production process in general. The new edition has been updated to include non-linear as well film-based editing room processes. Introduction to Film Editing by Bernard Balmuth (Focal Press) - much the same scope as Hollyn's book, but in a less accessible, textbookish-style; I don't know whether it's been updated since the non-linear revolution. Film Editing Nutz & Boltz by Film Guy - another popular technical manual, but one which is temporarily out of print. According to my friend and fellow editor Gary Mairs, there's "no word on when it will return; every cinema bookstore in town [Los Angeles] has long since sold out." Presumably, used copies are still floating around. The author's website, which itself used to be an excellent editing resource, is also sadly on hiatus. Film Editing Handbook: Technique of 16mm Film Cutting by Hugh B. Churchill - recommended by Bill Paton, who cites its "practical methods of dealing with 16mm film editing, such as use of the gang synchronizer, organization and more. Also includes sample forms and charts." Electronic Post Production and Videotape Editing by Arthur Schneider (Focal Press) - I haven't read it, but its author is a member of A.C.E. (and recent recipient of their Life Achievement Award--congratulations, Art!) and a 40-year veteran TV editor. Also check out the companion volume, Electronic Post Production Terms and Concepts. Digital Non-Linear Editing by Thomas A. Ohanian (Focal Press) - "great to introduce one to the basics of nonlinear editing," says Gustavo Gaiarsa, an editor in Sao Paulo, Brazil. As Ohanian is the much-admired Chief Editor at Avid, I don't doubt this for a second.

## The Art and Principles of Film Editing

The Technique of Film Editing by Karel Reisz and Gavin Millar (Focal Press)- "very British but excellent," sez rec.arts.movies.production contributor Tom Hartig. On Film Editing by Edward Dmytryk (Focal Press) - Most of Dmytryk's advice makes much more sense after one has already learned how to edit than before. Nonetheless, much of his theory seems quite sound; if nothing else, his advice for dealing with incoherent directors' requests for changes is quite priceless. When The Shooting Stops... The Cutting Begins by Ralph Rosenblum (and Robert Karen) - a fascinating memoir of a great editor's career, with lots of insight into creative editing processes. Editor Loren Miller has written a nice remembrance of Mr. Rosenblum. In the Blink of An Eye by sound and picture editor Walter Murch - interesting personal recollections and intriguing editing theory; thanks to film editor Lee Unkrich for recommending it. First Cut: Conversations with Film Editors by Gabriella Oldham - in-depth interviews with feature and documentary film editors. (Thanks to Lee Unkrich for bringing the book to my attention, and to Eddie Bailey for providing specifics on the title and the author's name.) Selected Takes: Film Editors On Editing by Vincent LoBrutto (1991: Praeger, New York) - This one gets a big thumbs up from Gary Mairs: "It consists of interviews with well-known feature editors, much like First Cut, with which it shares a number of interview subjects, though the interviewer seems better informed on editing practice." Jump Cut! Memoirs of a Pioneer Television Editor by Arthur "Jump Cut" Schneider - Mr. Schneider informs me that the book has just been released by McFarland Publishers. Grammar of the Film Language by Daniel Arijon (Silman-James Press) - "More like a book about directing, but teaches things every editor should know" (Gustavo Gaiarsa). Cinemeditor, "the official periodical of the American Cinema Editors, Inc." - you can order it online from the A.C.E. Store.

## Non-Linear Editing Systems

Avid Technology Online Avid help, from the general to the extremely detailed, abounds on the web. If you're new to non-linear, you might start with FrameWorks' Non-Linear Post Production page, a good introductory overview of the subject. For a more in-depth discussion of Avid issues, particularly as they relate to the relationship between 24 and 30 fps projects, move on to Alan Stewart's page of technical documents, which explains, concisely but completely, such topics as the 2:3 pulldown in film telecine and how the Avid deals with it (Stewart, an Applications Editor for Avid Technology, knows of what he speaks).

When technical issues really have you down and things are getting sticky, consult the codified wisdom of the myriad contributors to the Avid-L e-mail list: at one time or another, Avid-L has probably dealt with every major Avid technical issue imaginable, and Andy Birkhead's Avid-L Compilation presents some in well-indexed FAQ form (there's also a link there to his Edit-L FAQ). You can also visit a searchable, rather comprehensive Web archive of Avid-L threads. Digital Media's Avid Tools page may also be useful, as it contains links to other helpful Avid files and tips. You might also visit Avideditor.com, a site featuring resources for Avid editors, an editor registry, job postings, and chat rooms. Finally, Avid itself offers the Avid Knowledge Center, the official online compendium of Avid wisdom. Lightworks Home Page Runway Edit's Editor to Editor series features simply-written but informative articles of interest to film editors working on Avid and Lightworks. Media 100 Home Page; editor Jordan Goldman also recommends the Media 100 Resource Website and the Media 100 Worldwide Users Group page postforum - macintosh digital video resources - Perry Paolantonio's site for online discussion of Mac-based systems. FilmLogic Home Page - FilmLogic has created Power Mac software which, it advertises, moves Adobe Premiere and other desktop nonlinear editors into a true 24 fps film-editing environment, complete with the ability to produce negative cutlists.

## Other Editing Links

The Motion Pictures Editors Guild Home Page - the official website of IATSE Local 700, complete with information on how to become a member (hint: it's pretty hard), special members-only discussion boards, and--perhaps most useful for the lay public--the on-line version of its newsletter, which is loaded with interviews, non-linear tips, film and book reviews, and other articles of general interest to editors. American Cinema Editors - home page of the U.S.'s honorary organization for film editors. J&R/Moviola Editors Alley - the Hollywood post-production rental company's editing resource. EditorsNet - a very nice site dedicated to picture and sound editing, featuring interviews with editors of big films as well as business and tech news. editing? that's throwing away your movie! - a bizarre little site from the intensive cinema unit. Features a history of the upright Moviola and a quaint but very detailed step-by-step lesson on hot-splicing. SOFIA Editing Page - an overview of basic editing theory. Film Schools - the Film Maker's listing of North American colleges and universities with film programs and coursework; a more comprehensive list is to be found in the American Film Institute's published directory, available at most libraries. Film Maker also offers the Library Of Annotated Film School Survey, a page that allows film school grads to post "reviews" of their experiences at their particular alma maters. N.B.: There is no list that I'm aware of which specifically lists schools offering editing courses. (People frequently ask me about this.) Internet Filmmaker FAQ - Ben Craig's excellent all-purpose filmmakers' FAQ, which addresses a few editing issues. Cyber Film School - Online Filmmaking Learning - links to various production-related web articles and resources, organized by category. The editing section links to some useful technical pages (and even a link to this page, along with a flattering description... I'm blushing!). Fade to Black Post-Production Conference - transcripts from a 1996 Australian

conference on the role of digital editing in post. Thanks to Matthew Tucker for putting me onto this link. Page From Outer Space - Matthew Tucker's terrific editing site. Australian Screen Editors - another great site from Matthew Tucker; includes links to tips, anecdotes, ASE's monthly newsletter, and more. So what does an editor do? - an amusing but, sadly, not inaccurate short essay about film and video editors, courtesy of the BBC. I found the link on the Mining Co.'s Editing Internet Resources page. Reading a Film Sequence - of general interest for editors; from the University of Victoria's "New German Film" course. Thanks to Bill Paton for suggesting the link. Cut to the Chase - advertisement/ordering information for a software product that offers to provide Hollywood-style footage for users to practice editing on a home computer. The archive of DOX Documentary Film Magazine contains a very good article about "two-dimensional" documentary editing, which is an editing style that throws standard continuity rules out the window. The article is written by Lars Bo Kimergaard, professor of Film and Media Studies at Copenhagen University, who would appreciate hearing your thoughts on his article. Film Sound Theory - Sven E Carlsson's outstanding page defines sound terms, quotes liberally from theorists, and gets into some nitty-gritty case studies on film sound design, including Ben Burt's classic work on Star Wars. If you simply can't get your hands on an Avid (or a feature film) by any other way means, you could shell out to attend Avid Film Camp. A similar outfit is The Edit Center. Both, as I understand them, offer participants the opportunity to cut a real feature film collaboratively on Avid, under the tutelage of master editors.

Last updated: October 31, 1999.

# Film/Video Glossary

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**Above The Line:** Budget term denoting expenses for a video's creative costs such as the director, producer, and talent salaries (costs other than technical crew and equipment). In contrast see below the line.

**A/B Roll:** The use of alternating scenes, recorded on separate videotape reels (an A roll and a B roll), to perform dissolves, wipes or other types of video transitions.

AGC (automatic gain control): Electronic circuitry that compensates for either audio or video input level changes by boosting or lowering incoming signals to match a preset level. Using AGC, changing input levels can output at a single constant setting.

ambient sound: A representative sample of background audio (such as a refrigerator hum or crowd murmur) particular to a shooting location. Ambient sound is gathered in the course of a production to aid the sound editor in making cuts or filling in spaces between dialog. Also called room tone.

analog: A continuously varying electronic signal. Audio and video analog signals stored on tape deteriorate with each copy or generation. In contrast see digital.

analog recording: The common form of magnetic recording where the recorded waveform signal maintains the shape of the original waveform signal.

A-only edit: Audio-only edit.

aspect ratio: A measure of screen size as articulated by the ratio of width to height. Video's aspect ratio is 4:3.

assembled edit: Electronic edit that replaces all previously recorded material with new audio and video and a new control track, starting at the edit point. Inserting a new control track allows for a constant speed reference throughout the entire tape.

assistant director (AD): The video crew member acting as primary assistant to the director. Maintains continuity, logs shots, and acts as stand-in for the director.

audio: The sound portion of a program.

audio mixer: A component that combines more than one sound input for composite output.

auto assembly: Process of assembling an edited videotape on a computerized editing system under the control of an edit decision list (EDL). A computer automatically conforms source footage into an edited video program under the direction of a list of preprogrammed edit instructions.

auxiliary channel (AUX): In a video editing system, a channel reserved for connection to an external audio and/or video device.

A/V edit: An edit that records new audio and video tracks. Also called straight cut.

back focus: A physical repositioning of the CCD, the camera element that translates light into electronic pulses for recording on videotape. The effect is to lengthen or shorten the distance between the lens and the CCD.

barn doors: Two- or four-leafed metal blinders mounted onto lights to control brightness or direction.

below the line: Budget term denoting expenses for a video's production costs such as equipment rental, tape stock and technical crew salaries. Does not include creative costs such as director, producer and talent. In contrast see above the line.

Betacam: Broadcast quality 1/2 inch videocassette format developed by Sony.

Betacam SP: Advanced broadcast quality 1/2 inch videocassette format developed by Sony. Betacam SP has longer recording capabilities and more audio channels than Betacam.

boom: A "fishing pole" or arm-like microphone or camera stand that allows audio or video equipment to be held close to its subject without breaking the frame of the shot.

breakdown: A written accounting of the shooting schedule and production resources.

breakup: Disturbance in the picture or sound signal caused by loss of sync or by videotape damage.

B roll: exact copy of the A roll original material, or new original material on a separate reel for use in A/B roll editing.

bumping up: Transferring a program recorded on a lower quality videotape to a higher quality videotape (e.g., from Hi8 to Betacam). Bumping up to a higher format allows footage to be preserved on a more stable tape format and makes it possible to edit in a higher-end editing environment.

CCD (charged coupled device): The computer chip in video cameras that converts light images into an electronic signal.

character generator: Electronic device which produces graphics and characters for creating video titles.

chroma: Video color, or saturation.

chrominance: Saturation and hue characteristics of color television.

closed captioning: A method of embedding subtitles within the video signal. The subtitles can be descrambled and viewed on the television screen with the use of special decoding equipment.

closeup: A camera shot that is tightly framed, with its figure or subject filling the screen. Often qualified as medium closeup or extreme closeup.

color bars: Standard color test signal, displayed as rows or bars of color, used in the alignment of color video equipment.

component video: Video signal in which the luminance and sync information are recorded separately from the color information. Superior to composite video.

composite video: Video signal that combines both luminance and chrominance in a single signal. Inferior to component video.

composition: Framing or makeup of a video shot.

contrast: The difference between the brightest and darkest parts of the picture.

control track: The portion of the videotape that records the electronic pulses used to synchronize video during recording and playback.

control track editor: Type of editing system that uses frame pulses on the videotape control track for reference.

cut: In editing, an immediate switch from one image to another, without the aid of transitions such as the dissolve or wipe.

decibel (dB): Unit of measurement for sound levels.

degauss: Erase a videotape completely by exposing the tape to a magnetic field.

depth of field: The range within which all subjects, though located at different distances from the camera, are in focus.

digital: Electronic system which functions by converting the analog signal into a series of discrete binary bits (ones and zeros).

director: Video crew member controlling all aspects of action in front of the camera, including lighting, talent, and camera movement. Directs the entire crew and is responsible for final completion of the project.

director of photography (DP) or videographer: Video crew member responsible for producing the desired image, in both content and style, on camera. Works closely with the director and the gaffer.

dissolve: A video transition in which the existing image is partially or totally replaced by superimposing another image. One image fades in as the other fades out.

distribution amplifier: Amplifier that allows one video or audio signal to be sent to several pieces of equipment simultaneously.

drop-frame time code: SMPTE time code format that skips (drops) two frames per minute except on the tenth minute, so that the time code stays coincident with real time. The television broadcast standard for time code.

dropout: Drop in the playback radio frequency level, resulting from an absence of oxide on a portion of the videotape, causing no audio or video information to be stored there. Dropout usually appears as a quick streak in the video.

dub: To make a copy of a video recording.

dubs: Copies of videotape.

dynamic range: An audio term which refers to the range between the softest and loudest levels a source can produce without distortion.

edit: Build a video or audio program from source footage.

edit decision list (EDL): List of edits performed during on-line editing. The EDL can be handwritten list or computerized set of instructions used to direct the final outline editing assembly of the video programs.

enhancing: Electronically adjusting the quality and sharpness of a video image.

fade: Usually, a dissolve from full video to black video or from full audio to no audio.

feed: The transmission of a video signal from point to point.

feedback: A loop caused by audio or video signal being fed back into itself. In video the effect is caused when a camera is directed at its receiving monitor. In audio the effect, manifested as an echo or squeal, is caused when a microphone is aimed at a speaker.

flash: Interference or breakup to one field or less of the video signal. Also called a hit.

fluid head: Refers to a tripod mount that contains lubricating fluid which decreases friction and enables smooth camera movement.

format: Refers specifically to tape sizes and qualities, and generally to classes of video equipment. Popular video formats in decreasing order of quality and expense are: Digital Betacam, Betacam SP, Betacam, 3/4"SP, S-VHS, Hi8 and VHS.

frame: One complete video picture. A frame contains two video fields, scanned at the NTSC rate of 30 frames per second or the PAL rate of 25 frames per second.

frequency: A measurement of a signal's vibration, represented as cycles per second or Hertz (Hz).

gaffer: The head lighting technician in a film or video crew. Implements the lighting plans of the Director of Photography and is responsible for set power requirements.

generation: Copy of original video program material. The original videotaped material is the first generation. A copy of the original is a second generation tape and so on. Generally the edited master tape is a second generation tape. Quality diminishes with each generation.

head: Magnetic pickup device in a VTR used to record, erase or reproduce video and audio signals.

headroom: In composition, the space between a subjects head and the upper boundary of the frame.

hertz (Hz): A unit used to measure frequency. One hertz equals one cycle per second.

Hi8 (high-band 8mm): A higher quality version of the 8mm videotape format. Uses a higher luminance resolution to produce a sharper picture than regular 8mm videotape.

hiss: Background signal interference in audio recording.

hue: The shade of color. On television set, hue is called "tint."

in-point: Starting point of an edit.

iris: The video camera's lens opening which regulates the amount of light entering a camera.

jitter: Jumping or instability in the television picture, often caused by synchronization or tracking errors.

jump cut: A mismatched edit that creates a visual disturbance when replayed. Usually occurs when cutting between two images which share an identical subject but place the subject at different positions in the frame.

lavalier: A small microphone clipped to clothing or hung around the neck.

linear editing: A form of analog editing in which sequential edits are laid out in a linear fashion from the start to the end of the tape. Precludes inserting footage without re-recording all following edits. In contrast to nonlinear editing.

location: Shooting locale.

long shot: Camera view of a subject or scene, usually from a distance, showing a broad perspective.

luminance: Amplitude (strength) of the gray scale or black-and-white portion of the video signal.

master: Original videotaped footage.

medium shot: Camera perspective between long shot and closeup, whereby subjects are viewed from medium distance.

memory effect: Loss of power storing capability in NiCad (video camera) batteries which occurs when batteries are habitually discharged only partially before recharging. To avoid the memory effect, always fully discharge batteries before recharging.

mixer: See audio mixer.

mixing: Combining more than one audio sources into a single audio signal output.

monitor: A device for viewing video. A high resolution television set without a tuner for displaying live or recorded video signals.

monochrome: Black and white.



NiCad (nickel cadmium): Common rechargeable video camera battery type.

nonlinear editing: Digital editing style stores images on a hard drive rather than tape. Allows random access to images and "cut and paste" style arrangement of footage. Allows individual edits to be changed without necessitating the alteration of following edits. In contrast to analog or linear editing. NTSC: National Television Standards Committee, the group that established the color TV transmission system used in the US.

NTSC color video standard: The US standard for color television transmission, calling for 525 lines of information, scanned at a rate of 30 frames per second. (also see PAL).

off-line editing: Preliminary post-production editing session, used to establish editing points and to prepare an edit decision list (EDL). The result of an off-line edit is a rough cut. Compare to on-line editing.

off-line editor: Video crew member who edits footage shot during production in order to aid director in building the story aspect of the program in the form of a rough cut. Focuses on content, looking at transitions, juxtapositions and pacing throughout the entire piece.

on-line editing: Final editing session, the stage of post-production in which the edited master tape is assembled from the original production footage, usually under the direction of an edit decision list (EDL).

on-line editor: Video crew member who, guided by the rough cut from the off-line edit, edits the final piece using the camera masters. Possesses a mix of high-end technical proficiency and aesthetic skills to help the director and producer refine transitions and sound levels efficiently.

open-ended edit: Edit that has a start time but no designated stop time.

PAL (phase alternate line): The European standard for color television transmission, calling for 625 lines of information, scanned at a rate of 25 frames per second (also see NTSC).

pan: A horizontal camera pivot (from right to left or left to right) from a stationary position.

paper edit: Rough edit decision list made by screening original material, but without actually performing edits.

patch: Connect equipment with wires and/or cables.

pedding: Raising or lowering the camera while the camera remains level. Vertical equivalent of dollying. picture safety area: The area of a video signal which will be visible on a receiving monitor. Often denoted by marks within the viewfinder of the video camera.

playback: The viewing of recorded video footage.

post-production (post): All production-related tasks that occur after shooting is completed. Editing, titling and sound mixing are common post-production activities.

post-production coordinator: Video crew member responsible for overseeing the production flow of the editing process from camera original duplication to final on-line edit. Maintains good communication between editors and director and producer. Liaison to post-production facilities such as duplication houses, animators, editing houses, composers et al.

pre-production: The universe of tasks that must be completed before shooting begins. Includes budgeting, production planning, scheduling, and equipment rental.

preview: To rehearse an edit without actually performing edits.

processing amplifier: Electronic device that processes the video signals fed through it by allowing adjustment of the signal levels and providing stable horizontal and vertical sync.

producer: Video crew member who manages and organizes the video project from pre- to post-production. Works closely with the director to determine resources, quality levels and budget.

production assistant (PA): Video crew member who provides general assistance to the production. Roles vary from craft services (food preparation) and transportation, to coiling cables, breaking down sets and running errands for the crew during production.

raw footage: Videotape recordings that have not been edited.

remote: Videotaping outside of the studio environment.

rgb: Abbreviation for the primary colors of light: red, green and blue.

rough cut: Preliminary edit of raw footage to establish tentative sequence, length approximate sequence and content of the eventual video program.

saturation: Amount of color in the television picture.

shot: Picture information recorded by a camera.

shotgun: A long and narrow highly directional microphone. Aimed at its subject, the shotgun mic is designed to capture sound from long distances.

SMPTE: Society of Motion Picture and Television Engineers.

SMPTE time code: Binary time code denoting hours, minutes, seconds and frames. See also time code.

sound recordist: Video crew member responsible for the operation of sound recording equipment including microphones and mixers.

stereo: Sound received from two separate sources. Simulates human hearing.

storyboard: A sequential series of sketches illustrating stages or scenes in a production. Used as a visual script or shooting plan.

submaster: High quality copy of a master tape used to make additional copies. See also dub.

Super-VHS (SVHS): A higher quality version of the VHS videotape format. Separates chrominance and luminance information to produce a sharper picture than regular VHS videotape.

S-video (Y/C video): Hi8 and S-VHS signal that transmits chrominance and luminance information separately to minimize loss of picture quality.

sweetening: The final combining and enhancing of a video program's audio tracks.

switcher: Device for mixing multiple video signals. Used for special effects, transitions, generating titles.

sync: Abbreviation of synchronization. Usually refers to the synchronization pulses necessary to coordinate the operation of several interconnected video components. When the components are properly synchronized, they are said to be "in sync."

tilt: A vertical camera pan from a stationary position. The camera pivots up or down from a fixed point.

time code: Electronic indexing method used for editing and timing video programs. Time code denotes hours, minutes, seconds and frames elapsed on videotape.

titles: On screen text such as credits or dialog translation.

tracking shot: A shot containing camera movement.

VCR: Videocassette recorder.

VHS (video home system): 1/2 inch consumer videotape format.

video camera: A camera that captures light on chips that convert light into electronic impulses (CCDs) and then fix the electronic impulses onto tape.

videotape: Oxide-coated plastic-based magnetic tape used for recording video and audio signals.

viewfinder: Camera feature that allows operator to view the image as it is being recorded. Video viewfinders typically depict the recorded image in black-and-white.

VTR: Videotape recorder.

whip pan (swish pan): A quick movement of the camera from left to right or right to left which creates a blurred image.

white balance: A video camera feature that compensates for color temperature, automatically adjusting light levels to improve color recording. White balance is set prior to shooting by aiming the camera at a uniformly white object.

wide-angle: Refers to camera lenses with short focal length and broad horizontal field of view.

window dub: Copies of videotape with "burnt in" time code display. Hours, minutes, seconds and frames appear on the recorded image. Window dubs are used in off-line editing.

wipe: A editing transition in which reveals the next picture with a moving pattern or geometric shape.

zoom: Expanding an image within the frame by bringing the subject into closeup.

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# Video Glossary

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**A/A ROLL EDITING** Editing from a single source VCR using a freeze frame as a transition from the source VCR to itself (source "A" to "A").

**A/B ROLL EDITING** Editing from two source VCRs to a third recording VCR. A switcher or mixer is used to provide effects such as dissolves.

**ADO (Ampex Digital Optics)** Trade name for digital effects system manufactured by Ampex.

**AGC (Automatic Gain Control)** A circuit that automatically adjusts audio or video input levels.

**ALIASING** Undesirable video display effects caused by excessive high frequency video information. Three examples are: Jaggies or Stair-stepping - Stepped or jagged edges of angled lines, especially at the slanted edges of letters. Raster scan aliasing - e.g., twinkling or strobing effects on sharp horizontal lines Temporal aliasing - e.g., rotating wagon wheel spokes apparently reversing direction.

**ANALOG** An electrical signal using continuously varying electrical voltages. Analog video that is copied or edited several generations suffers from generation loss and is subject to degradation due to noise and distortion.

**ANIMATIC** Simple animation consisting of art work designed to be used as a video tape storyboard. Most commonly used for test commercials.

**ANTI-ALIASING** The process of electronically reducing aliasing, especially letters and genlocked graphic elements.

**AM (Amplitude Modulation)** Amplitude modulation is a process used for some radio (AM broadcast) and television video transmission. A low frequency (program) signal modulates (changes) the amplitude of a high frequency RF carrier signal (causing it to deviate from its nominal base amplitude). The original program signal is recovered (demodulated) at the receiver. This system is extensively used in broadcast radio transmission because it is less prone to signal interference and retains most of the original signal quality. See Frequency Modulation.

**AMIGA** The video computer that created the desktop video revolution.

**APERTURE** An adjustable opening in a lens which, like the iris in the human eye, controls the amount of light entering a camera. The size of the aperture is controlled by the iris adjustment and is measured in f-stops. A smaller f-stop number corresponds to a larger opening which passes more light. F-stop examples are F2, F2.8, F4, F5.6, F8, F11. F-stops are logarithmic. Each stop admits 100% more light than the previous one.

**ASPECT RATIO** Ratio of picture height to picture width in video and TV systems. The standard is 3:4.

**ASSEMBLY EDIT** An edit wherein all existing signals on a tape, if any, are replaced with new signals. Assembly edits cannot be used for editing because since they erase the control track portion of the video tape. (See also Insert Edit)

**AUTO ASSEMBLY** Process of assembling an edited video tape on a computerized editing system using an edit decision list.

**B ROLL** Cutaway shots which are used to cover the visual part of an interview or narration. The term is often used in TV news.

**BETACAM** The most common broadcast quality video format. Also Betacam SP, the enhanced version.

**BETAMAX** The obsolete home video format. Lost the format battle to VHS even though it was slightly superior. The cassette size, however, went on to become BETACAM.

**BLACK BURST** A composite color video signal comprised of sync, color burst and black video. Used to synchronize (genlock) other video sources to the same sync and color information. Black burst generators are used in editing systems "lock" the entire facility to a common signal ("house sync" or "house black").

**BLACK LEVEL** Voltage in a video signal which corresponds to black.

**BLANKING LEVEL** Also known as the pedestal, it is the voltage level produced at the end of each horizontal picture line which separates the portion of the video signal containing the picture information from the portion containing the synchronizing information. This voltage makes the electron beam "invisible" as it moves to draw the next visible line.

**BLANKING INTERVAL (Horizontal & Vertical)** The horizontal blanking interval is the time between the end of one scan line and the beginning of the next. The vertical blanking interval is the time between the end of one video field and the beginning of the next. Blanking occurs when a monitor's electron beam is positioned to start a new line or a new field. The blanking interval is used to instantly reduce the beam's amplitude so that the return trace is invisible. The screen goes blank for a fraction of second. (See VERTICAL INTERVAL SWITCHING)

**BNC connector** A type of professional connector used on some VCRs, cameras and video equipment providing twist-lock capability.

**BOOM** An overhead pole device used to position a microphone close to the actors, but out of the shot. A FISHPOLE is the portable version.

**BUY OUT** Music or music libraries in which a one-time fee enables the buyer to legally use the music in many productions without paying additional licensing or "needle drop" fees.

**C.C.D. Charged Coupled Device.** An integrated circuit which captures video images. It has largely replaced tubes in modern video cameras.

**CCTV (Closed Circuit TV)** A video system used in commercial internal installations for security, medical and educational.

**C.U.** Close-up shot.

**C.G. (Character Generator)** An electronic typewriter that creates titles for video.

CATV Acronym for cable TV, derived from the older term, community antenna television.

CHROMA The color information in a video signal, consisting of hue (phase angle) and saturation (amplitude) of the color subcarrier signal.

CHROMA CORRECTOR A device used to correct problems related to the chroma of the video signal, as well as color balance and color noise.

CHROMA NOISE Noise which manifests itself in a video picture as colored snow.

CHROMA KEY The process of overlaying one video signal over another by replacing a range of colors with the second signal. Typically, the first (foreground) picture is photographed with a person or object against a special, single-color background (the key-color). The second picture is inserted in place of the key-color. The most common example is in broadcast weather segments where pictures of weather maps are inserted "behind" the talent.

CHROMINANCE & CHROMINANCE LEVEL The color portion of a video signal separate from the luminance component, representing the saturation and tint at a particular point of the image. Black, gray and white have no chrominance, but any colored signal has both chrominance and luminance. The higher the chrominance level, the stronger the color (e.g., a strong signal produces red, and a weak signal, pink). Color saturation level can be changed using a proc amp.

CHROMAKEY Electronically matting or inserting an image from one camera into the picture produced by another. Also called "keying." The subject to be inserted is shot against a solid primary color background. Signals from the two sources are merged through a special effects generator.

CHROMINANCE The color portion of a video signal.

CLIPPING The electronic process of cutting off the peaks of either the white or black excursions of a video signal to limit the signal. Sometimes, clipping is performed prior to modulation, and sometimes to limit the signal, so it does not exceed the limits of the composite video signal (7.5 and 100 IRE units).

COAXIAL CABLE A standard cable consisting of a central inner conductor and a cylindrical outer conductor. Used for many video connections, especially the cable TV wire that comes into your home.

COLOR BARS A standard video test pattern which includes samples of primary and secondary colors. Used to conform the colors in video monitors and other equipment.

COLOR BURST The portion of a color video signal which contains a short sample of the color subcarrier used to add color to a signal. It is used as a color synchronization signal to establish a reference for the color information following it and is used by a color monitor to decode the color portion of a video signal. The color burst acts as both amplitude and phase reference for color hue and intensity. The color oscillator of a color television receiver is phase locked to the color burst.

COLOR CORRECTION A process in which the coloring in a television image is altered or corrected by electronic means. (See CHROMA CORRECTOR)

**COLOR DECODER** A device which divides a video signal into its basic color components. In TV and video, color decoding is used to derive signals required by a video monitor from the composite or Y/C signals.

**COLOR PHASE** The phase of the chroma signal as compared to the color burst, is one of the factors that determines a video signal's color balance.

**COLOR TEMPERATURE** A method for measuring the overall color of a light source, measured in degrees Kelvin (deg.K). Higher numbers indicate bluer light, lower numbers indicate a warmer light. The color temperature of the lighting must match the color temperature of the camera. In video this is accomplished by setting the white balance of the camera. Sunny Daylight is approximately 5500 deg.K. Overcast daylight is higher. Fluorescent Lights are approx. 4100 deg.K. Indoor incandescent lights are 2800 deg.K and professional Movie Lights are 3200 Deg. K

**COLOR SUBCARRIER** The carrier frequency (3.58 MHz in NTSC and 4.43 MHz in PAL) on which the color information is impressed. Color TV sets use special circuits which decode the color component for accurate display.

**COMMUNICATION PROTOCOL** A software language for linking computers, VCRs or edit controllers to allow bi-directional "conversation" between the units.

**COMPONENT VIDEO** Video signal in which luminance and synch information are recorded separately from the color information. Formats such as Betacam, SVHS and Hi-8 use component signals to achieve maximum quality. Component video comes in several flavors: RGB (red, green, blue), YUV (luminance, sync, and red/blue) and Y/C (luminance and chrominance). Y/C is also called S-Video used in the S-VHS and Hi-8 formats.

**COMPOSITE VIDEO** A video signal in which the luminance and chrominance elements have been combined in formats such as VHS.

**COMPOSITE SYNC** A signal consisting of horizontal sync pulses, vertical sync pulses and equalizing pulses only.

**COMPRESSION** The process of electronically processing video signals so that it requires less storage on a computer hard drive. A 5:1 compression requires more storage space, but yields better quality than a 10:1 compression. See Main Menu Desktop Video Handbook Part 1.

**CONTRAST** The degree to which luminance values contain very dark and very light values. A high-contrast picture has more black and white values with fewer values in between. A low contrast picture has more middle tones without very dark or very light areas.

**CONTROL-L** Sony's editing control protocol, also called LANC (Local Application Control), which allows two-way communication between a camcorder or VCR and an edit controller.

**CONTROL-M** Panasonic 5-pin edit control protocol. Similar to Control-L, but not compatible.

**CONTROL-S** Sony transport control protocol which duplicates a consumer VCR's infra-red remote transport control. Unlike Control-L, Control-S does not allow the controller to read tape counter information.



**CONTROL TRACK** Type of video editing that controls the in and out points of edits by counting pulses on a control track portion of the videotape. The pulses are counted by the edit controller to perform fairly accurate editing. Edit controllers which read time code make more accurate edits.

**CONFORMING** Online editing to create the final edit master. The offline edit master is used as a guide.

**CONTINUITY** Controlling the elements in a shot to insure that edits will flow smoothly and produce a coherent motion picture story without jarring the viewer.

**CRAWL** Text that moves horizontally across the screen.

**CROSSFADE** The audio equivalent of the video picture dissolve. The first sound track gradually fades out while the second sound track simultaneously replaces it.

**CROSSTALK** The interference between two audio or two video signals. In audio crosstalk this signal leakage may occur between the left and right channels. It can be caused by poor grounding connections or improperly shielded cables. In video, crosstalk between channels can be luminance/sync crosstalk or chroma crosstalk. Video crosstalk can cause ghost images from one source appear over the other.

**CUE CARD** A card with the actor's lines written on it to enable the actor to read or remember his lines.

**CUTAWAY** A shot of something outside the frame which can be used to hide an edit, e.g. during a testimonial.

**CYCLORAMA** A background where all corners and intersections are rounded.

**D1/D2/D3** Professional digital video formats. The D1 system uses component video. The D2 and D3 systems use composite video. There is no D4 format. Digital formats do not suffer from the generation loss inherent in analog formats.

**D.V.E.** Digital Video Effects. A shot can bend, twist and fold into various shapes. Before the advent of the VIDEO TOASTER, this was an expensive post-production special effect. Also, the trade name for a video system manufactured by NEC.

**D.V.I.** (Digital Video Interface) Multimedia standard for computer generated text and graphics which can be transferred to video.

**D.P.** Director of Photography

**DAT** (Digital Audio Tape) An audio recording and playback format developed by Sony, with a signal quality capability surpassing that of the CD.

**dB** (Decibel) A logarithmic unit which expresses the ratio between two amounts of electric or acoustic signal power. Used for measuring the strength of audio and video signals.

**DECODE** To separate a composite video signal into its component elements.

**DELAY CORRECTION** When an electronic signal travels through electronic circuitry or long cable runs, delay problems may occur. This causes a displaced image. Special circuits are used to correct the delay.

**DEMODULATOR** An electronic circuit which separates the audio and video signals from the RF carrier frequency.

**DEPTH OF FIELD** The range of objects in front of a camera lens which are in focus. Smaller f-stops provide greater depth of field, i.e., more of the scene, near to far, will be in focus.

**DIGITAL** A system whereby a variable analog signal is broken down and encoded into discrete binary bits of ones and zeros. These numbers represent a mathematical model of the original signal. When copied, they do not degrade as an analog signal does. An analog-to-digital (A/D) converter chip takes samples of the signal at a fixed time interval known as sampling frequency. This digital stream is can be recorded onto magnetic media. Upon playback, a digital-to-analog (D/A) converter chip reads the binary data and reconstructs the original analog signal.

Theoretically, this process should eliminate generation loss since every copy is an exact duplicate of the original. In reality, digital systems are not perfect and can introduce their own problems in maintaining the original signal. Digital signals are virtually immune to noise, distortion, crosstalk, and other quality problems.

**DIN (Deutsche Industrie Norme)** An international connector standard. DIN connectors carry both audio and video signals and are common on equipment in Europe.

**DISSOLVE** A video or film transition where one shot gradually fades out while a second shot fades in.

#### **DISTRIBUTION AMPLIFIER**

A device which splits and amplifies an audio and/or video source tape or signal to several audio/video outputs. Used to duplicate one videotape to any number of VCRs with minimal loss of signal strength.

**DOLBY (tm)** A compression/expansion (companding) noise reduction system developed by Ray Dolby, widely used in consumer, professional and broadcast audio applications. Signal-to-noise ratio improvement is accomplished by processing a signal before recording and reverse-processing the signal upon playback.

**DOLLY** A camera platform on wheels. To dolly is to smoothly bring the camera closer or farther from the subject.

**DOWNSTREAM KEYING** Electronically superimposing text or graphics over a scene (luminance key) or of placing one video image into another (chroma key). The Downstream Key signal must be genlocked to the other signals.

**DROPOUT** A defect on the videotape which causes a brief flash of a horizontal black line on the screen. Commonly found at the beginning and end of tapes. The quality of videotape is graded by the number of dropouts and priced accordingly.

**DROP FRAME** A type of SMPTE time code designed to exactly match the real time of common clocks. To accomplish this, two frames of time code are dropped every minute, on the minute, except every tenth minute. This corrects for the fact that video frames occur at a rate of 29.97 per second, rather than an exact 30 frames per second (see Non-Drop Frame). This time code system is used in television to insure that broadcast times coincide with real time.

**DUB** Duplicate copy of a videotape. Also called a dupe.

**EIA RS-170A** The timing specification standard for NTSC broadcast video equipment.

**ENCODE** The process of combining analog or digital video signals, e.g., red, green and blue, into a composite signal.

**ENCODER** A circuit that combines the primary red, green and blue signals into a composite video signal.

**E.C.U.** Extreme close-up shot.

**E.D.L.** (Edit Decision List) A complete list of time code numbers for each shot and sound used in the offline edit master. These time code numbers are used to create the final online edit master.

**ESTABLISHING SHOT** A wide shot showing much of the location.

**F.C.C.** Federal Communications Commission. The U.S. Agency which governs radio and television broadcasting.

**FADE** A video picture that gradually increases or decreases in brightness usually to or from black. Sound can also fade to or from silence.

**FIELD** One-half of a television frame, containing all the odd or even scanning lines of the picture. In NTSC 262.5 horizontal lines at 59.94 Hz. In PAL 312.5 lines at 50 Hz.

**FILL LIGHT** After the key light (primary light) is set, a fill light softens the shadows created by the key light.

**FILM CHAIN** Projectors, multiplexors and cameras, used to transfer film to video.

**FOCAL LENGTH** A measurement of the magnification of a lens indicated in millimeters. A zoom lens has a variable focal length which allows the camera to film closer or farther from the subject without moving the camera or subject. A 9mm - 100mm lens can makes its widest shot at 9mm, its closest at 100mm.

**FOLEY** Personal sound effects, like footsteps, breathing or punches used to heighten realism.

**FORMAT** Describes the video equipment and tape used. Popular formats listed in ascending order of cost and quality include VHS, SVHS, and Betacam.

**FRAME** A complete television picture made up of two fields, produced at the rate of 29.97 Hz (color NTSC), or 30 Hz (black & white NTSC).

**FRAMESTORE** A digital device designed to store and display a single frame of video as a freeze frame. (See also Still Store.)

**FRAME SYNCHRONIZER** Digital device which synchronizes two or more video signals. The frame synchronizer uses one of its inputs as a reference and genlocks the other video signals to the reference's sync and color burst signals. By delaying the other signals so that each line and field starts at the same time, two or more video images can be blended, wiped and otherwise processed together. (A Time Base Corrector takes this a step further by synchronizing both signals to a stable reference, eliminating time base errors from both sources.)

**GAFFER** The technician responsible for placing, rigging and adjusting lights.

**GAFFER'S TAPE** Similar to duct tape, but vastly superior. Used extensively in film and video production.

**GENERATION LOSS** Created when editing or copying one analog videotape to another videotape. Most apparent in less expensive video formats. Theoretically absent from digital video editing.

**GENLOCK/ENCODER** Device which allows computer text and graphics to be recorded or superimposed on video. Also includes a fader to fade video or computer graphics.

**GENLOCK** A system whereby the internal sync generator in a device, such as a camera, locks on to and synchronizes itself with a separate incoming signal.

**GRIP** Crew member who carries, sets up and strikes equipment.

**GOFER** Film or video production assistant often sent to "Go for" coffee or other essentials.

**GUERRILLA PRODUCER** One who produces an effective video on a shoestring budget.

**HARD LIGHT** Type of light that creates brilliant highlights and sharp shadows.

**HARRY** Trade name of a sophisticated digital effects system by Quantel. Includes Quantel's Paintbox digital effects generator.

**Hi-8** A video format technically similar to SVHS which uses smaller cassettes. The regular 8 video format is a home format which is inferior to Hi-8.

**INSERT EDIT** An electronic edit in which the existing control track is not replaced during the editing process. The new segment is inserted onto a prerecorded black video tape. See also Assembly Edit.

**INSERT SHOT** A close-up shot used to hide an edit or to emphasize a detail.

**INTERLACE** The manner in which a television picture is composed scanning alternate lines to produce one field, approximately every 1/60 of a second in NTSC. Two fields comprise one television frame resulting in the NTSC television frame rate of approximately 30 fps.

**IN THE CAN** Same as "that's a wrap" to indicate that the scene or program which has been completed.

**JUMP CUT** A jarring edit caused by the choice of shots rather than any technical imperfection.

**KEY LIGHT** The primary light used to illuminate a subject.

**KICKER** Also called a "hair light." Placed behind the subject to create a glamorous halo effect on the hair or a rugged-looking highlight on the cheek. Helps separate the subject from the background.

**JAM SYNC** Process of synchronizing a secondary time code generator with a selected master time code, e.g., using the time code generated by one camera to insert the identical time code on a second camera.

**KINESCOPE** Also called "Kine." A method of making a film copy of a television program in the days before the existence of Video Recorders. A movie camera was aimed at a specially designed television monitor. Before video recorders were invented this was the only means of recording TV programs. Many kinescopes are now over 40 years old and have the potential to outlast videotapes that were created much later.

**LAVALIERE** A small microphone that is clipped to a person's clothing.

**LOCATION** Any place filming occurs except a studio.

**LOG** A paper listing of the time code addresses of shots, scenes and takes. The log is an efficient way to find shots during editing.

**LAYBACK** Transferring the sweetened audio track back to the master video tape. See **SWEETENING**.

**LTC (Longitudinal Time Code)** Type of time code recorded on one of the audio channels of video tape. Requires tape movement to read. (See also **VITC**.)

**LUMINANCE** The monochrome portion of a video signal.

**MULTIPLEXER** Device for mixing television signals to a single video recorder.

**MATCH FRAME EDIT** An edit in which the source and record tapes pick up exactly where they left off. Often used to extend or correct a previous edit. Also called a "frame cut."

**M.O.S.** "Mit Out Sound" a slang term for silent shooting actually from the German "mit out sprechen" (without talking).

**MONITOR** A video display similar to a TV, but having superior visual quality and without a tuner. An audio monitor is a speaker.

**N.T.S.C.** National Television Standards Committee created this first international television system for use in the U.S. and other countries. It produces pictures by creating 525 alternating lines across the TV screen for each frame of video. Since **PAL** and **SECAM**, the other two world

systems, were developed later, they took advantage of better technology. Insiders joke that NTSC means "Never The Same Color."

**NANOSECOND (nsc)** One billionth of a second. An indication of the precision required in the timing of video signals.

**NON-DROP FRAME** A type of SMPTE time code that continuously counts a full 30 frames per second. As a result, non-drop-frame time code does not exactly match real time. See also **DROP FRAME**.

**OFFLINE** The creative editing process which uses copies of the camera tapes on a typically "cuts only" inexpensive editing system. All creative decisions and approvals are made during this process.

**ONLINE** The final technical editing process which uses the original camera tapes to repeat all decisions made in the offline editing process. Online editing uses a more sophisticated and expensive editing system capable of transitions like dissolves and wipes.

**OXIDE** The magnetic coating on video and audio tapes that stores picture and sound information. Iron oxide is created by combining iron and oxygen. The more primitive form is called rust.

**P.A.L.** Phase Alternation by Line. An international television standard. (see **N.T.S.C.**)

**P.O.V.** Point Of View. A subjective shot from the actor's point of view. The 1946 film, "The Lady In The Lake," holds the dubious distinction of being the only feature film in which every shot is a point of view shot. The hero is seen only once in a mirror.

**PAN** Movement of the camera on a horizontal axis. Also an unfavorable review.

**PAPER EDIT** A list of edits made entirely on paper by viewing Window Dub copies of the original camera tapes.

**POST-PRODUCTION** The complete editing process.

**PROC AMP** Processing amplifier that changes the video chroma and luminance signals feed through it. Also provides stable horizontal and vertical synch pulses.

**PREPRODUCTION** The vital phase of production in which the script, budget, locations, actors and props are planned.

**PREROLL** 5 to 7 seconds of camera running time before a shot can be used. In editing, this refers to a similar amount of automatic backspacing the edit decks perform to insure a stable edit.

**PRODUCTION** The actual filming and creation of the raw elements as required by the script.

**PROTECTION MASTER** A high quality copy of the master tape. Inexpensive insurance in the event that the master is lost or damaged.

**PAINTBOX** Trade name of a computer graphics system manufactured by Quantel. Used to create two-dimensional graphics, transform objects and change colors. The computer graphics generator for Quantel's Harry system.

**RGB** Red, green & blue, the primary color components of the additive color system used in color television.

**REACTION SHOT** A shot of a person reacting to dialogue or action.

**ROLL** Credit rolls consist of video text moving vertically up or down the screen, usually from bottom to top.

**RASTER** The area of a TV picture tube that is scanned by the electron beam. Also the active area of visual display on a TV, monitor or any cathode ray tube (CRT).

**RIPPLE** Automatic updating of an Edit Decision List after making a change to the list. "Ripple the list."

**SVHS** Super VHS. A video format developed by JVC which has largely replaced the 3/4 inch format for low budget productions.

**SAFE ACTION AREA** Electronic or physical markings on camera viewfinders and video monitors as the area that will be visible on most TV screens. Defined as 90% of the screen area measured from the center.

**SAFE TITLE AREA** The area on a monitor defined as 80% of the screen area measured from the center. Keeping the title within this area insures that the complete title will be visible on ALL TV sets.

**SAMPLE REEL** Also called a demo reel or tape. Contains samples of a person's or company's best video work for the purposes of marketing.

**SECAM** (Systeme Electronique Pour Colour Avec Memorie) The color television system developed in France. Used there and in most of the former communist-block countries and a few other areas including parts of Africa.

**SHOTGUN MICROPHONE** A highly directional microphone that may be hand-held or mounted on a boom.

**SLATE** A board on which script information, such as scene and shot numbers, is written. The slate is then filmed at the beginning of each shot to make the editor's job easier.

**SOFT LIGHT** Light which is diffused and creates very soft shadows.

**STILL STORE** Device which stores individual video frames, either in analog or digital form, allowing extremely fast access time.

**STORYBOARDS** A series of drawings to indicate different shots to be filmed. Used extensively in big-budget commercials and feature films.

**SWEETENING** Audio postproduction where audio is corrected and enhanced. Music, narration and sound effects are mixed with original sound elements.

**SWITCHER** Device with a series of video inputs that permits one or more selected inputs to be combined, manipulated and sent out on the program line or edit VCR.

**T.B.C. (TIME BASE CORRECTOR)** A device to correct timing errors which can cause unstable edits. These errors are caused by the slight mechanical defects inherent in the playback of video tape machines. Essential for online editing and duplication. This device can "clean up" a consumer VHS video so that it meets F.C.C. "broadcast quality" standards.

**TAKE** An individual shot. When time and budgets permit, many takes may be filmed of the same shot.

**TARGET AUDIENCE** The intended viewers. Successful business videos must define and address this audience.

**TILT** Movement of the camera on its vertical axis.

**TIME CODE** A system of numbering each frame of video with a unique address divided into hours, minutes, seconds and frames. There are 30 video still frames per second. See also **DROP FRAME**, **NON-DROP FRAME**, **VITC**, **LTC**.

**TELECINE** Device for transferring motion picture film to video tape.

**TRUCKING SHOT** A camera move which films the subject from side to side.

**TYPE C SMPTE** standard for 1-inch non-segmented helical video recording format.

**U-MATIC** Trade name for the 3/4 inch video format developed by Sony. 3/4 SP is an enhanced version. Formerly the standard for broadcast-quality, still used at many cable TV stations.

**ULTIMATTE** Trade name of a high-quality special effects system similar to a chromakey switcher. Electronic version of the blue screen technique used for motion picture special effects.

**UNDERSCAN** Special video monitor that can reduce the size of the video image so the four outer frame edges can be viewed in their entirety.

**USER BITS** Portions of VITC and LTC (time code) reserved for recording information of the user's choosing, e.g., date, scene numbers.

**V.C.R.** Video Cassette Recorder.

**V.H.S.** Video Home System. The most popular consumer video format used in the majority of home VCRs.

**V.I.T.C. (Vertical Interval Time Code pronounced vitSEE)** This type of time code is recorded in the vertical blanking interval above the active picture area. Can be read from video tape in the "still mode." See also **LTC (Longitudinal Time Code)**.



V.T.R. Video Tape Recorder.

VECTORSCOPE An oscilloscope designed to monitor and tweak the color portion of the video signal. See, also, waveform monitor.

VERTICAL INTERVAL Indicates the vertical blanking period between each video field. Contains additional scan lines above the active picture area into which non-picture information (captioning, copy protection and other control signals) may be embedded.

VERTICAL SYNC Synchronizing pulses used to define the end of one television field and the start of the next, occurring at a rate of approximately 59.94 Hz.

VIDEO TOASTER Software/hardware developed by NewTek for the Amiga Computer. Made special effects affordable for the low budget producer.

VIDEOGRAPHER A video photographer who specializes in events like weddings.

WAVEFORM MONITOR Oscilloscope designed for monitoring and adjusting luminance and all other parts of the composite video signal. See also vectorscope.

WHITE BALANCE A color camera function which determines how much red, green and blue is required to produce a normal-looking white. Shots made with improper white balance will have an abnormal color tint.

WILD SOUND Sound recorded after the visuals and edited into the master to enhance realism.

WINDOW DUB Also called a "burn in." A copy of the original camera tape with time code numbers visually displayed. A window dub that is made in the VHS format can be viewed, logged and edited on paper with a home VCR to save editing expenses.

WIPE A visual transition between shots in which the first shot is replaced with the next via a moving pattern.

ZOOM To vary the focal length from one size to another. Professionals most often use the zoom to set rather than to make a shot.

ZOOM HAPPY One who indulges in the gratification of zooming in and out to the torment of viewers. Common in home movies.

# Video Recording Formats

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## What this document covers and what it doesn't

There seems to be a lot of confusion about the huge number of different video recording formats and their specifications. Information is widely scattered and hard to find. This document will mostly cover professional and semi-pro formats, both those in use now and those being under development. If you want to know about "consumer" formats, check out this.

Formats discussed: Betacam SP • M-II • EBU C-format • EBU B-format • U-Matic D series formats • Digital Betacam • Ampex DCT • DV / DVCAM / DVCPRO • Digital8 • D-VHS • W-VHS • Digital S • Betacam SX • HDD-1000

For the time being, there isn't much information on analogue formats, but I will be adding more stuff as I come across it. Unless noted, all information applies to PAL 625/50 versions. I'm omitting SECAM on purpose, because it's rarely used for studio work anyway.

Many of the figures have been extracted from manufacturers' brochures and do not necessarily represent the best a given recording format can offer. Nevertheless, they should be pretty close.

And to keep things in perspective, let me remind you that 16 mm film beats the living daylights out of most formats depicted here, especially when it comes to dynamic range.

## Notes on specifications and nomenclature

### Broadcast quality defined - not!

The rest of this document, as well as many other texts handling video production, will frequently refer to "broadcast quality" without really defining what it is. Such a definition doesn't really exist -- many people think of it as describing the minimum quality for a program that is to be broadcast. There is no technical standard for this, and in fact, almost any crap can be restored to good enough quality with time base correctors and other digital processing.

From the technical point of view, broadcast quality can be thought of as a video signal fulfilling the timing and signal level tolerances placed by the relevant international standards. This doesn't say anything about the bandwidth (resolution) or signal-to-noise ratio of the actual picture -- that remains to be judged from the highly untechnical point of view: considering the contents of the program, is the picture watchable enough? Now that there are plenty of good recording formats available, broadcast quality recording usually means something that isn't noticeably worse than direct composite video from a good camera.

### Composite vs. component

In this context, component video means colour video represented by three separate signals (luminance and two colour difference signals). This is commonly referred to as Y/Cr/Cb colour space. RGB is almost never used in recording, because it requires 3/2 times the bandwidth of Y/Cr/Cb representation in order to achieve similar subjective quality. Some video equipment may still have RGB inputs or outputs, as converting between these two component representations is easy; see the equations at Rick Davis' digital video page (that's for NTSC, by

the way -- PAL uses slightly different coefficients). Charles Poynton's excellent FAQs on colour and gamma should answer the rest of your questions.

S-Video (or Y/C) does not count as component video, as most externally composite formats use separate chrominance and luminance signals in recording anyway. Additionally, the chrominance signal of S-video is already modulated in either PAL or NTSC to ride on a subcarrier and as such is limited in bandwidth. Component video does not have this limitation.

## Bandwidth and lines

Both of these figures refer to the horizontal resolution. "Lines" refers to the number of vertical alternating black and white lines that can be stuffed in the picture and still be perceived as separate lines and not a gray mass. It's clear that this is not a very scientific definition of resolution when the signal is in the continuous domain, like it is with all analogue formats. Therefore, the bandwidth is better expressed as the real electrical signal bandwidth fitting inside some dB limits, which can be easily measured.

But what about vertical resolution? Unlike the horizontal direction, the vertical direction of television picture is discrete and not continuous. Still, on the picture tube the lines overlap and are not normally perceived as separate. For this reason (and others, like the Kell factor, but I've digressed enough already from the original point of this document), the vertical resolution of TV is not such a big deal. If it were, people would have abandoned 525 line NTSC long time ago. As all of the analogue formats record picture lines totally independently of each other (with some exceptions, see below), there is no need to state the vertical resolution. It is always the same as in the video format itself -- 575 visible lines in PAL, 485 in NTSC.

The same story applies to the digital formats which are represented here. None of them throw away every other line, like CD-I for example does. Even the formats using compression maintain the entire vertical resolution, although all the compression methods are two-dimensional and operate on the image as a whole and not on separate lines.

## Digital formats employing compression

With compressed digital formats, bandwidth doesn't make as much sense as without compression or with analogue video. Quantization (sampling) type and the compression ratio are more interesting; most of these formats use quantization according to CCIR Rec. 601, [1], which is widely considered as the specification for "broadcast quality" when it comes to digital video. The most common CCIR 601 subformat is 4:2:2 quantization with 720 active samples per line. 4:2:2 means Y/Cr/Cb (YUV) format video, where the sampling rate for both of the colour difference signals is half the sampling frequency of the luminance.

Format	Quantization	Compression	S/N	Audio
Digital Betacam	4:2:2, 8/10 bit	per field DCT, 2.3:1		4x20bit + cue + TC
Digital S	4:2:2, 8 bit	intraframe DCT, 3.3:1 @ 50 Mbps		4x16 bit 48 kHz PCM
Ampex DCT	4:2:2, 8 bit	DCT, 2:1		
DV/DVCPRO	4:2:0/4:1:1 (see below)	5:1 @ 25 Mbps, per field/frame	54 dB	2x16 bit/ 4x12 bit PCM
DVCPRO 50	4:2:2	3.3:1 @ 50 Mbps		4 digital + cue
Betacam SX	4:2:2	10:1 MPEG-2, main level		4x16 bit 48 kHz

# Some background on the formats

Since many of these recording formats, especially the digital ones, are almost unknown outside the broadcasting companies wealthy enough to use them, I've decided to include some background information on them too.

## **Betacam SP**

Developed by Sony, perhaps the most popular component format for both field acquisition and post production today. Betacam uses cassettes and transports similar to the old Betamax home video format, but the similarities end there. Tape speed is six times higher, and luminance and chrominance are recorded on two separate tracks. The two colour difference signals are compressed in time by two and recorded sequentially on a single track.

## **M-II**

M-II (read em-two) was developed by Matsushita for Japan's national broadcasting company NHK. Today M-II is one of the most popular broadcast quality component formats with quality similar to Betacam SP. Large users of M-II include NHK, of course, and NBC. Recording technique is similar to Betacam SP but uses some enhancements which compensate for the lower tape speed.

## **EBU C format**

These machines use 1" tape in open reels. The main advantages are very fast transports and low recording density, which makes the format rather immune to drop-outs. Tape costs are high. The units can record single frames, which makes them popular in computer animation. Some units with vacuum capstans can operate from stop to nominal speed within one video field. The tape makes almost a full circle around the picture drum, and a single head is able to record and playback the entire video signal (short of a few lines right after vertical sync). Most other helical scan formats have at least two picture heads, which alternate between fields.

Note that in C format, the entire composite video signal is recorded and played back as is without splitting it to Y/C, like most composite recorders do, or limiting the bandwidth in any way. Numerous manufacturers include Sony, Ampex and BTS.

## **EBU B format**

Similar to C format, but uses segmented helical scan. The diameter of the picture drum is small, and a single video field is recorded in 6 separate tracks. Manufactured by Bosch. B format doesn't allow for many special modes - play, FF and REW are just about it.

## **U-Matic**

Another format by Sony. Has three different versions (LB, HB and SP), which differ by the subcarrier frequencies used for luminance and chrominance recording. U-Matic LB (Low Band) has been around from the early 70s and is one of the oldest cassette video formats. HB (High Band) has increased chroma subcarrier frequency, which improves colour resolution. In the SP variant, both chroma and luma subcarrier frequencies have been increased.

U-Matic SP (in common lingo "3/4" after the tape width in inches) is still a popular production format for those not wealthy enough to use Beta SP or similar. Although U-Matic doesn't appear much better than Super VHS on paper, the higher colour resolution and much better signal-to-noise ratio make the picture subjectively far more enjoyable. The U-Matic tape transport is also much faster in changing modes, which makes editing less frustrating.

LB and HB U-Matic tapes are often used for archiving because of the relatively low tape costs and low recording density, which makes the tapes robust against aging.

## D series digital formats

**D-1** was the first practical digital format, introduced by Sony in 1986. Although still considered a quality reference, D-1 is expensive to buy and use and has been mostly superseded by the more cost effective later formats.

**D-2** was developed by Ampex around the same time as D-1 was introduced and is meant to be a fully transparent storage for composite video, useful for composing "spot tapes" for programmes such as news.

**D-3** and **D-5** have both been developed by Matsushita. D-5 units can use two different sample rate / resolution combinations and are generally capable of playing back D-3 tapes. While D-5 is still a studio format, D-3 camcorders are available from Panasonic.

A high definition version of D-5 (D-5 HD) has been introduced by Panasonic. It uses 4:1 compression in order to accommodate the 1.2 Gbps HDTV data rate. It can work with both 1080 line interlaced or 720 line progressive (American) HDTV formats.

**D-6** is a digital HDTV recording format by Toshiba/BTS. Stores 600 GB worth of data on a physically huge 64 minute cassette. I was told that this format is more or less dead and the remaining tape transports were bought out by Toshiba - but in IBC'97, I saw a D-6 recorder in action, demonstrated as a joint venture between Toshiba and some other Japanese manufacturer, whose name escapes me. The picture quality was truly impressive.

DVCPRO should become D-7 later. Also, Digital-S will be designated as D-9 [unconfirmed].

As a curiosity, D-4 doesn't exist, as number 4 is a major taboo in Asian cultures (pronounced the same as "death" in Japanese). Rumours go that this even delayed the standardization of D-3 and D-5.

### Digital Betacam

Digital successor to the venerable Betacam SP format. Introduced by Sony in 1993, uses physically similar half-inch cassettes. Camcorders with 40-minute capacity are available, making Digital Betacam the first component digital ENG (electronic news gathering) format. Digital Betacam units play back, but do not record analogue Beta SP tapes.

The 2:1 compression is based on DCT (discrete cosine transform), like most modern video compression techniques. Each field is compressed separately.

### Ampex DCT

So far, fully proprietary format by Ampex (1992). Name is an acronym for "Digital Component Technology" and not for what you'd expect. According to Ampex, the main advantage of DCT over other digital formats is high tolerance for data errors, in the order of one uncorrected error per hour.

The units can switch between 525/60 and 625/50 operation, and allow a maximum recording time of more than three hours. These qualities give the DCT format a central role in Ampex' electronic film mastering scheme.

## DV/DVCam/DVCPRO

DV (formerly DVC) is a new format being backed by manufacturers such as Sony, Philips, Thomson, Hitachi, Matsushita (Panasonic) and others. It was the first digital recording format in the reach of consumer markets. DV uses 5:1 compression based on DCT. Depending on the image contents, the encoder adaptively decides whether to compress picture fields separately or combine two fields into a single compression block. As such, DV coding can be thought of as something half-way between Motion JPEG and MPEG.

As a curiosity, the consumer version (DV) sports one of the densest recording techniques based on magnetic tape media - more than 0.4 megabits per square millimeter. Imagine the data from your 3.5" HD floppy recorded on a single-sided 5x6 mm piece of tape. New equipment from Sony will push this even further with the deployment of LP mode, which will reduce the track width to 6.67 um and multiply the recording time by 1.5. Video specifications will remain the same.

DVCPRO is a professional variant of the DV by Panasonic. The only major difference is doubled tape speed, which is needed for better drop-out tolerance and general recording robustness. It is also capable of 4x normal speed playback. This doesn't mean your run-of-the-mill FF with picture, but accelerated transfer of all of the information into for example a non-linear editing system. DVCAM on the other hand is Sony's variation of the theme, sitting somewhere between DV and DVCPRO. Tape speed and track width have been increased, but not as much as for DVCPRO. Furthermore, it uses the same metal evaporated tape as DV, while DVCPRO uses metal particle tape. What exactly Sony expects from this format is quite puzzling, given that they already have two other digital ENG formats - Betacam SX and Digital Betacam.

These similar, but still different digital formats have made some people to fear for another War of the Formats, the players this time being Panasonic and Sony. But because the formats mainly differ in the way they store the data on the tape, the data itself being the same, the situation isn't quite that sad. Actually Panasonic has announced that their upcoming DVCPRO gear will be able to play back DVCAM recordings; according to Panasonic, this will only require reprogramming the capstan servo systems to accommodate for the slightly different track width (15 um in DVCAM vs. 18 um in DVCPRO) and therefore different tape speed.

As for the picture quality, all these variants are nearly broadcast quality, DV being available at nearly consumer prices. For newsgathering and other similar uses, the quality is certainly enough, especially considering that typical postproduction will be done digitally, which will not degrade the quality any further. Compression is mild enough to keep artifacts away in all but problem scenes. The 4:1:1/4:2:0 quantization will be visible if you try something like chroma keying, however. As stated before, the picture quality in all three formats is identical - the targeted market segments are differentiated with the features of the equipment and things like available camera quality.

Recently, DVCPRO has been accepted to be standardized as D-7 by SMPTE. Panasonic has also introduced a 4:2:2 version: DVCPRO-50, which is intended to directly rival Digital S in the professional market.

Chroma subsampling methods used in the DV variants

Above, both 4:1:1 and 4:2:0 sampling methods have been mentioned. The former means that both of the chroma difference signals (Cr and Cb) are sampled at one quarter of the luminance

sampling rate. The latter, on the other hand, uses half the luma sample rate for the colour differences, but the two differences are only sampled on alternating lines (resembling SECAM). Both give the same total data rate, but the 4:2:0 sampling gives a better apparent colour resolution for PAL.

In the NTSC world, all three DV variants use 4:1:1 sampling. In the PAL versions, DV and DVCAM revert to 4:2:0, whereas DVCPRO uses 4:1:1 globally. Here's a catch - if you dub between PAL DVCPRO and one of the other formats, you'll end up with the worst from both worlds: a 4:1:0 sampled image, where both vertical and horizontal colour resolutions are only half of the conventional broadcast quality 4:2:2 sampling.

A good source for further practical information on DV is DV Central.

### **Digital8**

A recently introduced consumer format from Sony. Digital8 records for all practical purposes the same signal as DV, but uses cheaper Hi8 tapes and can play back old analogue 8mm/Hi8 tapes.

### **D-VHS**

New format by JVC. This is a digital "bit bucket" format which is intended to store future digital broadcasts directly in its compressed format. Particularly, the machines will not have conventional video inputs and outputs at all - they work through a set-top decoder, just like direct digital broadcasts off the air. The machines will all have IEEE 1394 digital interfaces, like some DV format equipment do.

Longest tape should be able to store 44.4 GB of data. Recording times depend on the mode used, ranging from 3.5 hours of HDTV to 49 hours of 2 Mbps video in LP mode. Standard mode will record seven hours of video at 19.14 Mbps.

### **W-VHS**

W-VHS was introduced by JVC in the 1994 NAB show. It is an analogue high definition format using a cassette physically identical with VHS.

Normally records 1125 lines of analog RGB video, but can switch to an NTSC mode, in which it can either record twice as much high quality NTSC video, or even two different video signals. The latter function is used for field sequential 3D video.

### **Digital S**

Digital S is a digital format downward compatible with S-VHS. Cassette is basically a W-VHS high coercivity tape in a dust-proof version of the VHS cassette case. Digital S rivals the much more expensive Digital Betacam in terms of picture quality because of the mild compression and 4:2:2 quantizing.

JVC's Digital S editing deck sports a rarely seen feature, video pre-read head, which allows the old video recording to be played back while recording new signal just after that. This makes A/B roll edits possible with just two decks.

JVC also has a web site dedicated to Digital-S.

### **Betacam SX**



Hot from the ovens at Sony, Betacam SX is a digital format using a 4:2:2 coded variant of MPEG. Like DVCPRO, it's capable of accelerated playback/recording and is part of Sony's new all-digital production concept, targeted especially for ENG and newsroom use. Some units are 4:3 / 16:9 switchable.

Despite primarily being a tape format, some decks are actually disk/tape hybrids and provide rudimentary stand alone non-linear editing capabilities. "Briefcase" field editors resembling laptop computers are available, similar to what Panasonic has for its DVCPRO format.

More hype is available on Sony's Betacam SX site.

### **Sony HDD-1000**

This is a full bandwidth 1.2 Gbps digital HDTV recorder based on 1" open reel C format. Prototyped as early as in 1987, the format records 1125 line HDTV at either 59.94 or 60 Hz field rate. The steep price tag (~\$350000 for the units, and 63 minutes of tape will set you back \$1300!) makes this format somewhat of a curiosity, but it is both available and in use.

## References

[1] CCIR (ITU-R) Recommendation 601-2, Encoding parameters of digital television for studios, Recommendations of the CCIR, 1990, Volume XI - Part 1. Geneva 1990

[2] Ru van Wezel, Video Handbook, 2nd edition. William Heinemann Ltd, London 1987

[3] Pentti O A Haikonen, Videotekniikka

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# The DV, DVCAM, & DVCPRO Formats

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By Adam Wilt

You won't find a better videotape format in terms of price/performance for standard-definition television than DV or its related formats DVCAM and DVCPRO. Also, DV is the first broadcast-quality format small enough for a camera master to fall into a cup of tea (trust me on this; no need to try it yourself).

I first experienced DV in October of 1995, when I saw a Sony DCR-VX1000 hooked up to a 32" Sony XBR monitor at Fry's Electronics in Sunnyvale. I was impressed by the live pix, but blown away by the off-tape playback, which looked as good as live. I lay awake for three nights, thinking "the world has changed: Digital For The Rest Of Us..." before buying a VX1000, and selling my pro/industrial EVW-300 3-chip, interchangeable-lens Hi8 camcorder to pay for it...

# The DV formats tabulated

## Format specifications and current equipment capabilities

	DV	DVCAM	DVCPRO	Digital8
suppliers	consortium of 60 mfg including Sony, Panasonic, JVC, Canon, Sharp.	Sony	Panasonic; also Philips, Ikegami, Hitachi.	Sony
intended market segment(s)	consumer (although JVC makes a dockable DV VTR for the pro/industrial market)	professional / industrial	professional / industrial / ENG / EFP / broadcast	consumer (Video8 & Hi8 replacement)
who's actually buying the stuff	consumer / professional / industrial / ENG / EFP	professional / industrial / ENG / EFP	professional / industrial / ENG / EFP / broadcast	consumers
tape type	ME (Metal Evaporate)	ME (Metal Evaporate)	MP (Metal Particle)	ME, MP (uses Video8, Hi8 tapes)
track pitch	10 microns (SP) 6.7 microns (LP)	15 microns	18 microns	???
track width	10 microns (SP) 6.7 microns (LP)	15 microns (10 microns on some early gear)	18 microns	???
tape speed	18.81 mm/sec	28.215 mm/sec	33.82 mm/sec	28.6 mm/sec (estimated)
cassettes & max. loads	miniDV: 80/120 min (SP/LP) std: 3.0/4.6 hrs (SP/LP) (4.6/6.9 hrs possible using DVCAM 184 min tape)	miniDV: 40 min. std: 184 min.	small: 63 min. (note: small is larger than miniDV cassette) std: 123 min./184 min.**	Video8, Hi8 standard 120 minute tape: 60 min.
max. camera load	80/120 min. (SP/LP)	184 minutes	63 minutes (AJ-D700/810); 123 min. (AJ-D200/210); 184 min. (AJ-D215)**	60 min.
compression	5:1 DVC-format DCT, intra-frame; 25 Mbps video data rate	5:1 DVC-format DCT, intra-frame; 25 Mbps video data rate	5:1 DVC-format DCT, intra-frame; 25 Mbps video data rate	5:1 DVC-format DCT, intra-frame; 25 Mbps video data rate
	DV	DVCAM	DVCPRO	Digital8
resolution & sampling	720x480, 4:1:1 (NTSC) 720x576, 4:2:0 (PAL)	720x480, 4:1:1 (NTSC) 720x576, 4:2:0 (PAL)	720x480, 4:1:1 (NTSC) 720x576, 4:1:1 (PAL)	720x480, 4:1:1 (NTSC) 720x576, 4:2:0 (PAL)
audio recording (see " <a href="#">locked vs unlocked</a> " below)	2 ch @ 48 kHz, 16 bits; 4 ch @ 32 kHz, 12 bits; will accept 2 ch @ 44.1 kHz, 16 bits via 1394 I/O; unlocked (but can record locked audio via 1394)	2 ch @ 48 kHz, 16 bits; 4 ch @ 32 kHz, 12 bits; will accept 2 ch @ 44.1 kHz, 16 bits via 1394 I/O; locked (but some VTRs can be made to record unlocked via 1394)	2 ch @ 48 kHz, 16 bits; locked, plus one analog audio cue track; plays back 32 kHz, 12 bits and presumably 44.1 kHz, 16 bits.	2 ch @ 48 kHz, 16 bits; 4 ch @ 32 kHz, 12 bits; will accept 2 ch @ 44.1 kHz, 16 bits via 1394 I/O; unlocked (but can record locked audio via 1394)
These tapes can play back in...	DV, DVCAM, & DVCPRO VTRs	DV*, DVCAM, & DVCPRO* VTRs	DVCPRO VTRs; DSR-2000 DVCAM VTR	Digital8 camcorders
These VTRs can play back...	DV & DVCAM* tapes	DV & DVCAM tapes (DVCPRO in the DSR-2000; Oct '99)	DV, DVCAM*, & DVCPRO tapes	Video8, Hi8, Digital8 tapes
IEEE-1394 I/O (a.k.a. "FireWire" or "i.link")	Sony & Canon camcorders and VTRs; newer JVC camcorders (output only)	DSR-V10, DSR-20, DSR-30, DSR-40, DSR-200/200a, DSR-500, DSR-2000, DRV-1000	AJ-D210/215 camcorders and AJ-D230 VTRs with optional adapter.	yes
SMPT E 259M SDI (serial digital interface)	no	DSR-60/80/85/2000 VTRs with adapter	AJ-D750/650/640 VTRs with adapter	no
4X digital I/O	no	DSR-85 VTR	AG-D780 VTR; NewsByte NLE with onboard VTR	no
Analog component I/O	no	DSR-40/60/80/85/2000 VTRs only	AJ-D750/650/640 VTRs	no
Y/C & composite I/O	yes (DRV-100 & many camcorders; output only)	yes (DRV-1000: output only)	yes (no Y/C on AJ-D750)	yes
Edit control	LANC & IEEE-1394 (Sony, Canon); Panasonic 5-pin (Panasonic); J-LIP (JVC)	LANC & IEEE-1394 (DSR-V10, DSR-20/30, DSR-200/200a); RS-232 (DSR-20); RS-422 (DSR-40/60/80/85/2000)	RS-232 (AJ-D230/640/650/750); RS-422 (AJ-D640/650/750)	LANC & IEEE-1394

\*Interformat interchange:

DV plays back in all three format VTRs; DVCPRO VTRs require a cassette adapter to play back miniDV tapes.

DVCAM plays back in most DV VTRs excepting the DCR-VX700 and DCR-VX1000 camcorders which were designed prior to the introduction of DVCAM.

Early model DVCPRO VTRs (made before June 1997) require an EPROM upgrade to allow the servos to track DVCAM. Check the serial number: it's of the form MYxxxxxxx, where M is a month letter, A-L, and Y is the last digit in the year. F7xxxxxxx means the machine was built in June 1997, and it's OK. H6xxxxxxx would mean the machine was born in August of 1996 and the EPROM upgrade would be required.

**To play back DV or DVCAM in a DVCPRO machine, use the setup menus to specify DV or DVCAM before you insert the tape!** The playback mode "locks in" when the tape is inserted, so if you set DV or DVCAM mode *after* loading the tape, playback will still be attempted as if the tape were a DVCPRO tape.

PAL 4:2:0 DV and DVCAM played back on a DVCPRO are digitally resampled to generate a PAL 4:1:1 DVCPRO signal.

DV in LP mode will not play back in DVCAM or DVCPRO VTRs.  
miniDV tapes cannot be played back in the NewsByte VTR even with the cassette adaptor.

**DV in SP mode appears to be the universal tape format:** it will play back in any of the VTRs.

**DVCPRO appears to be the universal playback VTR:** it'll play back any of the DV-based formats, as will the new (NAB '99) DVCAM DSR-2000.

See also: [How DVCPRO \(D-7\) plays back DV tape](#) -- and why it doesn't record DV (which also probably explains why your DVCAM deck won't record DV either). Courtesy Panasonic Broadcast and Digital Systems.

The 4X high-speed transfer decks will *not* perform 4X play with a DV cassette!

**\*\*DVCPRO std. cassette run times:**

The "standard" standard cassette holds 123 minutes of tape, but there is a newer, 184 minute tape load available using the same sized cassette. All DVCPRO equipment accepting the std. size cassette should be able to record or play for 184 minutes, but only the newer equipment (such as the AJ-D215 and later model AJ-D230s; the 400-series VTRs should also fit this description) has been programmed to "understand" the larger load. If you put a 184 min. cassette into an older bit of equipment, it'll think that such a cassette can only hold 123 minutes, and as a result operations like fast-forward or rewind may only work as expected for 2/3 of the tape, after which the machine will slow the tape down, expecting it to end. The operation will proceed at this reduced speed while the machine is waiting for the tape to end (any minute now!); this can take quite a while... Before using the longer tape in older gear (600-series and 700-series VTRs, AJ-D200 and 210 cameras, and pre-NAB-1999 AJ-D230 VTRs), you might want to check with your Panasonic rep, or at least do a dry run to see how the older gear will behave with the longer tape.

# DV Frequently Asked Questions

## What is DV?

DV is an international standard created by a consortium of 10 companies for a consumer digital video format. The companies involved were Matsushita Electric Industrial Corp (Panasonic), Sony Corp, Victor Corporation of Japan (JVC), Philips Electronics, N.V., Sanyo Electric Co. Ltd, Hitachi, Ltd., Sharp Corporation, Thompson Multimedia, Mitsubishi Electric Corporation, and Toshiba Corporation. Since then others have joined up; there are now over 60 companies in the DVC consortium.

DV, originally known as DVC (Digital Video Cassette), uses a 1/4 inch (6.35mm) metal evaporate tape to record very high quality digital video. The video is sampled at the same rate as D-1, D-5, or Digital Betacam video -- 720 pixels per scanline -- although the color information is sampled at half the D-1 rate: 4:1:1 in 525-line (NTSC), and 4:2:0 in 625-line (PAL) formats. (See [below](#) for a discussion of color sampling.)

The sampled video is compressed using a Discrete Cosine Transform (DCT), the same sort of compression used in motion-JPEG. However, DV's DCT allows for more local optimization (of quantizing tables) within the frame than do JPEG compressors, allowing for higher quality at the nominal 5:1 compression factor than a JPEG frame would show. See Guy Bonneau's discussion of [DV vs MJPEG compression](#) for more details.

DV uses **intraframe** compression: Each compressed frame depends entirely on itself, and not on any data from preceding or following frames. However, it also uses adaptive **interfield** compression; if the compressor detects little difference between the two interlaced fields of a frame, it will compress them together, freeing up some of the "bit budget" to allow for higher overall quality. In theory, this means that static areas of images will be more accurately represented than areas with a lot of motion; in practice, this can sometimes be observed as a slight degree of "blockiness" in the immediate vicinity of moving objects, as discussed below. DV video information is carried in a nominal 25 megabit per second (Mbps) data stream. Once you add in audio, subcode (including timecode), Insert and Track Information (ITI), and error correction, the total data stream come to about 36 Mbps. [Roger Jennings' paper](#) on the Adaptec website runs through the detailed numbers.

## What's the difference between DV, DVCAM, and DVCPRO?

Not a lot! The basic video encoding algorithm is the same between all three formats. The VTR sections of the US\$20,000 DVCAM DXC-D130 or DVCPRO AJ-D700 cameras will record no better an image than the lowly DV format DCR-VX1000 at US\$4,000 (please note: I am *not* saying that the camera section and lens of the VX1000 are the equals of the high-end pro and broadcast cameras: there are significant quality differences! But the video data recorded in all three formats is essentially identical, though there may be minor differences in the actual codec implementations). A summary of differences (and similarities) is tabled in [Technical Details](#). The consumer-oriented DV uses 10 micron tracks in SP recording mode. Newer camcorders offer an LP mode to increase recording times, but the 6.7 micron tracks make tape interchange problematic on DV machines, and prevents LP tapes from being played in DVCAM or DVCPRO VTRs. Sony's DVCAM professional format increases the track pitch to 15 microns (at the loss of recording time) to improve tape interchange and increase the robustness and reliability of insert editing. Panasonic's DVCPRO increases track pitch and width to 18 microns, and uses a metal particle tape for better durability. DVCPRO also adds a longitudinal analog audio cue track and a control track to improve editing performance and user-friendliness in linear editing operations.

## Digital8?

Sony's Digital8 uses DV compression atop the existing Video8/Hi8 technological base. Digital8 records on Video8 or Hi8 tapes, but these run at twice their normal speed and thus hold half the time listed on the label. Digital8 will also play back existing Video8 and Hi8 tapes, even over 1394/i.link, allowing such tapes to be read into NLEs (at least, those for which the lack of timecode is not an issue -- batch capture utilities are unlikely to work, since Video8/Hi8 timecodes are not sent across the 1394 connection).

Digital8 is a camcorder-only format as of Spring 1999; no VTRs are expected. It appears to be the 8mm division's way of keeping its customer base from defecting to DV. By leveraging the massive investments of 15 years in 8mm analog camcorders and transports, the unit cost of Digital8 gear is kept very low, roughly half of what a comparable DV camcorder would cost, and its ability to play back legacy analog tapes is worthwhile for those with large libraries of 8mm. All Digital8 camcorders can record from the analog inputs (at least outside the EU), and all are equipped with i.link ports for digital dubbing and NLE connections.

## How good are the DV formats compared to other formats?

DV formats are typically reckoned to be equal to or slightly better than Betacam SP and MII in terms of picture quality (however, DV holds up better over repeated play cycles, where BetaSP shows noticeable dropout). They are a notch below [Digital-S and DVCPRO50](#), which are themselves a (largely imperceptible) notch below Digital Betacam, D-1, and D-5. They are quite a bit better than 3/4" U-matic, Hi8, and SVHS.

On a scale of 1 to 10, where 1 is just barely video and 10 is as good as it gets, I would arrogantly rate assorted formats as follows:

D-5 (10-bit uncompressed digital)	10
D-1 (8-bit uncompressed digital)	9.9
Digital Betacam, Ampex DCT	9.7
Digital-S, DVCPRO50	9.6
DV, DVCAM, DVCPRO	9.2
III, Betacam SP	9.1
D-3, D-2 (composite digital)	9
1" Type C	8.9
3/4" SP	6.5
3/4", Hi8, SVHS	5
Video 8, Betamax	4
VHS	3
EIAJ Type 1, Fisher-Price Pixelvision	1

[Note that I place D-2 and D-3 uncompressed composite digital formats lower than any of the component formats, even the analog and compressed ones. While D-2 and D-3 are excellent first-generation formats for composite analog playback and NTSC broadcast, the compositing of color with luminance (which includes a color bandwidth limitation even more severe than DV or BetaSP employ) makes clean multigeneration and multi-layer image compositing problematic at best (even such simple things as adding titles).

And, as we move into the 4:2:0 component DTV era, video will no longer be subjected to the delivery-point lowest common denominator of a single-wire composite feed: color-subcarrier composite was an excellent analog compression technology in the 1950s, but DTV obsoletes it and renders even the DTV consumer receiver essentially a component display.]

For a less biased discussion of DV quality, see the September 1998 [SMPTE/EBU Task Force for Harmonized Standards for the Exchange of Program Material as Bitstreams Final Report, Annex C](#).

Also, Jim Feely of [DV Magazine](#) used the Tektronix Picture Quality Analyzer, a "black box" that calculates before/after picture differences and evaluates them based on Sanoff Lab's JND analysis (a whole different topic -- in short, analysis based on modeling of the psychophysical characteristics of human vision), to evaluate a variety of formats for the May 1999 issue. The results are posted online as a [PDF file](#); discussion of the testing process is also [available](#).

### **What are the DV artifacts I keep hearing about?**

DV artifacts come in three flavors: mosquito noise, quilting, and motion blocking. Other picture defects encountered are dropouts and banding (a sign of tape damage or head clogging).

The most noticeable spatial artifacts are *feathering* or *mosquito noise* around (typically) diagonal fine detail. These are compression-induced errors usually seen around sharp-edged fine text, dense clusters of leaves, and the like; they show up as pixel noise within 8 pixels of the fine detail or edge causing them. The best place to look for them is in fine text superimposed on a non-black background. White on blue seems to show it off best. The magnitude of these errors and their location tends to be such that if you monitor the tape using a composite video connection, the artifacts will be masked by dot-crawl and other composite artifacts.

A spatial *quilting* artifact can also be seen on certain diagonals -- typically long, straight edges about 20 degrees off of the horizontal. These are minor discontinuities in the rendering of the diagonal as it passes from one DCT block to the next; so minor that they're usually invisible. Watching such diagonals during slow pans is often the only way to see the artifact.

*Motion blocking* occurs when the two fields in a frame (or portions of the two fields) are too different for the DVC codec to compress them together. "Bit budget" must be expended on compressing them separately, and as a result some fine detail is lost, showing up as a slight blockiness or coarseness of the image when compared to the same scene with no motion. Motion blocking is best observed in a lockdown shot of a static scene through which objects are moving: in the immediate vicinity of the moving object (say, a car driving through the scene), some loss of detail is seen. This loss of detail travels with the object, always bounded by DCT block boundaries.

Finally, *banding* or *striping* of the image occurs when one head of the two on the scanner is clogged or otherwise unable to recover data. The image will show 10 horizontal bands (12 in PAL countries), with every other band showing a "live" picture and the alternate bands showing a freeze frame of a previous image or of no image at all (or, at least in the case of the JVC GR-DV1u, a black-and-white checkerboard, which the frame buffers appear to be initialized with). Most often this is due to a head clog, and cleaning the heads using a standard manufacturer's head cleaning tape is all that's required. It can also be caused by tape damage, or by a defective tape. If head cleaning and changing the tape used don't solve it, you may have a dead head or head preamp; service will be required.

## Digital-S, DVCPRO50, DVCPROHD100, and HD Digital-S

### **What are Digital-S and DVCPRO50?**

JVC's Digital-S (SMPTE designation D-9) and Panasonic's DVCPRO50 use two DVC codecs in parallel. The tape data rate is doubled to 50 Mbps (video) and the compression work is split between the two codecs. The result is a 4:2:2 image compressed about 3.3:1. It's visually lossless and utterly gorgeous.



JVC's Digital-S uses the 1/2" SVHS form factor for tapes and VTRs, although the tape cassette itself is more robust and the transport is equipped with sapphire guide roller flanges and tape cleaner blades and a new scanner design. One of the Digital-S players will also play back analog SVHS tapes, allowing its use for editing existing libraries of SVHS tapes as well as newer Digital-S footage. Head life (so far, in on-air broadcast usage) is well in excess of 4000 hours; equipment cost is very low (comparable to 25 Mbps DVCAM or DVCPRO); and maintenance expenses are well below those of the Betacam decks that Digital-S is typically displacing. So far only JVC is supporting this format, which has resulted in a less-than-headlong rush by the video community to embrace it. Watch it, though; it's hot. **If you're doing high-end EFP on a budget, this is the format to use.**

Panasonic's DVCPRO50 uses the same DVCPRO tapes and transports as its 25 Mbps DVCPRO products (there is also a 93-minute DVCPRO50 tape due out specifically for the AJ-D950 VTR, which Panasonic says should only be used in DVCPRO50 mode. When using standard DVCPRO tapes, the maximum recording time is about 61 minutes since the P123L cassette is being run twice as fast). DVCPRO50 VTRs will also play back DVCPRO tapes.

The 900-series DVCPRO50 kit is real jack-of-all-trades stuff. The AJ-D900W camcorder (US\$39,900) will record either DVCPRO or DVCPRO50, in either 4:3 or true 16:9 modes. The AJ-D950 VTR (US\$26,500) records and play back either DVCPRO or DVCPRO50, and additionally is switchable between 525/59.94 (NTSC) and 625/50 (PAL) formats. The only thing you give up is miniDV cassette playback; even with the adaptor the 950 won't read the tiny tapes. Fortunately the AJ-D940 DVCPRO50 player, due out in early 1999 for US\$20,000 or so, *will* play back those miniDV tapes, and is supposed to offer a wider range of slo-mo speeds in the bargain. There's also a more affordable DVCPRO50 camera due early in '99, around US\$29,000 or so.

Unlike Digital-S, second-sourcing is available from Philips, Hitachi, and Ikegami. The DVCPRO50 kit is also a lot more portable and lightweight than Digital-S, so it's the format of choice if you're doing high-end EFP with a somewhat bigger budget and you want to keep your cameramen (and women) from wearing out as quickly!

Panasonic showed a mockup of a switchable DVCPRO/DVCPRO50 portapack (field VTR that doesn't dock directly to a camera head) at NAB '98, as well as prototype DVCPRO-P (480-line 60 Hz progressive scan) equipment using the 50 Mbps payload to handle this interim SDTV format chosen by Fox and NBC for the start of the DTV transitional era.

#### **Four codecs for HD?**

Both JVC and Panasonic showed mockups or prototypes of 100 Mbps DV-derived products at NAB '98 for handling HDTV. Both firms plan to gang four DV codecs together to get the 100 Mbps datastream, while preserving the same equipment form factor and operational methodologies used in the current 50 Mbps products. Panasonic calls their stuff DVCPROHD100, while JVC hasn't yet come up with all the necessary buzzwords.

It should be noted that both of these companies are well-placed to serve the growing DTV market whatever image format a broadcaster selects. Panasonic is selling a switchable 720p/1080i HD-D5 VTR (not based on DV technology), the AJ-HD2700, which has already become the studio standard VTR for the dawn of DTV. JVC's NAB '98 display featured Digital-S variants of most popular ATSC DTV formats -- 480i, 480p/30, 480p/60, 720p, and 1080i -- either

in prototype or in simulation. These two companies will be pushing the edge of the DV envelope for quite some time to come...

Sony's HDCAM format uses compression technology "derived from DV and with certain similarities", but it is not on the main branch of the DV family tree. Its data rate of 135 Mbps yields beautiful images; it's extremely rare to see a noticeable artifact in an HDCAM picture.

4:2:2, 4:1:1, 4:2:0

### **What are 4:2:2, 4:1:1, and 4:2:0 anyway?**

These are all shorthand notations for different sampling structures for digital video. They are also used for CIF and QSIF and suchlike MPEG frame sizes, but in the discussion that follows, I focus on the numbers for SDTV (standard-definition TV) digitized to the ITU-R BT.601 standards: 13.5 MHz sample frequency and 720 pixels per line.

The first number refers to the 13.5 MHz sampling rate of the luminance: "4" because (a) it's nominally almost approximately sort of four times the NTSC and/or PAL color subcarrier frequencies, and (b) because if it's "4" the other numbers can be integers whereas if it were "1" the formats would be "1:0.5:0.5", "1:0.25:0.25", and "1:0.5:0" respectively, and which would you rather try to read off in a hurry? The 13.5 MHz sampling yields 720 pixels per scanline in both 525/59.94 and 625/50 systems (NTSC and PAL/SECAM). This number applies to D-1, D-5, Digital Betacam, BetaSX, Digital-S, and all the DV formats just the same.

The other two numbers refer to the sampling rates of the color difference signals R-Y and B-Y (or Cr and Cb in the digital domain)

In **4:2:2** systems (D-1, D-5, DigiBeta, BetaSX, Digital-S, DVCPRO50) the color is sampled at half the rate of the luminance, with both color-difference samples co-sited (located at the same place) as the alternate luminance samples. Thus you have 360 color samples (in each of R-Y and B-Y) per scanline.

In **4:1:1** systems (NTSC DV & DVCAM, DVCPRO) the color data are sampled half as frequently as in 4:2:2, resulting in 180 color samples per scanline. The U and V samples are considered to be co-sited with every fourth luminance sample. Yes, this sounds horrible -- but it's still enough for a color bandwidth extending to around 1.5 MHz, about the same color bandwidth as Betacam SP (which, were it a digital format, would be characterized as a 3:1:1 format).

So where does **4:2:0** (PAL DV, DVD, main-profile MPEG-2) fit in? 4 x Y, 2 x R-Y, and 0 x B-Y? Fortunately not! 4:2:0 is the non-intuitive notation for half-luminance-rate sampling of color in both the horizontal and vertical dimensions. Chroma is sampled 360 times per line, but only on every other line. The theory here is that by evenly subsampling chroma in both H and V dimensions, you get a better image than the seemingly unbalanced 4:1:1, where the vertical color resolution appears to be four times the horizontal color resolution. Alas, it ain't so: while 4:2:0 works well with PAL and SECAM color encoding and broadcasting, interlace already diminishes vertical resolution, and the heavy filtering needed to properly process 4:2:0 images causes noticeable losses; as a result, multigeneration work in 4:2:0 is much more subject to visible degradation than multigeneration work in 4:1:1.

In US implementations of 4:2:0, the color samples are supposed to be vertically interleaved with luminance, whereas in European 4:2:0 they're supposed to be co-sited. Practically speaking, this is a headache for developers of codecs, encoders, and DVEs, but for DV purposes it's not especially exciting, since only European DV is 4:2:0.

### **Why does PAL DV use 4:2:0?**

The best explanation I can come up with why PAL DV went with 4:2:0 is that both PAL and SECAM show reduced vertical color resolution and better horizontal color resolution compared to NTSC, so 4:2:0 seemed a closer match to the native display systems in PAL/SECAM countries. As PAL DV was intended as a consumer format for off-air recording or camcorder

acquisition, multigeneration losses in 4:2:0 were considered a less important factor than the optimization of first-generation performance. PAL DVCAM also used 4:2:0.

When Panasonic developed DVCPRO, they opted for 4:1:1 even in PAL versions, specifically for the multigeneration advantage. Thus PAL DVCPRO decks have the pleasure and responsibility of handling both 4:1:1 DVCPRO playback and 4:2:0 DV playback; they have extra hardware to digitally resample the 4:2:0 signal and come up with a decently synthesized 4:1:1. Sometimes there *is* a reason for the higher prices that the poor Europeans are saddled with when it comes time to purchase gear...

### **Can I chroma-key with 4:1:1?**

Yes indeed. Many early DVEs were 4:1:1 internally; plenty of digital boxes out there still are (such as the Panasonic WJ-MX50 and Sony FXE-series vision mixers, both of which chroma-key). As previously mentioned, BetaSP could be considered a 3:1:1 format in terms of component bandwidth, and BetaSP is used for chroma-key applications all the time.

True, the chroma performance of 4:2:2 formats is superior to 4:1:1 formats, especially in multigeneration analog dubbing. Part of the standard JVC sales pitch for Digital-S is the superiority of 4:2:2 (which is true), and the utter doom and degradation that awaits you should you try to do anything -- including chroma-key -- with a 4:1:1 format (which is, shall we say, a wee bit exaggerated). But that doesn't mean that you can't do very satisfactory work in 4:1:1. A Bentley may not be as fancy as a Rolls Royce, but it'll still get you there in style. If you're used to the VW Beetle world of color-under analog formats, DV's Bentley should present few problems.

JVC has an excellent Digital-S demo tape showing multigeneration performance comparisons of DV, Digital-S, and Digital Betacam; watch it if you can. Just be sure you take the hype with a grain of salt...

### **Can I use 4:1:1 DV sources for upconversion to HDTV?**

All SDTV source material will suffer when upconverted to HDTV, compared with material originated in HD to begin with. 4:1:1 material is reported by some to be problematic in this aspect; certainly a 4:2:2 original will be more forgiving and if upconversion is your primary goal, you may want to look closely at Digital-S or DVCPRO50.

Snell & Wilcox have run DV through upconversion and reports that it look OK, especially if the excessive aperture correction (edge enhancement) in most DV cameras is turned down. Of more concern is that DV artifacts, especially mosquito noise, may become annoyingly prominent when upconverted. However, the jury is still out on this.

Also, all HD material (at least in the USA) is likely to be [16:9](#). The way many DV cameras produce 16:9 by throwing away vertical resolution is enough to send shudders up my spine for SDTV work; for HD, it'll be a complete disaster. Perhaps I should add a section on shooting for HD upconversion; there are lots of issues...

# 1394/FireWire

## What is 1394 and/or "FireWire"?

IEEE-1394 is a standard communications protocol for high-speed, short-distance data transfer. It has been developed from Apple Computer's original "FireWire" proposal (FireWire is a trademark of Apple Computer). Check out the white papers on [Adaptec's](#) website and check [DVCentral's links](#) for pointers to additional 1394 sites for detailed information. Sony calls their implementation of 1394 "i.Link".

## Why are DV and 1394 always discussed together?

They appear to have been developed together. The data stored on DV tape appear to reflect the packet structure sent across a 1394 link to a frightening degree of exactness. Certainly the DV format and 1394 High Performance Data Bus co-evolved, such that the first consumer DV camcorder in the USA (the Sony DCR-VX1000 and its single-chip brother the VX700) was also the first 1394-equipped consumer product available.

## What does a 1394 connection do for me?

Plenty of good things:

You can make digital dubs between two camcorders or VTRs using 1394 I/O, and the copy will be identical to the original.

You can do cuts-only linear editing over 1394, with no generation loss.

You can stick a 1394 board into your computer (PC or Mac), and transfer DV to and from your hard disk. If your system can support 3.6 MBytes/sec sustained data rate -- simple enough with many A/V rated SCSI-2 drives -- the world of computer-based nonlinear editing is open to you without paying the quality price of heavy JPEG compression and its associated artifacts, or the monetary price of buying heavy-duty NLE hardware and banks of RAID-striped hard drives.

Recently I edited a friend's wedding, going from Hi8 camera originals to a DV edit master. The 20-minute ceremony was covered by two cameras; we sync-rolled the VTRs and mixed the show in real time as if it were live. At the end, we weren't sure we liked it. So we dubbed it off via 1394 to another DV cassette, inserted a fresh DV cassette, and had another bash at the edit. This time, we liked it. We put the tape into the VX1000 and set up the DHR-1000 VTR as the recorder, using the built-in editor to drop the second attempt in frame-accurately atop the first across the 1394 wire. No generation loss. And we still had the first edit on the backup tape, should we have changed our minds.

## Is 1394 that much better than Y/C or component analog?

Yes. A 1394 dub is a digital copy. It's *identical* to the original. That's *really* nice.

Yes, you can do almost the same thing with a SMPTE 259M SDI (serial digital interface) transfer. But VTRs with SDI cost big money. 1394 is built into many low-end cameras and VTRs, and the connecting cable -- even at Sony prices -- is only \$50. And transferring DV around as baseband video, even digitally, subjects it to the small but definite degradation of repeated decompression/recompression

If a digitally-perfect copy is a 10, and a point-the-camera-at-the-screen-and-pray transfer is a 1, here's how DV picture quality holds up over different transfer methods:

IEEE-1394	10
SDI	9.8
Analog Component (Y, R-Y, B-Y)	9
Y/C ("S-video")	8

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Analog Composite	5
Point camera at screen and pray	1

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# Locked vs unlocked audio

## What's the difference between locked and unlocked audio?

**Locked** audio is "audio done right": the audio sample clock (the digital time reference used in the sampling process) is precisely locked to the video sample clock such that there is exactly the same number of audio samples recorded per "audio frame" of video (not all TV formats and sound sample rates have a neat integer relationship between audio samples and frames, so an "audio frame" is my term [similar to a "color frame"] for the number of video frames it takes for audio and video to match up in the same phase relationship).

For PAL, 625/50 video, locked audio provides exactly the same number of samples per video frame with either 32 or 48kHz audio, but for NTSC, 525/59.94 video, the 48kHz "audio frame" is 5 video frames: locked audio will provide exactly the same number of audio samples for every five video frames, though not every frame within that 5-frame sequence has an equal number of audio samples. 32kHz locked "audio frames" cover a whopping 15 video frames!.

[There is such a thing as an AES/EBU audio frame, but I'm not sure it that's the same thing I'm referring to. Comments/clarifications welcomed!]

### ***Unlocked audio: theory:***

Unfortunately, such precisely-locked audio clocks are expensive. Since DV was designed as a consumer format, **unlocked** audio was allowed as a cost-saving measure. In unlocked audio, the audio clock is allowed some imprecision, such that there can be a variation from the locked spec of up to +/- 25 audio samples written to tape for every frame, instead of a precise and exact number.

This economy measure is simply one of allowing the audio clock to "hunt" a bit around the desired frequency; the phase-locked loop (or other slaving method) used to keep the audio sampling in sync with the video sampling can have a bit more slop in its lock-up, with the audio sampling sometimes running a bit slower, sometimes a bit faster, but always staying in sync over the long run. **The total amount of sync slippage allowed in unlocked audio is +/- 1/3 frame** -- not enough to really worry about.

It's the difference between walking a dog on a short leather leash, always forcing the dog to stay right by your side (locked audio), and using a long, elastic leash or one of those "retractable clothesline" leashes that allows the dog to run ahead a bit or lag behind (unlocked audio). In either case both you and the dog will get where you're going at the same time, but along the way the "unlocked" dog has a bit more freedom to deviate from your exact walking pace.

Unlocked audio should *not* cause audio sync to drift away from video over a long period of time. The audio clock is still linked to the video clock; it's just allowed a bit more oscillation about the desired frequency (more wow & flutter if you will) as it's trying to track the video clock. Like the dog on the springy leash, it can run a bit ahead or a bit behind the video clock momentarily (up to 1/3 frame ahead or behind), but in the long run it'll still be pacing the video clock and on average will be right there in sync with it. I have shot one-hour continuous takes of talking heads with a consumer DV camcorder (DCR-VX1000) and experienced no drift at all between audio and video.

DV cameras and VTRs generate *unlocked* audio, both in 32 kHz 12 bit and in 48 kHz 16 bit recordings. DVCAM and DVCPRO cameras and VTRs generate *locked* audio in 48/16 audio

format, and DVCAM can also generate *locked* 32/12 audio. 44.1kHz, discussed below, is *never* locked; it has no neat integer relationship with either 625/50 or 525/59.54 frame rates.

Some non-linear DV/1394 editors generate locked audio, some output unlocked, and some allow the choice. DV gear is happy to record locked audio via 1394, as is the DVCAM DSR-20 VTR. The DVCAM DSR-30 VTR can also be made to record unlocked audio with a bit of coaxing (see [Tidbits](#)).

Also, many non-linear editors output 16 bit 44.1 kHz audio (at least on PC platforms), which both DV and DVCAM 1394-equipped decks record without any problems. 44.1 kHz is part of the Blue Book spec, so this is not too surprising.

### ***Unlocked audio: real life:***

"The difference between theory and real life is that in theory, there is no difference between theory and real life, but in real life, there *is* a difference." -DV Filmmaker Marshall Spight

While the theory sounds good, real life is sometimes a bit different. Some manufacturers appear to take the word "unlocked" literally; a completely separate clock seems to be used for the digitization of audio, with no direct linkage or locking to the video clock. The result is an audio timebase stability that's excellent (since no "hunting" around a target frequency is present), but the possibility arises of a long-term drift between audio and video, *when processed independent of each other*.

This was revealed at NAB '99 by Randy Ubillos, lead engineer on Final Cut Pro, who has found that while some cameras are pretty good, Canon cameras grab 48kHz sound at around 48.009 kHz, which can result in almost a second of video/audio slippage over the course of an hour (or around one frame every two minutes). Sonys, by contrast, seem to average 48.001 or 48.0005 kHz, resulting in perhaps a couple of frames of slippage over the same time period. Clocking rates for other cameras were not discussed.

In normal playback of the DV tape this isn't seen, since on playback the audio is played back based on its embedded clocking data, in sync with the image. Both the audio and video slave to the data samples in each packet; as these are commingled in the DV datastream, the sound and picture will always play back in sync.

In most DV NLE systems to date (May '99), it was also not a problem, since captures were limited to under ten minutes due to the 2 Gigabyte file size limit and the slippage seen in this short time period was minimal.

Final Cut Pro, however, uses file referencing to span the 2 Gig limit, allowing captures limited only by available disk space, and the QuickTime media format used treats audio and video as separate tracks, each with its own time reference. When capturing long clips, the drift can become apparent; Final Cut can measure this drift and recalculate the audio sample frequency so that QuickTime playback will stay in sync.

As far as I can tell, the AVI file format used in some Windows-based NLEs does not allow this sort of long-term slippage to occur, but I may simply lack sufficient data. I do know that various QuickTime-based DV NLEs have shown certain oddball audio/video sync problems that I have not seen or heard of in AVI-based NLEs; this is not a QuickTime problem *per se*, merely an



artifact of QuickTime's flexible and elegant approach to multiple-track media streams in that such problems *can* be made to occur.

### **Will unlocked audio hurt me? How do I deal with it?**

When using *analog* audio I/O, the whole question of locked vs unlocked is moot: it's analog and there are no clocks to worry about. Analog is *always* safe to use for dubbing or editing. As discussed above, DV audio data are converted to analog in real time as the data come off the tape, and audio slippage simply doesn't occur regardless of the accuracy of the sampling clock. It should also be of no concern when taking the audio in via 1394 to a DV-based nonlinear editing system. When all the audio samples are stored in a neat memory array, the software doesn't care if there was some timebase instability on the original recording; when non-real-time rendering is occurring, a sample is a sample is a sample.

However, some long-term slippage between audio and video can occur in long clips, at least in QuickTime format, if the capture application doesn't compensate for any audio clock inaccuracy. Fortunately, the problem is understood by those in the business (at least at Apple and Digital Origin), and corrective measures are taken at capture time: Final Cut Pro measures the actual number of samples captured over time vs. the theoretical number, calculates the actual effective sampling rate, and uses that in QuickTime file processing.

Unlocked is only a potential problem when doing *real-time* audio and video editing with *digital* transfer of the audio between source and recorder. "Digital" means conveyance of the audio using the IEEE-1394 bus, AES/EBU digital audio outputs (on pro DVCAM/DVCPRO VTRs), or SDI embedded audio (ditto).

As far as DV-based editing is concerned, when you make an edit *in the digital domain* between two different DV datastreams using unlocked audio, you might wind up with a few too many audio samples or not quite enough, in which case you can get a click or pop on the soundtrack during playback as the audio subsystem either has to discard some extra data and resynchronize (an audio buffer overrun), or as it winds up with too few bits of sound to cover the time available (buffer underrun) and you get a momentary dead spot or mute effect (depending on the audio circuitry used, the system may also mute when it's resynchronizing after discarding samples). In either case the audio glitch will occur in a fraction of a second; it won't result in several seconds of dead audio or any prolonged audio noise. Reportedly, it's also only a problem at the out-points of insert edits, not at edit in-points (unverified).

Interestingly enough the same problem may occur when cutting between two *locked* audio streams without regard to synchronization of the "audio frames", though here the problem is much smaller in scope since the variation in sample counts will only be +/- 2 samples per video frame. Such errors are typically inaudible, though they may still complicate things if the audio track is then used in real-time digital audio mixing (see below), and they'll only occur in 525/59.94 video, never 625/50 due to 625's 1:1 relationship between video frames and "audio frames".

[It's also worth noting that *any* hard cut between clips can result in a pop or click if the instantaneous level of the audio at the cut point is mismatched, causing impulse noise. This is true in locked or unlocked audio; it can even occur when working in analog. This is one reason that linear analog audiotape and film fullcoat mag tracks are often spliced at an angle instead of with a straight cut; this mechanically performs a quick crossfade between the two tracks instead of an abrupt transition.]

When all you are doing is editing one generation down from camera originals to an edit master, and then making release copies on an analog format such as BetaSP, SVHS, Hi8, VHS, or the like, all you need to be concerned about is audible popping or muting. The release copies will contain an analog track that records what you hear; there are no hidden gremlins due to asynchronous clocking, jitter, or other nasties that so complicate digital audio.

However, when you take the *digital* audio datastream from a DV tape and try to integrate it into a larger digital audio system, such as AES/EBU routers, digital audio workstations (DAWs), and/or multitrack digital audio recorders including the Alesis ADAT and Tascam DA-88/98, the sloppy synchronization of unlocked audio can cause glitches, artifacts, and distortion. If the receiving gear is trying to derive its audio clock from the unlocked audio datastream, the entire downstream audio chain can be rendered unstable and dysfunctional.

Furthermore, playback of unlocked audio including edit-point glitches as discussed above into a DAW or other digital audio system can cause a major commotion when the edit-point glitch is played back. Ever had a really bad splice go through the gate on a film projector, or past the heads on an analog audiotape recorder? A glitched unlocked audio edit is the digital equivalent of that crummy splice, only worse!

Fortunately it's fairly simple to avoid this. Either convert unlocked audio to locked, or use analog audio connections between your unlocked source and the digital audio chain you're feeding (and if your source tape has 44.1kHz/16 bit or 32kHz/12-bit sound, going analog into the digital system means that you get a rate conversion into 48kHz sound at however many bits are being used courtesy of the A/D converter on the professional digital system; it may actually sound better -- and be easier -- than hooking up digital sample rate converters in the chain).

There are four known ways to convert unlocked audio to locked audio:

- 1) The DSR-60/80/85 DVCAM VTRs will convert unlocked audio to locked audio on playback. DVCPRO VTRs are also supposed to relock DV audio on playback. This solved your problem at the point of playback. If you need to make a *tape* with locked audio, then...
- 2) Dub your DV tape to a DVCAM or DVCPRO tape using analog audio connections between the source and the recorder. Hey presto, locked audio! The video can be dubbed via SDI for minimal if any losses. This is also the recommended route if your source audio is *not* 48kHz since you want the dub to have 48kHz audio for best compatibility.
- 3) Play back the DV tape in a high-end DVCAM or DVCPRO VTR, and dub it to a DVCAM DSR-80 or DSR-85 using either the AES/EBU digital audio or the SDI embedded audio options. The recorder will relock the data and write locked audio to tape (this may also work with high-end DVCPRO machines, but I haven't confirmed this).
- 4) Transfer your footage into a non-linear editor that allows outputting locked audio, and use the NLE to write out locked audio, even to a DV-format tape. Slow and cranky, but it works.

### **How do I intermix locked and unlocked audio?**

It's best not to intermix *any* variations of digital audio on the same tape. While VTRs seem to cope with sudden changes in sampling rate, bit depth, and locked/unlocked status, often you'll get a brief moment of silence at the transition between audio types as the internal workings of the audio chain readjust themselves to the new audio type. Some non-linear editors are very uppity about audio changes; if you start digitizing a 48 kHz clip and the audio changes to 32 kHz, you'll get silence for the entire 32 kHz section (or vice versa; once the capture card and software start grabbing data at a certain rate, they're too busy to try to change rates in mid-stream. Furthermore, the meta-data stored with the clip can only remember one audio format

per clip). And if you try to digitally feed such mixed-mode tapes' audio into further digital processing, major glitches can be expected.

The best thing when doing a linear edit is to use analog audio, or (if the only changes you have are between locked and unlocked audio) use the digital outputs from a high-end VTR as described above. For non-linear editing, capture clips each containing only a single format of audio; when you render the finished project, all the audio will be converted to a common format.

### **Does unlocked audio explain why my audio loses sync in Adobe Premiere?**

Sorry, no! Adobe Premiere 4.2 and earlier versions have a historical problem with synchronous audio playback from the timeline. As discussed above, unlocked audio doesn't drift over the long term. Premiere audio can drift regardless of whether the source was locked or unlocked. This particular problem is variously attributed to the difference between 30 Hz and the 29.97 Hz that NTSC runs at; the inability of an AVI or QuickTime file to maintain synchronous audio; the weakness of the Windows VFW subsystem at really keeping things in sync, and the phases of the moon (if anyone knows what's *really* going on, this author would appreciate being appropriately enlightened).

Reportedly Premiere 5.1 fixes audio sync problems. Certainly I've had no problems with Premiere 5.1 on Windows editing clips up to 9:30 in length (the 2 Gig limit of my AVI-based system), nor have I heard of any such problems in discussions with other people.

# Linear editing

## Can I use DV in linear editing?

Certainly! Much of the fuss that's made over DV formats is in regard to non-linear editing, but it works fine for linear editing as well. DV gear interoperates with Hi8, SVHS, Betacam, MII, D-5, and other formats using composite, Y/C, component analog, and serial digital I/O (see [Technical Details](#) for which VTRs offer what I/Os). It works fine with the editors and SEGs and DVEs and terminal gear you're used to using.

## What sort of linear editing gear can I get in DV? What sort of machine control is there? How accurate is it?

**Low end:** The Sony and Canon camcorders as well as the DHR-1000 and DSR-30 VTRs are all remote-controllable using the Sony Control-L (LANC) protocol. The Panasonic camcorders (some of them at least) have 5-pin Panasonic ("Control-M") ports. All work fine as edit sources.

The JVC DV camcorders offer "J-LIP" ports for remote control and editing. I haven't seen any editors that support J-LIP protocol directly (but see "mid-range" below).

The DHR-1000 and DSR-30 VTRs have built-in 10-event cuts-only editors as well as separate audio and video insert-edit capabilities, allowing them to be used as the controller in bare-bones cuts-only LANC editing. These decks, while rated at +/- 5 frames accuracy, appear to be frame accurate better than 90% of the time. In-points on the DHR-1000 appear to be frame accurate all the time and there's no reason to expect that the DSR-30 is any different. Out-points may occasionally be off by a frame or two.

If you don't want to use the built-in controllers on these decks, there are a variety of standalone edit controllers that talk LANC and/or control-M. Among these are [Videonics'](#) AB-1 Edit Suit and Video Toolkit, and [TAO's](#) Editizer, all notable as being control-agnostic systems: depending on the cables used and the setups performed, these will control any mixture of RS-232, RS-422, LANC, and control-M VTRs (great for interformat editing). In my experience TAO Editizer's accuracy is typically +/- 1 frame, with the actual in-point on the DHR-1000 being frame accurate but with the feeder decks being off by perhaps a frame about 20% of the time -- not bad, given that these decks don't capstan-bump and Editizer doesn't varispeed 'em in preroll. (Note that these editors typically only support assemble editing on LANC or control-M recorders; historically, that's all that LANC/control-M machines have been capable of in their Video8, Hi8, and SVHS incarnations.)

**Mid-range:** you can integrate low-end gear with high-end editing systems by using protocol converters, so that the lowly camcorder or VTR appears to be a standard, RS-422 protocol edit source. Note however that for the most part these protocol converters allow the low-end decks to serve as edit feeders only, not recorders.

LANC: Sony provides the **IF-FXE2** LANC Interface Box, while TAO offers the **L-Port 422** LANC to RS-422 converter.

Control-M: TAO is coming out with an improved **L-Port 422** that also talks control-M (Panasonic 5-pin).

J-LIP: JVC offers the **SA-K38U** Control Interface, designed to allow the BR-DV10u dockable DV recorder to be controlled by an editor using either the RS-422 or JVC 12-pin interfaces. It probably works with the consumer DV camcorders as well, although I haven't verified this.

With all of these, the accuracy is likely to be in the +/- 1 to +/- 5 frame range depending on the edit controller used and the ballistics of the other decks involved.

**High-end:** The DSR-60/80/85 DVCAM and AJ-D6XX/7XX series DVCPRO VTRs use industry-standard RS-422 serial protocols for assemble and insert editing. They are frame-accurate, no-nonsense machines you'd use in editing just like BetaSP, MII, DigiBeta, or D-5 VTRs.

### **Is DV timecode the same as SMPTE timecode?**

No, technically speaking; yes, for most practical purposes (!).

There's a great deal of confusion about timecode. There are two different aspects of timecode that people mix up: how is it recorded on tape, and how is it used in editing. The first aspect is where "SMPTE" vs "RCTC" (Hi8) vs "DV TC" vs "Frame Code" (series 7 U-Matics) vs "CTL Time Code" (JVC SVHS) matters; it's largely a concern for historical reasons. The second aspect is what really matters: how does your editor see timecode. Nowadays, for the most part, how it's recorded on tape is *irrelevant* for this discussion.

Back in the dark, early days of linear editing with analog formats (the 1970s!), frame accuracy was not possible. Some clever folks came up with the idea of recording a unique code on every frame, so that edit controllers could repeatably reference an exact frame on tape. That developed into two timecode recording formats -- LTC and VITC -- that were formally standardized by the SMPTE and EBU, and adopted by manufacturers worldwide. The SMPTE/EBU timecode standards define where the timecode is recorded on tape, what amplitude the signal is, the encoding of the digital data, and so on. The standard also describes the time format of the timecode (HH:MM:SS:FF, two digits each of hours, minutes, seconds, and frames), and the format of "user bits", a separate set of hexadecimal digits the actual usage of which was left up to the individual.

LTC ("litsee") is Linear Time Code, a 1 volt square wave laid down either on a linear audio channel or on a dedicated timecode track. It is comparatively simple to build LTC into a VTR or to retrofit it to a VTR without timecode, as it's technically simple and requires no mucking about with the video signal itself. However, it's difficult to read during some off-speed tape motions (as when shuttling or scanning the tape) and impossible to read when the tape is paused.

VITC ("vitsee") is Vertical Interval Time Code, is a series of black and white pulses encoded into one line of the vertical interval of the video signal itself. VITC can be read even during pause mode (as long as the VITC line in the the video signal is readable) but it requires the rotating video heads to scan the tape, which isn't always possible during high-speed searches or shuttles. It's also more complex to implement, since you need to switch it into the video signal. Back when proprietary multipin control cables were used to control VTRs, it was important to know that "SMPTE timecode" was used, since you had to use an external box to extract the timecode from the the LTC track or the VITC line, and adherence to the standard way of recording the timecode on tape was necessary to guarantee recovery of the signal.

In the past decade or so, however, most editing systems and most VTRs have been moving to standardized serial control protocols, such as RS-422 or LANC (actually, RS-422 is a wiring and signal spec, not a protocol *per se*, but most of the "RS-422" gear out there speaks the same language derived roughly from the original Sony BVU-800 control protocol, with minor variations between different machines). In such systems, timecode data flow across the same wires as

the control data; it's up to the VTR to read timecode however it's written on the tape and turn it into a simple serial communications byte stream.

Furthermore, the SMPTE-spec timecodes aren't ideally suited to newer generation tape formats with slow tape motions, such as Video8, Hi8, and DV. LTC needs a fast-moving tape for proper data recording and recovery, and these formats just don't move the tape fast enough. Also, these formats already have digital data sectors on tape; why convert digital timecode to analog waveforms when you can record it as digital data to begin with?

Thus we have professional Hi8 with "Hi8 Timecode (but not really SMPTE timecode)" and consumer Hi8 with RCTC: "Rewriteable Consumer TimeCode". These are recorded as digital data in the subcode section of a Hi8 track. But an edit controller doesn't care; when it asks for timecode, it gets back something of the form "HH:MM:SS:FF", never you mind how it was recorded on tape! Likewise, the DV formats do digital magic to store timecode, but when an edit controller asks for it, it gets the same data over the wire that it would from a Hi8 VTR -- or a 1" Type C VTR, or Digital Betacam, or 3/4", or whatever.

Adding to the confusion is the "SMPTE TC" option for the EVO-9800 and 9850 Hi8 decks: This board takes the digital Hi8 TC or RCTC data and formats it into a 1 volt square wave signal as if it were coming off of an analog LTC timecode track. This allows the 9800/9850 to be used with edit controllers that don't understand serial timecode, but do their own recovery of it from the SMPTE LTC signal.

Are we having fun yet? The modern-day DVCAM DSR-60/80/85 and DVCPRO AJ-D6XX/7XX decks have this option built-in, allowing these VTRs to be used with editors that are expecting a noisy, distorted analog timecode and don't want nice, clean, serialized timecode data handed to them on a silver platter... really, though, I shouldn't be so snippy: while it sounds goofy from a technical standpoint, it provides backwards compatibility with a large installed base of very expensive editors, as well as a whole host of ancillary equipment that generates or takes in the SMPTE LTC signal. There *are* still occasions where having that LTC signal available on a BNC connector can be helpful, or downright necessary.

The bottom line is this: don't worry about whether or not the timecode recorded on tape is SMPTE or not. What matters is whether or not you have timecode, period (and DV *does* have timecode). Any modern-day edit controller should be able to use the timecode available over a serial protocol connection. For those that don't, or if you need SMPTE LTC I/O for other equipment (i.e., for a chase-lock audio synchronizer, an under-monitor display, or for jam-syncing of timecode from a common reference), there are DVCAM and DVCPRO decks that offer "SMPTE timecode" I/O ports.

# Non-linear editing

## What's non-linear editing?

Non-linear editing (NLE) is editing using random-access video storage, so that you don't have to wait for tape to shuttle to see a scene at the other end of the reel. Nowadays, this almost always means computer-based editing where you've transferred the video from tape to hard disk, and you assemble a show by arranging the clips along a timeline on the computer screen. When you're done, you output to tape, which happens either immediately (if you've spent a lot of money on gear) or after a rendering operation (if you've spent less money).

The "big names" in NLE are Avid (Media Composers of various flavors, models, qualities, and capabilities), Accom (formerly Scitex, formerly Imix) with its "sphere" products (descended from the VideoCube and TurboCube), Quantel (Harry, Henry, Harriet, EditBox, etc.), Media 100, D-Vision (turned into Discreet Logic Edit, and now is called Discreet edit\*), and half a dozen more up-and-coming, hanging-in-there, and/or where-are-they-now companies. These typically supply turn-key systems in the \$15,000 to \$150,000 range, even though some are built using open platforms such as MacOS, Windows NT, Truevision Targa cards, and the like. Sony and Panasonic each have two DV-native NLEs.

On the PC and Mac, at Prices For The Rest Of Us, the familiar names are Adobe Premiere, ULead Media Studio, Speed Razor, MotoDV, Video Action, and the like. These are software packages that work with (and are often bundled with) a variety of plug-in cards, including DPS Spark Plus, Pinnacle DV300 and DV200, Fast DVMaster, Canopus DVReX and DVRaptor, ProMax FireMAX, and so on.

## What's special about DV non-linear editing?

DV is compressed just enough to be able to stream into and out of current-day PCs and Macs, and the availability of inexpensive 1394 I/O cards and fast SCSI-2 hard disks means that high quality video storage and manipulation on desktop computers is now possible for the first time without having to spend a king's ransom on specialized RAID arrays and proprietary codecs. DV can be stored and manipulated in native form, without transcoding to JPEG, MPEG, Wavelets, or the like. The same high quality seen on DV tape is maintained in the computer.

You can put together a DV editing system with 90 minutes of online storage for under \$4000, and have a workable system that produces broadcast-quality output. If you already have an appropriate PC or Mac, you can get into DV editing for under \$1200 (a 1394 card with editing software and a 9 Gig A/V hard disk). Of course, you can spend a lot more, adding onscreen, full-resolution scrubbing; more storage; better machine control and the like. But the high video quality is there from the start, even in the sub-\$5000 system. This is a watershed moment in the evolution of affordable desktop editing.

## Who makes non-linear editing stuff for DV? What gear is available?

The answer to these is changing almost on a daily basis. These are exciting times.

**Low end:** A variety of "soft codec" systems are available for PCs and Macs, starting around US\$500 for the board and editing software. Among these are the [Canopus](#) DVRaptor, [DPS](#) Spark and Spark Plus (PC), the [Pinnacle](#)/Miro DV300 and DV200 (PC or Mac), the [Promax](#) FireMax (Mac), and [Digital Origin](#)' EditDV (Mac or PC). These systems *only* accept and output DV using an IEEE-1394 connection, although if you have other formats and a DV VTR, you can first re-record the video on the DV VTR and then bring it into the system (the DVCAM DSR-20 allows real-time composite or Y/C transcoding to DV without first recording the image on tape).

By the same token, you can output to analog video using the DV VTR as a digital-to-analog converter.

In mid-November 1998, Sony introduced a standalone DV/analog transcoder box, the DVMC-DA1, which goes for under \$400 at [ProMax](#). You can also order them through [Akiba Exports](#) in Japan (they accept American Express and wire transfers only, as of November 1998 [Jim Akiba has started working for Canopus as of April '99; he's kept up the export business, but DVMC-DA1s have vanished from sight]). With this box, real-time transcoding of DV to/from analog (composite or Y/C) can be added to a "soft codec" system, making such systems more viable for use with analog sources, and bringing them closer to "hard codec" systems (below) in convenience.

In May/ June of 1999, the DA1 was discontinued; a new model (DVMC-MS1?) is expected to be released at around US\$600. In the latter half of 1999, ProMax is expected to have a 1394 to Y/C / YUV / SDI(601) transcoder box of their own design for around US\$1500, as well.

The editing software supplied is Adobe Premiere, ULead Media Studio Pro, Speed Razor, Final Cut Pro, or something similar. Often, a separate DV capture/output utility is also provided.

**Mid range:** "Hard codec" board sets with editing software run around US\$3000. The [Canopus](#) DVReX and [FAST](#) DVMaster are two PC-based examples. These typically allow the use of other formats with real-time transcoding to and from DV; DV is the native format used on-disk. "Hard codec" systems also typically allow better performance during "scrubbing" and other manual editing tasks but are not necessarily any faster at rendering the finished show.

The software supplied may be Premiere, Media Studio Pro, or -- for the DVMaster Pro -- InSync's Speed Razor DV. A separate capture/playback application can also be used.

(I discuss ["soft" and "hard" codecs](#) later in this FAQ.)

**High end:** [FAST](#)'s "blue." system provides "any format in, any format out" editing for US\$60,000 or so. The captured video stays in its native form on disk (DV, M-JPEG, BetaSX, DigiBeta, ITU-R-601, etc.; analog formats are transcoded to a digital format when captured) and is only transcoded when necessary to do effects between streams in different formats or when outputting to a different format. blue. is supposed to ship some time in 1999.

"blue." has its own capture and editing application, developed with the experience gained from FAST's Video Machine line of products and incorporating user feedback. It's quite impressive, but perhaps a bit more expensive than readers of this FAQ are willing to put up with. :-)

Both Sony and Panasonic have Windows-based, turnkey systems for DVCAM (ES-3, using the blue. software; ES-7) and DVCPRO (DV Edit, NewsByte) respectively, that exploit the added features of these higher-end DV formats such as 4x transfer and editing metadata (in DVCAM, "ClipLink" good/no-good shot markers and clip picons provided by high-end DVCAM camcorders; in DVCPRO similar data are stored as "Picture Link" information). Prices start around US\$25,000 (no real-time 3D effects, no 4x transfer) and go up from there.

There are also realtime transcoders coming on the market (such as Truevision's Madras and Como's DVbox, or the Sony DVMC discussed above, or the expected ProMac box) that transcode DV into other digital and analog formats for use with Avid, D-Vision, and similar high-end editors, typically using M-JPEG (motion JPEG) formats on-disk.



Avid showed a DV-native editor under Windows NT at NAB '98; it's shipping in 1999.

### **Can I build a PC- or Mac-based NLE system myself?**

Yes. If you don't mind opening the computer case and fiddling with the innards, you can buy one of the low-end or mid-range board sets and do it yourself. But be warned, it's not a trivial task. All of these systems are very new, and most still have some bugs and incompatibilities. Also, DV systems pushed the limits of what you could do with early-to-mid-1997 PCs and Macs. Now, in the spring of 1999, most of the machines being shipped have the horsepower to handle DV (new blue Mac G3s, some Compaqs, and some Sony VAIOs even have 1394 built in), but it's still asking a lot from the computer to move DV data around at 3.6 MBytes/second without a glitch or hiccup. Careful attention to detail and optimization of system configurations and drivers are often required. Also be prepared to download the latest drivers from the Internet; often you'll need new video card drivers as well as newer drivers for the brand-new 1394 board you have just purchased.

Part of the joy of an "open systems" approach to building an editing system is that the list of possible conflicts and incompatibilities between different components of the system is huge and mutable. Scan the vendors' websites for lists of known good and/or known incompatible combinations of chipsets, hard disks, SCSI controller, and the like. If you're still in doubt, ask your local VAR (Value Added Reseller, the fellow you're going to buy the stuff from) about whether the stuff you're considering will all work together, or call the vendors directly and ask 'em if *their* board will work with *your* computer. One good tactic, if you're starting from scratch, is to settle on the DV card and software first, then buy a computer and the other components known to work with it.

Better yet, **if you're a video producer and not especially interested in fiddling with the innards of PCs and Macs, have your VAR build a system to your specifications.** Let them fight IRQ limitations and driver-incompatibility hassles -- and be willing to pay for it. If time is money for you, think about how much time it would take to resolve these hassles yourself (it took me the better part of three days to get my DPS Spark installed, working, and stable enough for my satisfaction, since Windows decided to reshuffle interrupts every time I rebooted, and I had an old Matrox Millenium driver that hogged the PCI bus. During that time I was only half as productive as normal: what's 1.5 days of *your* time worth?).

If you're Mac-based or at least platform-agnostic, I recommend checking out the turnkey FireMAX systems from [ProMax](#) in Southern California. Their systems work with a minimum of hassles and their prices are very aggressive. Good customer support, too. Alone in the DV NLE world, FireMAX offers a low-res "offline" capture mode that fits over 1/2 hour of video in a gig, with automated batch recapture of full-resolution clips for your final "online" assembly; and full support for four-channel audio. The FireMAX "C" board is one of only two DV systems certified by Adobe as Premiere 5.1 compatible as of December 1998 (the other is Radius MotoDV). You can even order a custom-configured JCooper control panel with jog-shuttle wheel and 20 dedicated Premiere function keys, for the traditionalist button-masher in all of us. Bloody amazing! [Disclaimer: I don't work for ProMax, nor do I get any sort of profit from recommending their stuff. I don't even own a FireMAX system... yet! Nor should I dissuade you from using other VARs or vendors, and/or getting a PC-based system.]

On the other hand, if you're a certifiable lunatic like me, just have at it! Just realize that it's still a "Plug and Pray" world inside that PC's case, and no, it's not an evil conspiracy against you when it doesn't work the first time. That's just the state of the art on the bleeding edge of desktop video technology...

## How much DV fits in a Gigabyte?

1 Gigabyte of storage is about 4 minutes 45 seconds of DV video. 2 Gigs is about 9 minutes 30 seconds.

The rule of thumb I use when estimating the storage I'll need for a project is 4.5 minutes per gig. Thus a 9 Gig drive works out to about 40 minutes of storage. An array of four such drives yields 2.7 hours. Not bad for about US\$1200 (USA retail prices, March 1999). And nowadays 9 Gig drives are small; you can get UDMA 16.8 Gig disks for almost the same price...

## What are SCSI-1, SCSI-2, Ultra-SCSI, etc.? What do I really need?

These are all peripheral buses for connecting hard drives (among other things) to computers.

**SCSI-1** is the "original" SCSI. It's an 8-bit bus with a maximum 5 MB/sec transfer rate. As DV requires 3.6 MB/sec sustained, SCSI-1 is generally too close to the edge for reliable DV transfers. Remember, that 5 MB/sec rate assumes no hiccups, and your computer has more to do than just wait around to dump DV data to/from the SCSI bus.

**SCSI-2**, also known as "fast SCSI" or "fast narrow SCSI", doubles the data rate to 10 MB/sec. This is usually acceptable performance for DV capture and playback

**Fast-Wide SCSI** uses a 16-bit data path for 20 MB/sec peak transfer rates (for this, you need to use the 68-pin cable, not the 50-pin Centronics or DB25 cable for slower flavors of SCSI). Likewise, **Ultra SCSI** or **SCSI-3** yields 20 MB/sec through faster data clocking. Fast-Wide or Ultra SCSI drives are fine for DV editing.

**Wide Ultra SCSI** (Fast Wide 20) combines the 20 MHz transfer rates with a 16-bit bus for 40 MB/sec, really quite a bit faster than needed for DV. There are even faster variants of SCSI, but these are exotic and expensive and are definitely overkill.

Want the big picture? Check out <http://www.adaptec.com/products/guide/ioposter.html> for a comprehensive matrix of I/O technologies. This big table lists all the SCSI flavors and everything else from parallel ports to USB to SSA to Fibre Channel to -- yes -- 1394.

Oh, yes: make sure that your hard drives are capable of the performance you need; just because a drive plugs into an Ultra-SCSI cable doesn't mean it can provide the sustained throughput needed for DV capture and playback. "A/V-rated" drives are a good bet; in general, check for 7200 rpm or faster rotation rates, plenty (512kB or more) of on-board read/write cache, and an advertised A/V capability. Faster never hurts: remember that time the computer sits around waiting to push data onto or read data off of the drive is time it isn't spending feeding data to/from the 1394 I/O card, updating the computer screen, reading the VTR's current position, or controlling the VTR.

## What about Ultra-DMA?

Ultra-DMA, also known as UDMA, Ultra ATA, or Fast ATA-2, is a further enhancement of the EIDE disk-drive interface, available on the newer G3 Macs and on some PCs (Intel 440TX, LX, BX, and later chipsets; VIA/AMD VPX, VP2/97, AMD-640 chipsets; Promise Ultra33 (FastTrack) controller. Win95 and WinNT require an upgrade to exploit UDMA; Win98 supports it fully). UDMA drives tend to be a lot cheaper than SCSI-3 drives, and are often capable of stutter-free capture and playback of DV data. UDMA allows best-case transfer rates of 33.3 MB/sec, compared with the 16.6 MB/sec best-case transfer rate under EIDE without UDMA (of course, this is only one of the bottlenecks in real-time DV work, which is why a fast raw transfer rate alone is not a sufficient indicator of DV suitability).

The early "blue" G3 Macs captured and played back DV without problems on UDMA drives, but *not SCSI* -- the PCI chipsets used (as of February 1999) appear to cause problems even with fast SCSI-3 drives. Apple released an [update](#) for the SCSI controller code in June 1999 that is supposed to solve these problems.

UDMA drives are backwards-compatible with IDE/EIDE controllers; you can drop a UDMA drive into an older computer and it will work. However, to get the level of performance needed for real-time DV work, you may need to have a UDMA-compatible controller with BIOS and OS support -- though I routinely play 9 minute clips from a Maxtor UDMA drive on a plain old EIDE controller with no dropped frames.

[\[More info on UDMA, from Maxtor\]](#)

### **Why doesn't my non-linear editor see timecode if it's already on the tape?**

Unfortunately, some current DV NLEs do *not* capture timecode into the clips stored on disk. This is not a hardware problem, it's a problem with the capture programs used by these editors. As the market matures, expect the software to gain this capability (and if it doesn't, ask your NLE vendor why not).

The 2.00 and later software releases for DPS Spark (PC) *do* capture timecode, as does Pinnacle/Miro version 1.6 software. The Canopus plug-ins for Premiere 5.1 (PC) capture timecode, though the stand-alone Canopus tools do not. Timecode capture is present in ProMax's FireMAX (Mac) and Apple's Final Cut Pro (Mac, of course!).

## "Hard" codecs vs "soft" codecs

### **What's a codec?**

A codec is a **compressor/decompresser**, a bit of software or hardware that takes raw video and compresses it, and can take the compressed video and decompress it back to raw video. Codecs exist for all kinds of compressed video, including DV, motion-JPEG, MPEG, Indeo, Cinepak, Sorensen, wavelet, fractal, RealVideo, vXtreme, and many others. (Indeo, Cinepak, Sorensen, RealVideo, and vXtreme are trademarks of their respective trademark holders.)

### **What are "hard" and "soft" codecs?**

Hard codecs are hardware codecs, such as the Sony DVBK-1 or "DVGear" chip. You supply power and raw video at one end, and get compressed video out the other end in real time. Flip a switch and pump in compressed video, and raw, uncompressed video comes out. Soft codecs are software modules that do the same thing, such as the "DVSoft" codec that comes with the DPS Spark card. Unless your computer is very powerful, though, and/or the codec is extremely simple (and the DV codecs aren't *that* simple), it will take longer than real time to compress or decompress the video stream, at least if you want the CPU to do anything else at the same time.

### **Which codec is better?**

That depends on what you're looking for, and what you want to spend. In the world of nonlinear DV editing as of early 1998, here's how things break down:

**One thing to keep in mind is that "hard" vs "soft" doesn't matter when it comes to picture quality: both give excellent if not identical results.** Be aware, though, that minor codec differences can cause accumulated errors over multiple compression/decompression

cycles [[Pix: multigen with different codecs](#)]. For example, the Sony soft codec used with the version 1.0 release of the DV300 causes a considerable [Y/C delay over ten generations](#), whereas the Adaptec DVsoft codec shows no such problem or a slight leftward chroma drift, depending on the testing done; the Radius codec seems to cause no drift either way. Not all DV codecs are designed the same way, as [discussed](#) by codec expert Guy Bonneau.

When capturing from or outputting to DV VTRs using a 1394 connection, it doesn't matter what kind of codec you have. A DV-based editor stores the same data on disk that travels across the 1394 wire; no compression or decompression occurs. Thus when you're doing capture or playback across a 1394 connection, all you're doing is a real-time data transfer; **the codec isn't even in the loop.**

The codec comes into play when you need to:

- Display DV video on the computer screen.
- Render transitions, titles, and effects.
- Capture from or output to non-DV VTRs.
- Buy a system, and pay for it!

It's here that the differences become apparent.

**Displaying DV video on the computer screen:** A hard codec frees up the computer's CPU to do things like shuffle video-overlay data around, whereas the soft codec takes CPU resources to decompress the DV video for computer display. Thus, all else being equal, the hard codec systems will offer larger real-time video windows on the computer display, and will allow better real-time jogging, shuttling, and scrubbing.

Hard codec systems such as the FAST DVMaster and Canopus DVREx display decently-sized (up to 360x240 or more) onscreen windows with real-time, 30fps scrubbing; the actual window size is only limited by the speed of the graphics card and its overlay capability. By contrast, soft codec systems such as DPS Spark and Pinnacle/Miro DV300 offer near-real-time scrubbing only in tiny, 120x80 windows; if the windows get much larger the frame rate drops off dramatically because the soft codec is taking too much of the CPU's time to allow for timely updates to the screen (though with the proper video card under Windows NT, DV300's software allows much improved performance in this operation). Final Cut Pro running on a 300 MHz G3 Mac can scrub almost full-screen DV to the Mac monitor *and* out the FireWire port using the soft codec alone, with little stuttering or frame dropping. As processors speed up, so do the soft codecs.

Hard codecs also allow scrubbing to the video (not computer) monitor with no extra equipment: DV data are pumped into the codec as the timeline is traversed, and the codec outputs the raw video and audio to a TV monitor.

Soft codecs require that a 1394-equipped VTR such as a DHR-1000, DSR-20, DSR-30, or 1394 camcorder be used as an "offboard" codec/transcoder, or the Sony DVMC-DA1 standalone DV/analog transcoder box, to see video on a TV monitor. The soft codec can also decompress the DV for display on the computer monitor. While this works (as in ProMax's FireMAX editor, or using Adaptec's DVSoft codec on the PC in Premiere), remember that if at the same time the soft codec is stealing CPU cycles to render things on the computer screen, the ability of the CPU to dump data across the 1394 wire can be compromised, and frame rates can suffer, leading to juddery, stuttering video output, though as processors get faster this is less of an issue.

**Rendering transitions, titles, and effects:** here the difference between hard and soft codec systems is less pronounced. To add an effect (say, a dissolve or wipe between two clips), the system has to take the two source frames, decompress them, perform the mix, and recompress the resulting frame. The soft codec takes CPU power to run, but the CPU has nothing else to do while waiting for the frames, so it might as well be involved. The hard codec runs in real time, but the CPU, once it has set up the data transfers, has to sit and wait for the output anyway. In early 1998, various vendors claim a 25% speed advantage of hard codecs over soft codecs, or a 30% advantage of soft codecs over hard codecs, or whatever... Too much depends on other factors, like the speed of the computer's CPU, bus and bus interface chipset, to decisively say that one codec will be faster than the other in effects rendering. However, as CPUs and buses speed up over time, the soft codecs (which, unlike their hard counterparts, aren't *limited* to running at real-time rates) are likely to take the lead in speed for rendering operations.

[Side note: we're discussing "single-stream" operations here: there is one video stream in the system and one codec; so to do a dual-stream effect requires that the available bandwidth and codec be shared between the two source streams of video and the output. Rendering an effect is inherently a non-real-time operation in such systems, no matter whether the codec is hard or soft. To date (unless FAST blue. offers it) the only native DV "dual-stream" systems which allow real-time effects rendering are the rather pricey Sony ES-3 and ES-7 and Panasonic NewsByte and DVEdit systems. This requires three codecs: two to decompress the two source streams used as inputs to the effect, and one to recompress the output back to disk. Currently this is cost-prohibitive and pushes beyond the limits of what can be done on affordable desktop computers without adding expensive dedicated disk controllers and the like, which defeats DV NLE's sweet spot: affordable high-quality video on affordable computers. Dual-stream capability *is* seen on some higher-end editing systems, mostly using M-JPEG codecs.]

**Capturing from or outputting to non-DV VTRs:** hard codec systems come with breakout boxes that include analog (composite, Y/C, and sometimes component YUV) connections as well as 1394 connections. You can connect up any VTR format with analog I/O to the box and capture it in real-time or output to it in real-time. This makes it easy, for example, to bring legacy Hi8 or Betacam footage into the editor to intercut with newer DV material. You don't even need to have a DV VTR or camcorder around to use the system, as it has its own hard codec onboard.

Soft codec systems supply a 1394 board for connection to a VTR, but offer no other inputs or outputs. For outputs, any 1394-equipped camcorder or VTR can be used to transcode to analog (composite or Y/C), so you can record the output of your NLE to Hi8, SVHS, BetaSP, or the like in real-time by using a DV VTR or camcorder as a transcoder (of course, you *must* have your DV machine present to act as the transcoder as there is no non-1394 output available).

However, to bring non-DV material into your soft codec based system, you may first have to dub the material to a DV tape: aside for the DSR-20 none of the 1394-equipped VTRs will transcode from analog inputs to DV "live" without first recording the material to tape. So it can still be done, but it's a two-step process: dub to DV, then capture (or buy a DSR-20 for live transcoding).

In mid-November 1998, Sony introduced a standalone DV/analog transcoder box, the DVMC-DA1. With this box, "live" real-time transcoding of DV to/from analog (composite or Y/C) can be added to a "soft codec" system, making such systems more viable for use with analog sources, and bringing them closer to "hard codec" systems in convenience. These \$400 boxes are in

short supply in the USA, but [ProMax](#) has them or can get them. You can also order them through [Akiba Exports](#) in Japan (they accept American Express and wire transfers only, as of November 1998). [Note: the DA1 appears to be discontinued as of June 1999. A more expensive Sony model is in the offing, and ProMax is expected to release a US\$1500(?) 1394 to SDI/YUV/Y/C transcoder of their own design in the latter half of the year.]

**Buying a system, and paying for it:** hard codec systems are not cheap; they run around US\$3000 at the present time. You can't just buy them on a whim, and even if you know you're going to use it, it might be difficult to conjure \$3000 out of thin air to pay for it (I haven't met anyone getting rich by making video!).

Soft codec systems cost around US\$700, which is considerably more affordable for most folks in this market. They're a much better choice if you are cash-poor or aren't sure that DV NLE is for you.

My recommendation? If your time is valuable (you edit video for a living), and looking at tiny onscreen windows is more than just a minor annoyance, you'll be happier in the long run with a hard codec system (you'll be much happier with a realtime, dual-stream system, but these get rater expensive). It's just a bit less tiresome to work with, and faster when you want to import non-DV material. It's also more convenient when sitting there with a client looking over your shoulder, since the onscreen previews are bigger and faster. You don't need to have your camera or DV VTR present to play back to the TV monitor, and if you're a small shop with limited resources and a busy schedule, this can justify the cost of the hard codec: your camera can be out shooting the next show while you edit the current one, and the money you save by not having to buy a VTR as an offboard codec will pay for the hard codec system.

On the other hand, the part-time videomaker, the short-of-cash, and the casual "prosumer" might well be better off with the soft codec systems. \$700 is certainly a lot more affordable than \$3000, and if you decide that DV editing isn't for you, you're out less money. If you spend most of your time doing something other than editing, then the interactive speed advantages of the hard codec may not matter much compared to the higher cost.

What am I using? A soft codec based DPS Spark. But then, my main job is software engineering, not video editing; the payback period for the more expensive product was too far out there (and in the mean time, hard codec prices are likely to drop). Besides, I'm used to looking at tiny pix: I used to cut double-system sound, A/B roll shows on Super8 film...

# Transcoding to and from M-JPEG

## Can I transcode between DV and motion-JPEG?

You can. Depending on the amount of JPEG compression used, you might not even see a difference.

It seems to be generally accepted that JPEG compression at 3:1 is roughly equivalent in quality to DV's 5:1 compression. It's also worth remembering that DV and JPEG are both DCT (Discrete Cosine Transform) codecs; they tend to have similar artifacts and effects on pictures. (DV gets its additional compressive efficiency through block-level optimization of quantizing tables, whereas JPEG uses a fixed quantizing table for an entire image).

Thus, one might venture to guess that whether one is compressing via 5:1 DV or 3:1 JPEG, similar amounts of damage are done to the image, and that transcoding between these two compression schemes might cause *less* degradation than the *initial* compression caused.

Indeed, at NAB '96 Panasonic had hidden away in a corner a most interesting demonstration. A D-5 (uncompressed ITU-R-601) signal was fed to a component digital switcher on input #1. It was also taken, compressed via the DVCPRO codec, decompressed, and fed to input #2. The processed signal was further fed through a Tektronix ProFile DDR using JPEG at around 2.5-3:1 compression, and played back to input #3. *That* signal was again fed through a DVCPRO compression/decompression chain, and brought up on input #4.

A wipe pattern was set up, and by pressing buttons one could see a split-screen of any two signals on the switcher. Remember, this was a digital component switcher, and the monitor was one of those gorgeous Panasonic digital monitors where the image data stay digital all the way to the modulating grid (really, these are amazing monitors; if you haven't seen one, you don't know how *good* video can look).

The original D-5 image was deep, quiescent, lucent: as good as 525/59.94 images get. The first DVCPRO-processed image showed the usual sorts of DV artifacts we've all come to know and love, but it was still pretty darn good; you had to look closely to see any degradation.

But that was it: the further stages of processing showed no noticeable difference. The initial DV compression had already thrown away the troublesome transients and difficult details. What survived the initial DV codec was a DCT-friendly image that suffered very little from further compression in the ProFile, and the ProFile-processed image ran through the final DVCPRO codec with ease.

I'm not saying the images were identical; there were probably minor truncations and losses occurring in the ProFile's JPEG codec and in the final DVCPRO codec. However, these were very minor and visually imperceptible. Because the entire signal path was digital, the image stayed in registration throughout; there was no shifting of 8x8 DCT block boundaries nor were there level shifts and noise introductions as could occur in analog connections, both of which could degrade further compression. Moreover, the compression on the ProFile was very mild; it was at least as good, visually speaking, as the DVCPRO compression.

So, it can be done. Bear in mind that the level of JPEG compression used is a big determinant of whether you can transcode successfully. If you're using low JPEG compressions of 3:1, 2:1, or less, and transcode in the digital domain (through a serial digital connection or software



conversion, rather than via an analog connection to a JPEG codec), you will see very, very little degradation of the image. If you dump your DV data into the JPEG world via an analog connection, or if you use higher compression rates, you will see a progressively higher amount of degradation.

Even so, there's always the risk of some loss. As a fellow said at SIGGRAPH '86, "Dealing with floating-point numbers is like shoveling sand: when you pick up a handful, you get a little dirt, and some sand trickles out..." and the same can be said about moving between different codecs.

### **Which is better for editing: DV or M-JPEG?**

Ahh, now *that's* the question! And with systems like [DraCo](#)'s Casablanca, Matrox's DigiSuiteLE, or [Pinnacle](#)'s ReelTime that work in M-JPEG but offer 1394 I/O, what's going on?

**DV** is good because if you've shot in DV and stay in DV on disk, there's no transcoding required. DV is ideally suited to desktop editing because the data rates are viable on not-too-exotic SCSI-2 or ultra-SCSI disks and controllers; you can assemble a perfectly usable DV editing system for under US\$4000 and produce excellent, broadcast-quality work (well, technically, at least; despite what the manufacturers would have you believe, *no* format or software guarantees to make you a creative genius).

If you're shooting DV, why not stay in DV all the way? The sweet spot for this format (to borrow Panasonic's DVCPRO slogan) is "faster, better, cheaper", and you can't get comparable M-JPEG quality for DV prices, DV data rates, and DV storage requirements.

On the other hand, DV's fixed data rate means that 25 Mbits/second is what you get: you can't use a DV codec to grab hours of low-res "offline" quality to disk for a rough edit.

**M-JPEG** is a mature technology used in most high-end (Avid, Accom, Discreet, etc.) editing systems. It offers the ability to capture at different rates, so you can save on disk space for the offline work and redigitize the rough cut for the online clean-up. At the lesser compression levels it offers potentially higher quality; if you're doing a lot of multi-pass or multi-layer effects work, you'll wind up with fewer cascaded compression artifacts with a high-end M-JPEG system.

Whether the difference is a visible one by the time your program hits a VHS cassette or an over-the-air analog transmission is arguable, but it *is* an issue to be aware of, especially if you need to protect as much quality as possible for DVD or future DTV usage.

M-JPEG will cost you more for the same level of quality, requiring faster disks or RAID arrays, and more of 'em.

Systems like Casablanca, DigiSuite, or ReelTime are M-JPEG at the core, but offer a 1394 connection so that you can pipe your DV data in and digitally transcode it to M-JPEG. As I discuss above, this need not visually degrade the image, assuming the underlying data rate is high enough that low compression levels can be used. It's definitely going to be better than an analog connection between your DV source and the M-JPEG data on-disk; these systems may seem odd, but they make sense from a technical standpoint.

So which one is better? It depends on your needs, your target distribution methods, and your budget. If you can't make up your mind, get the "blue." system from [FAST](#), and mix 'n' match



M-JPEG data and DV data as suits your mood!

### **What about MPEG-2 editing?**

Editing systems using "Studio Profile" MPEG-2, otherwise known as 4:2:2P@ML MPEG-2, are starting to appear (namely FAST's "six-oh-one"). This is basically the same compression scheme used in BetacamSX, a flavor of MPEG-2 using 1- or 2-frame GoPs (groups of pictures). I have no experience (yet) with such systems -- nor does just about anyone else in August of 1998 -- so it's hard to really review them in any detail. (FAST has announced the 601 (six-oh-one), and Pinnacle has shown the DC1000 at NAB '99; both are MPEG-2 editors, so we should soon start to see some real-world reports on their performance.)

For what it's worth, some in the industry as of August 1998 are predicting that before too long there will be only two flavors of compression used in editing: DV and MPEG-2. Both formats are "native" capture formats (DV, DVCAM, DVCPRO for DV, and BetacamSX for MPEG-2) and MPEG-2 is the distribution format for American DTV, whereas M-JPEG introduces a compression step that's neither native to an acquisition format nor used for distribution. The European Broadcasting Union, in [Annex C](#) of the SMPTE/EBU Task Force for Harmonized Standards for the Exchange of Program Material as Bitstreams Final Report, backs this up by recommending that DV family and MPEG-2 4:2:2P@ML family compression schemes be used in future networked television production. We'll see...

# 16:9 widescreen

## What is 16:9 widescreen?

16:9 is the widescreen format that the USA has standardized on for future DTV services. It has also been used in the NHK 1125-line analog HDTV standard and the Eureka 1250-line HDTV standard, as well as variety of enhanced SDTV (standard-definition TV) services in Europe and Japan. The screen is 16 units wide by 9 units high, so the "aspect ratio" is called 16:9 because it's easier to remember than 1.78:1 (approximately) which is the "normalized" number. Currently, most SDTV in the world is 4:3, or 12:9, or 1.33:1.

## Why should I care about 16:9?

As the world slowly and painfully switches over to digital broadcasting, it looks to be a 16:9 world we're all moving into. Although it's likely to take ten years or more before 16:9 receivers outnumber 4:3 receivers worldwide, and there will always be a huge legacy of 4:3 SDTV programs in the vaults, "premium" programming in the future will almost certainly be 16:9 material, in both "standard definition" and "high definition" forms.

4:3 program material won't be obsoleted by any means, but many forward-looking producers are composing and shooting for 16:9 to maintain as high a value as possible for all future distribution possibilities. Some are actually shooting 16:9, while others are practicing "shoot and protect" in 4:3, just by making sure that the material can be cropped to 16:9 without losing any important content from the top or bottom of the image.

## How do you get 16:9 pictures?

You can use the 16:9 switch on your camera (if it has one, and if it does 16:9 "the right way"). Or, you can shoot and protect a 16:9 picture on 4:3. Or, you can use an anamorphic lens. Many cameras have a **16:9 switch**, which when activated results in either a "letterboxed" image and/or an anamorphically-stretched image. But beware; there's a right way and a wrong way to do this.

The "right way" is to use a 16:9 CCD. When in 4:3 mode, the camera ignores the "side panels" of the CCD, and reads a 4:3 image from the center portion of the chip. When in 16:9 mode, the entire chip is used. In either case, the same number of scanlines is used: 480 (525/59.94 DV) or 576 (625/50 DV). You can tell when a camera is capturing 16:9 the "right way" because when you throw the switch, whether the resultant image is letterboxed in the finder or squashed, a wider angle of view horizontally is shown, whereas the same vertical angle of view is present.

The "wrong way" is for the camera to simply chop off the top and bottom scanlines of the image to get the widescreen picture. When you throw the switch on these cameras, the horizontal angle of view doesn't change, but the image is cropped at the top and bottom compared to the 4:3 image (it may then be digitally stretched to fill the screen, but only 75% of the actual original scanlines are being used).

[There are some Philips switchable cameras that do clever tricks with subdivided pixels on the CCDs; when you flip into 16:9 mode, the image's angle of view will get wider horizontally *and* tighter vertically. So to really be sure, use the change -- or lack thereof -- in the *horizontal* angle of view to see if your camera is doing 16:9 "the right way".]

The "wrong way" is wrong because the resultant image only uses 360 lines (525/59.94) or 432 lines (625/50) of the CCD instead of the entire 480 or 576. When this is displayed anamorphically on your monitor, the camera has digitally rescaled the lines to fit the entire raster, but 1/4 of the vertical resolution has been irretrievably lost. This is not too terrible for

SDTV playback (still, it isn't great), but it's asking for disaster if the image is upconverted to HDTV.

The bad news is that most inexpensive DV cameras (including the VX1000 and XL-1) do 16:9 the wrong way. 16:9 chips are still very costly and the yields are low; in late '98 Sony's DXC-D30WS 16:9-capable DSP camera (which, docked with the DSR-1 DVCAM deck, becomes the DXC-D130WS camcorder) was only available in short supply, and the Sony sales force was encouraged to steer folks to the non-widescreen D30 model unless they really *needed* widescreen, because the supplies were so limited. Even then, the WS model commands a US\$3000 premium over its 4:3-only sibling. The Panasonic AG-D900W, which is switchable between 4:3 and true 16:9 as well as between DVCPRO and DVCPRO50, is a good choice -- but at US\$39,000 it's not readily affordable the way a US\$3,900 XL-1 is... At NAB '99 the US\$15000 DSR-500Ws single-piece DVCAM camcorder was released, it's excellent and I'll post a review of it sometime soon. It's the current entry-level true 16:9 camera in the DV formats.

An **anamorphic lens** is the way film folks have done widescreen for years, though the video systems to use this (aside from the late, lamented Panacam) are few and far between. A cylindrical element squashes the image laterally, so that you get the tall, skinny pictures like images in a fun-house mirror. This squashing allows the 16:9 image to fit in the 4:3 frame. [Century Precision Optics](#) has an anamorphic adapter to fit the VX1000 and DSR-200 camcorders, as does [Optex](#) (distributed in the USA by [ZGC](#)). Both allow you to use the wider half of the zoom range, and both run about US\$800.

In the film theatre, or in the print lab, another anamorphic lens unsquashes the image to yield the original widescreen image. In video, you'd have to use a DVE or an NLE plug-in filter to unsquash the image, or you'd embed the appropriate codes into the data stream or video image (the codes differ in specification between different broadcast standards) to tell the receiver that the image should be displayed as widescreen.

So what's a poor DV shooter to do, if he or she can't afford a true 16:9 camera like the AJ-D900W or DSR-500WS, and can't find an anamorphic lens? **Shoot and protect** 16:9 on 4:3. Use the entire, non-widescreen 4:3 image, but protect your future revenue streams by ensuring that all important visual information is contained vertically in the center or upper 3/4 of the screen. That way you have the full resolution 4:3 image for use today, and you can always upconvert to HDTV later in the 4:3 aspect ratio *or* the 16:9 aspect ratio if you can accept the reduced vertical resolution. Should you need to repurpose the material into a 16:9 SDTV format later, you can letterbox it in post by setting up a vertical shutter wipe, putting black bands at the top and bottom of the screen just like on MTV. You're no worse off than with 16:9 material shot "the wrong way", but you have the freedom and flexibility of a full-resolution 4:3 image that's compatible with today's broadcast and non-broadcast standards.

# Frame mode, slow shutters, and "the film look"

## What is this "frame mode" I hear so much about?

Several cameras, including the Panasonic AJ-EZ1 and AJ-D210 and the Canon XL-1, have a "frame mode" or "movie mode" switch that appears to change the way the CCD is read out into buffer memory from interlaced to progressive scanning. This gives a 30 fps "film look" frame-based image instead of the 60 fps field-based image we normally see on TV.

A still frame taken from fast pan of a scene shot in frame mode with the XL-1 shows *no* interlace artifacts when viewed in Premiere; each 720x480 frame shows up as an intact frame-based image in which both the even and odd fields appear to have been captured at exactly the same time (of course, the data stream written to tape still interleaves the even and odd fields for proper interlaced TV display; it's just that both fields appear to have been clocked into the transport-and-hold registers of the CCD simultaneously instead of in even-odd alternation). When shown on TV, frame mode images have had their temporal resolution reduced by half to 30 fps, fairly close to film's 24 fps. For the 625/50 XL-1s sold in PAL countries, the 25fps video frame rate will make for an even closer match.

This is very exciting, especially for anyone wanting to originate on DV and transfer to film for release. The noninterlaced frame-based images should yield a much better film transfer. And for those wanting the "film look" on tape, this is a good start. Better yet, use a PAL camera in frame mode: the resulting 25 fps images transfer to film very, very nicely...

## How do I get "film look" shooting with DV cameras?

Buy a used Arriflex 16BL or CP GSMO, stencil "Canon XL-1 DV camcorder" on the side, and shoot film!

Seriously, though, the most important way to get a filmlike look is to shoot film style. *Light* scenes, don't just go with whatever light is there. Use lockdowns or dolly shots, not zooms. Pan and tilt sparingly to avoid motion judder (i.e., if you're using the XL-1's frame mode, you shouldn't compose any shot to call attention to the 30 fps mode). If you're using a camera that allows it (VX1000, most pro cameras), back down the "detail" or "sharpness" control. Reduce chroma slightly. Lock the exposure; don't let it drift. Use wide apertures, selective focus, and "layered" lighting to separate subjects from the background. Pay attention to sound quality. In post, stick mostly to fades, cuts, and dissolves; avoid gimmicky wipes and DVE moves.

Beyond that, you can use "frame mode" on the XL-1, Panasonic AJ-EZ1, or AJ-D210; try 15 or 30 fps on the VX1000. On the Sony it's not the same as frame mode and has other problems, but it may pass as film for some purposes.

On higher-end cameras (DSR-300, DSR-130, AJ-D700, and the like), you may have setup files to adjust gamma, clipping, sharpness, color rendition, and white compression; these can be exploited to give the camera a more filmlike transfer characteristic.

Take the aperture correction (edge enhancement or sharpness setting), if available, and turn it down or off. This also makes a *huge* difference both in film transfer and in HDTV upconversion. Try out the Tiffen Pro-Mist filters. I like the Black Pro-Mist #1 or lower (fractional numbers). Jan Crittenden at Panasonic prefers the Warm Pro-Mist 1/2. These knock off a bit of high-frequency detail and add a bit of halation around highlights. Bonus: by fuzzing the light around bright, sharp transitions, these filters have the added effect of reducing hard-to-compress high-contrast edges, resulting in fewer "mosquito noise" artifacts.

In post, there are a variety of filters or processes available to adjust the gamma; or to simulate 3-2 pulldown, gate weave, dust and scratches, film fogging, and so on.

There are also proprietary processes such as "Filmlook" that, for a price, make the video look so film-like that real film looks like video by comparison.

Of course, if you really wanted film, why didn't you shoot film? :-)

### **What do the slow shutter speeds do for me?**

The slow shutter speeds (those below 60 fps) found on many DV cameras use the digital frame buffer of the camera in conjunction with a variable clock on the CCDs to accumulate more than a field's worth of light on the face of the chip before transferring the image to the buffer and thence to tape. This can do two things for you: more light integration, and slower frame update rates.

More light integration means that you can get usable images in lower light than you might expect. I've shot sea turtles by moonlight at midnight at 1/4 sec shutter speed; the images update slowly but are certainly recognizable, whereas the same scene at 60 fps looked like I had left the lens cap on.

You can also use the long shutter times as a poor man's "clear scan" for recording computer monitors without flicker. As you increase the integration time on the CCD, the computer monitor goes through more complete cycles before the image is transferred, reducing recorded flicker; many computer images have little motion so the slow update rate may not even be noticed. Be aware, however, that at least some cameras (the Sony VX1000 among them) appear to go into a strange field-doubling mode at shutter speeds below 60; vertical resolution is cut in half (while two clearly-interlaced fields are recorded on tape, as can be seen in a NLE, the field-mode flag is set in the DV datastream so that field-doubling is performed by the DV codec during playback to eliminate interfield flicker) so fine detail will be impaired. You'll need to judge this tradeoff on a case-by-case basis.

Slower frame update rates are good for two things: a poor man's "film look" at 30 fps or 15 fps, and special effects at slower rates. You can capture a strobing, strangely disturbing image at the lower rates... use it sparingly, of course; no sense in annoying the viewers.

### **Why don't consumer DV cameras have "real" lenses with focus marks?**

"Real" lenses use helical grooves to rack focus; the resistance you feel when you focus such a lens is the natural friction of the rotating barrels sliding through the lightly-greased grooves. That smooth friction, alas, plays havoc with autofocus systems which all consumer cameras *must* have, so goes the conventional wisdom; strong and battery-draining motors are needed to spin such barrels, and they can't obtain the fast focus response that's so useful in optimizing autofocus algorithms.

Thus the autofocus lenses nowadays use lighter, more easily positioned internal focusing elements (which are also advantageous from an optical standpoint) with lighter, faster, more thrifty focus servos.

The "focus ring" you manhandle isn't actually connected to the focusing mechanism. It's a free-spinning ring with an optical or electromagnetic sensor attached: when you spin the ring, a

series of pulses is sent to the focus controller. The faster the pulse train, the faster the controller changes focus.

However, it's not perfectly linear. If you turn the ring too slowly, nothing at all will happen since the controller discards all pulses below a certain rate as random noise. If you spin it 1/4 turn very quickly, you'll get more of a focus shift than if you turn it 1/4 turn at a more moderate rate.

As a result of all of this, there's no way for the focus ring to have focus marks -- nor is it possible for you to measure such marks yourself and be able to repeat them.

The same argument applies to the zoom controls on some lenses, such as the 16:1 on the Canon XL-1.

### **How do I work with these lenses?**

Carefully, with patience and understanding. You can't set marks, or focus by scale. Slow, fine adjustments may do nothing. But with practice and perhaps some adjustment of operating style, most people can use if not necessarily love these lenses.

On the XL-1, you'll get better zoom control and smoother operations if you stick to the zoom rocker on the handgrip than if you use the zoom ring on the lens. Some folks are taping over the zoom ring entirely and only using the rocker.

Don't like it? Buy a *real* camera with a *real* lens, like the DSR-300 (US\$10,000 and up, with lens) or the AJ-D210 (US\$7,000 or so). Hey, it's only money...

# Image Stabilization

## What's EIS/DIS?

**E**lectronic **I**mage **S**tabilization and **D**igital **I**mage **S**tabilization are completely electronic means for correcting image shake. As the shaky image hits the CCD chip, these systems reposition the active area of the chip (the location on the chip that the image is read from) to compensate for it, by re-addressing the area of the chip that they're reading from. If you've seen Rocky & Bullwinkle (a US cartoon involving a moose and a squirrel), think of Bullwinkle running back and forth with the bucket of water to catch Rocky after Rocky jumps from the high diving board (of course, Bullwinkle winds up in the water, but that's another story).

The EIS/DIS controllers look for motion vectors in the image (typically a widespread displacement of the entire image) and then decide how to "reposition" the image area of the chip under the image to catch it in the same place. The actual repositioning is done in one of two ways: one is to enlarge (zoom) the image digitally, so that the full raster of the chip isn't used. The controller can then "pan and scan" within the full chip raster to catch the image as it moves about. The other is to use an oversize CCD, so that there are unused borders that the active area can be moved around in without first zooming the image.

The zoom-style pan 'n' scanner can be detected quite simply: if the image zooms in a bit when EIS/DIS is turned on, then a zoom-style pan 'n' scanner is being used. Unfortunately, such methods reduce resolution, often unacceptably.

All EIS/DIS systems suffer from several problems. One is that, because the actual image is moving across the face of the chip, image shakes induce motion blur. Even though the position of an image may be perfectly stabilized, you can often notice a transient blurring of the image along the direction of the shake. Sometimes it's quite noticeable. To get around this, many EIS/DIS systems close down the shutter a bit to reduce blur. This reduces light gathering capability. You can't have everything, you know.

Another problem is that the motion-vector approach to stabilization can be easily fooled. If the area of the image being scanned doesn't have any contrasty detail that the processor can lock onto, the stabilization can hunt, oscillate, or bounce. This looks like a mini-earthquake on the tape, and it can occur at the most annoying times.

Also, the stabilization can work *too* well. Often when one starts a slow pan or tilt with EIS/DIS engaged, the system will see the start of the move as a shake, and compensate for it! Eventually, of course, the stabilizer "runs out of chip" and resets, and the image abruptly recenters itself.

The big advantage of EIS/DIS is that it's cheap.

## **What's optical stabilization?**

Optical stabilization such as "SteadyShot" is descended from Juan de la Cierva's 1962 Dynalens design, a servo-controlled fluid prism used to steer the image before it hits the CCDs (in the '60s, of course, it steered images onto film or onto tubes!). In the late '80's and early '90's, Canon and Sony updated this technology for use in consumer gear, and it worked so well that Canon now offers a SteadyShot attachment for some of their pro/broadcast lenses.

The fluid prism is constructed of a pair of glass plates surrounded by a bellows and filled with fluid so that the entire assembly has a refractive index comparable to a glass prism. The angle of the prism is changed by tilting the plates; one plate can be rotated vertically, moving the image up or down, and the other rotates horizontally, steering the picture right or left.

Rotation rate sensors detect shake frequencies and tilt the front and back plates appropriately. Position sensors are also used so that in the absence of motion the prism naturally centers. The position sensors also detect when the prism is about to hit its limit stops, and reduce the corrections applied so that shake gradually enters the image instead of banging in as the prism hits its limits.

Optical stabilization of this sort is expensive, tricky to manufacture and calibrate, and must be tuned to the lens. Adding a wide-angle or telephoto adapter to a SteadyShot lens screws up SteadyShot; the processor doesn't know about the changed angle of view (all it knows is the current zoom setting) and thus over- or under-compensates for shake.

But for all that it works brilliantly: because the image is stabilized on the face of the CCDs, there is no motion blur; because rate sensors are used, the system isn't fooled by motion in the scene or by lack of detail; because a physical system has to move to reposition the image, there are no instantaneous image bounces or resets as can happen with EIS/DIS.

[It's interesting to note that on the XL-1, Canon added image motion-vector detection to the rate gyros on their optical stabilizer. As a result, the system seems to "stick" on slow pans and tilts just like an EIS/DIS system, although the recovery is more fluid and less jarring. On the other hand, it really does a superb job on handheld lockdowns.]

## **What about Steadicam/GlideCam?**

These mechanical stabilizers work by setting up the camera so that it has large rotational moments of inertia, but little reason to want to rotate: the camera is mounted on an arm or pole that's gimballed at its center of gravity or just above it. The gimbal mount is either handheld, or attached to an arm, often articulated and countersprung, mounted on a body bracket or vest. One steers the camera by light touches near the gimbal; otherwise it just tends to float along in whatever attitude it's already at. The trick is in getting it into an attitude that makes nice pictures, stopping it there, and then not disturbing it.

These systems work very well, but require a lot of practice for best results. It's very easy to oversteer the camera, and off-level horizons are a trademark of suboptimal Steadicam skills.

The handheld systems can also be surprisingly fatiguing to use for extended periods.

I find that the Steadicam JR is also a bit wobbly; its plastic arms aren't especially rigid and the whole thing tends to vibrate a bit. Fortunately, the wiggles that get through the JR are neatly compensated for by SteadyShot in the VX1000, resulting in buttery-smooth moving camera shots (complete with off-level horizons!).

## **When do I use what kind of image stabilization?**



Try it; see if it works; if it helps, then use it.

I tend to leave SteadyShot on the VX1000 on most of the time. I'll turn it off when using the wide-angle adapter, or when using the camera on a tripod and needing to conserve power. If I'm planning to do any significant camera motion during a shot, and I don't have a wheelchair, dolly, car, airplane, or helicopter available (there's *never* a helicopter around when you need one...), I'll use the Steadicam. Depending on the roughness of the ride in the aforementioned conveyances, and space allowing, I'll use Steadicam there, too.

And don't forget that other, less glamorous form of stabilization: the tripod. Tripods work really, really well. Try one sometime, you'll like what it does for your image!

# Recommended Video Tape Stock

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## Sony PDVM-32N or 40N

This tape is an Advanced Metal Evaporated Tape. It is a miniDV format, to fit the Canon XL-1 and GL-1, both of which are used at the Adcenter.

Although the tape number, 32, would appear to indicate the recordable time on each tape, the actual recording time on the above cameras is approximately 50 minutes.

This tape may be purchased at:

Whitlock Group  
273-9100

Contact: Carol Haley