NONLINEAR3

A Guide to Digital Film and Video Editing

Third Edition

by

Michael Rubin

A BOOK FROM PLAYGROUND PRODUCTIONS, SANTA CRUZ, CALIFORNIA

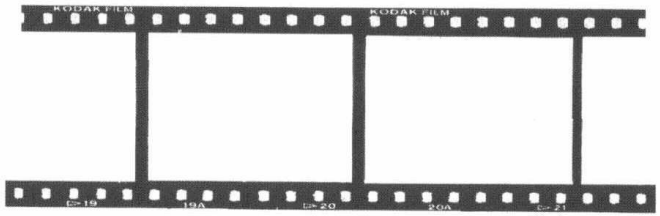
Although this handbook is not specifically about the editing of film or video, it is likely that many individuals working in videotape are unfamiliar with film, and vice versa. This section presents a brief overview of these two worlds of editing. Not all film or video projects will be exactly as described here, but it should provide you with a general understanding of the concepts and language involved.

THE FILM STORY

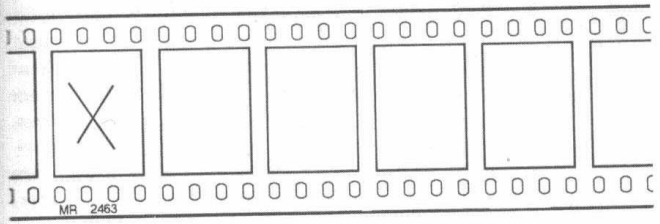
Francis Ford Coppola once described film editing as cutting up a dictionary and writing a novel with the pieces. At a mechanical level, editing is quite simple — cutting and taping.

Let's begin by examining the flow chart on page 26. Film is shot on *location*, along with production sound which is usually recorded on 1/4" audio tape or maybe DAT tape. The negative film you put in your Nikon 35mm camera is not all that different from the film loaded into a motion picture (like a Panavision) camera: it is 35mm wide, the film stock comes in small cans, usually from Kodak, Agfa, or Fuji.

When you get your snapshots back from the Photomat, you know how the film has those little numbers on the edges? 1 . . . 1A . . . 2 . . . 2A . . . and so on through your roll. These are called "latent edge numbers."



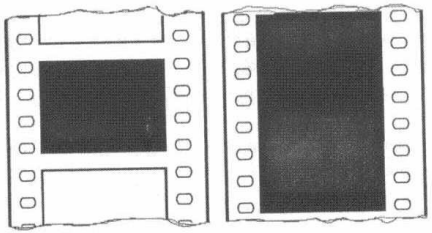
On motion picture film, these *edge numbers* (also known as *key numbers*), are divided into two parts: the *prefix*, which indicates what roll of film was used; and a *footage*, which increments once for each foot of film — usually 16 frames. These key numbers are extremely important because **every** frame of film must be uniquely labeled. Reference to a key number is **the only** way a specific frame of negative can be located.



There is also a manufacturer's code on the edge of the film. This tells people what kind of film stock was used, what company manufactured the film, and so on.

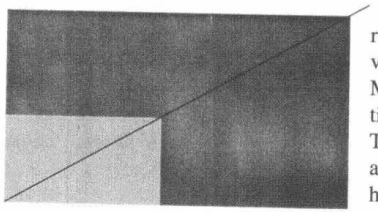
Another difference between your snapshot film and movie film is that your roll is about 3 or 4 feet long, giving you room for 24 to 36 exposures (frames). Movie film rolls are longer, usually 1000 feet each.

The shape of the frame on a roll of film is NOT determined by the film stock, but rather by the CAMERA: its mechanics and optics. The familiar shape and size of snapshot frames is different than the shape of 35mm frames shot in motion picture cameras.



Different kinds of motion picture cameras can even place the image on the frame in different positions and in different proportions. Panavision and Vistavision offer just two of the different ways frames can be placed on 35mm film.

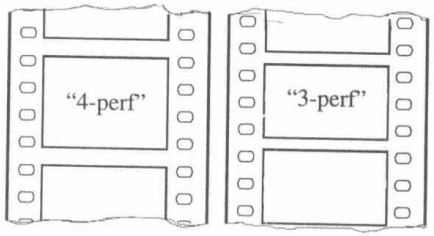
Aspect ratio is the length-to-width proportion of a film frame, regardless of the actual size of the frame. Clearly, two frames can have the same aspect



ratio but the area of one can be vastly different from the other. More area means higher resolution (or higher quality) of image. These two rectangles have equal aspect ratios but the larger one has more than four times the area.

The *sprocket holes* along the side of the film allow for toothed spools to move the film along in cameras (as well as in all film equipment). These sprocket holes are also called *perforations*.

For every frame on traditional 35mm film, there are four perforations along the side (hence the expression "4-perf film"). If you want to make the images a little smaller, you can modify your camera to shoot frames that only have three perforations along the side, called "3-perf." This makes the same 1000-foot roll of film hold 25% more frames, and although the aspect ratio is changed and film area is smaller, it often provides acceptable image quality at less cost.

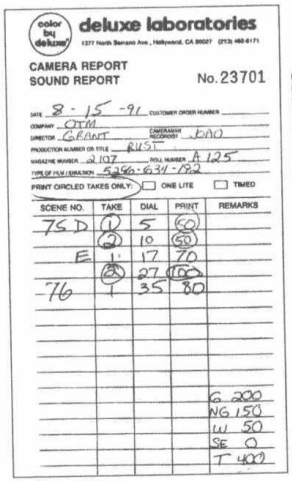


When a film roll is finished it is sent to the lab for processing, just like your own 35mm rolls. You are aware how expensive 36 exposures can be to develop and print; imagine millions and millions of exposures! Film productions would rather not waste money on prints of useless shots, consequently they develop every roll but only print selected scenes.

While each roll is being shot on a location, someone (often a Camera Assistant) takes notes as to what scenes are on each roll, how many takes were shot of each scene, and how much footage was used on each take. When a shot is completed, the director will often ask that it be "selected" or "circled," meaning that he liked it or might like it, and wants it to be printed. The Camera Assistant actually circles the take number on this "camera report" and this report goes with the roll of film to the lab.

Also during the shoot, the Script Supervisor takes notes on a copy of the script. These *continuity* notes describe each camera set-up, highlight circled takes, and "line" the script with vertical lines depicting each take. At the end of each day, these continuity notes along with copies of the camera reports are sent to the editorial department.

At the end of each day's shoot, the film and camera reports are sent to the lab for processing. The lab develops all the negative and then makes a positive



color by deluxe

deluxe laboratories

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CAMERA REPORT
SOUND REPORT

No. 23701

DATE 8-15-91 CUSTOMER ORDER NUMBER

COMPANY OTM

DIRECTOR GRANT CAMERAMAN / RECORDIST JOHN

PRODUCTION NUMBER OR TITLE RUST

MAGAZINE NUMBER 2107 ROLL NUMBER A 125

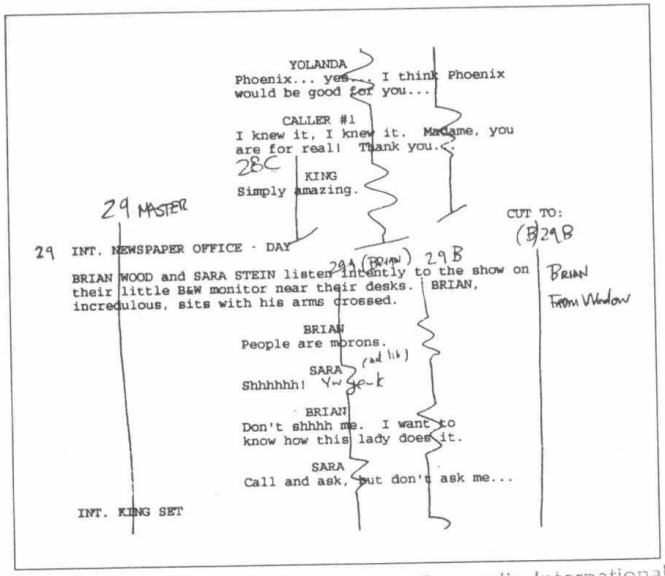
TYPE OF FILM / EMULSION 5296-5247-7222

PRINT CIRCLED TAKES ONLY: ☐ ONE LITE ☐ TIMED

SCENE NO.	TAKE	DIAL	PRINT	REMARKS
75D	1	5	60	
	2	10	60	
E	1	17	70	
	2	27	100	
76	1	35	80	

G 200
NG 150
W 50
SE 0
T 400

CAMERA REPORT



YOLANDA
Phoenix... yes... I think Phoenix would be good for you...

CALLER #1
I knew it, I knew it. Madame, you are for real! Thank you.

28C

KING
Simply amazing.

29 MASTER

CUT TO: (B)29B

29 INT. NEWSPAPER OFFICE - DAY

29A (BRIAN) 29B

BRIAN WOOD and SARA STEIN listen intently to the show on their little B&W monitor near their desks. BRIAN, incredulous, sits with his arms crossed.

BRIAN
People are morons.

(ad lib)

SARA
Shhhhhh! Yw ge-t

BRIAN
Don't shhhh me. I want to know how this lady does it.

SARA
Call and ask, but don't ask me...

INT. KING SET

Brian
From Window

LINED SCRIPT

Concordia International
University Estonia Library

print of the *circled takes*. The negative that was not printed is considered no good (or N.G.) and is placed in a vault as "B-neg"; it will probably never be used but could be printed if later needed. The negative that was printed is vaulted also, but kept separately from the B-neg. No one wants to handle the negative very much. You don't want to risk ruining it with scratches or dirt or anything. Remember, after you have shot a 50-million-dollar movie, after everybody goes home, all you really have to show for it is the negative. It is delicate. It is irreplaceable.

Meanwhile, the 1/4" audio tape that was recorded on location (probably on a Nagra brand tape recorder) is transferred to another magnetic stock, this one with sprockets on the sides so that it is in the same format as the picture. This stock is called "sprocketed mag."

In the editing department, the print from the shoot (usually called *workprint*) and the sprocketed mag (now referred to as *track)* are delivered usually the next day. First, one of the editorial assistants will *sync* the picture and sound. This involves finding each scene's slate, locating and marking the "clap frame" and then doing the same on the mag. Once the clap point has been found in both picture and sound, the two strips of sprocketed film are lined up, marked, labeled, evened out, and built into larger rolls of dailies.

Then the film dailies are *coded*. Coding workprint and track provides a numeric reference to locate which track goes with which picture. Workprint and track are fed into a table-top coding machine (Acmade is a popular brand) that applies *code numbers* (also sometimes called "rubber numbers") to the celluloid, one number per foot.

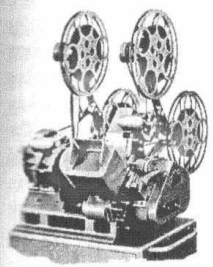
Now the workprint has two sets of numbers on it: the original key numbers that came on the negative and can be read on the positive print, and the new code numbers that allow the editor to sync picture and sound, and identify every frame on the roll.

The code numbers and key numbers have no relationship to each other in value or position; they are completely different sets of numbers. So assistants build extensive *log books* that refer key numbers to code numbers, and code numbers to scene numbers and they make labels for every scene to go with the rolls of film.

For each day that film is shot, it is sent to the lab, developed and printed overnight, and returned to the production the next day.

When there is time, the editor, director, cinematographer, and anyone else of sufficient importance gather to watch dailies, (or rushes) in a screening room. They screen all the previous day's film, perhaps discuss shots the director likes or how he'd suggest approaching the edit, and then other acting or technical matters are evaluated.

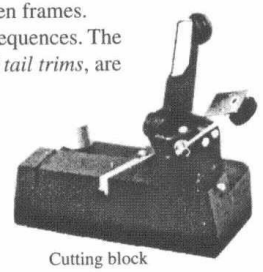
Finally, the editing can begin.



The dailies are "broken down" into small rolls, each containing one take. Racks of these little rolls are brought to the editor, who begins watching the film on a machine called an *upright*. The most widely used upright editing machine is manufactured by Moviola. The upright "Moviola" was invented in 1924, and has remained virtually unchanged since then.

Film is fed into the Moviola; it can be stopped and played, forwarded and reversed, at play and slow speeds. The editor uses foot pedals to control the machine. With a grease pencil, also known as a *china marker* (marks made are sometimes called "chinagraph marks") the editor marks frames, then pulls the film from the machine, and with a splicing block to hold the film, cuts it between frames.

Film dailies are cut apart and taped into sequences. The leftover portions of the dailies, the *head and tail trims*, are hung up on small hooks and draped into a large cloth basket — known as a "trim bin." Each piece of film must be labeled so that it can be later found if needed. Editors might have many bins surrounding them while working.


Cutting block

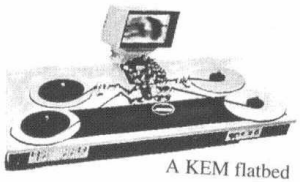
Many editors work with two Moviolas: one for watching and cutting dailies, and one for playing and re-cutting the developing sequences. Sequences are strung together until their total length is about 1,000 feet — these are called "reels." A thousand-foot reel is about the largest manageable load of film, although reels can be built larger, up to 2,000 feet, if necessary.

An average feature film starts with about 150,000 feet of selected dailies (equivalent to about 27 hours of film), and is edited down over the course of about 12 weeks to just under 2 hours (about 12 reels of film). Some movies begin with 500,000 feet or even a million feet on rare occasions.

A typical film room might also have a flatbed editing table for editing or screening. The most popular manufacturers of flatbeds are KEM and Steenbeck.

Some editors do not work on Moviolas, but prefer the flatbed approach. Other editors find the flatbeds cumbersome.

Either way, after months of film editing, a final cut is chosen, and the much-re-spliced workprint is sent to the *negative cutter*, along with a copy of the log book. Using the key numbers to locate negative, the negative cutter carefully cuts and splices the original film negative, using a hot-splicer to virtually melt the ends of the shots together. The workprint is used as a guide to cutting the negative, to insure total accuracy. Negative cutting for a film takes just over a week.



A KEM flatbed

courtesy of KEM

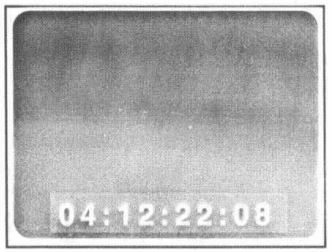
The final negative is later matched back with the final mixed tracks of audio (which, when completed, is printed as a single *optical track negative*) and dubbed to an "answer print" positive to check and modify color balance between shots. Answer prints may sometimes go through a few *trials* until the color timer gets all the colors right, and everyone likes how the film looks.

When these choices are finalized, an *interpositive print* or IP is created. This is a positive print of the film on negative stock, and is basically a protection copy for the original negative. From the IP, *dupe negatives* are produced, usually a couple, from which all *release prints* of a film will be created. The very first release print is also used as a *check print*, to verify the color timings after all the generations of dubs have been completed. If colors are still okay, all the remainder release prints are copied and sent to theaters around the country.

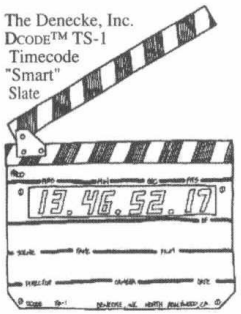
If this movie were for television, the final process would be slightly different. Rather than make all the expensive prints and dubs, the original negative of the **cut** film would be sent to a videotape post-production facility and *telecined* (transferred) to broadcast quality videotape, usually 1". Until electronic post production for television began changing the broadcast industry in the mid-80s — by allowing for source negative to be telecined, edited on videotape, and delivered on both film and video — this cut-negative telecine was the primary way film-originated material was shown on television.

THE VIDEO STORY

Videotape projects often start with a film shoot. If not originating on Betacam or 1" videotape, the project is often shot on 35mm or 16mm film. These film projects will finish on tape; so although they go through the 3:2 pulldown in telecine, they do not track film information. The telecine process gets the film into the video domain, where it will remain indefinitely.

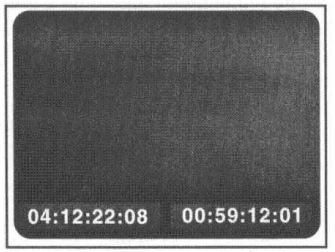


Telecine records the film onto 1" (or Digital Betacam, or D2, D3, D5, or DCT) raw stock, with a 3/4" tape recorded simultaneously during the session (sometimes referred to as a "simo"). This 3/4" tape is recorded with the same timecode as the master 1" tape, and a visible timecode window is generally "burned" into the lower portion of the frame.

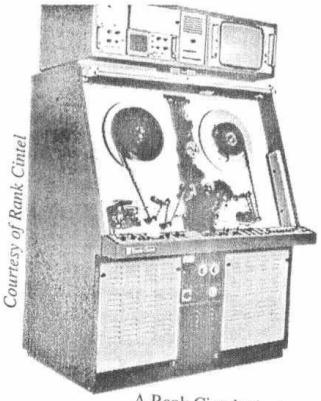


The Denecke, Inc. DCODE™ TS-1 Timecode "Smart" Slate

The audio, recorded on location using a Nagra 1/4" audio recorder (or increasingly on a Digital Audio Tape "DAT" recorders), is synced up by the telecine operator (known as a "colorist"). To facilitate the somewhat slow process of syncing the 1/4" audio and the negative, many productions utilize special *Smart Slates*. These are clap sticks that have a timecode displayembedded in them. Timecode is fed to both the Smart Slate and audio tape and the colorist can use these numbers to quickly and electronically sync the dailies in telecine.



For music videos, or projects with playback audio, the 1/4" music tape is synced to the source



Courtesy of Rank Cintel

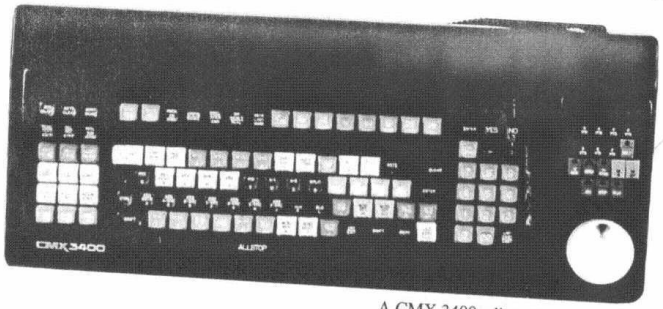
A Rank Cintel telecine.

picture, and laid down on the tape. The 1/4"'s playback timecode is also burned into a separate window on the simultaneous 3/4" tape and occasionally placed into the user-bits of the videotape (in telecine if not during the production shoot).

Telecine records tapes until they have no more than an hour of source material on them, and often less. Once completed, the 1" master tapes are stored in a special vault by the video post-production facility for use later.

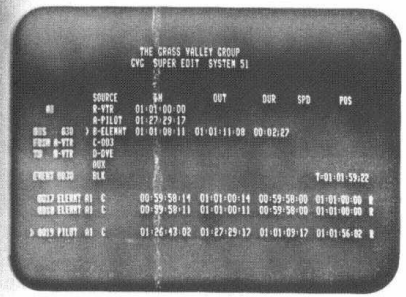
The 3/4" tapes are taken to an offline bay and screened. Often, during screening, a frame-grab printer is used to take "snapshots" of the tape at desired frames. This machine will print copies of selected video frames onto a special roll of paper ("thermal paper," like that used in FAX machines). Since the 3/4" tape has a visible window containing the timecode, rolls of these images can be built that act as a select log of sorts.

Using a keyboard, the editor types timecodes for cueing, or can mark edit locations "on the fly" (while the tape is playing), simply by pressing "mark in" or "mark out" buttons at the appropriate moment. Using the keyboard edit controller, the editor can mark ins and outs of shots, preview them, and record them onto a separate 3/4" tape called the "record." Edit controllers are manufactured by CMX and the Grass Valley Group, as well as by other manufacturers, all of which offer a range of systems that vary in price and functionality. Typical offline controllers include the CMX 3400, the GVG 141 or 151, the Sony BVE 910.



A CMX 3400 edit controller.

Linear edit systems consist of a keyboard controller, display monitors, and some kind of central computer interfaced to necessary machine controllers — running the peripheral tape transports.



The System 51 editing screen from the Grass Valley Group.

Since it takes time for a videotape deck to move a tape from a dead stop to 30fps, you need a kind of running head start before watching a tape. *Pre-roll* is the distance a tape is backed up before the in-point of an edit in order to be moving at the correct speed at the edit point.

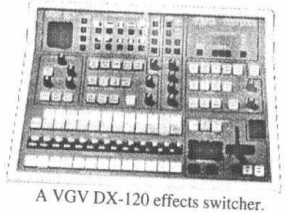
For a shot to be recorded properly, both the record tape and the source tape have to be moving together at the right speed. Consequently, editing systems must calculate an interlock relationship from the appropriate edit point, then pre-roll both machines a certain distance back, still synchronized up, then roll forward until they are at speed. Once at speed, the recording will begin at the chosen in-point. If one or both machines aren't moving at the correct speed, or fail to reach the edit point in time, the interlock relationship might be lost, and the edit will be aborted automatically. An editor wants sufficient pre-roll time, without making it so long that time is being wasted. Five seconds is usually enough.

Slowly, linearly, an edit decision list (EDL) is built. This list is a chronological history of the editorial decisions made. As each edit is recorded, an entry is placed in the computer memory. If a shot is modified, often both the old and new versions of that event remain in the list.

Monitors in an edit bay generally present the "record" tape large, centrally, and in color. This monitor will either double for "previews," or there will be a separate monitor adjacent to it. Secondary source monitors are located peripherally. These smaller black and white displays are provided for each source videotape deck. This way an editor can see where all the tapes are located.

There is often an *effects switcher* in the bay for doing simple effects and keys (superimposing images). The most commonly used switchers are the

Grass Valley 100-series. To create dissolves in offline, the outgoing and incoming shots must be on different tapes. If both shots are on the same reel of source material, as they often are, a *B-roll* must be created of the desired shot. This reel, named for the original source tape but usually with an appended "B", will be fed into the effects switcher along with the original source reel, and the switcher will superimpose the two as the effect dictates. Because of the technical properties of video, it is important that both images be synchronized not just in time but in framing and color. A peripheral device called a *time base corrector* (TBC) is used to balance both horizontal and vertical signals against visual timing anomalies like "jitter." TBCs are also used to synchronize multiple video decks' signals. In general, visual effects cannot be done in analog without a TBC on each videotape machine.

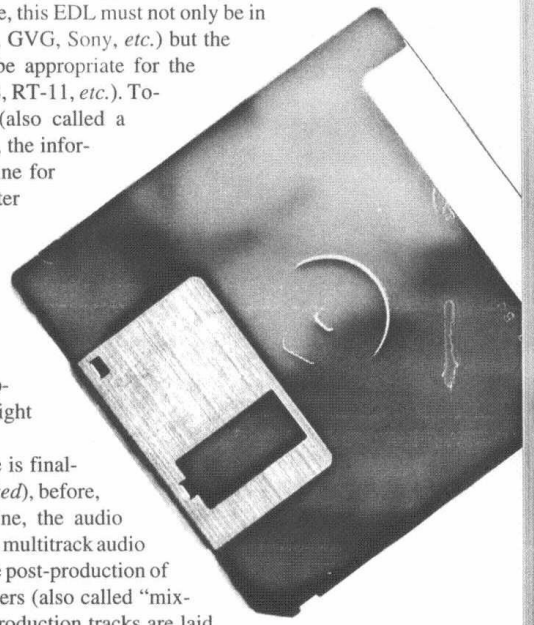

A VGV DX-120 effects switcher.

A "key" is a special superimposition of two or more video images. Keying is a complicated area of video editing. To simplify: one image, called the "matte," is a video element with holes in it through which other images can be seen. Sometimes, the key does not involve a matte with "cut" holes in it, but rather a background of one of the primary colors (red, green, or blue) that can be replaced by a keyed image. This *chroma key* is an older type of video keying. It is commonly seen in news and weather reports.

The offline editor edits and re-edits certain events, working in somewhat random ways, and will create numerous entries in the *edit decision list* (EDL). Some of these events will be current, many will be redundant, new shots will be added, and others removed; the list is not usually orderly nor is it easy to follow. Re-organizing the events of an EDL can be laborious and difficult; consequently, most EDLs are "dirty."

Once the offline session is completed, the "dirty" EDL should be "cleaned" in order to maximize the efficiency of the (expensive) online session. There are programs that will clean EDLs — the original for this was ISC's "409." Another significant program that cleans up EDLs is called "Trace," also originally developed by ISC. With Trace, the edited master tape can be moved from the record deck to a source deck, if desired. Now, with the edited tape as a source, new edits can be made from it to yet another record tape. In an effort to cull material from larger numbers of source tapes to fewer ones, this process is common in video editing. However the EDL will not automatically be able to follow where a shot originated after it has been copied from source to master a number of times. "Trace," using reel identification numbers and timecodes, will compile a single EDL that can re-create the edited master from the *ORIGINAL* locations of each source shot.

The EDL is copied from the editing system onto a floppy disk, formerly a 5 ¼" size but 3 ½" floppies are now generally the rule. Whatever the size, this EDL must not only be in the proper format (CMX, GVG, Sony, *etc.*) but the disk format itself must be appropriate for the online system (Mac, DOS, RT-11, *etc.*). Together with a printout (also called a "hard copy") of the EDL, the information is brought to online for re-creation using the master elements. Where offline might cost anywhere from very little to a hundred dollars an hour, online begins at a couple hundred per hour, but with digital equipment and full effects, it might cost $1,000+ per hour.



Once the master tape is finalized (and the EDL is *locked*), before, during, or after the online, the audio might be "sweetened" in a multitrack audio session. *Sweetening* is the post-production of audio for videotape masters (also called "mix-to-pix"). Traditionally, production tracks are laid down onto one or two of perhaps 24 tracks of a 2" audio tape machine. Although not quite as flexible, the 24 tracks of an audiotape are like 24 separate dubbers in a film sound department. Using SMPTE timecode to correlate sync between picture and sound, ADR, effects, and music can be edited to the 2" tape for mixing and eventual layback to the master videotape. In the mid-80s new nonlinear audio technology was introduced, called digital audio workstations (DAWs) that subsumed these multitrack mixes in the digital domain.

A BRIEF HISTORY
OF ELECTRONIC EDITING

Film editing has hardly changed since the upright Moviola was introduced in the 20s. Even after the flatbed was developed, although film editors often chose one "system" or the other, both involve many mechanical similarities and identical media.

Through the 40s and 50s, television was born and grew. TV was a strange and arguably inferior medium than the theatrical presentation of film, but it was a growing trend and unmistakably pervasive. In its early years, programming was LIVE, broadcast directly from studios in New York to viewers across the country. It was not edited, and thus didn't involve the editing community — it was just this other "thing."

But since Los Angeles time is three hours earlier than New York time, and LIVE television is seen *simultaneously* all over the country, there was no way for the early networks to provide ideal scheduling of shows. They wanted a way to delay West Coast broadcasts. But how do you delay a *LIVE* broadcast?

1956

✦ The delay problem is solved. A company in California — Ampex— invents an electronic recorder for broadcast television: the first *videotape recorder* (VTR) controls a 2" roll of magnetic tape and is called the *VR-1000*.

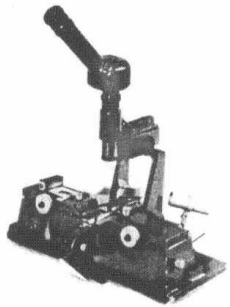
To properly set the stage, we must first recognize that of the three networks, CBS was clearly the leader. Not only did they have the top-rated shows, but also had a powerful research division called CBS Labs. Although a branch of NBC was actively doing research in mechanisms for using the new videotape, CBS was in the unique position of having both film and video (electronic) production companies in CBS Television: an electronic facility in New York and both electronic and film facilities in Los Angeles. At the LA film studio (in Studio City), they shot shows like "Gunsmoke." CBS Television was in a position to know both worlds well and recognize the advantages and drawbacks of each.

The director of engineering at CBS was Joe Flaherty, a visionary in broadcast electronics and considered by many the greatest single force in the advancement of broadcast editing technology. If Flaherty had a mission, it was to move television production from film to videotape. Film shoots tend to shoot too many takes to cover themselves; you can never be quite sure that you got the shot you wanted. Flaherty believed that with tape, by seeing the material immediately, you could save shoot time, location days, actors' time, *etc.* . . . in other words, save money.

1957

✦ All three networks purchase the new videotape recorders and begin experimenting with ways to edit the videotape.

Originally, editing videotape was like editing film or audiotape — with a razor blade and adhesive tape. Unfortunately, unlike audio, video must be cut between frames, and there is no visual guide as to where a frame boundary is located. Editors used a chemical mixture containing extremely fine iron powder that, when applied to videotape, made the 1/200-inch space between frames — called the "guard band" — somewhat visible. A "clean" edit between frames was difficult; cut transitions frequently lost picture signal and broke up. Videotape editing was extremely hit or miss. In the following years, an expensive (over $1,200) cutting block was developed, called a "Smith splicer," which allowed the editor to see the guard band through a microscope. Still, there was a differential between where audio and video events occurred on the tape; even sync-cuts involved careful and slow measurements of picture and audio.



The "Smith Splicer", 1957

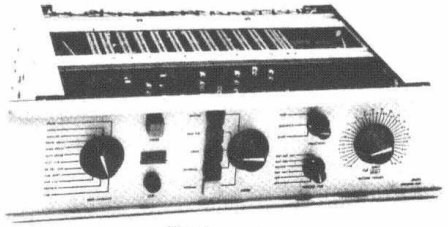
Engineers at NBC developed their own in-house methods for editing videotape that they called the "edit sync guide" or ESG. This was a track with an electronic beep every second, followed by a male or female voice announcing each minute and second. Coding the videotape and a kinescope (film copy) of the videotape with identical ESG codes enabled television to be edited via traditional film methods. Later, the ESG was used to help physically conform the master videotape, much in the way negative cutters use workprint to conform negative. NBC's methods were so successful that other networks often brought projects to them for editing.

It is somewhat ironic that in the late 50s, video editing was using film as its working media; by the 80s, film editing was beginning to use video.

1962

✦ The first commercially available electronic editing system, the *Editec*, is developed by Ampex. ✦ Time clocks are recorded onto magnetic tape; applications in editing are investigated.

The Editec involved the selective recording of one videotape (source) onto a target videotape (master). Since there was still no visible way to tell where you were on your tape, electronic pulse tones were recorded along the length of the tapes at desired edit points. An electronic edit meant a cleaner splice and the audio/video differential in cut point was rendered moot. But previewing or exactly re-creating an edit was impossible; you simply had to try it again. The problems were 1) the frame accuracy of the point the edit started recording on the master tape, and 2) how to synchronize the source tape and master tapes while rolling. These problems were solved very slowly over the following years.



The Ampex Editec, 1958

In the mid-1960s, Dick Hill, a CBS technician in Los Angeles, happened upon a piece of Defense Department technology that allowed electronic recording of a time clock on magnetic tape. When the military was testing missiles, they had devices monitoring from various locations around the test site: some at the launch point, some thousands of miles away. Launch and missile data were recorded on magnetic tape, and along with that information was a time-of-day clock, which allowed them to track and relate events occurring at different data recording locations.

Dick Hill felt this technology might solve the pulse tone problems in editing and began sending reports to CBS headquarters in New York. Adrian Ettlinger, a CBS engineer, was sent to investigate Hill's reports. Ettlinger reported back to CBS that this was a good thing, and that they should encourage the development of what was to become known as *TIMECODE*.

1967

✦ EECO (The Electronic Engineering Company), in Orange County, California, begins manufacturing the first timecode equipment.

With timecode available, CBS Labs began developing an editing system to utilize these numbers. Ettlinger, with other engineers, first experimented with a system of Sony recorders that could perform a continuous play of an edited sequence by accessing a number of duplicated source tapes — the origin of "look-ahead" previews. But the 2" tape machines were unwieldy and too many would have been required to achieve any useful kind of nonlinearity. Later they began using computers to control various kinds of newly-developed 1/2" videotape machines, with mixed degrees of success.

1968 - 69

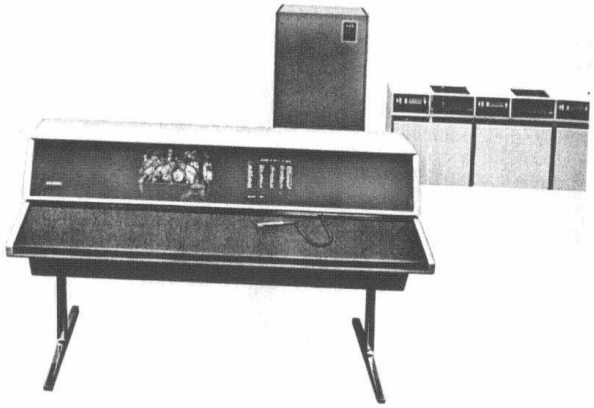
✦ NBC's "Laugh In" pioneers the use of videotape editing as something more than an extension of live switching. The show has 400 - 450 physical edits where most other shows have between 40 -100.

By 1969, none of CBS Labs' tape format experiments had proven particularly appealing, so they abandoned tape and began experimenting with magnetic disk platters for storing the analog video information. They ran into some mechanical problems involving the disk platters and turned to the Memorex Corporation for assistance. Memorex was intrigued with exploring the technical feasibility of recording video on disk media for random access.

1970

✦ In January, CBS Labs and Memorex create a joint venture called CMX to make editing systems. They build the CMX 200 and CMX 600.

The business plan for the CMX (which stood for **C**BS, **M**emorex, e**X**perimental) venture was drawn up by Adrian Ettlinger and Bill Connelly (both from CBS), and Bill Butler and Ken Taylor (both from Memorex). Butler became the company's general manager. Their first product had two parts. The first part, the *CMX 600*, was a computer with a stack of removable disk platters, each holding about 5 minutes. The platters looked like a horizontal bread slicer — their cost: $30,000. With six disk drives working in union, the 600 could locate any frame in under a second from about 30 minutes of mediocre (half-resolution) black-and-white dailies. This part was a nonlinear editor, using what would become SMPTE timecode. It did not produce a master videotape; rather, a punched paper tape encoded with



The CMX 600, as shown in the original CMX product brochure, 1971

a list of timecodes for re-creating the edits on a broadcast-quality machine. The second part of the system was the *CMX 200*, a linear tape assembler that would take as input the 600's list and build a master 2" broadcast videotape.

1971

✦ The CMX 600/200 combination costs $500,000 and is patented by CBS; its inventor is Adrian Ettlinger. In April it is demonstrated at the CBS stockholders' meeting.

The first commerical application of a nonlinear editing system, the CMX 600, is begun. CBS Television used the the system on a movie-for-television called *Sand Castles*.

1972

✦ After a number of years of investigation, the Society of Motion Picture and Television Engineers (SMPTE) adapts the EECO timecodes and standardizes their industry use.

By this time, five CMX 600s had been built — besides placements at CBS and Teletronics in New York, one was located at Consolidated Film Industries (CFI) in Los Angeles. Head editor there, Arthur Schneider, formerly with NBC, and Dick Hill (formerly at EECO) worked with CMX programmers, among them Jim Adams and Dave Bargen, to develop and beta test improvements to the systems. Problems in the CMX 200 led to the CMX 300. Where the 200 could only take input from a 600's printed papertape, the 300 allowed for a keyboard terminal to interface directly with the assembly editor. CFI suggested that there was a wonderful product in the linear online system, the 300. Both for practical reasons (perhaps due to its high cost, poor image quality, high maintenance requirement, and limited storage of source) and for social ones (it radically changed all accepted work rules and production concepts), the 600 did not catch on; however the linear editing products that CMX developed did.

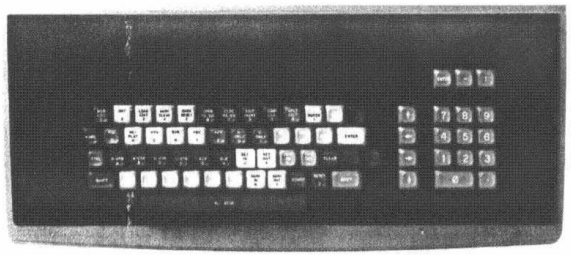
At the National Association of Broadcasters (NAB) show, the CMX 300 was demonstrated. With guidance from users like CFI, the CMX 300 continued to evolve; by 1978 it had become the 340.

1973

✦ Sony introduces 3/4" tape. ✦ The CMX 50 is debuted at NAB.

Sony introduced the first 3/4" machine (and a standard for 3/4" tape called U-matic) with hopes of seeing it adopted for home television recording; but it was too expensive and too large for consumers, and ultimately did not take off. On the other hand, because it was more cost effective than previous editing formats, 3/4" videotape was picked up by the broadcast and industrial markets.

At the NAB show CMX introduced the CMX 50, the first commercially available 3/4" edit controller — because of the inexpensive U-matic tape machines, it was considered the first viable "offline" system. The product used a standardized Edit Decision List (EDL), look-ahead previews and assemblies, and a style of editing that continues today. With the commercial



The keyboard controller for the original CMX 50, 1973

...and the 70, CMX wanted to expand; however, Memorex was financially strained, and CBS would not contribute more than 50% of company ownership. The decision was made to sell the upwardly mobile company.

1974

✦ Orrox purchases CMX and names Bill Orr as president. CMX's manager of product development, Dave Bargen, leaves the company. ✦ After two years of development, two separate corporations — MCA and N.V. Philips — announce that they are working together to standardize formats for their new invention, video-discs.

1975-76

✦ The MCA/Philips agreement produces a format for optical video discs known as the LaserVision standard. Around the same time, a number of companies, among them Sony, Philips, and Hitachi, announce their research into laser optical audio discs.

Due to popularity of the systems among existing CMX clients like CFI and Vidtronics, Dave Bargen began writing software programs that would increase the functionality of the CMX systems. First he developed "409" (an EDL cleaning program), then "Trace" (another special list management tool), and finally "Wizard," (which became "Super Edit"). Eventually, Bargen marketed these products to other CMX clients.

1977-78

✦ The CBS-Sony system is created. ✦ Laserdisc players are first sold. ✦ A film from young director George Lucas dominates at the box office. *Star Wars* begins what will become the largest ticket sales in the history of movies; the trilogy of films will gross over 4 billion dollars in ticket, cassette, and ancillary product rights over the next ten years.

Because Joe Flaherty still believed that television should be done on videotape, CBS Labs continued to develop systems. Late in 1977, CBS began an advanced form of their CMX 600 project, this time using a new type of 1/2" videotape that was being developed by Sony called "Beta." This new format unfortunately required expensive tape decks. CBS's new editing system used modern computers and the interface, like the 600's, was through a lightpen. Adrian Ettlinger was moved from consulting peripherally on the project to being the system's software product manager. By 1978 the CBS-Sony system, as it was called, was in use at CBS. But both companies decided not to pursue the marketing and manufacturing of the product, and it remained in-house at CBS.

In 1977, the first LaserVision videodisc players were sold in the educational market. MCA teamed up with Pioneer to form a venture, Universal Pioneer Corporation (UPC) to mass-produce videodisc players. Magnovox introduced their competing disc format, "MagnoVision," utilizing completely different technologies to play video discs.

1978-79

✦ New video formats deluge the market. ✦ ISC is formed. ✦ Philips demonstrates the first audio "compact" discs in May. ✦ Bell and Howell acquires Telemation. ✦ CMX invests in DBS; begins developing new kinds of editing systems. ✦ Lucas and Coppola investigate video applications to filmmaking.

A host of new video formats began to inundate the consumer market: Sony's *Beta* format on 1/2" videotape; Panasonic also had a 1/2" tape format called *VHS*; Magnovox's *MagnoVision* videodiscs; MCA and partner IBM's 5-year-old entity DiscoVision Associates (DVA)'s 12" videodisc format, *LaserVision*.

Dave Bargen, formerly of CMX, worked with a former chief engineer of Vidtronics, Jack Calaway, who had built a somewhat more flexible machine controller interface than the previously best-known CMX I^2. Bargen used a DEC computer, Calaway's hardware, and his own CMX-like software to create a new editing system. He formed the Interactive Systems Company (ISC).

In mid-1979, CMX/Orrox's penetration into the equipment market was beginning to plateau (over 90% of all broadcast editing in 1978 was on CMX equipment). CMX/Orrox saw the Direct Broadcast Satellite (DBS) business as the next boom industry. In a bold move, they began to invest heavily in DBS.

At the same time, development began on the newest CMX products, the 3400 and 3400 Plus. The plan was to move videotape editors smoothly from somewhat difficult and number-intensive editing (in the 340) to a modern editing system: the 3400 Plus would have a database management system (DBMS) and soft-function keys, and would implement a new computer feature, a windowed graphical interface.

Also in 1979, George Lucas began investigating ways of improving the filmmaking process. His friend and mentor Francis Ford Coppola had been active in using video technologies to help in production. Coppola and Lucas, like their friend at CBS Joe Flaherty, understood the cost savings that could be achieved on location by shooting in video instead of film — by being able to view immediately the material you had shot. Since neither felt video

looked as good as film for production, it was generally understood that the video would only be a tool in the film process.

Coppola had pioneered the use of a video camera alongside the film camera on shoots — the video was fed to and recorded in a customized trailer that sat at his locations, called "the silver bullet." With his video specialist Clark Higgins, Coppola is considered the first to use *video assist* in film productions, in particular on 1982's *One From the Heart*.

Lucas was more interested in facilitating post production by using computers and video technology, and hired an expert from the New York Institute of Technology (NYIT), a leader in academic computer applications, particularly in computer graphics and animation. Ed Catmull moved to Lucasfilm in California where he began investigating the post production process and planning what type of technologies could be used.

Bell and Howell, a Chicago-based film equipment company established more than a half-century earlier as a manufacturer of 35mm film printers, purchased an equipment distributor/manufacturer called Telemation. Bell and Howell's Video division (consisting mostly of tape duplication) hired Jim Adams for Telemation, and in doing so, acquired his previously developed editing system, the *Mach-1*.

1980-81

✦ German equipment manufacturer Bosch-Fernseh purchases 50% of Telemation from Bell and Howell in 1980; by 1981, it acquires the remaining 50% (and the *Mach-1*) from Bell and Howell, and calls the new company Fernseh, Inc. ✦ Early in 1980, George Lucas creates his Computer Division. Late in 1981, Lucas releases his third blockbuster, *Raiders of the Lost Ark*, directed by friend Steven Spielberg. ✦ Adrian Ettlinger begins work on his ED-80 editing system.

At Lucasfilm, Ed Catmull presented a plan for the development of three products: a picture editing tool, a sound editing tool, and a high-resolution graphics workstation. The proposed development cost of this three-project plan was about 10 million dollars. It got the go-ahead after the success of Lucas' new film, *The Empire Strikes Back*.

By the end of 1980, Catmull hired three computer experts: the picture-editor (which became the *EditDroid*) was led by NYIT friend Ralph Guggenheim — also an NYU film school graduate; the sound-editor (which became the *SoundDroid*) was led by Andy Moorer — a digital audio pioneer who had been with CCRMA (the Center for Computer Research in Music and Acoustics at Stanford University); the graphics-project (which became the *Pixar*) was led by Alvy Ray Smith — a graphics expert from NASA's Jet Propulsion Lab (JPL) and before that, Xerox PARC (their research division). By late 1981 the Lucasfilm Computer Division was actively developing these products.

But on what kind of workstation would they be run? At the time, there was no such industry as "desktop computers," and a number of companies were competing against the giant IBM for the market of smaller high-powered computer workstations. The host computer had to be relatively small, fairly inexpensive, and of high enough horsepower to run simultaneously all the things these systems had to do. Lucasfilm investigated all options, tried a few different hosts, and finally chose a SUN computer (with Motorola's 68000 processor) costing around $25,000.

As for what video media would be the source for the EditDroid, the decision was made in Catmull's '80 report. At the time there were only a handful of potential formats: 1/2" Beta, 1/2" VHS, LaserVision and MagnoVision 12" videodiscs. Catmull, and later Guggenheim, saw laserdiscs as the defining characteristic of the EditDroid project — they were convinced the price of laserdiscs would drop, that a consumer adoption of discs was just around the corner, and that discs were the only way to achieve any kind of real nonlinearity.

Lucasfilm began talks with leaders at DiscoVision Associates about the possibilities of recordable LaserVision discs. The EditDroid, at the time called the *EdDroid*, was a nonlinear, computer-controlled, disc-based editor. The system would control tape (because you had to control 3/4" for *emergency* linear editing), however the thrust of the development was on a new "style" of editing, manipulating the laserdiscs, and the idea that the human interface was going to be significantly more "user friendly" than computers or video editing systems.

The point-and-click computer style, mouse-based control, bit-mapped and icon-based graphics were unseen in the consumer world, and only beginning to take the academic computer world by storm. The Computer Division's products all utilized these features.

Throughout the early 1980s, numerous individuals and organizations came through Lucasfilm's Computer Division to see what was going on. Among them, an English entrepreneur named Ron Barker, who had been working outside of Boston, and who was interested in developing a revolutionary new editing system of his own. Also visiting the team was Adrian Ettlinger, who had much earlier left CBS Labs and had also been developing a new editing system of his own.

Ettlinger's system was based on a smaller computer, the Z-80, and was originally called the *ED-80*; named for the host computer and for the year in which his project began.

1982

✦ The Montage Computer Company is formed and work begins on the Montage Picture Processor®. ✦ The Optical Disc Corporation is formed.

Ron Barker teamed up with engineer Chester Schuler and formed a new company outside of Boston, The Montage Computer Company. They began development of a tape-based nonlinear editor, using the 1/2" Beta format videotapes as their source media. They called the system the Montage *Picture Processor*® because in many ways it was like a word processor.

DiscoVision Associates (DVA), the venture between MCA and IBM, was shut down and most parts were sold to former-partner Pioneer Electronics. DVA remained as a small company holding the rights to all the laserdisc-related patents. Members of the DVA development team joined forces to start a company to develop a recordable laserdisc, initially for the editing market. They called the company the Optical Disc Corporation (ODC).

Lucasfilm hired Robert Doris to take over the management of the Computer Division. A fourth project that had been in the works for some years under the Licensing Division was added to the Computer Division: Games. For the next 18 months there was a great deal of development activity both at Lucasfilm (outside of San Francisco) and at the Montage Computer Company (outside of Boston).

1983

✦ A prototype of the Ediflex is built. ✦ BHP spins off as an independent company. The TouchVision is announced. ✦ Lucasfilm and Convergence create a joint-venture for the Droid products.

During its time at Bell and Howell, the Mach 1 interested members of the R&D division, called Bell and Howell Professional (BHP). They were interested in potential applications of video technology for film. Bruce Rady, with the rest of the R&D team at BHP, began working on a new video-for-film editing system project which they called the *Envision*.

When Bell and Howell was taken over in a leveraged buyout, they began to analyze ways to divide up and sell off the company. Management chose to drop all things "video" related, and the Envision project was dismantled. The members of BHP were encouraged to purchase their division from the Bell and Howell parent company, which they did; Bruce Rady bought the rights to the Envision project for developing on his own time.

Rady began designing his own hardware and software, in particular an extremely low-cost VITC reader, for use on his system — its name was then changed to *TouchVision*.

CMX/Orrox decided to close its DBS manufacturing division. Changes in microprocessor technology along with other factors left them unable to recoup their huge investments. At the NAB show CMX/Orrox debuted their 3400 and 3400 Plus to crowds; following the show, CMX began layoffs and eventually stopped development of the 3400 Plus. Its designer, Rob Lay, moved to Lucasfilm's computer research department to work with the assembled team on the editing project. CMX's slow-down in the editing equipment market allowed other companies to enter the arena and offer new products. ISC began to erode CMX's high-end equipment line, and new smaller companies formed to move on lower-end systems.

Ettlinger, now with partner Bill Hoggan, completed a prototype for a new editing system with specific applications for the television market in Los Angeles. He worked with a number of editors and designed a script-based editing system that would control 1/2" VHS videotapes as sources. The system, no longer the ED-80, was called the *Ediflex*.

Lucasfilm's Computer Division, under Robert Doris, begin looking for an equipment manufacturer to license and sell the Droid products they were developing. Their investigation turned up seven companies, among them CMX, ISC, Grass Valley, and Convergence. Lucasfilm considered the ideal partner to be a privately-held company (like itself), one that was relatively profitable, and one that was ready to sustain a joint venture. In September '83, Lucasfilm Ltd. and the Convergence Corp. signed a joint-venture agreement for the Droid products.

1984

✦ The Montage and the EditDroid debut at NAB. ✦ ISC merges with the Grass Valley Group. ✦ Apple introduces the Macintosh personal computer. ✦ ODC begins shipping laserdisc recording systems in the Fall. ✦ The Laser Edit facility opens in Hollywood.

In late '83 and into '84 both the Montage Computer Company and Lucasfilm had been teasing the market with advertising and promotions about their new film editing systems. For the EditDroid, Convergence was beginning to manufacture the necessary hardware, and Lucasfilm was continuing the development.

NAB 1984 was the debut of the two editing systems, to a great deal of interest. Although both presented prototypes, neither the EditDroid nor the Montage was market-ready. The EditDroid had to deal with the high costs of making laserdiscs and also the software difficulties associated with releasing a product running on the UNIX operating system. The Montage

[illegible] with the seventeen 1/2" consumer Beta machines that the editor controlled. Betamaxes had no provision for machine control, and so each machine on each system had to be specially fit with a custom machine-control card. (The cost of 17 *professional* videotape machines would have been prohibitive.)

By the summer, Lucasfilm and Convergence were still hammering out the nature of their joint agreement. Lucas decided to spin off all parts of the Computer Division; Convergence, still running its own independent business, signed the spin-off papers officially creating a new company with Lucasfilm. Negotiations continued for more than six months. Guggenheim, the leader of the editing project moved to the graphics project, and Robert Lay was moved into his position.

The original product nameplate for the EditDroid, 1984

ISC, after having grown tremendously since its inception, was merged with Grass Valley, an almost 20-year-old company known for its video production switchers, graphics and routing equipment.

Apple released the first desktop personal computer to use bit-mapped and icon-based graphics and a Motorola 68000 processor at under $5,000—the *Macintosh*. Advances in memory and processor-power began to dramatically affect the "computer-consciousness" of the public, with powerful computers that were easy and affordable.

By spring, a new post production facility was formed in Burbank, called Laser Edit, Inc.; it owned its own in-house system called the Spectra-Ace (developed by Spectra Image exclusively for them). Laser Edit was the beta site for the prototype of an optical disc recorder made by the ODC, and developed over the previous two years. The Spectra system was similar to conventional *linear* videotape editing systems except that dailies were delivered on ODC laserdiscs and used in specially-developed two-headed laserdisc players. Although disc-based, the system was linear and proprietary at the Laser Edit facility. President Bill Breshears initially marketed the system to multicamera television productions.

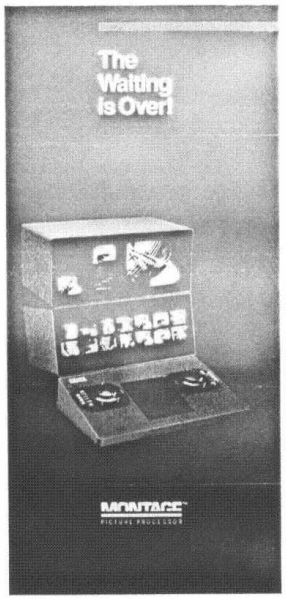
1985

✦ Interscope purchases the Montage Computer Company. ✦ Cinedco is formed to manufacture the Ediflex. ✦ The CMX 6000 project begins at CMX. ✦ Film-originated television programming begins testing the new systems.

In February, the Montage Company sought a new finance partner; Interscope Communications (which had just purchased Panavision from Warner Communications) bought the company from founder Ron Barker and brought in new management. The company was again on solid ground.

At the NAB show both the *Montage* and the *EditDroid* were shown again, this time considerably more stable than as prototypes the previous year. A prototype for the *SoundDroid* was also displayed by The Droid Works (the new Lucasfilm and Convergence company). The cost of the Montage and the EditDroid were comparable, well over $200,000 each, and both already had placed a few "beta" systems in the field.

Also at the show was a prototype of Bruce Rady's film-style editing system, the *TouchVision*. As a developer from the film equipment business, Rady was relatively unfamiliar with the video editor's world. But in extensive interaction with film editors, Rady learned that 1) film editors didn't really want computerized equipment, and 2) every editor described what he or she did differently, so coming up with a grand new simplified model of editing would be problematic. Basing the TouchVision on a flatbed, his system essentially allowed editors independent control of the source decks, instead of disguising the multiple decks necessary for achieving nonlinearity. By being able to lock and unlock various decks, editors were allowed to work as if using an electronic (videotape) multiplate flatbed. The TouchVision prototype controlled three 3/4" Sony decks for source and was target-priced around $100,000.



The Montage brochure cover, 1985

[illegible] Forman and Adrian Ettlinger formed Cinedco to manufacture and rent Ettlinger's *Ediflex* system. Ediflex was not at the NAB show, because as part of a cautious marketing plan, it was only *rentable* in Los Angeles, for around $2,500 per week. By approaching the film market in a way it understood — system rental — the Ediflex, too, was being tested for use in the post-production of the 1985-86 episodic television season. The script-based system originally controlled eight JVC-400 VHS decks with its central computer, and used a light-pen to interact with the screen. Also for rental-only was Laser Edit's *Spectra System*, in Burbank.

CMX began to develop a new nonlinear system specifically for film editors. Seeing nonlinear as the direction all editing would go, CMX developer Robert Duffy became project leader on a completely disc-based system that will become the *CMX 6000*, a modern incarnation of CMX's earlier 600, and bearing little resemblance to their existing linear products.

Lorimar, more than any other studio, experimented with electronic post under Gary Chandler, Lorimar's vice president of post-production for both television and theatrical projects. Lorimar's motion picture, *Power*, directed by Sidney Lumet, was the first feature film to be edited electronically, using the Montage Picture Processor.

Pacific Video, the largest facility in Los Angeles in 1985, began testing the new electronic systems — the EditDroid, the Montage, and the Ediflex — for use on film-originated television programming. President Emory Cohen created a film environment in a video post facility in an effort to streamline the new electronic process for traditionally film-oriented productions: he coined the term "the Electronic Lab."

1986

✦ Television and some films begin using the new nonlinear systems. ✦ The Montage Computer Company is closed and re-formed. ✦ BHP's TouchVison and CMX's 6000 debuts at the SMPTE show.

Sales slow, and development costs high, heads of both Montage and The Droid Works are troubled. In spite of great excitement over their products, the president and principal owner of Interscope Communications, Ted Fields, announced in March that the Montage Computer Corporation would be sold off to liquidators. Similarly, Droid Works Chairman of the Board Doug Johnson announced the departure of TDW president Robert Doris. The demise of the Montage was ironic in light of the activity on the roughly 29 systems in the field: Alan Alda had switched from editing *Sweet Liberty* [illegible] film to the Montage; director Susan Seidelman was planning on using the system for *Making Mr. Right*, and rumors from London said Stanley Kubrick was planning to use the system for *Full Metal Jacket.*

NAB '86 did not see the Montage; however, improved EditDroids and SoundDroids were demonstrated on newer and less expensive SUN/3 computers. By May, the Montage technology had been purchased at auction for $700,000 by a New York businessman, Simon Haberman.

By June, The Droid Works' board had appointed a new president to the company, (the first president of CMX) William Butler.

In August a new company was formed from the remains of the Montage Computer Corporation. Called the Montage Group, Ltd., the new company announced a new smaller Montage II system that would cost $150,000 *less* than their original system, and promised that it would be shown in prototype at NAB '87.

Ediflex boomed in the television rental market. By August, Cinedco announced that all 21 Ediflex systems were in use and that they were turning away business. Lorimar-Telepictures, under vice-president of post production technical services Chuck Silver, pioneered the use of the Ediflex, as well as other videotape-based systems, for use in network television. Universal was also experimenting with electronic post under vice president of post production Jim Watters: Universal's Alan Alda-directed feature *Sweet Liberty,* cut first on film, went through additional cuts on the Montage, following the system's success on Lumet's *Power*.

CMX 6000 advertisement, circa Winter 1986

At the SMPTE show in October, CMX introduced its *CMX 6000* — controlling only laserdiscs and no videotape. It was extremely fast and was the first system with a "virtual master," the ability to roll a "simulated" version of the edited master in all directions and at all speeds, without recording to tape.

Also at the show was BHP, Inc., the manufacturer of Bruce Rady's *TouchVision* system, now controlling 9 or 12 VHS tape machines instead of 3/4" tape, and featuring a unique touchscreen for control. Notably absent from the show was The Droid Works' *SoundDroid*. Two other products of interest shown were Kodak's prototype of their new film numbering system, *Datakode*; and Cinesound International's *Lokbox* — for interlocking a videotape machine with a film synchronizer. Both would aid in the electronic post production of film.

BHP TouchVision advertisment, circa Winter 1986

1987

✦ The Droid Works is closed. ✦ Work begins on the E-PIX, the EMC and the Avid/1.

By the end of January, Lucasfilm announced the closing of The Droid Works, and that no more Droids would be sold. No SoundDroids were ever manufactured beyond the prototype, and only 17 EditDroids were made. The post-production division of Lucasfilm, Sprocket Systems, absorbed the remaining Droids and continued in-house development of the EditDroid with a new development team.

NAB '87 saw the new Montage Group demonstrating their Montage II in prototype.

A software designer on staff at Adcom Electronics, a Toronto-based equipment distributor and manufacturer, wrote a program that would help some filmmakers edit their film project on videotape. Shawn Carnahan, the designer, created a database for establishing a relationship between film edge numbers and timecode, and Adcom sold the product as "Transform LM." Soon, Carnahan began to add machine control and video switching to the product. He called the system the *E-PIX*.

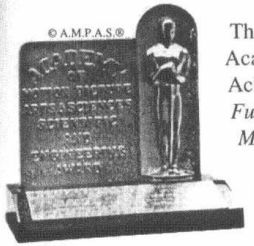
Desktop computers continued to become more powerful, memory continued to increase in density, and applications became more sophisticated.

Bill Ferster, president of West End Film in Washington DC, had grown increasingly weary in the videotape assemblies of his company demo reels each year. He designed a PC-based editing system that accommodated his needs, storing images digitally on hard disk, and playing them back at 15fps. He decided to sell his seven-year-old animation/graphics company.

At around the same time, William Warner, a marketing manager at Apollo computers outside of Boston, had grown frustrated with the time and cost of the online he endured for the preparation of corporate projects. He, too, began developing an editing system; this one on the Apollo workstation — a high-powered professional system designed for computer graphics applications.

1988

✦ The Montage wins an Oscar. ✦ E-PIX debuts at NAB show; the EMC debuts at SMPTE.



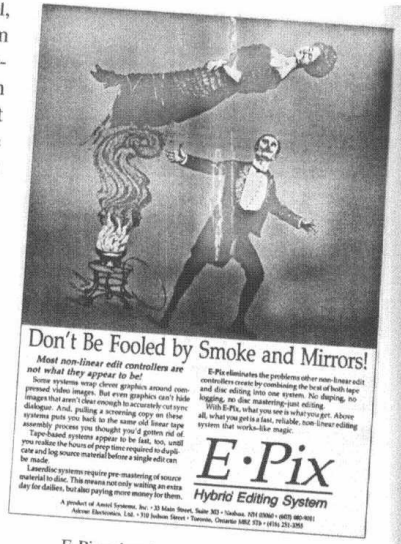
The Montage Picture Processor won the 1987 Academy Award for Scientific and Technical Achievement — for its use in cutting films such as *Full Metal Jacket, Power, Sweet Liberty,* and *Making Mr. Right.*

By the NAB show in Las Vegas, two new systems were demonstrated in prototype. Adcom debuted its disc-based system, the E-PIX, after eight months of development. Carnahan had designed the system after examining the problems of the major systems in 1987: he did not want a huge bank of peripheral equipment, and ODC disc mastering was still somewhat expensive and difficult to come by. He wanted a stand-alone system that was not tailored to any single market, but generalized to many high-end markets.

William Warner arrived to the NAB show with no intention to market or sell his system, only to get suggestions for improvements. He set up two of his prototypes in a hotel room; the system was called the *Avid/1* and ran on the Apollo computer with a fixed hard disk, played video at 15fps, and

...capabilities. Still, interest in the digital system was high, and Warner absorbed the information given him: the system had to run at 30fps, video image had to be better quality, it needed audio tracks, and storage quantity was a big concern.

After NAB, Warner left Apollo and created Avid Technology with venture capital from the Boston investment community. Apple approached Avid, and by the end of the year the prototype was ported to a Macintosh computer, video was moved to magneto-optical discs for storage, and playback was at 30fps.



E-Pix advertisement, circa Fall 1989

In July, with $6 million from the sale of his West End Film to Pansophic, Bill Ferster financed a new company to manufacture and market his digital nonlinear editing system running on a personal computer. Ferster called it the Editing Machines Corporation, and the system was called the *EMC²*; he had moved the storage media from hard disks to magneto-optical drives. The EMC2 had its debut at the SMPTE show in New York. The system price was under $30,000.

1989

✦ In January, EMC has shipped the first digital systems. ✦ The Avid/1 debuts, and the company begins taking orders.

At the NAB show, Avid Technology began to take orders based on their prototype of the Avid/1, now with full editing capabilities, although no systems had yet been manufactured. At the SMPTE show, Avid demonstrated a second channel of audio; plans were to ship the beta systems by year's end. By December 29th, the first Avids were shipped.

1990

✦ LucasArts shows a new editDROID. ✦ Montage plans to create a fully digital version of their system. ✦ Steady improvements are made in all digital systems.

February, the EMC² demonstrated 30fps digital video, and began using the C-Cube compression technology in order to increase resolution.

Early in the year, Lucasfilm unveiled a new company structure and a new "*editDROID*." LucasArts Editing Systems is the manufacturer and developer of the improved system; it was released after a three-year hiatus for re-design; 18 new systems had been built and 12 more were under construction at a plant located on Lucas' Skywalker Ranch. The system was announced as only rentable for its first year.

At the SMPTE show, the Montage Group demonstrated a digital-tape hybrid system, called the *Montage II-H*. This hybrid would lead the way to a fully digital system, expected to be shown in prototype at the next NAB show.

In London, Paul Bamborough, a founding partner of Solid State Logic (SSL), the professional audio console company, begins work on a new system. He had been considering improving editing sytsems since the early 80s, but had felt the EditDroid did about as much as could be done with existing technology. By the late 80s, Bamborough left SSL, and began work on a new graphical system, primarily for film work, that would use compressed digital video. His intention was to make a system that was both simple to use, and more playful than traditional editing systems. He joined with some friends of his who had experience in engineering and system architecture, and formed O.L.E. Ltd., a partnership to manufacture a new system, to be called the "Lightworks."

A programmer at SuperMac designs a new software editing package to help demonstrate their new video digitizing cards for the Macintosh. Randy Ubillos calls his program "ReelTime." By the end of the year, SuperMac has sold the software to Adobe, who renames it "Premiere."

1991

✦ OLE debuts the prototype of the Lightworks. ✦ Apple releases QuickTime. ✦ Chyron (and CMX) are purchased by Pesa.

Early in the year, a small group of people who left Grass Valley Group in 1990 gathered to form a company to make a new kind of video computer. Calling themselves "ImMIX" — a variation on the Greek word for a

Avid brochure, circa Summer 1990

gathering of friends — they were acquired by Carleton and incorporated by February.

At NAB, there were eight familiar nonlinear editing systems, and a handful of new ones: the *Montage III* was shown in prototype as expected — a kind of an upgraded Montage II with DVI-based digital video source material; *editDROID* was demonstrated, after having been used on significant portions of Oliver Stone's *The Doors*; the *Ediflex II* was demonstrated with Panasonic write-once discs instead of the familiar VHS decks. *E-PIX* was demonstrated, as was the *TouchVision*. TouchVision, Inc., Rady's new company, demonstrated a prototype of its DVI-based digital system, called *D/Vision*. The TouchVision had just finished its work on the Madonna documentary, *Truth or Dare*. Chyron/CMX showed their familiar *CMX 6000* after having cut a Bernardo Bertolucci film, *The Sheltering Sky*, and a Paul McCartney concert film during the past year; there was a fair amount of activity at both the *EMC2* and *Avid* booths, both showing prototypes of upgraded systems — more editing features and better resolution images. Prototypes were demonstrated for the *Lightworks* system, the Mac-based *Blade Runner* digital editing systems, and D/FX's *Video F/X*.

In May, Apple Computer Company announced a new format for running digital video in many Macintosh applications — called "QuickTime." With a grant from Apple, the American Film Institute opened their new AFI-Apple Computer Center, dedicated to investigating new technologies for film making and professional applications of the new QuickTime format. Adobe releases version 1.0 of *Premiere*.

By year's end, Chyron was purchased by the Spanish video equipment manufacturer Pesa.

1992

✦ Avid introduces their OMF Interchange format. ✦ Hollywood begins to adopt the digital nonlinear systems in place of the original analog ones. Image quality for offline editing reaches an acceptable trade-off between size and resolution.

As expected, NAB was rich with digital nonlinear systems. A release version of the much-anticipated *Lightworks* system was shown, as were a wide array of products from Avid Technology. CMX privately announced a low-cost digital system based on the 6000, to be called the *CMX Cinema*. Montage again showed a prototype of their *Montage III*. All the principal equipment manufacturers demonstrated upgraded systems, with the single exception of the *editDROID* from LucasArts.

The issue of digital image quality finally began to be seen as the red herring it was — diverting spectators from the serious issues of editing system interface, storage, and price. After a number of years where image quality was *the* issue, all systems demonstrated "reasonable" images at comparable compression rates.

Encore Video, in Los Angeles, made the first significant strides in the use of the *Avid* for episodic television. Paramount Pictures began the first significant use of the *E-Pix* for television and, finally, theatrical film work by the end of the year. The Post Group, also in Los Angeles, became the principal *Lightworks* installation, giving the system some of its first serious trials on television programming.

By the end of the year, it was clear that 1992 had been a watershed year for nonlinear editing, and digital nonlinear systems in particular. Avid had placed over 1000 systems worldwide over the previous few years, successfully introducing the concept of nonlinear editing to the video and broadcast communities that had long been unaware of the available products. Now, too, there were viable competitive systems to the *Avid* being evaluated. Television was now taking the digital offline systems more seriously — and theatrical features, the long-time holdout, moved one more step toward the acceptance of these systems as the future of theatrical post.

1993

✦ Montage III and CMX Cinema, digital versions of established systems, are beta-tested. ✦ Avid Technology goes public. ✦ J&R Film Company takes over the editDROID from LucasArts and begins shifting from Moviolas to digital film systems. ✦ "Online" nonlinear systems are debuted. ✦ Unprecedented numbers of feature films move to digital nonlinear systems.

January saw beta shipments of CMX's digital *Cinema*, the only digital departure from the windowed and mouse-driven environments of other systems. Both *Montage III* and *CMX Cinema* were anxiously awaited for their national release at NAB. Both were introduced more slowly than expected.

...nology, rising high as the leading digital nonlinear vendor, made an initial public offering (IPO) in February, and also announced its purchase of DiVA's *VideoShop* — a Macintosh application software product that is a low cost desktop video system — and the principal competitor to Adobe's *Premiere*. Avid also begins shipping first versions of Airplay, NewsCutter and MediaRecorder products. They enter the corporate market with their Media Suite Pro.

NAB was for the first time filled with software companies, offering a whole range of editing products. New arrivals to the scene included Adobe and SuperMac.

Ediflex announced the impending arrival of their *Ediflex Digital,* one more in the growing list of established nonlinear systems moving into the digital domain; although the system was not shown at NAB, it was demonstrated throughout the Spring and initially released that Summer.

J&R Film Company, the owner of Moviola, began the slow phaseout of their Moviola rental business by acquiring digital nonlinear systems for film rental — a dramatic step that was precipitated by other Hollywood establishment film rental houses (like Christy's) doing the same. It was a landmark move in an industry where the Moviola has been the bedrock of traditional editing equipment for almost 100 years.

By April, J&R took over the ownership and support of the editDROID from LucasArts, thus ending the Lucasfilm connection to the product, began more than a decade earlier. Lucas, in turn, announced a plan of future development with Avid Technology.

The buzzwords of the year involved "online nonlinear systems," with the prototype of ImMIX's *VideoCube*, Avid's *4000* and *8000* series, and an early prototype of Lightworks' *Heavyworks*. There were also many new products targeted towards the industrial and corporate "online" desktop: Matrox *Studio*, Data Translations' *Media 100*, and the German FAST Electronics *Video Machine*. Many manufacturers began to unbundle their products into available software and boards, for end-users to use with their personal computers.

The year was a key for theatrical features moving towards electronic film; after well-watched trials for Oliver Stone (on the Lightworks) and Martha Coolidge (on the Avid), those two systems made the move into feature films and began steady work as accepted tools for Hollywood.

1994

✦ Avid Technology increases massive market penetration and differentiation of products. ✦ CMX Cinema project is ended. ✦ Lightworks' Heavyworks is the first ...ible digital nonlinear system used for traditional multicamera television programs. ✦ Cinedco, owner of the Ediflex, closes its doors; sells patent rights to ...erfilm, Inc. ✦ Many manufacturers begin steering their video products into digital and nonlinear domains while existing nonlinear manufacturers push the image resolution limits with better and better images — further blurring the online/offline distinctions. ✦ EMC is purchased by Dynatech. ✦ Softimage is purchased by Microsoft.

After 5 years in business, Avid reported gross sales of $203 million dollars and profits of 4 million. Their R&D budget exceeds the gross sales of every other nonlinear manufacturer to date. At NAB they make the first public demonstrations of their OMF (Open Media Framework™) Interchange. By December, Avid had purchased Digidesign, a leading digital audio company.

Montage settled into slow adoption of their digital *Montage III*, but continued to aggressively pursue enforcement of their patents concerning digital images in editing systems.

Adcom phased out their E-PIX editing system, and replaced it with a high end digital "online" nonlinear product called *Night Suite*, boasting D1-quality video output.

Sony demonstrated a prototype of their first nonlinear product, called the *Destiny* Editing System. One of the key designers of the Destiny system was Robert Duffy, the engineering designer of the CMX 6000.

1995

✦ Tektronix purchases Lightworks. ✦ Grass Valley signs agreement with Data Translations to distribute the Media 100. ✦ Avid purchases Parallax Software Group, developer of high-end paint systems; and Elastic Reality, a leading developer of image special effects software. A prototype of an AvidDroid is shown at NAB. Avid licenses Ediflex's Script Mimic technology. ✦ Inventors of the Avid and Lightworks products win 1994 Academy Awards for Technical Achievement. ✦ All major networks have broadcast programs directly from nonlinear systems. ✦ Sony stops development of its nonlinear *Destiny* product. ✦ According to an NAB survey, 38% of broadcasters use nonlinear equipment.

In March, Avid acquired Parallax Software, developer of high-end paint and compositing systems *Matador* (2D paint and animation) and *Advance* (compositing and image processing). At the same time, Avid also acquired Elastic Reality, a software developer known for their advanced morphing and image restoration products. At NAB, Avid showed versions of products that run on Macs, PCs, and introduced new Silicon Graphics configurations. They also debuted an SGI Onyx-based online system that incorporates their products. According to company literature, Avid employs 1200 people. Their presence at the NAB show was pervasive.

Announced at the NAB show was the merger between video giant Tektronix (revenues of $1.3 billion in 1994) and Lightworks. As of NAB, Lightworks employed 100 people and had *approx.* 1000 high-end film cutting systems in the worldwide market.

Grass Valley Group announced a Mac-based personal production suite called VideoDesktop. Although the product literature makes no mention of it, the system is the result of an alliance with Data Translation where GVG is able to assemble and sell turnkey Media 100 systems. Grass Valley also shipped their V.1 of their "nonlinear" Sabre System.

A new company arrived at NAB made up of 11 senior staff members from NewTek (makers of the Video Toaster) who call themselves Play, Inc. The hip team demonstrated a prototype of a PC-based, D1 video bus (rather than PCI) post-production system called *Trinity*.

Following NAB, Avid announced a patent infringement suit against Data Translation, designer of the Media 100 and a rising competitor to some of Avid's products. The suit concerned proprietary audio and video manipulation methods internal to the Macintosh.

Ironically, in a year with more than 120 hard disk-based nonlinear-type products, there were more video tape formats introduced than at any previous NAB. The buzz at the show was on MPEG compression, networking systems, and in dedicated broadcast news nonlinear systems.

The year showed a marked increase in development on the PC as a video platform: with the introduction of Microsoft's Windows 95, plus the creation of the Open Digital Media "Language" (OpenDML) consortium, on top of the continued development of PCI-bus plug-and-play video boards, windows-based products had a surge in popularity.

The NAB show itself was in many ways a metaphor for the state of the industry. The giant convention center in Las Vegas had an annex in 1991 (and for the previous few years) dedicated to HiDefiniton Video; by 1992 that was superseded with something called Multimedia World. By 1995 it was as if Multimedia World was beginning to reach adolescence; the convention was split and it was not unlike the "adults" in the main floor, and the "kids" in multimedia world. It perfectly represented the transition from the broadcast realm to the computer realm; from the establishment to the revolution. It was not uncommon to see midlife broadcasters wandering lost and confused among the multimedia booths; and to see youth drunk with their newfound power, but not quite sure what to do with it. More than anything, NAB exemplified the still-enormous knowledge gap between the two worlds, and the few participants who could speak both languages. The corporate giants of the establishment having failed to truly invent the future were forced to grab it by brute force, buying and merging with the new technologies and placing them, like badges, on their corporate jackets.

THE MONTAGE PATENT

Very often, a company does more than build a really great editing system. Sometimes they actually invent something totally new. And when they do this, they usually patent it. Once patented an invention can work to give a company a competitive edge in their product line, or the patent can be licensed to other companies which can give the inventor extra revenue in the form of royalties. Some manufacturers have not patented their original inventions, and so these features have found their way for "free" into the array of products you see at shows: like timelines and rippling edits. A core bit of research was performed at XEROX PARC in the late 1970s — their unpatented inventions are widespread in computer graphics and editing systems worldwide: the mouse, the bit-mapped display, the icon, and so on.

There are many patents that are central to the development of nonlinear editing systems, many very technical and some more theoretical. Among the important patents and inventions worth noting in the history and future of systems are ones like the first nonlinear system (1970, patent number 3,721,757, by Adrian Ettlinger) to ones originally from Cinedco's Ediflex — the script mimic — licensed by Avid in 1995.

But of all the patents with which manufacturers must deal, the most important has been the one for digital picture labels used in editing systems. Patented in 1982 and first demonstrated in the form of the original Montage Picture Processor, Ron Barker and Chet Schuler's work has been hotly contested but never rebuked. And as the Montage Group has evolved over the past decades, this patent has proven a valuable asset to the company, one of the cornerstones of nonlinear editing. Excerpts of the patent's 67 claims are reprinted here for serious students of the industry.

PATENT NUMBER 4,538,188
AUGUST 27, 1985

Inventors: Ronald Barker & Chet Schuler
Assignee: Montage Computer Corporation
Abstract Excerpt: "A video composition apparatus and method select (sic) segments from image source material stored on at least one storage media and denote serially connected sequences of the segments to thereby form a composition sequence. The apparatus and method employ pictorial labels associated with each segment for ease of manipulating the segments to form the composition sequence."