



DV primer

Authors' note: The 1st, 2nd and 3rd editions of The Digital Filmmaking Handbook featured lots of information about working with the DV format. This format is no longer considered cutting edge technology so we've removed those sections from the 4th edition of the book and compiled them here for those of you who still want to work with DV equipment.

DV and the Independent Filmmaker

“Indie” films are nothing new, but the number of independent productions has increased dramatically since the 1970s and 1980s when people like John Cassavettes, John Sayles, and Spike Lee scraped together shoestring budgets and begged and borrowed equipment and talent to produce their films. In 1998, more than 1000 films were submitted to the famed Sundance film festival, and four of 1997’s Best Picture Oscar nominees were independent productions. Although independent filmmaking is cheap by Hollywood standards, the independent filmmaker still has to come up with tens or hundreds of thousands of dollars to pay for sets, actors, locations, and, most of all, equipment. In the past, cameras, lights, film stock, editing facilities, special effects, and post-production were the most expensive items in an indie film budget. The indie producer had to cover those costs, just to get the film made at all, with no guarantee that it would be picked up for distribution (meaning no guarantee of a return on the investment).

With DV, though, those core expenses are much lower. With DV, it’s possible to get a polished, edited feature “in the can” for substantially less than if you were shooting on film. Once your feature is finished, you can use your final, edited digital videotape to shop around for a distributor who will pay for a transfer to film. In other words, you can “back-end” what used to be the most expensive part of indie filmmaking.



DV in the Home and Office

Even if you're not interested in becoming a movie mogul, you might find yourself facing increasing demand for video production. Thanks to Web-based streaming technologies and faster desktop computers, more and more businesses are finding corporate and industrial applications for high-quality video production tools. Whether it's live Webcasting or producing a CD-ROM-based annual report, you might have recently found yourself needing to wear the video producer hat.

Or, it might just be that you want to make a movie simply because it's really fun. The fact is that the collaboration, imagination and work involved in crafting even a short film is extremely enjoyable. DV technology actually makes it possible to be a *hobbiest* filmmaker – something that has never before been possible. And, with web-based film festivals and distribution, you no longer have to be a hobbiest filmmaker with no audience. You can actually present your finished work to an audience for practically zero cost.

This book will teach you everything you need to know, whether your aim is to create a feature-length production with the hope of a theatrical release, an industrial or corporate production, or a short film or music video simply for your own enjoyment.

This book is meant to be both a start-to-finish production guide and a reference for learning more about particular tasks. For more experienced users, we've included details on the latest technologies, tips and guidelines for transitioning from older video or film technology, and suggestions and strategies for using digital equipment and digital workflow to reduce your production costs. From sophisticated titles to complex compositing, *The Digital Filmmaking Handbook* will show you how to create shots and effects that are rarely associated with low-budget production.



Full blown video production is a huge affair that involves many different arts, crafts, and sciences. No single volume can address the tremendous amount of training and expertise that is required to master all of these disciplines. However, we have tried to fill you in on the questions you need to ask and the major problems and issues you will have to solve at each stage of your production. So, even though this book doesn't cover, for example 3D animation, our post-production chapters should at least bring you up to speed on the issues you can expect to face when trying to pull off an effects shoot. These questions should help you better interface with the artisans and craftspeople who *do* have the skills for these various disciplines and point you in the direction of further self-education if that's your intention.

New to this version are updated technical details on the latest hardware and software, including coverage of the latest high definition formats and technologies such as HDV and HD. In addition, the book has been slightly re-organized so that it more closely matches the workflow of a typical digital filmmaking production.

Whether your goal is an industrial project, a short subject for your Web site, or a feature-length movie for a film festival, *The Digital Filmmaking Handbook, 3rd Edition*, contains everything you need to know to get your project in the can.

What Type of Equipment Do I Need?

This book assumes you will be using a Macintosh or Windows-compatible computer. Some familiarity with your operating system of choice is required, as well as a video camera of some kind. Guidelines for selecting equipment are provided throughout the book.

We also assume that you are familiar with some basic computer terms—RAM, kilobytes, megabytes, clock speeds, and so forth. A glossary is included in the back of the book.

Finally, although we assume no formal training in video or film production, we might—on occasion—use film and video production-related terms. These are also included in the glossary. You might be surprised to learn how much you already know about video production. Watching movies is the best way to learn the visual literacy required of a good filmmaker, and most people have seen plenty of movies.



What Is Digital Video?

The phrase *digital video* is very confusing because there are many things that are, technically, “digital video.” A QuickTime movie downloaded from the Web is digital video, as is an animation generated by a computer graphics program. A video hobbyist might use an inexpensive digital video camera to pour video from her home video camera into her computer, while a big film studio might use special scanners to transfer 35mm motion-picture film into high-end graphics workstations. The results are all “digital video.”

Things get even more complicated when you consider that some people use the phrase *digital video* to refer to very specific pieces of equipment (a “DV camera,” for example), while others use “digital video” as a broader term that encompasses any type of digitized video or film.

Your computer salesperson might have said something like “with this FireWire interface, this computer is a great ‘digital video’ machine.” What does this really mean? Can you plug any old camera into it? Is the machine ready to create a great new digital video feature-length movie? Unfortunately, the answer to both of those questions is “no.” However, such a computer can be used as one component of a system that can take video from a video source, edit it, add special effects and graphics, and then output the results to a video or film recorder. In some cases, your source video will be a special digital video camera or tape deck. In other instances, it might be a traditional analog camera or deck. The main difference between a digital and an analog camera is that a digital camera digitizes video *while* you shoot, and stores it on tape in a digital format or even a hard disk, while an analog camera stores video and audio on tape as analog waves.

For the most part, when we say “digital video,” we’re referring to the broadest definition: a process wherein your source video is “digitized” at some point so that it can be manipulated and edited on the computer.



What Is Digitizing?

A digital video camera is a lot like a flatbed scanner, in that both devices “digitize” an image. A flatbed scanner, for example, divides a page into a grid of tiny pixels and then *samples* each pixel. Each sample is analyzed and assigned a numeric value—a digit, or series of digits—that represents the pixel’s color.

A frame of video can be digitized using the same process. However, since one video frame is comprised of an average of 720×480 pixels (or 345,600 pixels), and each second of video requires 30 frames, you need a fast computer with a lot of storage to handle even a small amount of video.

A digital video camera has built-in digitizing hardware that digitizes while you shoot and then stores the resulting numbers onto a tape. Consequently, if you use a FireWire connection to transfer video from a DV camera into your computer, you don’t technically “digitize” the video, because the camera has already done that for you. Rather, you simply copy the numbers (which represent the digitized images) from the tape into your computer, a process called “capturing.”

If you have an analog video camera, then you’ll need special digitizing hardware in your computer that can change the analog video signal from your camera into digital information and store it on your computer’s hard drive. Like a DV camera, these “video capture boards” also compress the video before storing it and decompress it when you’re ready for playback. Video capture boards run the gamut from inexpensive, low-quality capturing to very expensive, uncompressed capturing (Figure 1.3). High-end digital video editing (such as HD) also requires special video capture cards.

We’ll discuss the details and merits of both systems later in this book.



fig 1.03a

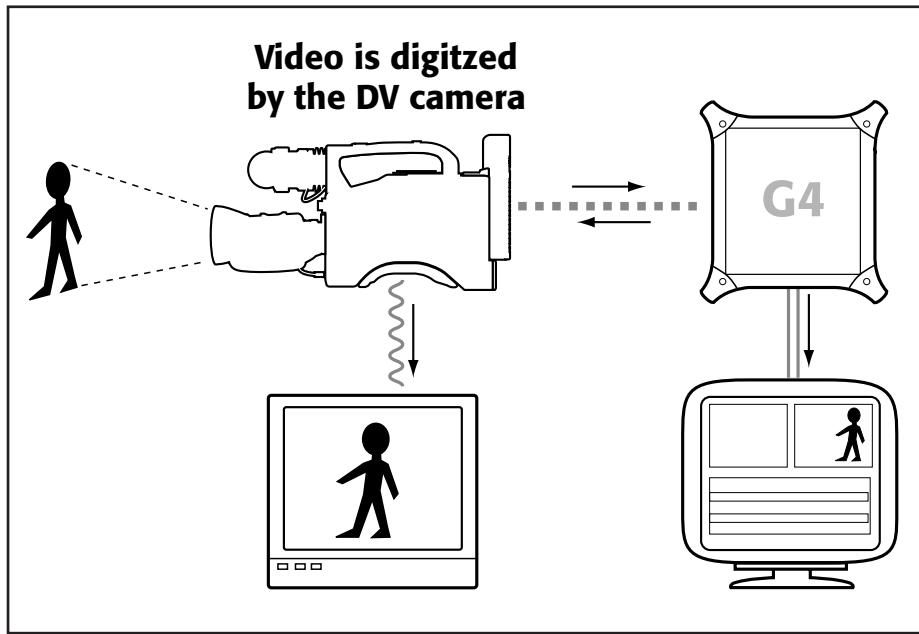




fig 1.03b

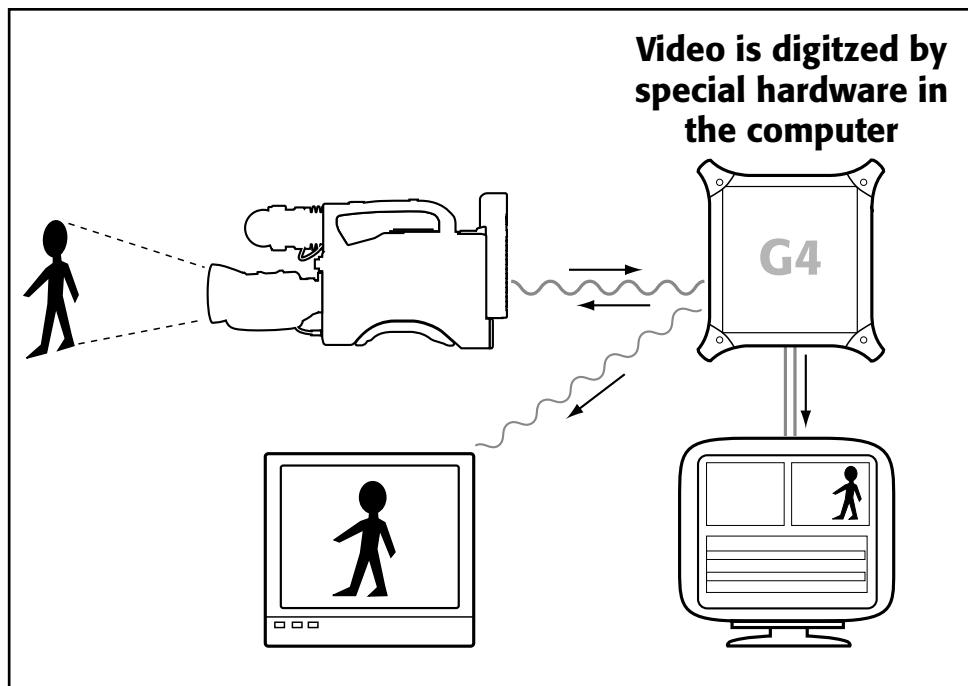


Figure 1.3a In a typical DV editing workflow, video is digitized by the camera and the resulting digital file is sent to the computer. When editing, the computer transmits a compressed digital signal back to the camera, where it is decoded for playback on an NTSC monitor.

Figure 1.3b If your editing system uses a video capture card, then video is sent to the computer's capture card where it is transferred for editing and converted back for final output to tape. The computer also takes care of sending a signal to a video monitor for playback.

DV Cameras

When you hear people talk about the “DV Revolution,” they’re really referring to three different pieces of technology: high-performance desktop computers with sophisticated editing software; high-speed digital interfaces such as Firewire that allow for video capture without expensive add-on digitizing hardware; and high-quality video cameras that allow the capture of broadcast-quality video. These three technologies work



together to make it possible to produce high-quality finished output using far less gear (and money) than ever before.

The digital filmmaker can now buy an affordable camera that rivals professional cameras of just a few years ago. Understanding the features and trade-offs of different cameras is essential to selecting a camera and using it to its full potential.

In this chapter, we'll explain the various features and functions of a DV camera, with details of how these features work, and guidelines for evaluating and selecting the right camera for your project.

Choosing a camera is a process of weighing three factors: image quality, price, and features. Feature filmmakers should be most concerned about image quality, particularly if planning on digital projection or a video-to-film transfer.

Choosing a camera also means making a decision about which tape format to shoot on. Because there are so many digital formats available, it's worth taking some time to consider your choice of format. This choice can have a lot of ramifications for your production process because not all cameras have the same features. Cameras that record high-quality formats, such as the various HD formats, tend to have high-end features whereas cameras that record consumer-oriented formats, such as DV, can range from a surprisingly high-end feature sets to the video equivalent of "point and shoot."

Image quality

Portability and cool features are nice, but if that lightweight camera with the cool special effects produces images with lousy color and distracting artifacts, the audience is going to be less inclined to pay attention to your story.

The format you choose has a lot to do with image quality, of course – HDV is going to look much better than VHS – but within a particular format, you will be able to choose from among many different cameras. Film shooters have an advantage over video shooters in that image quality is heavily dependent on lenses and the film stock they stick in their camera. It's not so simple with video: In addition to the usual concerns about lens quality and camera features, you also have to worry about how good a job the camera does at actually capturing, processing, and storing an image.

Two factors contribute the most to your camera's image quality (or lack thereof): the camera's lens, and the number of chips the camera uses to create an image. Your first choice, then, will be to decide between single-chip and three-chip models.

CCD

In the old days, video cameras used vacuum tubes for capturing images. Today, video cameras use special imaging chips called CCDs, or charge-coupled devices. Just as their tube-based predecessors used either one or three tubes to capture an image, CCD-based cameras use either a single CCD to capture a full-color image, or three separate CCD sensors to capture separate red, green, and blue data, which is then assembled into a color image (Figure 4.1).

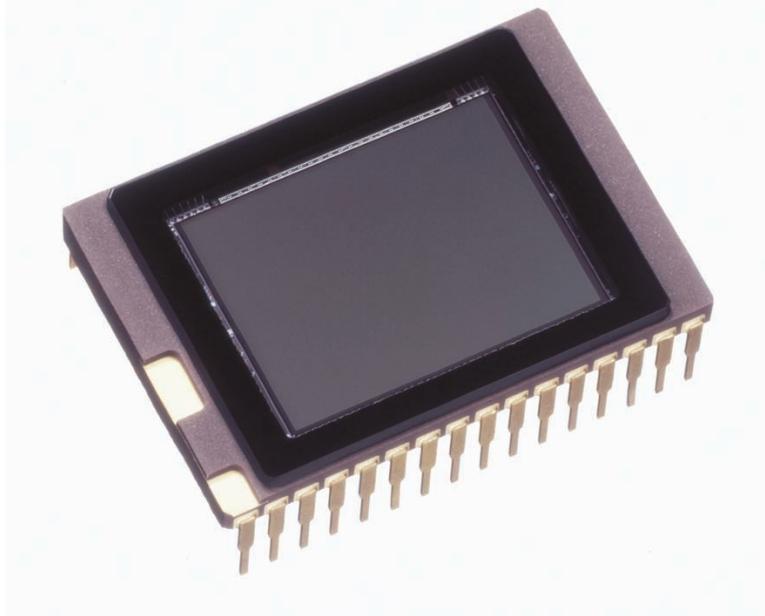


fig 4.1

Figure 4.1 – An Olympus CCD image sensor.

A CCD looks like a normal computer chip, but with a sort of light-sensitive “window” on the top. The imaging window is divided into a grid; the finer the grid, the higher the resolution of the CCD. The circuitry controlling the CCD can determine the amount of light striking each cell of the grid, and that data is used by the camera to build an image.

Single-chip cameras have red, green, and blue filters arranged over clusters of cells in the CCD. These filter the light coming through the lens and allow the camera to record color images. In a three-chip camera, a series of prisms splits the incoming light into separate red, green, and blue components, and directs each of these components onto a separate CCD. Because the camera is dedicating an entire sensor to each color, color fidelity and image detail are much improved over single-chip cameras (Figures 4.2 and 4.3).

When compared to a three-chip camera, a single-chip image might show strange color artifacts or bleeding, smeary colors as well as a softer, lower-resolution image.

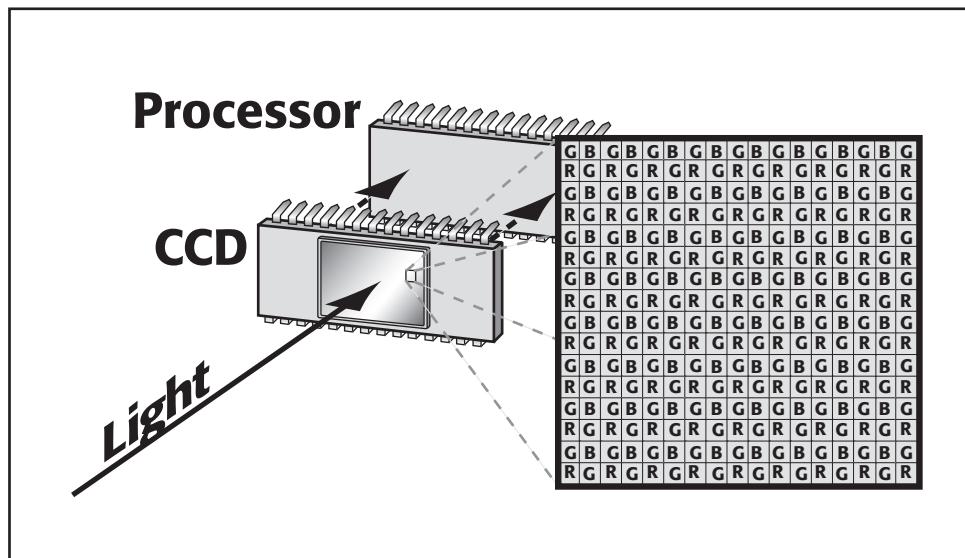


Figure 4.2 – In a single-CCD camera, light is focused by the lens onto the CCD. Red, green, and blue filters placed over alternating cells of the CCD enable the camera to calculate color. The resulting data is passed on to the camera’s processor. (Notice that there are far more green cells to accommodate your eyes’ high sensitivity to green.)

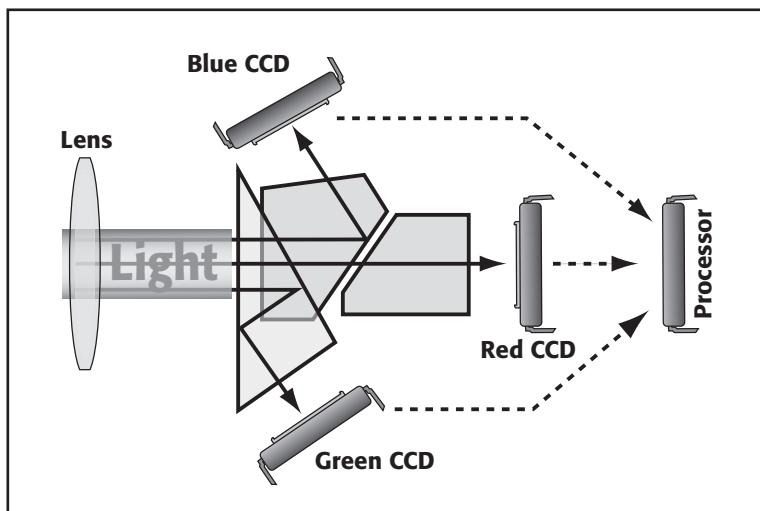


Figure 4.3 – In a three-CCD camera, light is focused by the lens onto a series of prisms that split the light into red, green, and blue. Each component is directed toward its own CCD.



The image data gathered by the CCD(s) is passed to an on-board computer that processes the data and writes it to tape. How the computer processes the data can have a lot to do with how images differ from camera to camera. Some cameras tend to produce warmer images, with stronger reds and magentas while others might produce cooler, less-saturated images with stronger blues. One approach is not better than the other, but you may find that you have a personal preference, or that one is better-suited to the tone of your project.

Ergonomics

Currently, DV cameras range from the size of a portable MP3 player all the way up to large, shoulder-mounted units. Choosing a particular camera body involves balancing features and shooting style with cost.

Smaller cameras typically lack high-end inputs such as XLR audio jacks (more about audio jacks in Chapter X). They also usually don't have as many manual features and practically never include such niceties as lenses with aperture and focus markings, sharpening controls, and refined image quality adjustments.

On the other hand, small size makes a camera easier to carry, and ideal for surreptitious shooting. For documentaries, a low-profile camera might help you to get candid footage (nothing shuts up an interview subject faster than sticking a big lens in his or her face) or to shoot clandestinely in locations that wouldn't normally allow a camera (Figure 4.6).



fig 4.06



Figure 4.6 – The design of your camera not only dictates how comfortable the camera is, but what types of shots you'll be able to get. While a small hand-held may be more portable, a larger camera will facilitate more complex cinematography.

Similarly, if you're shooting a feature, a smaller camera makes it easier to shoot scenes without being seen (drawing a crowd with your production can often slow things down). If you're shooting without a city permit or permission, the "tourist" look of a smaller camera may be just what you need to keep from getting hassled.

Larger cameras usually sport three CCDs for better image quality while their heavier weight makes for easier shooting and smooth, steady camera moves. And, let's face it, they look cooler.

Don't ignore the camera's physical feel. To get the footage you need, you must be able to move the camera with great precision. If a camera is too heavy (or light) or too bulky for you to pan and tilt comfortably, you may not be able to get the shots you want.



The camera's weight can also have budgetary consequences, as a heavier camera will require a more sturdy—and therefore more expensive—tripod.

Frame Rate

As explained in Chapter 3, frame rates for video can vary a lot these days, depending on where you live and whether or not you're shooting HD. Earlier, we said that film has a frame rate of 24 fps. Actually, 24 fps is just the frame rate at which film is usually shot and projected. In fact, most film cameras offer variable frame rates. Sometimes, if a project is shot on film and destined for video, film is actually shot at 29.97 fps, to match the frame rate of analog NTSC video.

It used to be that video cameras only had one frame rate available – 29.97 fps if you live in North America or Japan and 25 fps if you live in the rest of the world. Now, inexpensive video cameras are available that can switch from 29.97 fps to 25 fps (described as “NTSC/PAL switchable”) and HD cameras can sometimes also record at film frame rates (24 fps/23.976 fps) in addition to the NTSC and PAL frame rates. (See Chapter 3 for the lowdown on all the possible frame rates of HD.)

The ability to choose between frame rates can save a lot of time and trouble later on. If you know you will have your video blown up to 35mm film, shooting at a frame rate that is the same as that of film will result in a better video-to-film transfer. (See Chapter 18 for more details on 35mm blow-up.) Some people argue that shooting at 24 fps results in more of a “film look” even if you are not going to transfer the video to film. But beware that you'll eventually have to transfer the 24 fps video to either 29.97 fps (NTSC) or 25 fps (PAL), depending on where you plan to distribute it.



fig 4.09

Fig 4.9 – Cameras like the JVC GY-DV500 provide a full complement of manual controls, pro-level audio inputs and controls, and more.



Progressive Scan

In Chapter 3, you saw how current video standards such as PAL and NTSC are interlaced; that is, each frame of video consists of two sets of scan-lines, or *fields*, which are separately painted onto the screen every 60th of a second.

Some cameras can shoot in a non-interlaced, progressive scan mode. Progressive scanning—painting the scan lines on, in order, from top to bottom—is what your computer monitor does, and it typically produces a clearer image with a more film-like sense of motion. (Some companies refer to this as “Movie mode.”) However, on some lower-end cameras the clarity of the frames also means that fast-moving images sometimes have a strange, stroboscopic quality to their motion. On these cameras, progressive-scan mode is really intended for still photo use.

On higher-end cameras, progressive-scanned video usually looks much more “film-like” than interlaced video. The reason for this is not grain or texture, but, rather, the lower frame rate itself. Since progressive scanned video is running at 29.97 whole frames per second, it’s closer to film’s 24 fps than interlaced video’s 60 half-frames per second.

Some film transfer houses claim that progressive scan yields a better film transfer, and many transfer houses recommend shooting this way. Others are more comfortable with interlaced, because that’s what they’re used to transferring. Similarly, some “film look” software packages prefer one form of video over another.

Be sure to do a lot of test shoots before you commit to shooting in progressive scan mode.

Tip: Faux Progressive Scan

On some cameras, the progressive scan mode doesn’t shoot a true 30 full frames per second. Instead, they shoot a single field, and duplicate it to create to create a full frame. Very often, they do this at a much slower frame rate of 15 frames per second. Though this can look a lot like a regular progressive scan, you’re only getting half the vertical resolution. Stay away from these faux progressive modes.

Aspect Ratio

Many cameras include a “widescreen” mode that lets you shoot in a 16:9 aspect ratio à la HDTV or widescreen film. These features work by cropping the top and bottom of the frame to letterbox the image down to 16:9.

The downside to this “hacked” 16:9 effect is that you lose a lot of vertical resolution. If your CCD only has 360,000 pixels and you’re using a third of them for black areas above and below your image, you’re effectively shooting with much lower resolution than your camera is capable of (Figure 4.10).

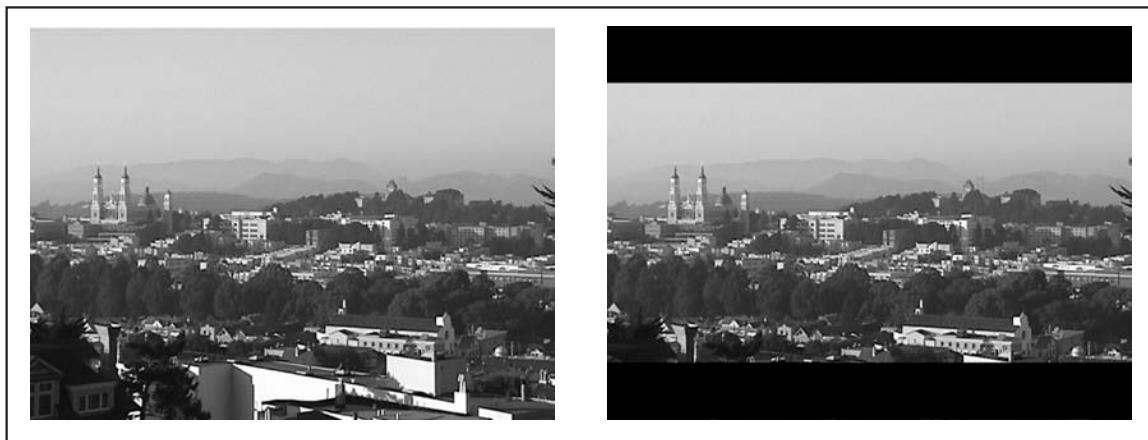


fig 4.10

Figure 4.10 – The “widescreen” feature on many cameras simply masks the top and bottom of your image, effectively wasting a third of your vertical resolution!

Some formats can shoot a true 16:9 aspect ratio because they use rectangular CCDs that actually have a full 16:9 ratio's worth of pixels. DV and other formats that don't provide a "true" 16:9 mode, can usually output a widescreen, non-letterboxed image to a widescreen TV, but this is only useful if you know that your project will be delivered and viewed on a widescreen device.

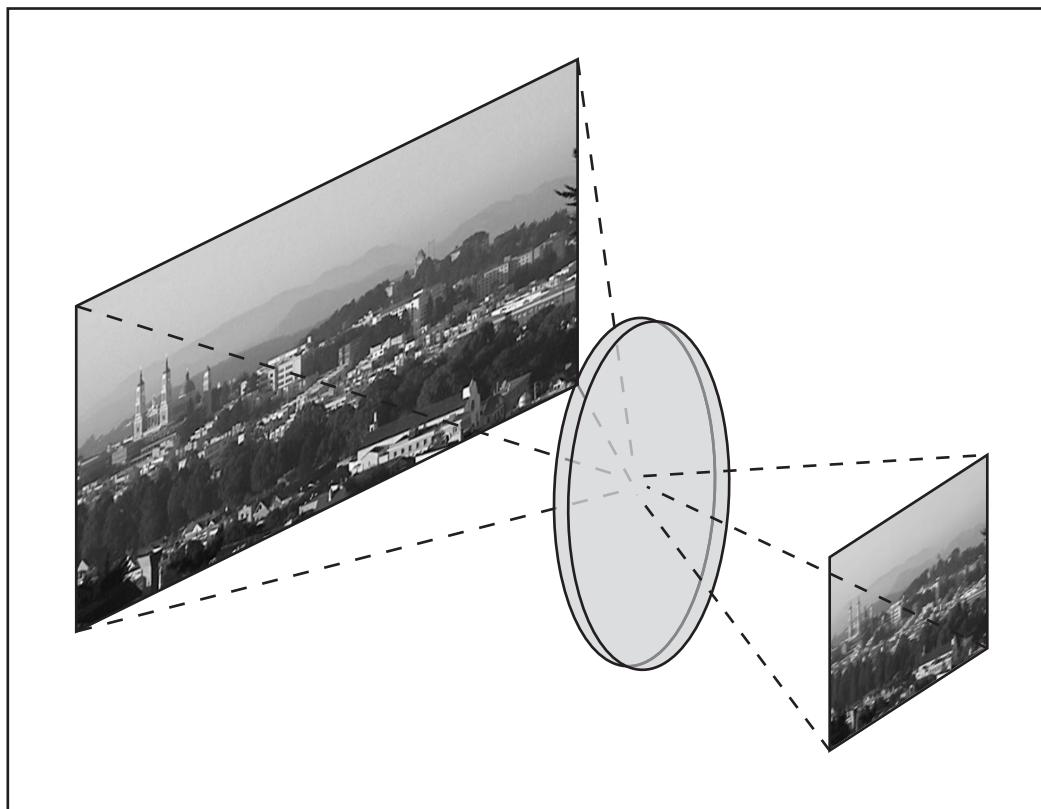


fig 4.11

Figure 4.11 – An anamorphic lens optically squeezes a wide image down to the aspect ratio of your CCD. To look right when viewed, it must be correspondingly de-squeezed.

Another route to shooting wide screen is to leave your camera in its normal shooting mode, and do what film users do: get a special lens.

An *anamorphic* lens optically squeezes the image horizontally to fit a wider image onto the CCD. If you look at an individual frame of film shot with an anamorphic lens, you'll see a squished image that's greatly distorted. But project that image back through a projector that's been fitted with an equivalent anamorphic lens, and you'll get an undistorted, really wide picture. Similarly, you can use your editing software to unsqueeze your anamorphic footage to create a true widescreen image (Figure 4.11).

Several manufacturers make anamorphic attachments for camcorders. If you're determined to use one of these, however, you'll need to make sure it works with your camera. Check with your vendor for compatibility. Also, if you're planning on transferring to film, check with your service bureau or film lab to make certain that they can handle anamorphic footage.



FireWire Users, Take Notice!

Remember, even if you're using a FireWire-based system, you'll still need to use analog video cables to attach your DV camera or deck to an external video monitor. Therefore, you'll have FireWire carrying video and audio from your deck/camera to your computer, and an analog cable carrying video and audio from your deck/camera to your video monitor.

How a DV Editing System Works

When you press “play” on a DV deck (or camera), the compressed digital information is read from the DV tape. The deck does two things with this information. First, it decompresses the signal into analog video, which is sent through the unit’s analog outputs—usually either S-video or composite. These outputs can feed a video monitor, an analog tape deck, or an analog digitizing system. Simultaneously, the camera or deck sends the raw, compressed digital stream out through its digital interface (FireWire or SDI). If you have a computer attached to the other end of that digital interface, you can capture that compressed stream (remember, it's *capturing*, not *digitizing*, because the video has already been digitized) and store it on a hard drive. Not all computers have the processing speed to completely decompress the incoming video stream for playback. As such, the image displayed on your computer screen by your editing program is usually a low-res proxy of your final video. The only way to see a full-resolution playback of your captured video is to attach a video monitor to the analog output of the video deck (Figure 10.4). Because the camera/deck



is capable of fully decompressing the video, you'll get full quality on your analog monitor.

The video passing into and out of your computer is in a raw digital form, so it's possible to shoot, edit, and print back to tape with no loss of quality (unlike analog systems, which experience *generation loss* each time you make a new copy). Note that we said "it is possible." Depending on the type of effects and edits you are making, you might inadvertently recompress your video, resulting in loss of quality through recompression.

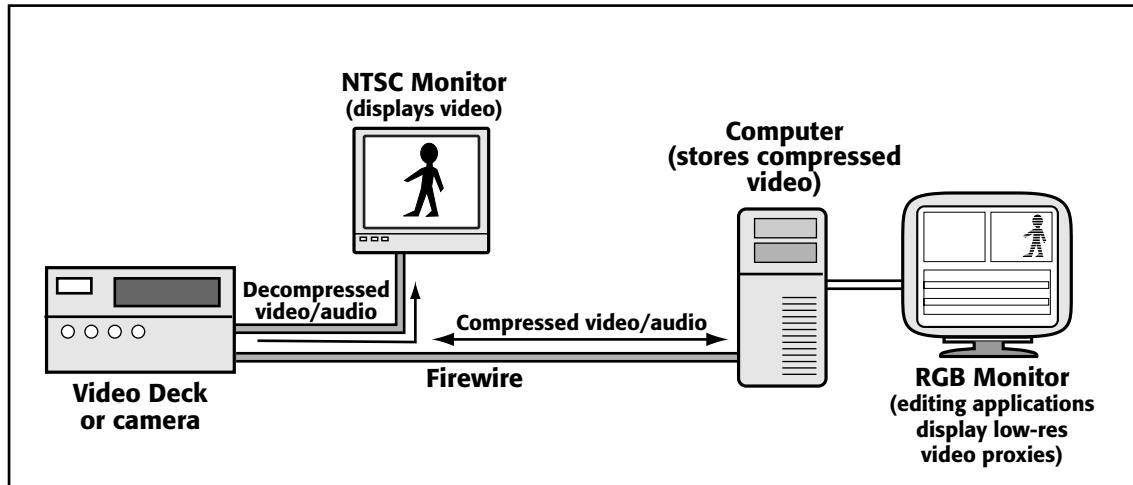


fig 09.03

Figure 10.4 With digital video formats, the camera takes care of the digitizing and compressing. When you get ready to edit, you use a digital interface to capture the digitized, compressed video from your camera or deck into your camera.



Manufacturer's Recommendations

No matter what platform you're using, you'll need to be concerned about compatibility between your computer and video hardware. Fortunately, most vendors are diligent about publishing compatibility lists. Such lists include approved drives, interfaces, and CPUs. Before you make any purchases, you'll want to be sure to check out each vendor's compatibility claims. In addition, make sure that your dealer has a good return and exchange policy.

Pixel Aspect Ratios

As we mentioned in Chapter 4, "Choosing a Camera," although the pixels on your computer screen are square, digital video formats—including DV—use rectangular pixels. Unfortunately, this means that your images and video can end up stretched and distorted as you move back and forth between different pieces of software.

Because digital video uses rectangular pixels, it will appear wider when displayed on your square-pixel computer monitor. Most editing and effects programs compensate for this by squishing the image horizontally to bring it back to a 4:3 aspect ratio on your computer screen. (If your software doesn't do this, you'll just have to get used to working with stretched footage. *Don't* perform horizontal squishing yourself, or your video will be distorted when it goes back to tape and gets played on a video monitor.)

Today, most video packages let you specify a pixel aspect ratio—many even let you explicitly configure for DV format—when you create a new project. Consult your software's manual for more information on how to set pixel shape (Figure 17.15).

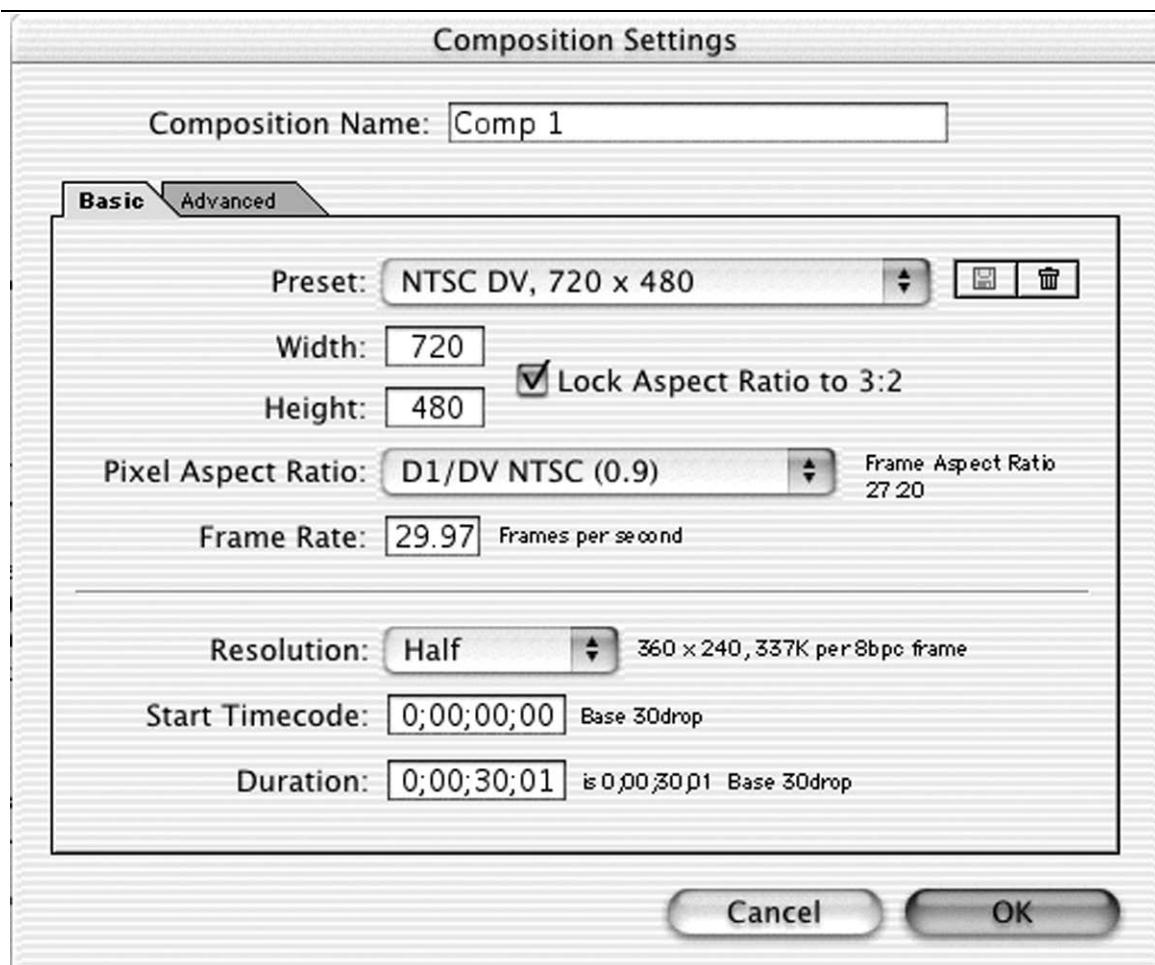


Figure 17.15 Most editing and effects packages now let you specify a pixel aspect ratio when creating a project. Shown here is the Composition Setup dialog from Adobe After Effects 5.5.

If you're creating graphics in a paint, image editing, or 3D application, you'll need to do some extra planning if they're destined for videotape.

If you are using a square-pixel videotape format such as VHS or Hi-8, you can go ahead and create your graphics at 640 x 480 pixels and import them into your editing application normally. If you're using DV video, then you should create square pixel graphics at 720 x 540 while working in Photoshop, or any other square pixel environment. At this aspect ratio, they'll appear the same as they'll eventually look on a video monitor. When you're done with the artwork, save a copy and resize the copies to 720 x 480 before you import them into your editing package. (Figures 17.16a, 17.16b, and 17.16c).



fig 16.15a,b,c

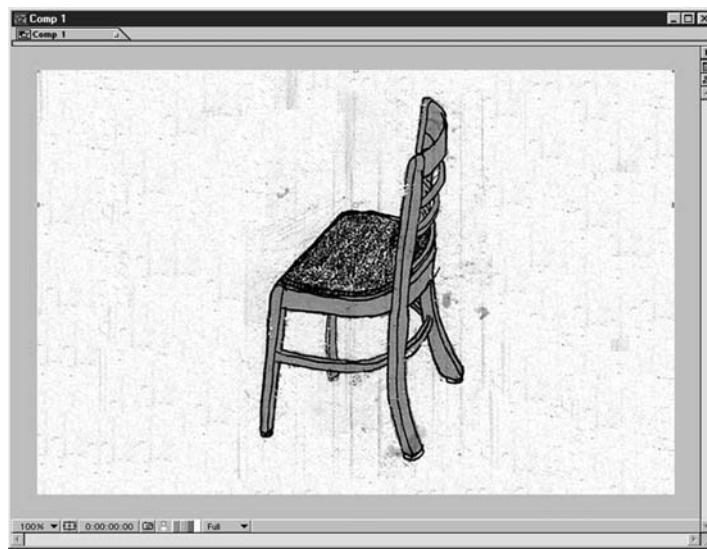
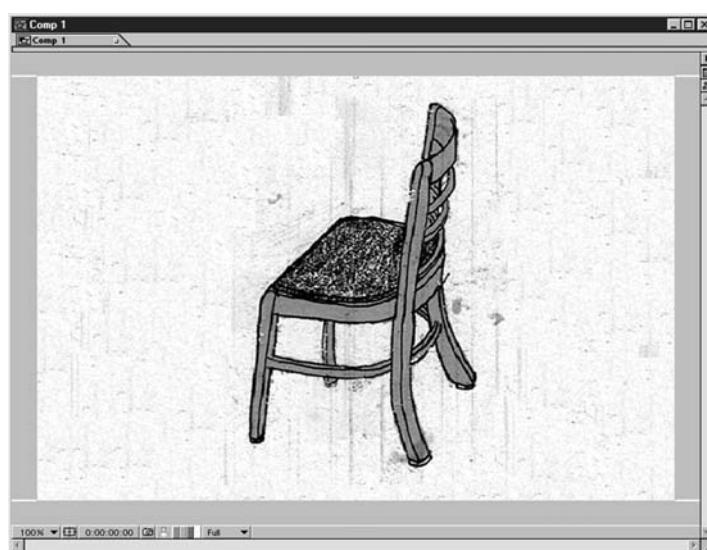




Figure 17.16a When creating images for export to video, start with pixel dimensions of 720 x 540.

Figure 17.16b When imported into a program that supports rectangular pixel aspect ratios, the image will appear too wide.

Figure 17.16c By simply applying a 90-percent horizontal scale, you can return the image to its correct aspect ratio.

In our tutorials, we assume that you are selecting the correct pixel sizes and project settings to compensate for the pixel aspect ratio of your chosen format.