Chapter 1

Choosing a DV Camcorder

There are many fine analog camcorders out there that deliver lovely quality video that translates to high-quality streaming video or DVD output.

On the other hand, if you're buying a DV camcorder, it's easy to get confused by the multiple formats that are available today and the rich feature sets of the individual camcorders. To help you sort through all the options, this chapter starts by identifying the digital video formats available today and their strengths and weaknesses.

Then, looking primarily at DV camcorders, I'll identify the basic components and features of a camcorder, describing which are important and which aren't. Then we'll look at the current crop of Sony camcorders to identify the types of features that boost the price from $699 to $1,499 and when it's worth spending the extra dollars.

The chapter concludes with a look at the types of features that higher-end camcorders deliver as well as a short section on how to test-drive a camcorder before buying.

Reviewing the Digital Formats

A digital camcorder is any camcorder that stores video in digital rather than analog format. Life was simple about five years ago, because camcorders using DV as the storage format were the only digital camcorders, so if it was digital, it was DV. Now the field has expanded into a number of siblings and kissing cousins that are related to DV but different. Starting with DV, let's review the most relevant members of the digital camcorder family.

Why I Love the DV Format

DV cameras store video in digital rather than analog format. They first appeared around 1996, promising and delivering exceptional quality and ease of use. I switched over from Hi8 to DV in 1998 and never looked back. If you're working in analog format and considering DV, here are the top seven reasons digital is better than analog:

- Tapes are more robust. Hi8 tapes are very fragile.
- The ability to control the camera from software simplifies all camera and computer interactions.
- Capture is much simpler with DV. There are no brightness or color adjustments and no volume controls; just a simple file transfer.
- Time codes in the DV tape allow software video editors to scan the tape and identify scenes, saving hours of scanning time.
- Captured video is free from the ragged edges pervasive in analog video, which usually appear on the top or bottom of your captured video.
- Video quality is outstanding.
- Grabbing still frames is much simpler, and frames are higher quality.

DV Format

The first and most widely used format for digital camcorders is DV, an interlaced format with a resolution of 720x480 pixels and a combined audio/video data rate of approximately 3.6MB per second. Resolution and interlacing are discussed in more detail later in the chapter.

DV uses JPEG compression on each frame to achieve roughly a 5:1 compression ratio, which is generally unnoticeable on most video. DV uses two kinds of tapes: full-size and Mini-DV tapes, the latter being about the size of a small matchbox. Virtually all camcorders under $5,000 use Mini-DV tapes, and I'll talk exclusively of Mini-DV cameras from here on out.

DV has several professional offshoots, including DVCPRO, DVCAM, and DVCPro-50 that use heavier-duty tapes and slightly different encoding schemes. None of these formats appear in consumer camcorders, so I won't mention them again.

DV camcorders use a serial port transfer mechanism called IEEE 1394 to send video back and forth to computers. This transfer mechanism also includes "machine control," which allows software on the computer to control the camera's playback mechanism, for playback, fast-forwarding, and rewinding operations.

IEEE 1394 was invented by Apple as FireWire, dubbed iLink by Sony and other names by various vendors. As Billy Joel might say, "It's all 1394 to me," and these devices by any name are almost universally interoperable.

Digital8

Digital8 camcorders use the DV format but store video on Hi8 rather than DV tapes. This was important back in the early years of DV when DV tapes cost $25 or more, which was prohibitive for many

consumers. Most, but not all, Digital8 camcorders also can play Hi8 tapes, allowing backwards compatibility for those with significant libraries in this format. In addition to sharing the DV format, Digital8 camcorders also use 1394 to communicate with computers.

Overall, Digital8 camcorders are wonderfully inexpensive mechanisms to enter the world of digital video with. On the other hand, one of the key benefits of the DV format is the robustness of the tapes, and in my experience, solely using Hi8 to capture analog video, are fragile as flowers. Now that prices of entry-level DV camcorders and DV tapes have dropped so significantly, I would probably spend the extra money and go DV.

MicroMV

MicroMV camcorders encode their video in MPEG-2 format, which is more highly compressed than DV, allowing tapes and camcorders to be smaller. The only characteristic they share with DV is the transport mechanism to the computer, FireWire. Sony does enough things differently with MicroMV, however, that few video editors support the format, and those that do, like Pinnacle Studio, had significant startup issues. This, and the inherently lower quality of MPEG-2, makes DV a better choice for those who want to edit digitally on their computers and produce top-quality video.

What You Need to Know about MPEG-2

MPEG-2 is the format used in MicroMV and DVD camcorders as well as in DVD videos. Briefly, MPEG-2 is a compression technology, or codec, that typically outputs between 1MB per second (DVD videos) and 1.375MB per second (MicroMV). It's a scalable format that also can encode at much higher or lower rates.

DV is also a codec and uses intra-frame-only techniques, which means it encodes each frame without reference to other frames. In contrast, MPEG-2 uses intra-frame and inter-frame compression, which eliminates redundancy between frames. This inter-frame compression allows MPEG-2 to produce very good quality at much lower rates than DV, but it also complicates editing on the computer, since the computer is constantly having to re-create frames encoded with inter-frame compression.

MPEG-2 quality depends upon the encoding tool used. Hollywood producers use expensive, high-end equipment that can take hours or days to produce a movie. MicroMV and DVD camcorders use inexpensive chips that must store the video in real time. For this reason, don't expect MPEG-2-based camcorders to output the same quality as Hollywood DVDs.

In my view, MPEG-2 is a great *delivery* codec — or a compression technology optimized for delivering content. In contrast, DV is a great *capture and editing* codec, delivering much higher quality and better responsiveness during editing.

Certainly MicroMV and DVD camcorders are great for simple shooting and playback, but if editing quality is your major goal, stick to DV.

DVD Camcorders

DVD camcorders store captured video in MPEG-2 format on either DVD-RAM or DVD-R disks. The former is ideal for rewriting and instantly accessing individual scenes without the usual capture process; DVD-R disks are targeted for immediate playback of the videos on a DVD player. The MPEG-2 compression used in these cameras is scalable and peaks at 1.125MB per second for DVD-RAM and 750K per second for DVD-R.

These camcorders are fairly new and share many of the same issues as MicroMV, including reduced quality and little compatibility with video-editing programs. For these reasons, unless you have a compelling need to capture directly to DVD, you're probably better off with a DV-based camcorder.

Table 1-1 summarizes the similarities and differences between the four formats discussed so far.

Table 1-1 Characteristics of DV, Digital8, MicroMV, and DVD Camcorders

	DV	***Digital8***	***MicroMV***	***DVD Camcorder***
Storage format	DV	DV	MPEG-2	MPEG-2
Recording medium	DV tape	Hi8 tape	MicroMV tape	DVD-RAM/DVD-R disk
Outputs	Analog (composite, S-Video and stereo audio)	Analog (composite, S-Video and stereo audio)	Analog (composite, S-Video and stereo audio)	Analog (composite, S-Video and stereo audio)
Transfer to computer via: method	1394	1394	1394	USB or disk

Camcorder Basics

Now that we've reviewed the camcorder formats, let's focus our attention on the camcorders themselves, starting with the major components and then working our way down to individual features.

Charge Coupled Devices

Charge Coupled Devices (CCDs) are the electronic chips that sense the image coming from the lens. When comparing camcorders, we care primarily about the number of CCDs employed by the camcorder, their physical size, and the number of pixels each chip can resolve.

THE NUMBER OF CCDS

Briefly, CCDs use light-sensitive regions that create electrical charges based upon the intensity of the light hitting the CCD, distinguishing between bright and dark regions by measuring the electrical charge at each pixel. To discern colors, camcorders with three CCDs split the incoming light with a

prism, sending red, green, and blue streams to the respective CCDs and then merging the three signals electronically.

In contrast, single-CCD camcorders use an array of colored filters over the CCD to separate the colors, which is less effective. For this reason, three-CCD camcorders almost always produce video with superior clarity and color accuracy.

As you might expect, most consumer camcorders use one CCD while all prosumer and professional camcorders use three CCDs. In the past, most three-CCD camcorders started at around $2,000, but Panasonic announced a three-CCD camcorder for under $1,000 in mid-2003, and I'm sure other vendors will follow suit.

Probably the most significant determinant of quality and price between camcorders is the number of CCDs used in the camera. Whenever comparing camcorders, be sure to identify this first.

CCD SIZE

CCDs typically range in size between ⅛ and ½ inch. Though some experts claim that CCD size doesn't directly relate to quality, higher-end camcorders typically use larger chips than consumer models.

Still, this is a fairly esoteric metric; in several tests at *PC Magazine,* camcorders with smaller CCDs outperformed those with larger. For this reason, I wouldn't pick one camcorder over another because it has larger CCDs.

CCD RESOLUTION

On the other hand, CCD resolution, or the number of pixels captured by the CCD, is a very key metric, especially if you plan to use the camcorder for capturing still images as well as video. Interestingly, if the camcorders' primary focus is DV video, which has a resolution of 720x480 pixels, the ability to capture about 340,000 pixels is sufficient, and more is a waste. That's why CCDs for prosumer camcorders, like Sony's DCR-VX2000, have fewer pixels than many consumer camcorders.

In contrast, more pixels are better on camcorders designed to capture high-quality stills, and most vendors offer models with 1.5-or 2-megapixel CCDs for still-image capture. When comparing camcorders, be sure to identify both the CCD resolution and maximum picture resolution, typically represented as 640x480, 1600x1200, or similar numbers.

If the number of pixels in the largest image exceeds the number of pixels in the CCD, the camcorder is zooming the image digitally, which delivers less quality than a pixel-for-pixel image capture. For example, the JVC DV3000U camcorder has a 1.33-megapixel CCD with 1,330,000 pixels yet outputs images as large as 1600x1200, which really requires 1.92 megapixels, derived by multiplying 1,600 times 1,200.

In contrast, the Sony DCR-TRV80 shares the same maximum image size of 1600x1200 but creates the picture with a true 2.1-megapixel CCD. All other things being equal, the larger CCD will deliver a higher-quality image.

In short, as with still image digital cameras, if the picture output in pixels is larger than the actual pixels on the CCD, the camera is zooming the image digitally, which you could do in your image editor. Obviously, however, this doesn't add any quality. Accordingly, when assessing a DV camera's still-image capabilities, compare pixels on the CCD, not output size, which can be arbitrary.

SCAN CAPABILITIES (INTERLACED VERSUS PROGRESSIVE)

Scan capabilities refers to the technique used to store the incoming frames. There are two methods, interlaced and progressive.

Televisions in the United States operate under the NTSC (National Television Standards Committee) standard. NTSC video consists of 29.97 frames per second, with each frame made up of two fields, essentially two half frames, the first containing odd lines (1, 3, 5, 7) and the second even lines (2, 4, 6, 8). When shooting NTSC video, the camcorder actually shoots about 60 times a second. The first shot becomes field one and contains the odd lines in the first frame. The second shot becomes field two and contains the even lines in the first frame. Because the two fields are combined to make a frame, this video is considered interlaced.

Interlaced video works well at 60 fields per second but causes problems when shooting for still-image capture, especially if there's high motion in the video. That's because a surprising amount of motion can occur during the ⅙₀ of a second between the two fields, resulting in two pictures of slightly different things. This is shown on the left in Figure 1-1, where the two fields don't combine into a matched frame.

In contrast, progressive scan CCDs store images from top to bottom (lines 1, 2, 3, 4, and so on), just like digital still-image cameras. When shooting in progressive scan mode, DV camcorders shoot only 30 times a second, capturing a complete frame from top to bottom, then dividing each frame into the two fields required for NTSC compatibility, one with even lines and one with odd lines. Similarly, when capturing still images only, the progressive scan camcorder shoots only once, just like a digital still-image camera. As you can see on the right in Figure 1-1, a progressive image of the same motion is very sharp, because the two fields precisely match.

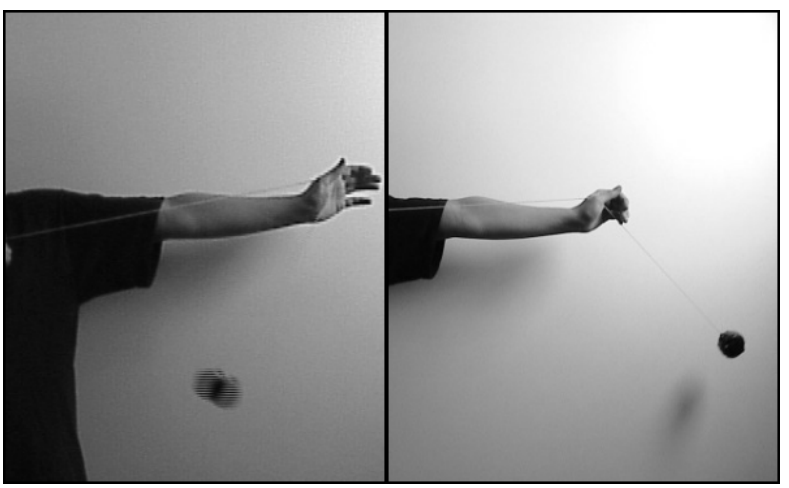

Figure 1-1: On the left is an image shot in interlaced mode, showing the dual images from the two fields that comprise the frame. On the right is an image from a progressive scan camcorder, which shows no such artifacts, or visual anomalies within the frame.

In practice, the image on the left in Figure 1-1 is an extreme example, because camcorders use de-interlacing techniques to minimize the artifacts, and we disabled this for our tests. Still, a camcorder shooting a still image in interlaced mode must combine two disparate fields to create a single frame, generally resulting in a slightly blurry image like that shown in Figure 1-2. Clearly, if you're shooting

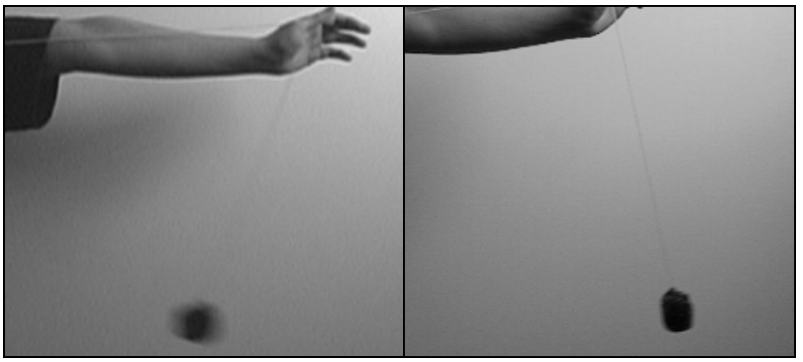

Figure 1-2: Most camcorders use de-interlacing techniques (left) to minimize the artifacts, which produces fuzzy images. As the image on the right shows, you get a much clearer image with progressive scan capture.

for still-image capture, the progressive scan technique provides better quality than interlaced, even after de-interlacing.

Interestingly, progressive scan capabilities first appeared to produce video that could easily be converted to film, which consists of 24 discrete frames per second. That's why newer DV camcorders like Panasonic's DVX100 can capture 24 frames per second in progressive scan mode. Progressive scan capture is also useful, but not essential, when converting to frame-based digital formats like MPEG-1 or streaming formats like Real, QuickTime, or Windows Media Technologies.

As I'll discuss in more detail below, if you already have a high-resolution still-image camera and just want to capture video for video's sake, progressive scan probably isn't a feature worth paying extra for. If you're looking for a high-resolution CCD to capture high-quality still images and video, you should verify that the camcorder captures in progressive scan mode, but virtually all camcorders with high-resolution CCDs do.

If you're looking to produce a movie that ultimately will be displayed on film, as in a theater, progressive scan is essential. Be sure to identify the number of progressive frames per second (fps) the camcorder outputs, however, because some, like the VX2000, produce only 15 fps, which is inadequate for film. Most DV camcorders produce 30 fps, which can be converted to 24 fps for film, though native 24 fps, or the ability to capture directly at 24 fps, is preferable. (Check out Table 1-2 for a comparison of CCD types.)

Table 1-2 Comparing CCDs

	Consumer	***Mid-Range***	***Prosumer***
Number of CCDs	1	1	3
Size	⅙ inch	⅓ inch	⅓ inch
Pixel resolution	340,000	1–2 MP	340,000
Scan capabilities	Interlaced	Interlaced and progressive	Interlaced and progressive

Analyzing Lens Capabilities

Most major camcorder vendors source their lenses from other vendors, with Sony buying from legendary vendor, Carl Zeiss, for many cameras, while Panasonic and Canon employ DICOMAR lenses from equally legendary vendor, Leica. Both brands have their advocates, some quite vocal, and they're both excellent companies, which complicates a brand-based buying decision.

Instead, when I compare camcorders, I focus on comparative performance, particularly how they perform in low-light conditions. Figures 1-3 and 1-4 show why. Though low-light performance is a function of CCDs and camcorder electronics as well as lenses, I'll discuss it here.

Briefly, I took these videos using Sony's three-CCD DCR-VX2000 on the left and a one-CCD consumer camcorder on the right. (I won't name the camcorder because it's simply not a fair comparison; no consumer camcorder can compete with the VX2000.) I placed both camcorders in fully automatic mode and then shot the videos, shutting lights and shades during the shoot to darken the scene.

On the CD-ROM

An MPEG-1 file containing side-by-side shots of the videos is on the CD-ROM, titled Figure 1-3.MPG.

In Figure 1-3, the scene is generally well lit, and the consumer camcorder holds its own. If you were seeing the image in color, you would probably notice that Rosie's sweater (she's on the left) isn't quite the right color and that the contrast and detail overall isn't quite as good. Still, you probably wouldn't pay $1,500 extra for the camcorder on the left based upon this image.

VX2000 One-CCD

Figure 1-3: The one-CCD camcorder on the right does fairly well when lighting conditions are good.

However, in Figure 1-4, when lighting conditions are poor, the VX2000 still produces a usable image while the one-CCD camcorder is pretty much worthless. Now the moral of the story isn't that you need to buy a three-CCD camcorder to produce good video in low light. Rather, if you likely will shoot in low-light conditions (and believe me, you will), there are a number of features to look for to improve your chances of shooting good quality.

VX2000 One-CCD

Figure 1-4: Under low-light conditions, however, the consumer one-CCD camcorder falls apart completely.

ASSESSING LOW-LIGHT CAPABILITIES — LUX

The best measure of a camcorder's low-light capabilities is its lux rating. Briefly, one lux is the light of one candle one yard away from the subject. The VX2000, which performed so well in Figure 1-4, has a lux rating of 2, which translates to good quality even under low-light conditions. The other camcorder has a lux rating of 7, which is pretty standard among consumer camcorders. Essentially, less is more when it comes to lux, because it indicates that the camera can capture a usable image in less than perfect lighting conditions.

Note that some vendors don't publish their lux rating, or they publish them as zero using "NightShot" and similar features that claim to capture images in zero light. These work, but the images are usually white or faintly green, almost other worldly. Alternatively, camcorders slow the shutter speed (defined below) so severely that any motion creates severe blurriness.

Figure 1-5 compares the VX2000 with the other camcorder using its NightShot equivalent, while Figure 1-6 shows the VX2000 and the other camcorder's normal shooting mode. Figure 1-5.mpg on the CD-ROM is the video from which these frames were captured and provides much better detail than the black and white picture on the page.

Obviously, with the low-end camcorder, NightShot mode is better than normal mode, but isn't a panacea. The best solution is a camcorder with a great low lux rating, so be sure to ascertain the camcorder's lux rating without NightShot or similar mode before making your purchase decision.

VX2000 One-CCD

Figure 1-5: The low-lux VX2000 (on the left) does a great job capturing the image, while NightShot (on the right) has the greenish tinge of infrared light.

VX2000 One-CCD

Figure 1-6: Without NightShot mode, however, the image falls apart completely with a one-CCD camcorder.

LINES OF RESOLUTION

The DV format is capable of more than 550 lines of resolution, compared to 220 or so for VHS and 400 for S-Video. This doesn't relate to the number of pixels in the frame, of course, which is always 480 for all DV camcorders, but the number of distinct lines the camcorder can resolve.

To test this, we shoot an image of a test chart at the specified range, capture the image to disk, and then use markings in the test chart to assess the detail preserved by the lens. Figure 1-7 is an example

Best NightShot

Speaking of NightShot, here's my favorite DV camcorder story.

When Sony introduced the DCR-TRV9 camcorder in 1998, it debuted infrared-only NightShot, which some enterprising videographers soon discovered could see through sheer synthetic fabrics like bathing suits in direct sunlight and certain other conditions.

Rumors started circulating, and mention of this appeared in several prominent news magazines, belying that old adage that "any PR is good PR." The camcorder immediately became a best seller until Sony pulled it off the market.

Sony continued the NightShot feature on future versions, but according to a company official, they changed the camcorder mechanics "to eliminate this unintended function."

of a resolution test chart. This is a fairly common test performed during formal product reviews and is occasionally included on camcorder specification sheets, especially for higher-end camcorders.

The VX2000 generally achieves around 530 lines in tests, with some consumer camcorders producing as low as 350. The general rule here is that more lines of resolution are better.

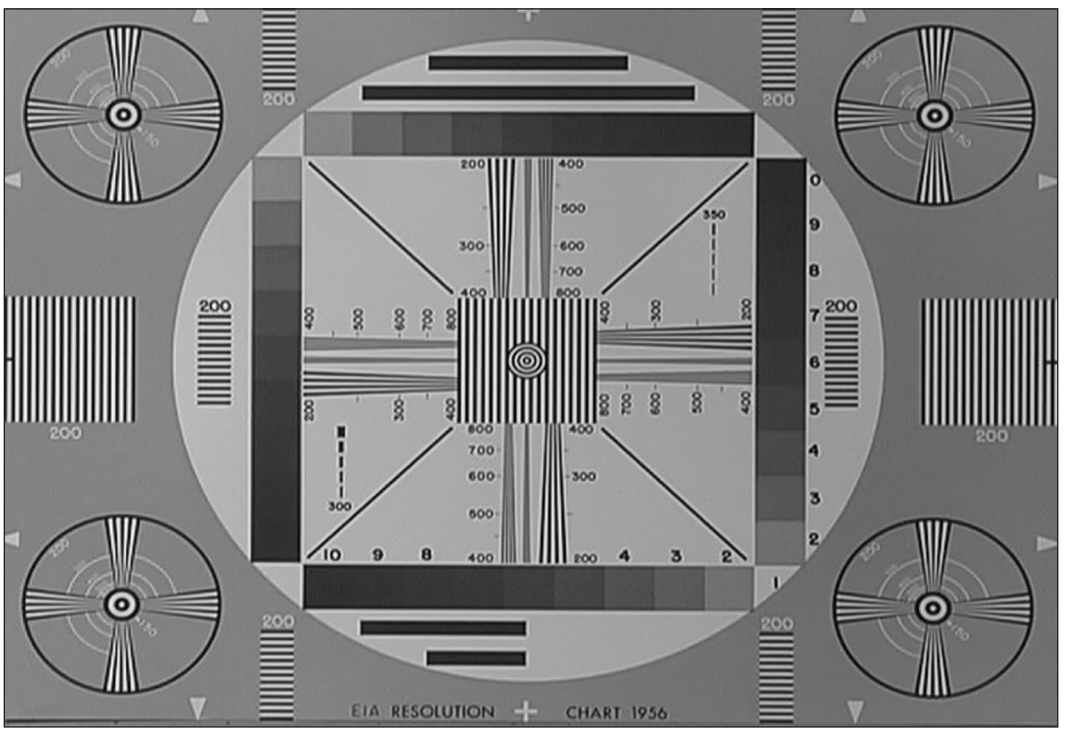

Figure 1-7: A test chart used to determine camcorder resolution.

DIGITAL VERSUS OPTICAL ZOOM

A camcorder's zoom is a measure of its ability to magnify an image. At 1X, the camcorder sees approximately what the human eye sees from the same distance. At 10X, the camcorder can zoom the image ten times larger than normal.

There are two different techniques used to achieve zoom: optical and digital. Optical zoom is produced by the optics in the lens and is generally distortion-free. Digital zoom is magnification produced by camcorder electronics, much like you can zoom a still image in an image-editing program. Though filtering and interpolation techniques can reduce pixilation to some degree, at high-magnification levels, distortion is inevitable.

Figure 1-8 shows an image zoomed at 1X, 20X, and 120X. As you can see on the right, the image is visibly distorted with pixilation showing around the wheel rim. However, the 20X image is reasonably clear, and some camcorders, like Canon's GL2, produce pretty clear video up to 40X zoom.

Figure 1-8: A wheel is a wheel is a wheel at 1X (upper left), 20X (lower left), and 120X (on the right). Note the lack of clarity in the highly zoomed image.

Nonetheless, some video purists recommend disabling the digital zoom, which generally is the course I follow. However this isn't always possible. In the past, all the camcorders I owned were all or nothing; either digital zoom was enabled or disabled — there was no in between. While this prevents you from creating zoom distortion unnoticeable on a 2.5-inch LCD screen while shooting, it also prevents you from accessing lower levels of distortion-free zooming.

I've seen two great compromises to look for when buying. First, several newer camcorders eschew the all-or-nothing approach and let you choose between no digital zoom, the maximum zoom, and some in-between figure ranging from 20X to 40X, which should be reasonably distortion-free. The other approach is a visual indicator in the viewfinder that reveals the magnification level and is especially useful when you've left optical and moved into digital zoom territory.

Needless to say, however, you should assume that any zoom capabilities over 40X to 50X are useless and ignore them when comparing camcorders.

FOCAL LENGTH

Focal length is a measure of zoom ratio that's widely used in the 35mm world. The easy answer here is to ignore focal length in favor of zoom ratio, but let's press on, if only for 35mm analog camcorder jockeys making the conversion to DV.

As with zoom, the focal length is a measure of lens power or magnification. In the 35mm camcorder world, a focal length of 50mm is the standard. Shorter focal lengths, like 24 to 35, are considered wide-angle lenses, while larger numbers are zoom lenses that increase magnification levels proportionately. For example, a lens with a 100mm focal length delivers an image that is twice the normal size, while a 300mm focal length delivers 6X magnification.

If you're coming over from the analog camcorder world, recognize that because digital camcorders and DV camcorders use much smaller CCDs than film cameras, the focal lengths are much smaller, often in the 4 to 40 range. For example, where a typical consumer DV camcorder has a CCD that's ¼ inch in size, the Canon EOS-1D, or the equivalent of the Canon EOS film camera, has a CCD over 1 inch in size.

You can translate the focal length of DV camcorders to 35mm camcorders by multiplying the value by the "focal length multiplier," but this value changes for each camcorder depending upon the size of the CCD. To help clear the confusion, some vendors list what's called a "35mm conversion" to help those used to 35mm cameras understand the camcorder's capabilities. For example, the true focal length for Sony's VX2000 is 6.0mm to 72.0mm, while the 35mm conversion is 43.2 to 518.4.

Cross-Reference

See `www.lonestardigital.com/multipler.htm` for an excellent explanation of the math underlying the focal length multiplier and its relation to the size of a CCD.

Interestingly, the difference in CCD size is why DV camcorders can deliver stunning optical zoom ratios with relatively small lenses. That is, the larger the CCD, the larger the lens has to be to deliver data to the CCD.

Since DV camcorders only need to resolve 340,000 pixels to create video, a small CCD can do the trick, which allows a lens the size of a lipstick container to deliver 10X zoom. In contrast, delivering the same magnification level to a data-hungry 35mm camcorder requires a lens costing thousands of dollars that's the size of a 64-ounce bottle of soda.

Now that we've analyzed the camcorder lens, let's move on to other features.

ELECTRONIC VERSUS OPTICAL IMAGE STABILIZATION

Most DV camcorders offer image stabilization, a technique that attempts to reduce or eliminate minor shakes that occur during shooting. High-end camcorders typically use optical image stabilization,

which actually moves the lens system in the camcorder to compensate for the motion. This is generally considered superior to electronic image stabilization, though many professionals simply disable all image stabilization and shoot from a tripod.

In contrast, electronic image stabilization (EIS) shifts the captured image around after it's through the lens and CCD system and digitized by the camcorder. Since it involves chips rather than mechanical components, EIS is cheaper than optical.

When originally introduced, EIS worked by zooming the video frame slightly to provide margins for shifting the captured image around, which degraded quality to some degree. However, most consumer camcorders now use larger-resolution CCDs to capture enough margin to shift the image without zooming. For this reason, though optical image stabilization is still preferred, the qualitative difference between the two has narrowed significantly.

Viewfinder and LCD Panel

Most DV camcorders offer two mechanisms for viewing while shooting and displaying your video post-shoot: a viewfinder and an LCD panel. When comparing camcorders, be sure to note the following characteristics of both.

For viewfinders, look for the following:

- **Color or black and white.** Most consumers prefer color, while many professionals prefer black and white because it focuses their attention on exposure, which they can control more effectively than color.
- **Number of pixels.** More is better, because it translates to a crisper image, with inexpensive camcorders usually offering around 115,000 pixels, while higher-end models provide at least 180,000 pixels.
- **Fixed or movable.** Many small camcorders have an unmovable viewfinder, which complicates shooting from a tripod or other fixed positions. Most other camcorders allow you to shift the viewfinder up and down for more flexibility.
- **Focus diopter.** Virtually all camcorders have a mechanical wheel diopter for focusing the viewfinder, which is absolutely critical, especially for those who wear glasses.
- **Rubber eyepiece.** The primary reason most people use the viewfinder (rather than the more convenient LCD) is because direct sunlight fades the image of most LCD displays. Better camcorders have a rounded eyepiece that shades the eyes from sunlight.

For LCDs, look for the following:

- **LCD size.** This is expressed in inches, which are measured diagonally. Larger is better, but often LCD size drops proportionately with the size of the camcorder. On standard camcorder-sized models, look for 2.5 inches or larger.
- **Number of pixels.** As with the viewfinder, the number of pixels translates directly to image crispness, which is especially important for larger LCD sizes. For example, Sony's

DCR-TRV80 has a 3.5-inch LCD panel with 184,000 pixels, while the JVC GR-DVL820 has a 3.5-inch LCD panel with only 110,000 pixels. The image on the Sony LCD is noticeably crisper, providing better feedback during shooting and better quality during playback.

- **Brightness controls.** Not all low-end camcorders have brightness controls, which come in handy when shooting outdoors.
- **Range of motion.** Most LCD panels can rotate 180 degrees for use in "vanity" mode when you're shooting yourself. Be sure that the LCD can rotate to this degree and that the image will shift 180 degrees so that you're not upside down when shooting.

Camcorder Input/Output

Figure 1-9 shows the compact input/output panel similar to that found on the Sony DCR-TRV80. We'll take a closer look at most of these connectors in Chapter 11, when we capture video. In this chapter, we'll simply discuss what these connections do and what you should look for when buying a camcorder.

Most connections are fairly standard and don't help you differentiate between camcorders. I'll start by describing those that do.

KEY DIFFERENTIATING INPUT/OUTPUT

Pay attention to the availability of these ports and their capabilities when making a buying decision:

- **Microphone port (plug-in power).** If you plan on doing any serious shooting at all, a microphone port is essential, and it's not standard on lower-end models.
- **Note also that there are two types of microphone ports.** Those with plug-in power, like that shown in Figure 1-9, work with microphones without separate power, allowing you to use very inexpensive computer microphones. Most low-end consumer camcorders do *not* supply plug-in power, which means you'll have to purchase a more expensive powered microphone. Virtually all microphone connectors are simple stereo microphones; you'll have to go into the $3,000-plus range to see professional XLR connectors.
- **USB port.** Universal Serial Bus ports serve multiple purposes including transferring still images from camcorder to computer, and USB streaming, where the camcorder can replace a Web cam for Internet videoconferencing. There are other ways to get still images to your computer, like transferring the physical storage medium or using Bluetooth (discussed later in this chapter), but USB is often the most convenient. Note that USB is never used to transfer DV video to your computer, though some DVD camcorders use USB for this purpose, as do camcorders that support MPEG-1 encoding.

STANDARD I/O PORTS

These items are included in or with most DV camcorders, so they probably won't help you differentiate between two camcorders that you're considering.

- **FireWire (IEEE1394).** This DV port (shown in Figure 1-9) is used to connect the camcorder to your computer or another FireWire device. Virtually all consumer DV camcorders come with FireWire connectors.
- **S-Video port.** Most consumer DV camcorders also support S-Video output, an analog format that is higher quality than composite output. This is true even with the tiniest of tiny MicroMV camcorders, though sometimes the S-Video port is placed on a separate connecting chassis. You'll use the S-Video port to copy DV video to an S-VHS camcorder or player, to view it on a television set, and for camcorders that support analog input (discussed in the next section), to input analog video into the DV camcorder.
- **Stereo audio/composite video port.** Virtually all DV camcorders have a single port for outputting composite video, the lowest-quality analog output, and stereo audio, using a three-headed, color-coded cable with yellow (composite video) and red-and-white stereo audio connectors.
- **Headphone port.** Most camcorders have a port that lets you plug in headphones for previewing the audio while shooting and listening in while playing. Note that few consumer camcorders actually allow you to adjust incoming volume, so your only option to get better sound may be to move closer to or farther away from the subject.
- **LANC.** This is a camcorder control protocol used before the advent of FireWire. Like your appendix, it's vestigial, since FireWire is both more commonly supported on the computer and more accurate than LANC.

Analog Input

Unless your DV camcorder is your first camcorder, you likely have substantial quantities of analog tapes. Analog input is a feature that makes it easy to convert these tapes to DV format; you simply connect the audio video cables from your analog camcorder or VCR to your DV camcorder, and use menu controls in the DV camcorder so the camcorder looks for input through its ports rather than the lens.

During the conversion, the DV camcorder digitizes and compresses the analog footage to DV format, just like it does with input through the lens. Once copied over, you treat the analog footage exactly like DV footage originally shot by the camcorder.

Since DV capture systems are so inexpensive, this is a great way to edit analog videos on your DV system. For example, I've used analog input many times to copy yoga and Tai Kwon Do tapes from VHS to DV to edit and burn them to DVD.

Cross-Reference

On the other hand, using the analog input on a camcorder to convert analog footage to digital is not your only alternative. Chapter 11 discusses devices that can capture your analog footage in DV and MPEG-2 formats, saving the time and tape cost associated with this analog input feature.

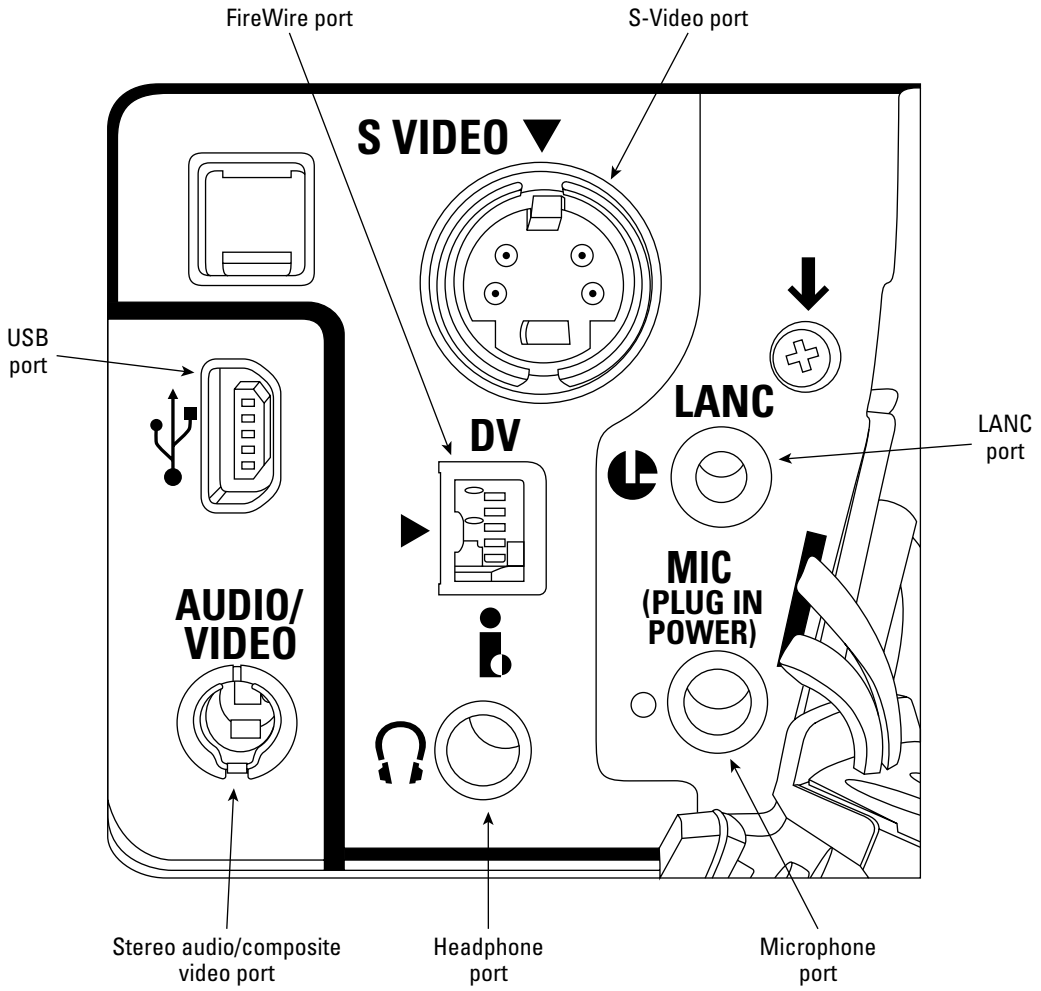

Figure 1-9: The connections panel from a camera similar to the Sony DCR-TRV80.

Microphone

All DV camcorders incorporate stereo microphones, almost universally omnidirectional microphones that capture sound equally from all directions. You'll get the best audio quality with microphones attached to the camcorder's handle, like the camera shown in the center of Figure 1-10 (very similar to Sony's VX2000). Next best are microphones on the front of the camcorder body, like on the camera on the right (similar to my ancient but still-working TRV9), while microphones mounted on top of the camcorder typically produce the worst results, primarily because they pick up noise from the camcorder user, which both other locations minimize. This is where Sony placed the microphone on the PC7 camcorder (represented by the camera on the left).

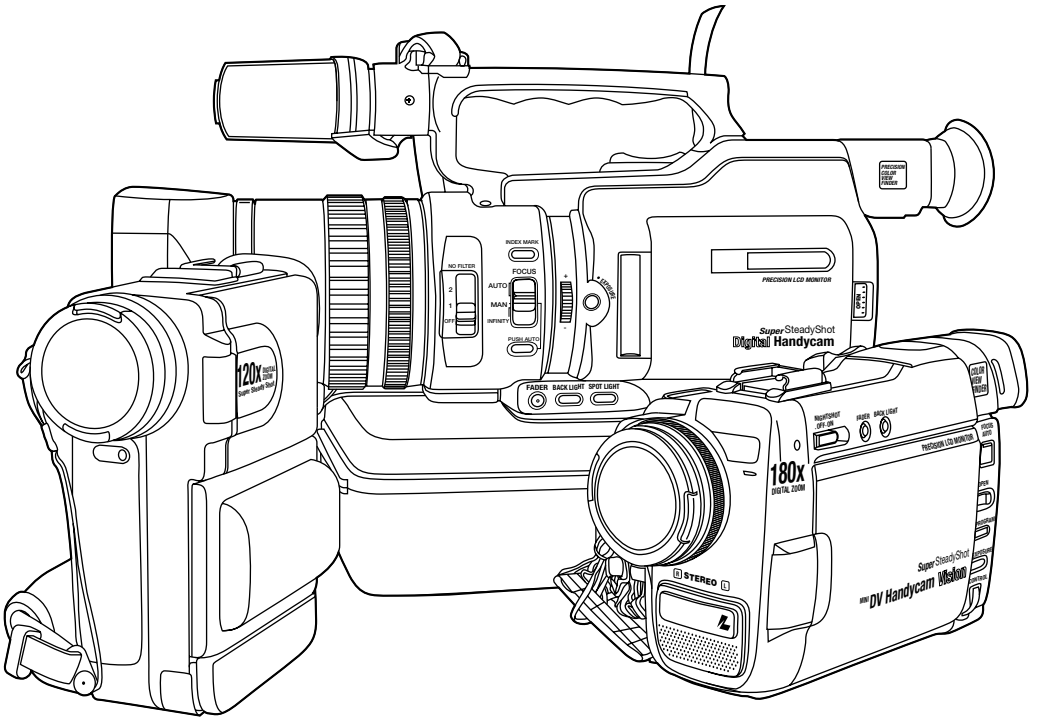

Figure 1-10: These camcorders represent Sony DV camcorders I have known and loved. Note microphone location: on the boom for the center camcorder, which delivers the best audio quality; on the front for the one on the right, which is next best; and on top for the one on the left, which is generally noisier than the other two.

These microphone locations generally represent the typical microphone placement for each camcorder body type. That is, larger camcorders with handles place the microphone on the handle, while traditional camcorder bodies place them on the front. Smaller camcorders almost always have the microphone on top, accounting for generally lagging performance in audio quality.

When comparing camcorders, you might also consider the cost of a unidirectional, shotgun microphone to help improve audio quality, especially the capture of speech in a noisy environment. For example, Sony offers an optional microphone for its consumer camcorders for $99; the lowest-cost Canon option in $199.

Accessory Shoe

Accessory shoes are slots that sit atop most DV camcorders. There are two types: intelligent and non-intelligent shoes. An "intelligent" accessory shoe provides power and operational commands to a range of supported accessories like microphones and lights, and a non-intelligent accessory shoe simply functions as a bracket to attach accessories to that have separate power and manual controls.

Intelligent shoes obviously give you greater flexibility; if you plan on purchasing a microphone and/or additional lighting in the future, this is definitely the way to go.

Batteries

Most camcorders now ship with Lithium Ion batteries, which offer good performance and high-energy density, which translates to lots of power in a small package. If the battery isn't Lithium Ion, it's a significant red flag.

When comparing camcorders, be sure to identify the life and recharging time of the battery actually *included* with the camcorder. Some vendors cite long operation times, but you have to buy an optional battery pack to actually achieve it.

Battery charging is also an issue. While some vendors provide a separate charger, allowing you to charge a battery while you're off shooting, others don't, forcing you to charge the battery in the camcorder or purchase a separate charger. Since chargers can cost well over $100, you should factor this into your price comparisons — unless your use will be so infrequent that this doesn't matter that much.

Automatic and Manual Settings

A number of factors, including exposure or gain control, aperture, shutter speed, white balance, and focus, impact the ultimate quality of your video. Let's define each element in turn and then discuss how much control over these variables different camcorders provide.

EXPOSURE AND GAIN CONTROL

Whether analog or digital, still or video, taking a picture involves admitting light through a lens to expose the light-sensitive film or CCD. Two factors control the amount of light that gets through: the aperture, which is the size of the lens opening, and the shutter speed, which is the length of time the shutter stays open. All DV camcorders have an auto-exposure function that measures the amount of available light and adjusts aperture and shutter speed accordingly.

Sometimes, however, even the widest aperture and slowest shutter speed doesn't let in enough light. In this instance, DV camcorders cheat, so to speak, and digitally boost the "gain" in the picture, much like you can boost the brightness of a picture in an image editor. This is called automatic gain control, and it's a feature in virtually all DV camcorders.

Many camcorders also enable manual gain adjustment, usually calling it exposure adjustment. This gives you creative control over lighting and is definitely a desirable feature.

APERTURE

Some high-end camcorders also let you adjust aperture, providing control over depth of field (the portions of your image that are in focus). This is shown in Figure 1-11.

Using the VX2000's aperture priority mode, I set the aperture to an F-Stop of 2 on the left, which is wide open. While the subject's hair is clearly focused, the picture in the background is quite blurry. This technique is used for artistic effect but also for producing streaming media, because an image with a blurry background has less detail, making it easier to compress.

On the right in Figure 1-11, the F-Stop is set to 11, a much smaller opening that brings the background picture into focus. This would be useful in shots where all detail, foreground and background, need to be in focus.

Few consumer-level camcorders enable manual control over the aperture, so you'll likely have to upgrade to a prosumer camcorder to take advantage of this function.

Figure 1-11: Focusing on the model on the right, the left image was taken with the aperture wide open (F.2), blurring the background considerably. On the right, the aperture is relatively closed (F.11), bringing much more of the picture into focus.

SHUTTER SPEED

If you're into sports and other fast-action photography, control over shutter speed can be very useful. For example, if you're shooting a sporting event, you'd want to be able to select a fast shutter speed, say ¼000 of a second. Though all camcorders support multiple shutter speeds, they are implemented automatically or in Program AE modes (see the next section); few allow you to select shutter speed directly.

PROGRAMMED AE MODES

In addition to fully automatic and fully manual modes, some camcorders offer a series of "Program AE" (Auto-Exposure) settings for common shooting scenarios like sports, sunlight, moonlight, spotlight, dusk, and others. When you select the program, the camcorder uses the gain, shutter, and aperture settings that deliver the best results under those conditions.

For example, in sports mode, the camcorder would force a fast shutter speed to avoid blurriness during high motion, adjusting the aperture and perhaps the gain to ensure sufficient light hits the CCDs. Most camcorders also have controls on the camcorder body to adjust for backlighting or spotlight effects, which are also helpful.

Advanced users will benefit from shutter and aperture priority modes that allow you to select values for either of these options to achieve the desired effect, with the camcorder automatically selecting all other values. This is how we shot the videos shown in Figure 1-11.

WHITE BALANCE

White balance is something you pay little attention to until you shoot for an entire day and then notice that your video is tinged with blue or yellow and pretty much unusable. Then you smack yourself on the forehead, find the camcorder manual, and learn how to white balance.

Simply speaking, white balance is the process of telling your camcorder what is white in the scene, which allows the camcorder to adjust the other colors accordingly. While we think white is white, it looks slightly different in the sun, in the shade, and under different types of lights.

It Pays to Shop Around

You probably know this already, but it pays to shop around when buying a camcorder and accessories. I'm not sure why there is such a disparity, but there it is. Here are a couple of examples:

DV cable (camera to computer):
$8 at www.adaptec.com
$75 at www.sony.com

Canon GL2 camcorder:
$2,800 at www.ritzcamcorder.com
$1,693 at www.newworldvideodirect.com
$1,025 (lowest price for new product, but not yet sold) at www.ebay.com

All DV camcorders offer automatic white balancing, which generally works by assuming that the lightest object in the scene is white. This can be a problem if the object is actually light yellow or pink.

While most consumer camcorders allow you to adjust for common lighting situations, like fluorescent or incandescent light, few allow you to manually white balance. To address this, it's generally good practice to start each shoot by zooming into a white object until it fills the screen, and then shooting for about ten seconds. Do this again each time you change lighting conditions dramatically, such as moving from sunlight to shade and especially from indoors to outdoors or vice versa.

FOCUS

Focus, of course, is the process of adjusting lens position to achieve the sharpest possible image. All consumer-level camcorders offer auto-focus — where the camcorder does this work for you — and manual focus as well.

Note, however, that camcorders differ in how they implement manual focus. The best and most common approach, at least for my taste, is a focus ring on the end of the camcorder, just like 35mm camcorders. Note however, that many low-end camcorders use completely digital controls on the camera body for manual focus, which isn't quite as intuitive.

Features to Disregard

Here are some features that sound great and are often trumpeted by the manufacturers. However, they aren't truly useful if you plan on editing on a computer and should be ignored when buying a DV camcorder.

- **Digital effects.** Some camcorders can fade in and fade out for you, or even convert the video to black–and white or sepia. Since you're reading this book, I'll assume you want to edit on your computer, and if so, any video editor — even free ones like Microsoft's Movie Maker 2 — can perform a much greater range of special effects than your camcorder. Plus, if you change your mind, you're not stuck with the results, like you are with your camcorder.
- **Titling capabilities.** Same deal here. You'll get better results with any video editor on the computer.

- **Assemble editing.** Several consumer-level camcorders offer assemble editing, which lets you identify discrete segments in the video and then write them in sequence to another analog deck. These simple cut-and-paste functions work well, but again, they don't offer the flexibility or ease of use available on your computer.
- **16:9 mode.** As you may know, most Hollywood films are shot with a wider aspect ratio than NTSC video, usually 16:9 rather than NTSC's 4:3. Widescreen Hi-Definition Television (HDTV) sets can display movies and specially prepared television shows in their widescreen glory, and 16:9 mode in a DV camcorder harkens up images of HDTV.

  Unfortunately, this isn't the case. DV is a fixed format of 720x480 pixels, and when shooting in 16:9 mode, the camcorder simply lops off the top and bottom of the screen, creating an effective resolution of 720x405. This is shown in Figure 1-12. On the left is chez Ozer, here in Galax, Virginia, shot in normal mode, while on the right is 16:9. Note that the video is no wider on the right; it's simply stubbier, with large strips shorn off the top and bottom. Though it may be tough to see in the screenshot, the quality of the 16:9 shot is also degraded.

With all this as background, let's look at some features and factors to consider when buying a one-CCD camcorder.

Figure 1-12: 16:9 video on a DV camcorder (on the right) isn't really widescreen as much as stubby screen. As you can see by comparing it to the full resolution DV on the left, the camcorder simply cuts strips from the top and bottom of the video.

Buying an Inexpensive Camcorder

Most readers will purchase a one-CCD DV camera priced between $500 and $1,500 street, so I'll focus my discussion on this segment, ignoring MicroMV, Digital8, and DVD camcorders. To illustrate the types of features that drive camcorder prices from bargain basement to pricey, I'll use the 2003 Sony line of camcorders, shown in Table 1-3. Similar features differentiate camcorders in the Canon, JVC, and Panasonic lines, which are not quite as extensive. Prices are all list; I'm sure you can do much better at any number of online or discount retailers.

When buying a consumer camcorder, your first key decision relates to the form factor, or size and shape of the camera. Simply stated, tiny camcorders, whether DV or MicroMV, are easier to pack, fun to use, and sexy, but they are more expensive and typically trail other camcorders in both audio and

video quality. For example, Sony's DCRPC120 is a very small mini-DV camcorder that costs $1,799, only $200 less than the TRV950, a standard-sized, three-CCD camcorder.

I haven't tested either camcorder, but experience tells me that the TRV950 will produce vastly superior audio and video. For example, in *PC Magazine*'s 2002 DV Camcorder roundup, the three worst performers were the three smallest camcorders, including the Canon Elura 10 and JVC GR-DVP3, both slightly larger than a pack of cigarettes. Both scored two out of five in video and audio quality. Unless you're a spy or need a tiny camcorder for some other reason, I would go with a more traditional camcorder design.

After choosing a form factor, your next decision relates to how you intend to use the camcorder and the features you find necessary. For that, let's jump to Table 1-3. Note that the bolded items in the table represent features upgraded from the previous model, essentially highlighting the justification for the higher price.

Table 1-3 Feature Summary for Sony Consumer Camcorder Line

Camcorder	***TRV19***	***TRV22***	***TRV33***	***TRV38***	***TRV39***	***TRV70***	***TRV80***
Price	$599	$699	$799	$899	$999	$1,299	$1,499
Camcorder features							
Lines of resolution	500	500	**520**	520	520	**530**	530
Viewfinder (pixels)	Black & White (113K)	**Color (113K)**	Color (113K)	Color (113K)	**Color (180K)**	Color (180K)	Color (180K)
Color LCD (pixels)	2.5" (123K)	2.5" (123K)	2.5" (123K)	**3.5" (184K)**	3.5" (184K)	2.5" (211 K)	**3.5" (184K)**
Lux	5	5	**7**	7	7	7	7
Analog input	No	**Yes**	Yes	Yes	Yes	Yes	Yes
Manual focus ring	No	No	No	**Yes**	Yes	Yes	Yes
USB Network capable	No	No	No	No	**Yes**	Yes	Yes
Bluetooth	No	No	No	No	No	No	**Yes**
MPEG video	No	**Yes**	Yes	Yes	Yes	Yes	Yes
Still image							
Maximum still-image size	640x480	640x480	**1152x864**	1152x864	1152x864	**1600x1200**	1600x1200
Progressive scan	No	**Yes**	Yes	Yes	Yes	Yes	Yes
Flash	No	No	No	No	No	**Yes**	Yes
Memory Stick®	N/A	**8MB**	8MB	8MB	8MB	8MB	8MB
Standard features							
USB streaming	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Zoom (optical/digital)	10/120X	10/120X	10/120X	10/120X	10/120X	10/120X	10/120X

Continued

Table 1-3 Feature Summary for Sony Consumer Camcorder Line *(continued)*

Standard features							
Intelligent accessory shoe	Yes	Yes	Yes	Yes	Yes	Yes	Yes
NightShot	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Manual focus	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Manual white presets	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Program AE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Gain control	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Manual aperture	No	No	No	No	No	No	No
Manual shutter	No	No	No	No	No	No	No
Image stabilization	Yes	Yes	Yes	Yes	Yes	Yes	Yes

As you can see from the standard feature list, Sony has raised the bar for entry-level camcorders. USB streaming is a nice feature that lets you use your camcorder as a Web cam or for videoconferencing, and an intelligent accessory shoe helps you make use of available accessories. Even the base-level camcorder has image stabilization, manual focus, and several program AE and white-balance selections (but no manual white balance on any camcorder). On the other hand, there are no manual aperture or shutter controls, though these are adjusted automatically in the various program AE modes.

If I were choosing between the TRV19 and TRV22, paying $100 extra for the latter is a bit of a no-brainer, since you get a color viewfinder and analog input capabilities. Progressive scanning of still images and the Memory Stick to store it on are nice throw-ins, though you really can't do much with 640x480 images these days.

Similarly, MPEG video is the ability to encode and store MPEG-1 files on the supplied Memory Stick. It's a nice way to shoot and transmit video quickly, though quality is lacking in most tests that I've performed. Ditto for camcorders that output MPEG-4, a video format that offers greater compression than MPEG-1 but much lower quality. Unless you have a specific need for this capability, I wouldn't pay extra for it.

Best Reviews of Consumer Camcorders

- www.pcmag.com
- www.CNET.com
- www.camcorderinfo.com
- www.dvspot.com

Key Accessories to Purchase with Your Camcorder

OK, in a few pages, I'm going to tell you to dig deep and spend as much as you can for your camcorder. Dig a bit deeper and buy these accessories with the camera:

- Clear lens filter to protect the camcorder lens ($15–$25)
- A spare battery ($50–$150, depending upon recording time)
- A battery charger if not included ($60–$150)

Consider these accessories once you've paid off the initial credit card charges:

- Gun or boom microphone ($60+)
- Video light ($100+)

The TRV3 series is an interesting sell, primarily because 1152x864 still images, while over the magic megapixel mark, are still too small for printing larger than 4x6-inch pictures. If you're going to print your pictures or have them printed by a service, you'll probably still need a digital still-image camera with a higher resolution. In addition, there's no flash, so you'll either pay extra to buy a flash or forgo indoor shots.

On the other hand, the TRV39 introduces the networking concept into the Sony line, providing a modem connector that allows you to dial into an ISP for sending images and MPEG movies and even view and send e-mail messages. This could be very helpful in specialized vertical market applications like journalism or insurance or simply for sending pictures back home from the road. However, unless this capability or the 3.5-inch color LCD is particularly alluring to you, most budget-conscious buyers will probably stick to the TRV22.

At 1600x1200, the TRV70 and TRV80 offer twice the resolution of the TRV3 series and a flash, allowing serious use as a still-image camera. Lines of resolution are highest of all listed cameras though the lux rating of 7 is actually higher than the TRV19 and TRV22, which means that images captured in low light won't look as good as the lower-cost models, which is worse. The TRV80's Bluetooth capabilities are clearly the wave of the future, allowing wireless transmission of images or MPEG-1 video from camcorder to printers or compatible computers and handheld devices.

If shooting video is your primary concern, however, the TRV80 doesn't offer that much more than the TRV22. If I were contemplating spending these kind of dollars for a DV camcorder, I'd be comparing this unit more to the three-CCD Sony TRV950, which will deliver much better quality.

The takeaway from this exercise should be these key points:

- Decide form factor first. Recognize that if you purchase a tiny camcorder, part of the price you'll be paying for convenience is reduced audio and visual quality.
- Before buying, decide whether still-image capabilities are important. Large progressive-scan CCDs and flash capabilities bump the price significantly, but they don't improve video quality significantly, if at all. Don't pay for them if you don't plan to use them.
- If you want a camcorder for video and still images, make sure the still images are at least 2 megapixels in size and that the camcorder has an embedded flash. Make sure that all the

controls you care about, like exposure, F-Stops, and timer are as accessible in the video camcorder as they are on a digital still camera. Finally, make sure that the price premium you're paying for the still-image capabilities doesn't exceed the cost of a good standalone digital still-image camera. You may still decide to combine the two functions into one camera, but at least you'll know what it's costing you.

- Understand that camcorder vendors change their lines frequently, so the camera you read about in a review may not be available when you decide to buy. It's frustrating but an unfortunate reality.
- Before buying, decide whether you'll actually use enhanced features like MPEG-1 videos, USB streaming, or Internet connectivity via USB or Bluetooth. If not, don't spend extra money on camcorders with these features.

The Prosumer Line

Say you want to step up to the next level and purchase a three-CCD prosumer camcorder. Using the VX2000 as an example, let's look at the types of features you can expect.

The VX2000 has three ⅓-inch CCDs and a lux rating of 2 that produces high-quality video under dismal lighting conditions. At 13 inches long, it's much bulkier than the average consumer camcorder and sports only a 2.5-inch LCD — though with 200,000 pixels, the image is very sharp.

In addition to manual focus on the lens, the VX2000 offers a manual zoom ring on the lens that's much less twitchy than the electric controls on most consumer camcorders, facilitating precise adjustments. The camcorder has a handle for below-the-waist shooting with a separate start and stop control easily accessible from the handle.

Several features help ensure optimal quality. First is a zebra pattern, which displays a black-and-white pattern over regions in the video that are overexposed. Second is an internal two-step neutral density (ND) filter that reduces incoming light without changing colors, which is very useful in direct sunlight and other bright conditions. Even better for beginners, the VX2000 displays a blinking status indicator in the LCD panel telling you when to turn the filter on and off.

Best Sites for User Feedback and Forums

- www.pcmag.com
- www.epinions.com
- www.cnet.com
- www.camcorderinfo.com
- www.dvinfo.com
- www.dvdoctor.net
- www.amazon.com

Best Reviews of Prosumer Camcorders

- www.pcmag.com
- www.videomaker.com
- www.dv.com
- www.cnet.com
- www.zdnet.com
- www.videouniversity.com
- www.emediapro.net
- www.camcorderinfo.com

You have full control over shutter speed and exposure, all available on the camcorder body where you can easily access them while shooting. That said, automatic modes work exceptionally well, so novices can achieve nearly as good quality as advanced users.

The camcorder's microphone input port can handle both microphone and line input with manual gain control and an audio meter for precise adjustments. Necessary options are surprisingly affordable with a 3-watt flash costing around $100, and a gun/zoom microphone (explained in Chapter 8) around $60.

Beyond this tech-speak gobbledygook is the simple fact that this camcorder shoots video so striking that my technology-iconoclast wife sat up and took notice, a first in my memory. In double-blind jury tests, *PC Magazine* test subjects have been equally impressed, awarding the VX2000 five out of five stars for video and still image quality, though with a 640x480 maximum still image resolution, it's inadequate for most still image functions.

Overall, here's the pitch for a high-end camcorder. Video is the ultimate garbage-in/garbage-out medium, so if the source footage is poor, there's little you can do to fix it. You can get away with inexpensive equipment the rest of the way through the production cycle, capture with a $15 FireWire card, edit with a free editor, and produce a DVD with a $49 program, and your output quality will match that of systems costing thousands of dollars.

But if you skimp on the camcorder, you've limited production quality from the start. Long story short, I'm not going to tell you to buy a new computer, a hot new capture card, and the most expensive editor available, but I will tell you to spend as much dough as possible on a great DV camcorder. I guarantee you'll be happy you did.

Test Drive

Let's face it; a department store or camcorder shop is no place to test-drive a camcorder, but if that's all you've got, here are about ten minutes of tests you can use to avoid buying a lemon. Test two camcorders side by side to help see the difference or one after the other if the store has a monitor you can connect to the camcorder during testing.

For low-light performance, look for the following:

- Make sure the camcorder is in fully automatic mode. Aim the camcorder at a dark region in the store, say behind or under the counter, and see how well the camcorder reproduces the scene. Look for graininess or snow that indicate noise from electronic gain.
- Try to find brightly colored objects in less-than-optimal lighting conditions. Compare the real images with their reproductions in the LCD and assess their brightness.

For performance under normal lighting, look for the following:

- Focus on a face (hopefully someone you know). Determine whether the camcorder preserves the contrast in the face or whether it converts it to one blob of largely uniformed color. Have the subject stand directly under a bright light and see if the camcorder handles it well or if there's a bright white glare on the forehead.
- Focus on some brightly colored objects and observe how close the color in the LCD or viewfinder matches the real objects.

For focus performance, look for the following:

- Make sure that digital zoom is off and auto-focus on. Aim the camcorder toward an aisle or other area where people are walking into view. Zoom in so that each individual takes up about ¼ of the screen. Hold the camcorder steady, and as individuals walk into view, observe how long it takes for the camcorder to come into focus. A few milliseconds or two is OK, but two or three seconds is far too long.
- Zoom into a scene with high contrast, like text on a wall, and see if the focus stays firm or if it seeks back and forth attempting to focus in. Try this in normal light and low light. If the focus doesn't stay constant, this may be a recurring problem during operation.
- Zoom into the same high contrast scene, wait for the camcorder to get focused, and then slowly zoom away. The camcorder should maintain focus throughout.
- Engage manual focus in the camcorder. Find the manual zoom controls and use them to focus in on a nearby object. Are these twitchy or smooth?
- Close the LCD panel and focus through the viewfinder. If you wear glasses, take them off. Use the mechanical focus diopter to bring the viewfinder into focus. If you can't, the camcorder will be tough to use in bright sunlight and other conditions where the LCD isn't viewable.

For zoom controls, look for the following:

- Zoom noise. Hold the camcorder close to your head and zoom in and out a few times. If you can hear the zoom noise, usually you'll hear it on your tapes.

- Zoom feel. Try to zoom slowly into or away from an object and gauge how firm the controls are. Many consumer camcorders are twitchy and over-responsive, making it tough to smoothly control camcorder motion.
- Zoom controls. This may sound petty, but I like horizontal controls that you push to zoom in and pull to zoom out. Vertical controls always confuse me. Decide which type works best for you.

For audio quality, look for the following:

- If it won't make you feel totally geeked out, bring a set of stereo headphones with a standard stereo computer jack to the store. Go to a quiet place, plug in the headphones, place the camera in shooting mode, and observe how much ambient noise the camcorder picks up. If there's lots of noise, that bodes poorly for capturing high-quality speech from talking-head subjects in your videos. On the other hand, if there's no noise, the camcorder may be insensitive. Move to the next test.
- Have the sales rep or someone else speak to you from about five feet away. The voice should be clear and free of distortion.
- If you have the headphones, perform the zoom test described above, zooming the camcorder in and out to see if you can hear the zoom noise. Once again, if you can hear the noise, it's likely the onboard microphone will pick it up as well.

Look for the following general mechanical issues:

- Check to see if there are threads on the lens, either for a clear filter to protect the lens from scratches or for a wide-angle or telephoto lens.
- Does the camcorder feel like it's made of plastic, or is it clearly magnesium or other high-grade metal? Plastic camcorders simply don't last as long.
- Check the access to the cassette mechanism. If it's on the bottom, you may not be able to change tapes while on a tripod.
- Open all access panels to analog, DV, electrical, microphone, and headphone jacks. Are the panels well secured and sturdy, or are they flimsy?
- Open the LCD panel and swivel it around. It should feel firm and sturdy, not loose and flimsy.
- Hold the camcorder in shooting position. Are all relevant controls for zooming and other operations accessible?

Summary

OK, you've evaluated all the features discussed above and identified the best model for your needs. You're ready to buy, and the money is burning a hole in your pocket. Whoa, Nelly, take these steps first:

- Go to www.pcmag.com, and check for reviews and user comments. Check for the best available price.
- Go to www.cnet.com and www.amazon.com for user comments.
- Check www.epinions.com, read reader comments, and check for the best available price.
- Go to the manufacturer's Web site and make sure the camcorder is still currently available.