A Guide To
The Panasonic
HVX200 Camera

How to get the most from the revolutionary AG-HVX200 Camera

by Barry W. Green

Published by Fiercely Independent Films Inc., P.O. Box 10721 Wilmington, NC 28414, USA

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Foreword

At the National Association of Broadcasters convention in 2005 Panasonic unveiled their next "big thing" – the high-definition AG-HVX200. Rather than settle for the consumer recording format employed by other manufacturers, Panasonic instead implemented full-featured DVCPRO-HD in this camcorder – the same format as used on their premium AJ-HDC27F VariCam™! Thanks to the flexibility and versatility of the P2 recording system, it was possible to replace the expensive tape deck with a memory card that can record the full bandwidth of this professional high-def format. Not only that, they introduced unprecedented features: 1080/24P recording (becoming the first camera under $100,000 to offer this feature), 1080/60i recording, 720p recording in variable frame rates, and DVCPRO50 recording for superb standard-definition quality.

Having written a guidebook for the equally-groundbreaking DVX100, I was privileged to have a chance to work with the HVX200 early on. It is an amazing tool. It is one of the most powerful and capable low-cost cameras ever to be released to the professional video market. It's not like they were starting from scratch either: the prior entry-level model in their professional camcorder lineup is the phenomenally successful DVX100 series, the biggest-selling professional camera in Panasonic's history. So when it came time to design an entry-level high-definition model they used the DVX series as their starting point, and included and incorporated all the features that made the DVX so successful, and then went above and beyond by implementing many oft-requested and welcome new changes. Many of the HVX's features were suggested by end users in Internet forums such as www.DVXUser.com. Jan Crittenden Livingston, Panasonic USA's Product Line Manager for the DVX and HVX series, paid careful attention to the features that users requested most.

The HVX does things and combines features that no other camera in its price class can do. Here we have a camcorder that runs a Linux operating system and can control external hard disks – one that shoots in-camera overcranking and plays it back immediately in film-style frame-accurate slow motion – one that shoots high-
def in both 1080 and 720 – and also shoots 4:2:2 DVCPRO50 for excellent standard-definition recording. And it retains all the best features of the DVX as well – it is a DVX, and so much more. It’s uniquely positioned as a digital cinema camera, offering the so-called “holy grail” of indie filmmakers: 1080/24p recording. It’s uniquely positioned as a transitional camera, offering standard-definition tape recording for today, and high-definition acquisition for today & tomorrow. It’s uniquely positioned as a news camera, using the rugged, reliable, and instantly-editable P2 cards to get the shot in any conditions and edit and transmit it faster than any other system. It’s uniquely positioned as a B-camera for VariCam, HDX900 and SDX900 shoots. It’s uniquely positioned for broadcast, since it records all six of the high-definition broadcast standards endorsed by the ATSC, and all the formats endorsed by the EBU. And it does it all at a U.S. list price of $5,995 (P2 cards are additional).

There has never been a camera this empowering before. Mastering the craft of film and video has never been just about the camera, of course – but for those who are ready, the HVX200 gives you creative flexibility that no other camera in this price class can match.

This guidebook is not intended as a replacement for the user’s manual. Rather, it is a collection of essays on the camera, a thorough examination of its features and settings, and suggestions for how to use those settings to get the results you’re after. There are also explanations on camera fundamentals and shooting fundamentals. To some readers this may be familiar material; to others, it will hopefully be an enlightening guide that will help you understand not only this tool, but also the process of producing images with a video camera, and the ways to get the most performance from the HVX. This guidebook will occasionally refer back to the HVX200 Owner’s Manual since subjects covered adequately there will not be discussed here. This guidebook will expand upon subjects that may not have been explained thoroughly enough in the manual, as well as provide techniques, tips and insight on how to best use the various features. You may find some technical jargon in these pages, but we’ve tried to provide plain-English explanations so that users of all experience levels will benefit.
Acknowledgements

This book has been a huge undertaking, but an enjoyable one due to the many talented, dedicated, and knowledgeable people who lent me their expertise. There are so many good people who worked so hard, and I’d like to take a moment to acknowledge and thank them.

First, there’s Jan Crittenden Livingston, the Product Line Business Manager for the AG-HVX200. Jan listens to the customers, she lets us participate by spelling out what features are most important to us, and she is perhaps the one person most responsible for making the HVX be what it is today. She’s generous with her time and her knowledge; she’s tireless, unstoppable, and devoted in her support of the product and her customers.

Michael Bergeron is a Camera Engineer at Panasonic Broadcast, and besides sharing valuable knowledge about how the HVX actually does what it does, Mike took the time to proofread the entire book to make sure that what the book says it does is accurate.

Harry W. Foulds is Panasonic’s National Training Manager, and has written many documents and papers explaining the features of the DVX and HVX.

Barry Werger also proofread the entire book, and was extremely helpful in helping organize these 270+ pages into a cohesive, consistent final product, and I am grateful for his help.

Many thanks to Victoria Hart of Pink Kitty Design in Las Vegas for the graphic design work.

And, of course, huge thanks to Jarred Land and the membership of www.DVXUser.com. Jarred created a one-of-a-kind community where DVX and HVX users share information, knowledge, questions, techniques, answers, and footage. I’ve met some incredible people through that site, and interacting with tens of thousands of DVX and HVX users around the globe is what led to the creation of the original DVX Book and this HVX Book. Thanks to every one of you!
HVX200 Articles and Frequently Asked Questions

What's That Click?

The first question many new HVX owners ask is "What's that click?" When a new owner picks up the HVX for the first time, they will usually hear a "click" or "rattle" when tipping the camera back and forth, like there is something loose inside the camera. This is completely normal, there's nothing wrong with the camera. What you're hearing is an element of the optical image stabilizing (OIS) system. When the camera is powered on, the OIS system is energized, and the rattle disappears. This is one of the most frequently asked HVX questions, so if you were concerned by the "rattle," have no fear, you're in very good company! Since this is one of the first questions HVX users ask, we thought it only appropriate that it be the first answer in the guide.

Why Can't I Play My Clips Back?

If there's a frequently-asked question that's HVX-specific, this is probably the one. After shooting some clips and experimenting with the various recording modes, new shooters frequently toggle over to playback mode and find that a lot of their clips just won't play back. Are they broken? Corrupted? Damaged?
No, none of the above. What’s happening is a byproduct of the camera having so many different recording modes available. In playback mode, the HVX won’t automatically switch modes, so it will only play back clips that were shot in the same mode as it’s currently set in. What this means is, if you shoot two clips in 720/24pN mode, and two more clips in 1080/30p, and another clip in 1080/60i, and another clip in 480/60i, and then you go to the thumbnail screen to play them back, the only clip you’ll be able to play back will be the 480/60i clip you just shot! All the other clips will have their identification number displayed in red. There’s nothing wrong with the other clips, but the camera was last set in 480/60i mode, so that’s the only mode of clip that’s available for playback. If you go back to camera mode and change the REC FORMAT (in the RECORDING SETUP menu) to 720/24pN, then the first two clips you recorded will now be available for playback (but the 1080 and 480 clips won’t be). If you look at the bottom left corner of the P2 thumbnail screen, it’ll tell you what mode the currently-selected clip was recorded in, so you can set the camera into the proper mode for playing back that clip.

Sounds like a hassle, but in reality it’s not a big deal. Usually you only change recording modes when you’re experimenting, but once you settle down to shoot a particular project, you’ll usually pick one recording mode for the entire project, so the mode-changing issue becomes largely irrelevant in actual practice. Just remember that if you can’t play a clip back, and its thumbnail number is displayed in red, that just means you need to change the recording format before being able to play the clip back.

Strobing

When new users shoot 24P/25P mode for the first time, they sometimes just wave the camera around and then say “hey, wait a minute, what’s all this strobing?” The motion in their shots appears very “jerky,” and not smooth at all. For those unaccustomed to shooting film, the look is unfamiliar and can be unsettling; many times they think that there may be something wrong with their camera.
There's nothing wrong with the camera. What's happening is a perceptual difference between what the shooter is familiar with (50- or 60-field video) and what they're now using (24-frame video). There's a very different look between 24P (or 25P) and traditional video, also known as "60i" (or "50i" in PAL). In 24P, the camera shoots twenty-four frames every second, like a film camera does. In regular interlaced 60i video, the camera shoots sixty "half-frames" per second. The difference is dramatic: the 24p footage looks more like a movie, and 60i video looks more like a soap opera or news broadcast.

But shooting at a slower frame rate may exhibit a side effect called "strobing." Pan the camera, or move it side-to-side too fast, and you might see choppy, stuttery movement. Strobing can be unpleasant to watch. It needs to be properly managed. Film runs at 24 frames per second, and film exhibits the same strobing issues that the HVX does. Fortunately for us, film cinematographers have been fighting this issue for the last 100 years, and over the years they've developed some ways to combat the strobing effect. These techniques include panning the camera slowly; following a stationary subject in the frame; using a slower shutter speed; and increasing your frame rate.

First, pan the camera slowly.

The chart below was inspired by a chart from the American Cinematographer's Manual, a publication of the American Society of Cinematographers. It's been adapted to reflect the focal lengths of the HVX lens, and shows just how slowly you need to move the camera to execute a smooth 90-degree pan, depending on what focal length you have the lens set at.
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<th>24P Pan speed</th>
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<td>11 seconds</td>
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<td>Z20/6mm</td>
<td>18 seconds</td>
<td>14 seconds</td>
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<td>Z25/6.5mm</td>
<td>21 seconds</td>
<td>16 seconds</td>
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<tr>
<td>Z36/8mm</td>
<td>25 seconds</td>
<td>20 seconds</td>
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<tr>
<td>Z47/10mm</td>
<td>36 seconds</td>
<td>27 seconds</td>
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<td>Z63/15mm</td>
<td>50 seconds</td>
<td>38 seconds</td>
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<tr>
<td>Z73/20mm</td>
<td>60 seconds</td>
<td>45 seconds</td>
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<tr>
<td>Z84/30mm</td>
<td>80 seconds</td>
<td>60 seconds</td>
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<td>Z92/40mm</td>
<td>90 seconds</td>
<td>75 seconds</td>
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<tr>
<td>Z99/55mm</td>
<td>120 seconds</td>
<td>120 seconds</td>
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To read that chart properly, what it’s saying is, if you’re at Z25, and you want to pan 90 degrees with no juddering or stutter, and you’re shooting 24P, you have to take 21 seconds to execute the pan. If you take the full 21 seconds, the pan will be glass smooth. That’s really slow, but it’s what you need to do if you want smooth motion. Any faster than that, and smoothness will suffer and strobing will begin. If this chart seems complicated, remember this general rule of thumb: make sure that an object takes about seven seconds to cross the screen. That’s for shooting 24P (or 25P). You can go faster if you’re shooting 30P — at Z25, you can pan the 90 degrees in 16 seconds at 30P and it’ll still be smooth. When shooting interlaced (or 50P/60P), you can pan at any speed with no restrictions, but when shooting slower-frame-rate progressive you have to carefully monitor how fast you pan.

If you’re at maximum telephoto, things change dramatically: you have to go much, much slower than if you were shooting at wide-angle. If you want a glass-smooth 90-degree pan, it will take two minutes to execute that pan at 24P.

Right now you’re probably thinking “that’s outrageous – nobody pans that slowly!” Those are the panning rates, as established by the combined experience of the American Society of Cinematographers.
Having shot film for the last 100 years they've figured out the speeds you need to stick to if you want smooth pans. When people say "pan slower," they're not kidding!

Obviously those speeds are very restrictive. If you choose to go faster, you just need to determine what level of stutter/judder is acceptable to you. Fortunately with the HVX you can hook up an external monitor and see exactly what it looks like (with film, they had to wait until it was developed and projected, which is why they took the effort to devise the chart in the first place). Panning quickly enough will eliminate all strobing – a "swish pan" will be strobe-free. You only really need to worry about strobing in that "dead zone" between proper panning speed (on the slow side) and swish-panning (on the fast side).

Second, follow a screen-stationary object.

Another rule to minimize strobing is that you can move the camera much quicker if you put something stationary (relative to the screen) in the foreground for the eye to follow. If you're following a person or a car or some other foreground object, as long as you keep that object relatively stationary on the screen, you can basically pan as fast as you want. Having a stationary subject on the screen gives the viewer's eye something to focus on other than the strobing background. The background's strobing just as much, but the viewer doesn't notice it because they're watching the subject. Once you see how this technique works, you'll start noticing it all the time in movies and film-shot television shows.

Why does the motion strobe? Usually because there's an abrupt change between the frames of the video, and this is more likely to happen the slower the frame rate you're shooting at. With high-sampling frame rates (like 60i or 60P) strobing is never an issue. Furthermore, when shooting for a filmlike look, there's a difference in the way the shutter works. With film and 24P (and 25P), the camera's shutter is typically only open for half the time, but in 50i/60i (or 50P/60P) the shutter is usually always open. In 60i the camera shoots 60 fields per second, and each field is exposed for 1/60 of a second, so the camera's eye is basically always open,
always recording motion. There's never a time when the camera is "blind" to the action. But with 24P, the camera captures 24 frames per second, and each frame is exposed for half that time, or approximately 1/48 of a second. This means that the camera's eye is 'shut' half the time. This can accentuate the abruptness of changes between frames. In 60i the shutter is always open, but in 24P it's open/closed, open/closed. So the motion "strobes" just like a strobelight. If you've had the chance to observe motion in a room that's lit only by a strobelight, you'll recognize the choppy, stuttery movement we're talking about (except obviously it's quite exaggerated in the strobelight example; however the principle remains the same.)

Film works the same way. Film cameras have a rotating disc "shutter." The shutter is an opaque disc with a wedge of it "cut out." This wedge is where the film gets exposed; on film cameras the shutter opening is usually about half the disc, or (expressed in terms of a 360-degree circle) 180 degrees.

Two examples of film shutters:
180 degrees and 90 degrees.

As film is shot, the shutter rotates, alternately covering-up or revealing the film frame. When the shutter is closed, the film advances to the next frame, and then the film gets held stationary while the shutter is open. So film works on this same principle of "open/closed." Fully half the time a film camera is running, it's "blind" to the action! That's why motion strobos in film, and why it also strobos in the HVX and in all 24P cameras.
So, is this strobing a good thing or a bad thing? Obviously it makes motion more choppy, but if you want your footage to look like film, it's a necessary effect. Although some people say that film doesn't strobe like 24P video does, we decided to find out. We strapped a 24P DVX to a 16mm camera and mounted them both on a tripod, and shot the exact same scene side-by-side. When the film footage was transferred to video, we split-screened the scenes, and were able to conclude that the 24P DVX renders motion exactly the same way 24fps film does, and the HVX performs identically as well. What this means for you is, if you find the strobing in your footage objectionable, the camera's not at fault, it's doing exactly what it's supposed to do. You need to adapt your technique to follow the American Society of Cinematographer rules for shooting film: slow down your pans, and follow a subject. Disobey the rules and your footage will strobe, exactly like film does.

**Using a Slower Shutter Speed**

Using a longer shutter speed (or larger shutter angle) will induce more motion blur. Film cameras typically use shutter speeds anywhere between 1/40 and 1/60 of a second (shutter angles of 220 to 150 degrees). Faster shutter speeds mean sharper footage and perhaps more strobing. Slower shutter speeds mean more motion blur and slightly less strobing. On the HVX you can select a shutter speed as slow as 1/12 in 24P/25P mode, or you could go into the SYNCRO SCAN menu and select any shutter speed between 1/24.1 and 1/249.8 (50Hz cam = 1/248.9) in VIDEO CAM mode; in FILM CAM mode you can choose any shutter angle between 10 and 350 degrees in .5-degree increments. The slower the shutter speed, the more light the camera will let in, and also the blurrier the motion will be. Shutter speeds slower than about 1/36 will result in extreme motion blur and a loss of film-like motion rendition. To keep a realistic simulation of what film looks like (while getting a little better low-light performance and a little more motion blur) stick to a speed no slower than about 1/36.0 (240 degrees). The more motion blur you have, the less noticeable the strobing will be, but too much is too much; at 1/24 you get an artificial blurry-motion look that definitely doesn't resemble film motion. If you have a certain shot in mind which demands a certain panning
speed, and you find the strobing unacceptable at that speed, you
can consider using a slower shutter speed to get the shot while
not overwhelming the viewer with strobing; the tradeoff will be
that you're getting blurrier video, so be sure to test the technique
on a television to make sure that the blur/strobe compromise will
deliver the look you're after.

**Increase the Frame Rate**

One last technique to minimize strobing is to increase your
frame rate. Shooting at 30P will get 25% more frames per second,
which will mean less strobing. The faster the frame rate, the less
strobing. Shooting your project in a 30P time base will make it look
a little more like video, but still look sort of film-like. 30P can't be
transferred to film or to European/Australian television well, but
if you're bothered by the strobing in 24P you may find 30P more
to your liking. And since the HVX offers variable frame rates, you
have many frame rates to choose from. Overcranking (shooting
at a faster frame rate and playing back at a slower frame rate) is
perhaps the best way to eliminate strobing because strobing comes
from having too low of a sampling rate; increasing the sampling
rate reduces the appearance of strobing. But you have to incorporate
that overcranked footage into your main program, and that will
mean the overcranked sections will play back in slow motion.

Or, you can always shoot in interlaced mode at 50i/60i or 720P at
50P/60P and completely eliminate all strobing, but your shots will
look completely like video instead of film. The choice is yours, but
unfortunately you can't have it all: if you want the film look, you
have to work to control the strobing, and if you shoot in interlace
mode you don't have to even worry about strobing at all, but the
footage will look like video instead of film. Some people have tried
to shoot in interlaced mode and then use aftermarket film-look
plug-ins that convert interlaced footage into a simulation of 24P,
and find to their dismay that yes, their footage starts strobing
again. Strobing is inherent in the slower capture rate. You can't
avoid it; all you can do is intelligently manage your circumstances
(and heed the wisdom of 100 years of cinematographer experience!)
to control the strobing.
Focusing

Getting precise focus is not so easy in high-definition; certainly not as easy as it is in standard-def. In this section we’ll explore focusing and explain the techniques you need to use to get razor-sharp focus.

First, understand that proper focus is absolutely critical in high-def. High definition video means a frame that has between 2.7 and six times as many pixels as a standard-def frame. Standard-def’s low resolution could mask small focus errors; high-def’s sharpness will point out focus errors blatantly, each and every time. You have to get your focus right.

Second, it’s important to acknowledge another fact: it’s impossible to judge focus properly on the on-camera LCDs by themselves. The very best you can do is get in the ballpark; it’s mathematically impossible to judge focus of a 2-million-pixel image on a 200,000-pixel display device. No small high-def camera’s display is going to be adequate, by itself, to show you proper focus; it’s just not possible. The viewfinder does have more pixels than the flip-out LCD panel, so it may help you get a little closer to accurate focus, but it’s not enough to make the difference you need.

Setting focus involves finding the exact spot where the focus is pinpoint-sharp. Usually you do this by adjusting the focus ring until the subject looks as sharp as possible, and usually adjusting the ring too far until it actually starts to go out of focus; then you pull back until it comes back into focus and keep adjusting until it goes out of focus again, and keep refining this process and splitting the difference until you get the absolute sharpest image. Obviously this technique relies on being able to actually see the image sharply!

Fortunately, there are several focus assist methods available to assure you’re getting the best focus possible. Use them all; you’re going to find they all are helpful.
First, there’s the magnified FOCUS ASSIST which brings up a square window in the center of the LCD, with a magnified center extraction from the frame. The magnified FOCUS ASSIST is a wonderful option and indispensable for achieving sharp critical focus.

Second, there’s the EVF DTL system (also known as “peaking”). Simply put, you must use this. Press the EVF DTL button on the back of the camera until the LCD shows “EVF DTL ON”. Peaking uses the high-frequency detail in the image to draw an outline or highlight on edges that are in focus. If you don’t have EVF DTL on, the LCD will simply look too blurry to get accurate focus; with EVF DTL on you’ll see when areas of the image start to “snap” into focus. Combine EVF DTL with the FOCUS ASSIST for best results.

The third focus assist feature is the distance readout in the viewfinder/LCD. This lets you see just where your lens is being focused at. In film cinematography it’s common to use a tape measure to measure the distance to the subject; with the HVX you can do the same thing: use the tape measure to measure from the front of the lens to your subject, and then set the focus ring to that distance setting. A new high-tech way to do this is to use a low-power Class II laser tape measurer; aim the red spotting laser at the point you want to focus on and it will report the distance down to the inch. Then spin the focus ring to that distance, and you’ll have instant sharp focus. A tool like the Leica™ Disto™ A3 laser measurer can be very accurate, claiming accuracy within three millimeters over a distance of 100 meters! (Note: don’t even waste your time with ultrasonic measurers, you want/need a good-
quality laser if you're going to try this method). And, obviously, lasers should never be shined in or near anyone's eyes! If you're measuring distance to people or animals, don't use the laser and doubly don't use a laser around any creature's eyes! You will permanently damage someone's vision by shining a laser into their eyes, so never point a laser measuring tool anywhere near eyes. Only use a Class II low-power laser delivering less than 1mW of power, and exercise caution and good judgment. Never use a Class III laser near people's eyes or animal eyes.

The final focus assist tool would be an external high-resolution production monitor. A native 1280x720 LCD panel will provide enough resolution to focus accurately with 720p; a 1920x1080 LCD provides enough pixels to accurately focus in 1080 mode.

If you use most or all of these tools, your focus is likely going to be perfect. But there's another technique that is extremely helpful in gauging proper focus: narrowing your depth of field.

When judging focus it's obviously much easier to judge what's in focus if the depth of field is extremely narrow (meaning, very little is actually in focus in the shot; when only the part you want is in focus and everything else is out of focus, it's obviously easier to know that you've properly focused your shot). To narrow the depth of field for checking focus, zoom all the way in (Z99/55.0mm) and open the iris all the way up (f/2.8 or OPEN). If the image gets too bright and blown-out to see what you're looking at clearly, use one of the neutral density filters, but the important thing is to be at f/2.8 and Z99/55.0mm when setting critical focus. That will narrow the depth of field down as small as it can be, letting you choose exactly where to set your focal point. Then, before shooting, you'll zoom back out and set your iris to the proper exposure again.

As you zoom out, the depth of field becomes deeper, which brings more and more of the frame into focus. And as you stop the iris back down to the proper exposure, more and more of the frame comes into focus. So if you can nail the focus at f2.8/Z99(55.0mm), then as you zoom out and stop down you can be assured that the focus is just getting better and better, crisper and sharper.
Don’t go too far though! F/5.6 is about as small an aperture as you want to use; maybe f/8 but that’s it. Don’t go to f/9.6 or f/11 when shooting high-def, or the image will get softer again due to the principle of diffraction. Stick between 2.0 and 5.6 whenever possible (see the essay below for more information).

Another focus assist tool you may want to consider is autofocus; if you can’t get focus any other way, you can press and hold the “PUSH AUTO” button until autofocus locks in. That’s no guarantee that your focus will be accurate, however; autofocus may not choose to lock onto the part of the frame that you prioritize as being most important. If you have no other way of double-checking your focus, temporary autofocus is probably better than nothing, but it certainly shouldn’t be your primary focus assist tool.

Different shooting circumstances may dictate which methods of focus assist will be available to you. For example, when focusing for drama/film: have a production monitor handy. Zoom in to Z99/55.0mm, and open the iris to f2.8. Measure to the subject using a tape, and set the focus ring based on what the tape/laser says. Then refine the focus by watching the monitor until you’ve found pinpoint sharpness. (If you don’t have a monitor, use the FOCUS ASSIST and EVF DTL, and make arrangements to get a monitor!)

If you’re shooting events and/or run & gun: learn to estimate distances. Spend time practicing with a laser tape measurer or an actual tape measure and learn to judge distance accurately. Then, when you’re in the field, ballpark your focus using the distance meter, and fine tune using EVF DTL and FOCUS ASSIST (when possible). Also, try to keep your depth of field deep so you have a better chance of keeping the shot in focus: avoid full telephoto and wide-open iris as much as possible. If you can stay around f/4.0 or f/5.6 you’ll have much deeper depth of field, and keeping the lens wider (under 20mm) will also give deeper depth of field.
Recommended F-stop Range

An oft-repeated factor in lens design is that lenses typically perform at their sharpest in a certain f-stop range, usually a range from about two stops down from wide-open to two stops up from fully-closed. Still-camera lenses usually begin to lose some sharpness at their widest-open and most-closed apertures. A further issue that confounds small-sensor cameras is the issue of diffraction: the propensity of light to scatter when forced through a too-small aperture, which makes it appear like the image is out of focus – an issue that especially affects small-CCD high-definition cameras.

We tested the HVX lens for diffraction and to find the f-stop range where the lens is sharpest. We used a high-resolution LCD monitor and a resolution chart, lighting the chart at different light levels so we could test it at proper exposure using different apertures.

Over the course of the iris range the lens performed consistently. There was less than a 4% sharpness difference between all stops from f/2.8 and f/8; not enough to even worry about. In fact, because shallow depth of field is such a sought-after effect, cine-style video lenses are designed to operate at their optimum sharpness at maximum wide-open aperture (and Zeiss makes this point clearly in their marketing for their DigiPrime™ video lenses). The HVX lens was designed with this in mind, so keeping the lens open for shallow depth-of-field purposes won't be giving up hardly any resolution.

f/9.6 is just a tiny bit lower resolution, resolving approximately 3% less than f/5.6. There is no substantial effect on resolution due to diffraction between f/2.8 to “true” f/9.6.

Diffraction becomes an issue at the smallest apertures. In standard definition it’s not a problem; the smallest aperture of f/1.1 still provides plenty of sharpness and resolution for standard-def video. But for high-definition it’s a whole different matter. Because the high-definition frame has so many more pixels, and the pixels are so much smaller, the HVX in high-definition mode is more
susceptible to diffraction-induced resolution loss. At f/11 it shows a noticeable drop in observed resolution, displaying approximately 15% less vertical resolution. But that's not all; while the HVX iris display reads out to f/11, the lens can actually be closed down by two increments past f/11 before the iris closes completely. Those are 1/6-stop increments, so the additional iris readings are f/11+1/6 and f/11+1/3. At f/11+1/3 (one tick above CLOSE), resolution drops by almost 30% as compared to f/5.6! That's a dramatic drop-off, and primarily attributable to diffraction. For this reason, we recommend that you try to avoid f/11 entirely; while true f/11 shows a 15% drop, you may find yourself at f/11+1/3 without knowing it, and be recording footage that's 30% lower in resolution than you thought you'd be getting! For maximum image sharpness, never use an aperture smaller than f/9.6 when shooting high-def modes, and because different wavelengths of light may encounter diffraction sooner, we recommend staying at f/8 or wider.

The HVX ASA/ISO Rating

When using an external light meter to meter your scenes, it's necessary to know what the equivalent "film speed" (or "sensitivity") the camera is operating at. For instance, when using a light meter with 320 ISO film, you set the meter to 320 ISO and the appropriate shutter speed. Meter the scene, and the light meter tells you exactly what f-stop to set on the camera for proper exposure. If you knew the "ISO" of the HVX200, you could theoretically use a light meter with the HVX and get similar results.

That's the theory, anyway. In practice it's not so easy to use a light meter based on the actual "speed" of the camera, because it depends on several factors, such as which gamma setting you're using and the true t-stop of the lens.

We have tested the HVX thoroughly under all light conditions, with various settings, and the HVX responds at approximately 320 ISO. All testing was done on an HVX200 at 24P and 1/48.0 shutter speed, using HD Norm gamma. Testing was performed using an 18% gray card as well as using real-life scenes, using the
HVX's auto-iris to determine exposure for the camera as tested against a Sekonic L-508C lightmeter in spotmeter mode, and using a waveform monitor to gauge the camera's response.

In general, the camera responds at 320 ISO across the entire exposure curve from f/2.8 to f/11. However a few things can affect this apparent speed rating. First, if the camera is set in 60i/50i interlaced mode, or 720/60p or 720/50p mode, it's approximately 1/4 stop less sensitive. The reasons for this are not exactly clear, but seem to center around the idea that the shutter speed is somewhat abbreviated when in 50i/60i or 50p/60p mode: it cannot truly scan sixty updated fields/frames at 1/60 shutter – there simply must be some time set aside for the CCD to offload its signal. Accordingly, the camera seems to reduce the exposure just a bit when in 50p/60p or 50i/60i mode, giving itself enough time to offload the CCD signal (which may explain why you can't select a 360-degree shutter either; the camera lets you select a maximum 350-degree shutter when in FILM CAM mode.)

Second, in extreme low light circumstances (requiring an iris of f/1.6, f/1.7, or f/2.0), the reported sensitivity is lower than might be otherwise expected. When the autoiris system recommended an f/2, the light meter showed an equivalency to 200 ISO. In a very low light scene, dark enough to use f/1.6 ("OPEN") on the iris dial, the spotmeter reported that the HVX was responding at around 125 ISO. However, there still were very real changes in the brightness of a scene switched between 1.6 and 2.0, in spite of the similarity one would expect based on solely the sensitivity readings; middle gray responded at 200 or 125 ISO, but the highlights still responded noticeably to the iris changes as one would expect from a linear exposure system.

In real-world conditions shooting a variety of subjects, the results were consistent at varying light levels, usually indicating 320 ISO.

Also, depending on the gamma curve used, the exact IRE level of middle gray can be shifted up or down, resulting in a different perceived ISO rating as pertaining to a gray card. We conducted
testing using HD NORM gamma. If shooting in CineLike-D, an 18% gray card would need to be exposed lower than 50%. Using High gamma, the 18% gray card should be exposed above 50%. When using a fixed ISO equivalent rating, this correction is automatic. Under very bright (f/11 + 2/3) conditions, under HD NORM gamma we calibrated the camera at 400 ISO. In CINE-LIKE-D it corresponded to 320 ISO. That's only a difference of 1/3 stop, but it's something to be aware of.

The lesson to learn here is that based on the camera's f-stop markings, the HVX's exposure is usually linear, but the camera appears less responsive at lower light levels. Or, at least, that's how it appears. An alternative interpretation would be to say that the exposure curve is indeed linear, and that the f-stops displayed in the viewfinder are not exact representations of the actual light being transmitted (T-stops). If we are to consider the CCD to be delivering an actual linear response, then we must conclude that the f-stop markings are not matching the true amount of light being transmitted; they're a bit optimistic at the open end.

This gives us a small problem when trying to use an external light meter to judge exposure. In general, if you were to "rate" the camera at 320 ISO, you'd be within about a third-stop of being accurate at either end of the exposure spectrum except for the very most-open iris settings (1.6, 1.7 and 2.0). But if using an alternate gamma, that may cause another 1/3-stop of exposure variation into the formula.

Our recommendation is that using an external light meter as your sole judge of exposure is not the best technique. The camera has an internal light meter which is far more accurate, since it takes into account the CCD exposure response characteristics, the effects of the gamma curves, and any light-transmission difference between the rated F-stops and the actual T-stops. Using an external light meter can give you a general idea of what the exposure should be, and can be handy for judging lighting ratios or for scouting locations, but because the camera responds differently at different levels of light, and under different gamma settings, it's much
more accurate (and reliable) to use the camera’s zebra settings to
determine overexposure, a professional (and properly calibrated)
production monitor to judge overall exposure, and the MARKER
(page 182) or (preferably) a waveform monitor to fine-tune
exposure. If you wanted to invest in an external device to help you
judge exposure, a waveform monitor would be a far more accurate
tool for use with the HVX than an external light meter would be.
While a hardware waveform monitor can be expensive, software
emulators are also available; Serious Magic’s DVC Rack™ gives
you a waveform monitor, vectorscope, production monitor, and
digital disk recorder all in one; DVC Rack can be very helpful in
determining proper exposure. Apple’s Final Cut Pro (version 4.5
or later) also has the ability to read the incoming data stream and
display a software waveform monitor, and other applications will
as well.

24P vs 24PA

(This section is not applicable to PAL-European/Oceanic/50Hz
cameras; only NTSC/North American/Japanese/60Hz cameras
have 24P and 24PA recording systems and pulldown.)

Panasonic introduced 24P shooting to the DV camera world, and
with the HVX they’re bringing 24P shooting to the 1080P DVCPRO-
HD format. By definition, DV as a video format doesn’t make any
 provision for 24P, and neither does 1080i DVCPRO-HD. Panasonic
 engineers cleverly found a way to shoot 24 frames per second
but embed those frames on tape in DV-standard interlaced video
mode, thus ensuring that HVX recordings (even 24P recordings)
can be played back on any DV deck or camera. Even though 24P
is not part of the DV format specifications, Panasonic was able to
bring fully DV-compliant 24P recording into being. They’ve applied
this same technology to the HVX200, offering 24P recording in
DV, DVCPRO, DVCPRO50, and 1080i DVCPRO-HD (and, of course,
720P mode).
For the interlaced (480i & 1080i) recording modes, Panasonic employs the same 2:3 pulldown sequence as that which is used when film is transferred to video. Film runs at 24 frames per second, just like 24P video does. And interlaced video runs at 60 fields per second (technically 59.94 fields per second in NTSC/ATSC). Note: NTSC video does not run at 30 (or 29.97) “frames” per second – that’s an unfortunate misnomer that’s been associated with NTSC from the beginning. It actually works at 60 (or 59.94) “fields” per second. Two fields do not make up a “frame,” because the fields are equally spaced in time. It’s not like two fields are transmitted separately, buffered, and then presented all at once; that’s not how fields work. Field Two is as far away from Field One as it is from Field Three. Fields are not “grouped together” in NTSC video; rather each field will spend as much time on screen with the field that precedes it, as it will with the field that follows it. Fields are equally distributed in time. Because of this, engineers had to figure out how to spread film across the video fields, since they’re not running at the same rate.

In order to transfer film to video, engineers long ago came up with the “2:3 pulldown sequence,” which prints one frame of film onto two fields of video, and the next frame of film onto three fields of video. The pattern then repeats. Using this pattern, every two frames of film get printed onto five fields of video, and this pattern happens 12 times per second, so 24 frames of film (two frames x 12) get printed to 60 fields of video (five fields x 12). Here’s a pictorial example that shows how the frames get recorded to video, and how they get interlaced. First, assume that we have four frames of film, which look like this:

```
A B C D
```

When those frames get recorded on videotape or on P2 cards, the HVX will split each frame into “fields” and interleave them sequentially on the tape or card, like this:
In our 2:3 example, one frame will get written to tape as two video fields, and the next frame will get written out to three video fields. So every other frame is written out as three video fields. In our example, frames “A” and “C” will be written for two fields, and frames “B” and “D” will take up three fields. How this looks on tape or card is, frame “A” gets split into two fields and written out to two video fields, and since each pair of fields can be reconstituted in post as a “frame,” frame A gets written out to tape/card essentially intact. Frame “B” gets split into two fields and printed to three video fields (one field is written out twice). The first two fields can be reconstituted as a distinct frame, and the third field gets combined with one of the fields from frame “C”, resulting in what’s called a “split frame.” Frame “C” will be written out to two fields, so the first field is combined into a split frame with the third field from frame “B”, and the second field will be combined into a split frame with the first field from frame “D”. Frame “D” gets written out as three fields, so its first field is used as a combined split frame with a field from frame “C”, and then the frame gets written out to two more fields, which result in something that can be reconstituted into a complete, intact frame. Sounds confusing, but in practice it works very well – watch any Hollywood movie on broadcast television or VHS or on a (non-progressive) DVD, and you’ll see 2:3 pulldown in action.

In 24P mode, the HVX CCD actually runs at 24Hz, capturing a new and distinct frame 24 times per second (some other cameras actually run at 60Hz and try to “simulate” the 24P look in-camera, but the HVX actually scans the same way a film camera does, scanning a complete image 24 times per second – or, more accurately, 23.976 times per second). However the DV, DVCPro50, and DVCPro-HD 1080i recording standards require 60 interlaced fields per second to be recorded to tape or to P2 card, so the HVX slices each frame into fields, and performs in-camera pulldown to transform 24
frames into 60 fields. The result is video that looks like it was shot on film. The frames look “right” when displayed on an interlaced television, just like Hollywood movies that were shot on film at 24fps and were transferred to video. It’s the same process.

However, in order to edit this video in a progressive-scan timeline, the “split frames” will need to be un-split and properly recombined with their proper field-mate, in order to reconstitute the original 24-frame sequence of “A B C D”. This re-combining process requires an uncompres/recompress cycle in the editing program and can result in a small loss of quality. However, if editing in a 60i timeline, the video needs no processing and the 2:3 pulldown system will result in the smoothest 24P motion on an interlaced TV.

For higher quality and for better performance in editing, Panasonic developed a new pulldown method which is used in the “24P Advanced” recording mode. This new method is called 2:3:3:2 pulldown. In 2:3:3:2 pulldown, one frame gets printed to two video fields, and the second frame gets printed to three video fields. The third frame also gets printed to three video fields, and the fourth frame gets printed to two video fields. Here’s a pictorial example:

A B C D

The end result is that for every group of four 24P frames, they get recorded to four “video frames,” with one additional “split frame” created to round out the sequence. Four 24P frames get printed onto 10 video fields, and this happens six times per second, so 24 frames (four x 6) get printed onto 60 video fields (10 x 6). The difference is, 24PA footage can be reconstituted to its original 24 distinct frames easier and with no uncompression/recompression, something that’s not as easy to do with 24P 2:3 footage. As you can see in the example, all of the original frames exist in their original un-blended, un-compromised form; all the editing program needs to do is discard the “split frame” and it can directly edit on the original, pure progressive frames. However, the cadence is not quite as smooth as in 2:3 pulldown, so raw 24PA footage may look
just slightly more “stuttery” or “jerky” than 24P 2:3 footage on an interlaced TV.

The DV, DVCPRO, DVCPRO50, and DVCPRO-HD 1080i compression algorithms include two compression techniques: when the compressor detects significant amounts of temporal difference between the fields of a video “frame” (a grouping of two video fields is called a “frame” even though it bears little resemblance to a film frame or a 24P frame) it will employ field-based compression, but when it doesn’t detect much temporal difference, it will instead employ progressive frame-based compression. Progressive frame-based compression is more efficient and cleaner than interlaced field-based compression. When 24P 2:3 footage is written to tape/card, the 24P frames get split into fields and blended together: the odd field from one frame may be combined with the even field from the next frame and then written to tape, resulting in a “split frame” as described above. This means that the field-based compression algorithm is more likely to be used on a split frame. When 24PA 2:3:3:2 footage is written to tape/card, all the original 24P frames are kept intact: for every group of four 24P frames written out, they are written out one-for-one onto video “frames,” and then a fifth “split frame” is also created (the “Cs” frame in our A/B/Cs/C/D example). The original 24P frames (having been kept in their original state) can be compressed using the frame-based compression algorithm, resulting in more efficient compression. The fifth frame (the “split frame”) will probably use field-based compression, but it’s really irrelevant, because when the editing program imports this footage it can take the four original frames and simply discard the split frame. This is not possible with 24P 2:3 footage, where the footage needs to be decompressed and have the fields re-combined into their proper order. 24P 2:3 is therefore a little less efficient for editing in a 24P timeline than 24P Advanced, and 24P Advanced may benefit from better compression efficiency.

In the end, there’s not really much of a difference between the two. 24P 2:3 will look a little bit smoother on playback on a 60i timeline than 24P Advanced would. 24P Advanced will probably have a bit better compression, maybe a bit fewer artifacts. Both can be edited
on either 24P or 60i timelines, both can be blown up to film, and both can be used to author 24P DVDs. The main difference as to when to choose which mode is determined by how you intend to edit the footage: if you are going to edit it on a 24P timeline, using a program that understands 24PA pulldown, it’s better to shoot in 24P Advanced. If you’re going to edit it on a 60i timeline, (or you don’t know how the footage will be edited) it’s better to shoot regular 24P. The choice between 24P (2:3) and 24PA is one of editing convenience. The differences are minor, so if you choose one or the other you’re not necessarily going to lock yourself out of other options, but if you know in advance how you intend to edit the footage, you can get a little better quality or a little smoother footage by choosing the appropriate pulldown sequence.

As for 30P, there is no pulldown involved. Each frame is written directly to two video fields, and frame-based compression is employed. In PAL/50Hz mode, there is also no pulldown: PAL/50Hz 25P mode works exactly like NTSC/60Hz 30P mode, where each PAL/50Hz frame is written to two video fields. Since there is no pulldown, and no consideration of 2:3 or 2:3:3:2 (or Advanced), the PAL/50Hz models offer only the one choice: 25P or 50i. There is no such thing as “25P Advanced” on the 50Hz camera, nor is there any reason you’d want such a thing; pulldown (and the complications it involves) only affect the NTSC/60Hz version.

**24pn/25pn/30pn Mode vs. 24p/25p/30p/60p Mode**

When shooting in 720p mode, field-based pulldown is never an issue: there is no such thing as interlaced 720p. 720p is always, by definition, recorded as progressive scan. Each and every frame stands alone as an individual, discrete frame.

However, there is still such a concept as “pulldown,” even in 720p. To understand why, you first have to understand that tape-based recording systems and broadcast signals typically conform to one standard frame rate. In the US, HDTV 720p broadcasts are done almost exclusively at 720/60p. Even though the ATSC provides for 720/24p and 720/30p broadcasts, the networks broadcasting
720p signals have chosen universally to broadcast 720/60p at all times. In Europe the EBU has endorsed 720/50p as their preferred broadcast standard. DVCPRO-HD tape works the same way – it always, always records a 720/60p data stream, regardless of how many frames per second the camera is set to produce.

So how does 24p or 30p fit into a 720/60p broadcast? And how would 25p fit into a 720/50p broadcast? The answer lies in the concept of frame duplication. Let’s take an easy example: 720/30p, being broadcast over a 720/60p broadcast signal. In this case, each frame is simply duplicated once, so each frame is shown twice. The net effect is indistinguishable from a 720/30p broadcast: the viewer sees 30 distinct frames per second. There is no discernible difference to the viewer when the duplicate frame is shown; as far as the viewer is concerned, he/she is seeing 30 distinct frames per second. A 720/60p broadcast, when showing 720/30p footage, therefore duplicates each frame and transmits these duplicate frames.

In Europe, the same thing occurs with 720/25p footage being broadcast in a 720/50p stream: each frame is shown twice.

With the VariCam (Panasonic’s 2/3” DVCPRO-HD variable-frame-rate camera), all recording is done to DVCPRO-HD tape. Because the tape is a constant 60p medium, it requires the camera to feed it 60 frames per second. The camera, however, is capable of variable frame rates – so how do the two seemingly incompatible technologies (variable frame rate imaging vs. constant-frame-rate tape) work together? By using the same frame duplication technique as is used for broadcast. When the VariCam is set to run in 30P mode, it creates a new image every 1/30th of a second, and feeds that image to the tape deck. The tape, however, records each of those frames twice. That way the tape receives 60 frames per second, even though the camera is updating only 30 frames per second.

When using a frame rate other than 30, the duplication pattern is a little different. A VariCam running at 15 frames per second would output the same frame four times; when running at 6 frames per second it would output the same frame 10 times, etc. But for not-
evenly-divisible frame rates, some sort of pulldown pattern must be employed. For example, 24 does not evenly divide into 60, so the frame duplication pattern for 24P needs to be different. When recording 24P, the VariCam writes each even frame twice, and each odd frame three times. The result is the same effect as 2:3 pulldown (the process used when film gets transferred to video.) The even frame gets written twice, and the odd frame gets written three times, which means that for every group of two source frames, five destination frames are written to tape. So over the course of one second this will happen 12 times: two source frames \( \times 12 = 24 \) source frames; five destination frames \( \times 12 = 60 \) destination frames. All of the VariCam’s variable frame rates employ some method of frame duplication to round out the sequence to 60, in order to accommodate the constant 60p data stream dictated by DVCPRO-HD tape. On tape, it would look something like this:

```
A A   B B B C c D D D
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The HVX200 can record in this same fashion. This method of inserting duplicate frames is referred to as “Over 60” (meaning, for example, that putting the camera in 720/24P mode results in 24 frames being carried “over 60”; the 50Hz camera uses a similar “Over 50” recording method). For compatibility with an external tape deck or other DVCPRO-HD-aware equipment, the 60Hz HVX can embed its variable frame rates within a 60P data stream, using duplicates to round out the sequence (and always embeds within a 60p data stream on its analog component outputs). But with P2, you don’t have to record all those duplicate frames. With the HVX200, DVCPRO-HD tape is not a factor. With the HVX200, the data can be written directly to the P2 memory cards - and unlike the tape deck, which requires 60 frames per second, the cards bear no such restriction. And writing duplicate frames to the card seems wasteful, doesn’t it? So why do it?

That’s the reasoning behind the HVX200’s 24PN mode, and its 30PN mode (and the 50Hz camera’s 25PN mode). The “N” stands for “Native,” meaning that only the native, active frames are written
to the card. No duplicate frames are written on the card. No space is wasted. Only the actual frames that are imaged from the camera get written on the card.

This sounds ideal – and in many ways, it is. You get more recording time on the card, your footage has no wasted space, it will transfer quicker to the editing computer, it will take up less hard disk space... how can you beat that?

The only drawback to 24PN/25PN/30PN Native mode is, it doesn’t get transmitted over the 1394 connection. If you’re streaming video over the 1394 cable, and performing a live capture on a DVCPRO-HD tape deck, you cannot stream Native mode data on the 1394 cable. No other DVCPRO-HD-compatible device (such as the AJ-HD1200A deck, or computer editing applications, or the FireStore FS-100) would understand a non-60P data stream. Only the “Over 60” modes of 720/24P, 720/30P, & 720/60P, or the “Over 50” modes of 720/25P & 720/50P, can transmit their data over the 1394 cable; the Native modes cannot. (Of course, we’re talking only about live video streaming here; you can obviously execute a file transfer of a Native mode file from an HVX to a Macintosh over 1394, or to a Windows PC using USB, or stream 480i, 576i, or 1080i streams).

When in Native mode, only the active frames are written to the card. You can see the effect of this in the “available time” on a P2 card. Start with a freshly-formatted 4GB card, and put the camera in 720/60P mode, and it will show that you have four minutes of available recording time. Switch to 720/30P (“Over 60”) mode, and you’ll see that you still have 4 minutes of available recording time. Switch to 720/24P (“Over 60”) and it will still show 4 minutes of available recording time. But now switch to 720/30PN mode, and you’ll see the available time jump up to 8 minutes! Because no duplicate frames are being recorded, you now get twice as much storage space, since in 30PN mode you’re recording only 30 frames per second, versus the 60 frames per second of the “Over 60” modes. Switch to 720/24PN mode and you’ll see your available time jump up to 10 minutes; 24 frames per second takes up less
space than 30 frames per second, which means the card will be able to hold more minutes of recorded footage. If you change to FILM CAM mode and change the FRAME RATE to 12 frames per second, you’ll see the available time jump all the way up to 20 minutes – that’s five times as much recording time as you would get in the “Over 60” modes! (Of course, 720/12p will look very different from 720/60p, and won’t record audio, so it’s not a direct apples-to-apples comparison.)

So, when would you choose one mode over the other? Obviously if you’re using the 1394 cable to stream to an external capture solution, such as the FireStore FS-100 or to a DVCPRO-HD tape deck, or to a computer for live capturing, you’d need to put the camera in “Over 60” mode. You can still extract the frames and work with only the “active” frames, but it will involve a little bit of work in post-production using a tool such as Apple’s software Frame Rate Converter utility. But to maintain compatibility, you’d need to select “Over 60” for use with 1394-cable capture devices.

When recording to the P2 card, you’d almost always want to use Native mode. The Native mode is optimized for use with the P2 card, and results in the easiest-to-edit files. And, Native mode offers another big benefit – you can preview variable-frame-rate clips on the card at their proper running speed, right in-camera. You can’t do that with “Over 60” mode; with “Over 60” the footage must be run through the frame-rate-conversion process in post before you can see how the slow-motion or fast-motion effects look. But with Native mode, the camera can actually conform the video around your chosen time base, so a 720/30PN clip (shot at 60 frames per second) will play back at a rate of 2:1 slow motion. And, the Native mode allows you to make DV downconversions onto DV tape while still preserving that time base, so the downconverted clips will be slow-motion or fast-motion, depending on what frame rate you chose to shoot in.

It’s possible to shoot in variable frame rates in both Native and “Over 60” modes, which can result in very different looks (although it is also possible to conform “Over 60” footage to deliver the
same look as can be had by Native mode footage.) One significant difference is that if you use variable frame rates in Native mode, no sound will be recorded. Sound will still be recorded in “Over 60” mode regardless of what frame rate you select, but the Native modes only record sound if recorded at their default frame rate; overcranking or undercranking in Native mode means no sound will be recorded.

Each mode has unique advantages, and each can result in very different looks. We’ll discuss this in more depth in the “Frame Rates” article below. However, for the most part, Native footage enjoys several advantages, especially when shooting onto the P2 cards, and “Over 60” mode is most useful when shooting 60 frames per second for the “live” video look, or when streaming 720p content out the 1394 port.

Since we’ve drawn the distinction between “Native” mode and “Over 60” mode, that leaves us to ponder: what is the difference between the various “Over 60” modes? Between 720/24P, 720/30P, and 720/60P? Obviously the frame rate is the key difference, but can’t you just choose 720/60P mode and then select 24 or 30 frames per second, and accomplish the same thing? (or for the 50Hz camera, choose 720/50P mode and 25 frames per second).

720/24p mode produces identical results to selecting a variable frame rate of 24 fps in 720/60p. Both settings would result in 24 distinct frames being duplicated in a 2:3 pattern to pad out a 60p data sequence. But remember that you can only select variable frame rates when in FILM CAM mode. So in FILM CAM mode, yes 720/30p mode would provide identical results as 720/60p when using a variable frame rate option of 30 frames per second. But that doesn’t mean that Panasonic could just do away with the 720/24p (“Over 60”) or 720/30p (“Over 60”) modes as redundant! The difference comes in when you want to use VIDEO CAM mode; if you want the look of 24P or 30P but you want the features of VIDEO CAM mode, that can only be accomplished by choosing 720/24P or 720/30P “Over 60” modes. VIDEO CAM mode doesn’t allow for selecting different frame rates, so the only way to get
720/24P “Over 60” or 720/30P “Over 60” in VIDEO CAM mode was to create separate modes.

VARIABLE FRAME RATES

Apart from the VariCam, the HVX200 is the first camera on the market that provides for variable-frame-rate shooting. This is probably one of the most exciting features of the new HVX200, and certainly one of the most powerful. And it’s far more capable than most users realize at first glance – the variable frame rates provide you with unprecedented creative choices, especially when combined with some simple in-camera and post techniques that can easily give you 7 times as many frame rates as would otherwise seem possible!

When talking about variable frame rates, we’ll usually limit the discussion to the high-definition 720p mode. In that mode the HVX200 provides almost a dozen different frame rates to select from. In 1080 or 480 mode there’s even a small provision to shoot with some different frame rates: there are three to choose from (24p/30p/60i), although it’s possible to simulate even more, specifically 1p, 2p, 4p, 8p, 12p and 15p. (In the 50Hz/European model, there are two standard frame rates in 1080 or 576 modes, which are 25p and 50i; there’s also the possibility to simulate 1p, 2p, 4p, 7p, and 12.5p).

Focusing on 720p, there are 11 different frame rates to choose in the camera’s menus. In the US/60Hz model, those frame rates are 12, 18, 20, 22, 24, 26, 30, 32, 36, 48, and 60 frames per second. In the European/50Hz model the frame rates are mostly the same, but a few are a little different; they include 12, 18, 20, 23, 25, 27, 30, 32, 37, 48, and 50 frames per second. Since the frame rates are so similar, for the rest of this article we’ll primarily stick to the 60Hz frame rates for illustrative examples.

Why so many choices, and when and why would you use them? The frame rates chosen for the HVX200 have been selected from among the most popular frame rates on the VariCam. The VariCam
is actually capable of choosing any single individual frame rate between 4fps and 60fps, in 1fps increments. On the HVX200, Panasonic has provided a select group of the most popular frame rates, each suitable for a certain specific effect (although, of course, creative users will find other ways to take advantage of the choices offered).

To start with understanding why variable frame rates even matter, let's reference back to how film gets shot. In film, slow motion is shot by running the camera at a faster frame rate. Film normally runs at 24 frames per second (fps), but for slow motion the cameraman might shoot it at something like 48 fps. When those 48 frames are played back at the 24 fps speed, it'll take twice as long to play back, so everything will be moving at half speed, giving that superb film-style slow-motion look. Shooting at a faster frame rate is called “overcranking,” because in the early days cinematographers would actually crank the film faster. Similarly, shooting at a slower-than-normal frame rate results in a “fast motion” effect - think of the Keystone Kops or an old Charlie Chaplin movie and you'll get the idea. If you only shoot 12 frames in a second, but you play those frames back at the 24fps speed, it'll only take 1/2 second to play back action that took a full second to record - accordingly, the motion will be twice as fast as normal. This is referred to as “undercranking.”

Using actual overcranking and undercranking can yield dramatically smoother, superior off-speed effects in your productions. Prior to the introduction of genuine over/undercrank, video shooters had to try to synthesize slow motion effects in their nonlinear editors. This led to frames being blended together, footage being de-interlaced, new frames being interpolated, motion artifacts, and all sorts of other compromises that resulted in lower-quality footage and a less-than-filmlike slow motion experience. With the true overcranking and undercranking potential of the HVX200 you no longer have to settle for those types of compromises; now you can shoot genuine frame-accurate film-style slow motion effects (or fast-motion effects).
We'll offer some examples of what each frame rate is useful for, and ways that you could use them. This is not by any means an exhaustive list, there are likely many, many more uses where each frame rate could be used, but this listing will give you a basic overview. Each of the choices listed below assumes that you're going to be playing back the footage at the film-standard rate of 24 fps (or 25fps for the European/50Hz version).

- **12 fps**: usable for extreme fast motion, twice as fast as normal motion. In the indie hit film "El Mariachi", director Robert Rodriguez made use of 12fps for fast-motion scenes such as the hotel front desk clerk scrambling to the telephone to make a call.

- **18 fps**: this is the frame rate that early silent films were shot at, and the frame rate that most 8mm and Super 8mm home movies were filmed at. Since film has been standardized at 24fps these older films usually are played back with fast-motion effects. If you're looking for the "Keystone Kops" or "Charlie Chaplin" look, 18 fps is where you should start.

- **20 fps**: 20fps is a fast-motion effect that's not nearly as exaggerated as 12fps is, but it's fast. If you wanted to show someone running extremely quickly, 20 fps might be a good choice for that. It starts to push the bounds of what the audience can believe is "real," but it's very fast motion without being exaggeratedly fast.

- **22 fps**: this is a subtle fast-motion effect. 22 fps is a very popular frame rate for karate action movies - shooting at 22 fps and playing back at 24 fps makes motion look very fast but completely believable. Shooting a car chase or a fight scene at 22 fps will lend an added edge of excitement and action to your scenes. The 50Hz camera's equivalent would be 23fps.

- **24 fps**: this is the standard movie film speed. Shooting at 24 fps and playing back at 24 fps gives your footage the temporal feel of motion picture film. This is the speed you'd normally shoot all dialogue scenes and "normal action" scenes. The 50Hz camera's equivalent would be 25fps.
26 fps: this frame rate can add a subtle, subliminal slow motion effect to your footage, but the effect is very mild. Things moving slower than normal can be perceived as being “larger than life” – if you want to add a bit of elegance and grandeur to your scene, but don’t want it to be obvious that you’ve done so, 26 fps can add that additional element of drama. The 50Hz camera’s equivalent would be 27fps.

30 fps: this is a slow motion speed. It’s mild slow motion, but noticeable. 30fps not very subtle, it’s the first of the “real” slow motion speeds.

32 fps: just a little slower than 30 fps. If you’re shooting your main program in 720/30p mode, filming at 32fps and incorporating in your 30 fps project can give you a similar slightly-larger-than-life feel as 26 fps does in a 24fps project.

36 fps: at 36 fps, the scene is obviously slow motion. Action takes 1.5 times as long to play out as it took to shoot it. 36 fps is as slow or slower than many movie cameras can shoot. The 50Hz camera’s equivalent would be 37 fps.

48 fps: full-fledged slow motion. This is a “walk-away-from-the-explosion” caliber slow motion speed. 48 fps makes everything take twice as long to play back as it did to shoot it.

60 fps: super-slow motion. 60 fps is suitable for shooting explosions or extreme slow motion scenes. It’s the slowest slow motion possible on a conventional video camera (certain high-speed specialty cameras can go faster). The 50Hz camera’s equivalent would be 50fps.

Obviously, having nearly a dozen different frame rates gives the camera operator a great degree of flexibility and creative choices. But if that weren’t enough, let’s point out that there are even more frame rates available, as long as you’re willing to work “outside the box.” A little creativity when shooting, and a little manipulation in post, can add significantly to the list of available frame rates.
First, let’s explore the intervalometer feature. The HVX200 provides for single-frame intervalometer operation – that means it can shoot one single frame at certain specified intervals. Well, using that feature with some of the shorter intervals lets you get frame rates of 1, 4, 8, and 15 frames per second! Those are legitimate frame sequences – if you put the camera in intervalometer mode and tell it to capture 1 frame at a time, with an interval time of 1 second, that’s 1 frame per second. If you tell it to capture 1 frame at an interval of 16 frames, that’s approximately four frames per second. At an interval of 1 frame captured every 8 frames, that results in approximately 8 frames per second. And at an interval of four frames, that gives you 15 distinct frames per second. (all calculations based on a 60fps timebase).

So let’s bring our current list of active frame rates up to speed so far: in 1080 or 480 modes, you can get 1p, 2p, 4p, 8p, 12p, 15p, 24p, 30p, and 60i. That’s 9 different variable frame rates. And in 720p mode, combining the intervalometer with the frame rate functions, you can get 1, 4, 8, 12, 15, 20, 22, 24, 26, 30, 32, 36, 48, and 60 frames per second. That’s 14 distinct frame rates.

And, of course, that’s not all. No, there are actually more frame rates you can create, if you bring the slow shutter speeds into play in 720p! Here’s how that works – when using the variable frame rates in FILM CAM mode, you’d normally use a shutter angle of 180 degrees. That results in an exposure that’s half as long as the nominal frame rate (i.e., for 30 frames per second, the exposure would be 1/60th; for 24 frames per second the exposure would be 1/48th; etc). But the shutter angle can be set to as wide-open as 350 degrees. In a case like that, the motion blur present in a frame will directly simulate the motion blur that would have occurred had you shot at half the frame rate with a normal shutter. To clarify, a 180 degree shutter at 30 frames per second results in an exposure of 1/60th of a second. And a 350-degree shutter at 60 frames per second also results in an exposure of approximately 1/60th of a second. So if you were to expose at 1/60th of a second, at 60 fps, the result would be 60 frames that look exactly (motion-wise) like a 30-frame-per-second sequence at 1/60th. Now, you’d still have
60 frames per second instead of 30, but if you dropped every other frame out of the sequence you’d end up with 30 frames per second that look identical to the sequence you could have shot at 30fps with a 180-degree shutter angle.

It’s easy to test – shoot a 60p segment with a 350-degree shutter, and then shoot the same sequence at 30p with a 180-degree shutter. Bring the 60p segment into your editing program and play it back at 2x speed (which will eliminate every other frame) and the result is that you’ll see 30 unique frames per second, each one looking exactly like the frames in your 30p footage.

Using this knowledge we can then simulate even more frame rates from the HVX200. Each frame rate is now capable of simulating the frame rate of half its speed – so 32 frames per second, at 350-degree shutter, can be used to simulate 16p at 180-degree shutter. 18 fps at 350-degree shutter can be used to simulate 9p at 180 degrees, etc. This doesn’t double our potential frame rates, however, because some of the “new” frame rates are identical to already-existing frame rates (i.e., 60 can simulate 30, and 48 can simulate 24, but we already have 30 and 24, so simulating them doesn’t add anything new).

The new frame rates that can be created using the 350-degree-shutter/double-playback speed method are 6, 9, 10, 11, 13, and 16 frames per second. (Don’t worry, at the end of this article we’ll establish a table that shows each frame rate and how to accomplish it.)

Therefore, the total list of individual frame rates that an HVX200 can deliver, in 720p mode, includes: 1, 4, 6, 8, 9, 10, 11, 12, 13, 15, 16, 20, 22, 24, 26, 30, 32, 36, 48, and 60 frames per second. That’s 20 different frame rate possibilities right there!

It may be starting to get overwhelming when you consider all the creative possibilities that this wide array of frame rates gives you. So it’s probably unfair of me to thoroughly overwhelm you by announcing that not only do you get 20 frame rates, but each of
those frame rates can provide three different looks too! Depending on the time base you select for your program, each of those frame rates can look quite different. And with three different time bases possible to choose from (24P, 30P, or 60P) that means that each of those frame rates has three different looks it's capable of. And while we're pushing you over the edge, let's point out that due to the way 60P records flagged/duplicate frames, there's actually four different looks you can attain from each frame rate! That's approximately 80 different looks that can be accomplished, just in 720p mode.

Here's how it works - each acquisition frame rate is an individually-timed capture of live images. But how you play those frames back determines what the motion looks like, and three different time bases deliver three different looks. So you can't just assign a certain frame rate with a certain look (for example, you can't just say "24p = the film look"), because it depends on what frame rate you choose to play it back at. If you play it back at 24 frames per second, then yes it's an exact direct mimicry of the film look. But if you play it back at 60 frames per second, it'll instead be super-hyper fast motion!

The acquisition rate, and the playback rate, are two different things. Under normal circumstances, you want them to be the same - i.e., acquire at 24 frames per second, play back at 24 frames per second, and you get real-time action. Acquire at 30 frames per second and play back at 30 frames per second, and you also get real-time action - a bit smoother than the 24fps/24fps sequence, and less film-like, but still real-time. Acquire at 60 frames per second and play back at 60 frames per second, and you also get real-time motion. 60fps/60fps looks nothing like film, it looks like "video," and gives the smoothest strobe-free motion possible. In the 50Hz version, the equivalent would be to shoot 50fps and play back at 50fps for the "video" look.

But what happens if you acquire at 60 fps and play back at 30fps? The result is slow motion, a 2-to-1 slowdown factor. And what if you acquire at 60fps and play back at 24fps? It's also slow motion, but it's even slower: it's a 2.5-to-1 slowdown factor. And if you
acquire at 30fps and play back at 30fps, it'll be real-time, but if you acquire at 30fps and play back at 60fps, the result is 2:1 fast motion. The same frame rate, played back at different time bases, delivers different looks to the viewer.

Selecting your time base, and selecting your acquisition frame rate, are therefore interconnected when you decide what type of look you're choosing for your program. With 24P you'll have film-like footage, and the most wide-ranging slow-motion capabilities. With 30P you'll have hybrid film/video footage – it'll be smoother/less stroby than 24p, but it will still have some strobing and a somewhat film-ish look to it, and it’ll still be capable of up to 2:1 slow motion. With 60p you'll have video-looking footage, with no capability for slow motion but with tremendous fast-motion capability: imagine 1fps acquisition played back at 60fps – it'd be 60-to-1 fast motion.

Because of this, you can't just think of "60p=slow motion," because it depends on your playback rate. 60p played back at 60p is the "reality" look, or the "video" look. The acquisition rate and the playback rate work hand-in-hand to generate the final look.

A simple rule of thumb to determine what the footage will look like is to divide the playback rate by the acquisition rate. Acquiring 60p and playing back at 30p, you'd divide 30/60 for a result of 0.5:1. That means the acquisition footage will play back half as fast as real-time (0.5 times as fast). That means slow motion. On the other hand, acquiring at 24p and playing back at 30p would give you a playback rate of 1.25:1, meaning the 24p footage would play back 1.25 times as fast as real-time, for a mild fast-motion effect. 24p acquisition played back at 24fps means film-like footage; 24p acquisition played back at 30fps means mild fast-motion, and 24p played back at 60fps means super-fast motion.

Finally, let's totally push things over the top by pointing out that there's a fourth, completely different look that's possible for each frame rate. When shooting in the "native" modes (720/24pN or 720/30pN), the camera establishes the acquisition frame rate from
the menu and the playback frame rate from the mode you selected (24pN or 30pN). And the camera only records the chosen amount of frames to the P2 card – i.e., for 12fps, it'll record 12 frames per second, and for 48fps it'll record 48 frames per second. But what happens when you acquire at 60p, but use variable frame rates?

Something very different happens in that case. When establishing 60p (or 50p) as your time base, the camera always records 60 (or 50) frames per second, no matter what you establish as the acquisition frame rate. If you choose 30fps from the “FRAMES RATE” menu, and 720/60p as your time base, the camera will image 30 distinct individual frames per second, but will still write 60 frames out to the card. How does it do this? By duplicating frames as necessary. In the case of 30p, the camera will write each frame out once, and then write out a duplicate frame. On playback, you'll see 30 distinct and individual frames played each second – but there are actually 60 frames being played back; you just can't tell because half of them are duplicates so you can't discern between them. The result will look visually indistinguishable from 30fps acquisition and 30fps playback.

So what happens when you shoot 24 fps in the 720/60p mode? Frames are again duplicated, but in such a way as to conform the sequence so that it takes up 60 frames per second (see the description and example on page 35.) Because the frames are duplicated, the look is very different than what we've been heretofore discussing. We've been talking about playing back the frames on a 1-to-1 basis, so 30fps played back at a 60fps rate yields 2:1 fast motion. But when shooting with the 720/60p time-base, that's not how it actually works (although you can make it work that way in post). Because of the frame duplication issue, shooting 12fps in a 720/60p time-base results in a surreal step-printing look, where it looks like a dream-sequence or almost looks like slow motion. However, if you conform the footage to get rid of the duplicates, that same 12p sequence played back on the 60p timeline would instead look like super-ultra-fast 5:1 fast motion! Be sure to set the User Bits to FRM. RATE if you're planning to conform the footage by removing duplicate frames in your NLE.
In 480 (or 576) and 1080 recording modes, there are also a few options for undercranking, and even one for slight overcranking. For the most part it would be prudent to shoot off-speed motion in 720p mode and then have your Non-Linear Editor (NLE) convert the 720p footage to 1080i for inclusion in your 1080i program, or have the camera downconvert 720p to 480i/576i for inclusion in your 480i/576i program. But if you want to create off-speed motion effects in-camera, there are a few ways to do it.

First, we will reference DV, DVCPro, DVCPro50, and 1080 DVCPro-HD all simultaneously. All are interlaced recording codecs which work in the same basic fashion: they can all record an image that's been generated from 24P, 30P, or 60i (or for the 50Hz/European model, 25p or 50i). Normally that would give you a choice of three frame rates, all played back in an "Over 60" scenario: 24P, 30P, or 60i. 24P gives you the temporal feel of film, 30P gives a smoother rendition of motion that's sort of a hybrid look between film and video, and 60i gives the look of live video. (On the 50Hz camera, 25P delivers the temporal feel of film, and 50i delivers the look of live video). On the 60Hz camera, there is the possibility to do a little overcranking: shoot your main program at 24P, and shoot some mild slow-motion effects at 30P. Integrating 30P footage into your 24P program frame-for-frame will result in some glass-smooth, film-style slow motion. It's a mild slow motion effect, but it is film-style in that it is frame accurate genuine overcranking. Similarly, if you're shooting a 30P project, 24P could be integrated for film-style undercranking, providing noticeably faster motion than normal.

Finally, you can use the slow shutter speed to simulate a couple of undercrank speeds. In the 60Hz camera, shooting 24P at 1/24 second, and playing back at twice normal speed will result in a perfect frame-accurate simulation of 12P. Similarly, shooting 30P at 1/30 and playing back at 200% playback speed results in a direct frame-accurate simulation of 15P. And you can go another step too; using the 1/15 shutter speed (and correspondingly faster playback rate) will result in the simulation of 8P. And using the intervalometer function, you can add 1P, 2P, and 4P to the list as well.
It's less convenient to use the intervalometer, because it requires you to turn the camera off in order to exit the intervalometer function. So while it's possible to get 8p and 15p in 1080/480 modes through the intervalometer, using the slow shutter speed method is more convenient. The results, after post-processing, will be identical.

So in 720p, 20 different frame rates to acquire footage at, and four different time-base methods to play it back at (24p, 30p, 60p, or 60p-conformed-to-native), for nearly 80 different combinations; nearly 80 different creative choices available for you to use. Combined with the 9 different frame rates possible in 1080 mode, plus 9 frame rates possible in DVCPRO50 mode, the 9 frame rates possible in DVCPRO/DV mode, plus you should double the looks possible in DVCPRO50 & DVCPRO/DV modes to account for both 16:9 and 4:3 shooting modes, and that brings us to a grand total of nearly 125 different "looks" that you can create with the unparalleled HVX200.

<table>
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<th>Shoot at:</th>
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<th>And play back in your NLE at a speed of:</th>
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And, finally, we should point out that the nominal frame rate and the actual frame rate are not exactly the same. For example, in “24P” mode on the HVX, the camera is actually running at 23.976 frames per second, which is the proper speed for compatibility with the US television system. In the 50Hz camera, 25p is actually 25.000, but other frame rates are not running at precisely the same rate as they’re named. This chart shows the actual running speed for each of the frame rates:
<table>
<thead>
<tr>
<th>60Hz Camera</th>
<th>50Hz Camera</th>
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</thead>
<tbody>
<tr>
<td><strong>Stated FPS</strong></td>
<td><strong>Actual FPS</strong></td>
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<tr>
<td>12</td>
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<tr>
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<td>48.17</td>
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<tr>
<td>60</td>
<td>59.94</td>
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**INTERLACE LINES ON PROGRESSIVE FOOTAGE**

When shooting in the progressive modes of the HVX, many first-time users are disappointed or even alarmed to see interlace-line artifacts on their interlaced CRT televisions. They assume there must be something wrong with their camera, or that they did something wrong: after all (they reason) if shooting in progressive, they should never see interlace artifacts, right?

If displaying the footage on an interlaced television, the answer is "no." The interlaced television will display interlace artifacts even on progressive footage. To explain, let's first separate 30P (or PAL's 25P) away from 24P. The way 24P is recorded, there will be frames that are blended together in the recording – that's unavoidable, if you're not using 720p. In 1080i or 480i, 24P blends two frames together out of every five, and 24P Advanced blends one frame out of five (see the prior discussion on 24P vs. 24PA for the reasons). However, 30P (and 25P on PAL) record with no blended frames: each progressive frame is written out to two fields of video (called a “frame” of video); there is no blending or field-mixing occurring.
When displayed on a progressive device (such as a computer monitor) you won’t see any interlace artifacts from 30P/25P footage.

But on an interlaced television, you’ll see lots of interlace artifacts. It’s unavoidable, based on the way interlaced televisions function. And any standard CRT-based television will be interlaced; this applies for standard-definition as well as high-definition 1080i.

For the sake of clarity in this discussion, we will define the term “frame” to mean a complete, discrete picture of full resolution (similar to how the term is used to describe an individual “frame” of movie film). In DV video, a frame consists of 480 horizontal scan lines, each containing 720 pixels of information (for NTSC; in PAL a frame consists of 576 scan lines of 720 pixels each). In high-definition, a frame consists of 1080 scan lines.

Interlaced televisions do not display “frames,” and much confusion comes about when people describe NTSC televisions as running at 29.97 “frames” per second, or PAL televisions at 25 “frames” per second. These television systems do not ever display actual “frames.” What interlaced televisions display is a series of “fields,” and the term “field” can be described as basically 1/2 of a frame, consisting of (alternatingly) the even or odd lines. Fields are not divided in half by something as simple as “top” or “bottom,” instead each pair of fields consist of one field that contains every even scan line, and one field that contains every odd scan line. Because the fields are divided in this manner, interlaced televisions can provide the illusion of updating the entire display every time, when in reality it’s updating only half the picture (the even lines or the odd lines). Because the television displays the even lines, followed by the odd lines, the image is said to be “interlaced.” Think of it as clasping your hands together: the result is a unit that consists of 10 fingers, interlaced together. The “even” fingers may belong to your left hand, and the “odd” fingers to your right hand, but when clasped together they form a 10-finger unit. That’s basically how interlaced televisions work: they have one field that consists of the “even” lines, and one field that contains the “odd” lines, and they get drawn on the television one after the other.
Televisions "paint" the image on the screen, using a raster scan system that starts at the upper-left corner and draws an entire line, then it starts over at the left again, skips a line and draws the next full line, and so on until it's drawn an entire field, every other line. After completing an entire field (say, the "even" lines) the raster beam will start back at the upper-left corner, drop down one line, and commence drawing in all the odd lines. When the raster finishes drawing all the odd lines, it's said to have displayed a "frame," since all the even and all the odd lines are existing on the display at the same time.

Now, the question of how progressive scan can display interlace artifacts can be more easily understood when you understand that the television doesn't draw two fields and then take a break, as it were: instead the television regularly and continuously draws new fields: Frame 1 Even, Frame 1 Odd, Frame 2 Even, Frame 2 Odd, etc. It draws these fields at regular and continuous intervals in time. At any particular moment in time, two fields will be displayed: there will always be an even field, and always an odd field being displayed by the television. But fully 50% of the time, those fields will not be coming from the same source frame!

The following illustration will show how this works. Assume that when recorded, our 30P video consisted of four distinct progressive-scan frames, like so:

```
A
B
C
D
```

If this sequence were to be played back on a progressive-scan device, such as an LCD television, a computer monitor, or transferred to film, you would see exactly that: a progressive-scan sequence of frames, with no interlacing and no artifacting. However, if played back on an interlaced TV, you'll instead see something that looks more like this:
Because the interlaced television runs at 60 fields per second, it will actually update twice per frame, drawing the odd and then the even lines. So for the first frame, the odd and even lines of frame “A” get drawn. When moving to the next frame, it will draw the odd lines, but the even lines from frame “A” are still displayed! So for that instant, that 1/60th of a second, you will see an interlaced split-field frame on the television. The next 1/60th of a second the television will draw the even lines from frame “B”, and it will look proper. But the next 1/60th of a second, it will draw the odd lines from frame “C”, and again you’ll see an interlaced frame on your television.

This is not a problem with the camera, it’s an inevitable occurrence that happens from mixing media, trying to display progressive content on an interlaced display. Watch carefully in movies that have been transferred to video, and you’ll see the same effect. Film frames are transferred to video the same way the HVX transfers its progressive frames to video, and the television displays them the same way, so you will see the same type of effect. But, again, display your progressive footage on a progressive-scan display and you’ll see it in all its pristine progressive nature.

When editing on the computer, if you shoot in 30P (or 25P in PAL) you should never see an interlaced frame. However, when shooting 24P, it’s entirely possible that you will see interlaced frames. Because the frames are recorded in their interlaced format (as shown in the examples above and also in the 24P vs. 24PA article), importing that footage into a 60i timeline will bring it in exactly as it’s written to tape (or on the card). And on the recording, some frames are blended. On the computer screen, you’ll see blended frames. The way around this is to be sure to use an editing program that’s capable of extracting the “pulldown” from the footage. Use a program such as Apple’s Final Cut Pro™ or Canopus’ EDIUS Broadcast™, edit in a 24P timeline, instruct the program to
remove pulldown from imported footage, and the program will automatically discard split frames out of 24PA footage, or split up and recombine footage from 24P footage, to give you access to the original 24P frames with no interlacing lines. Of course, if you intend to output that footage back to DV tape (or VHS tape or any other NTSC video standard) you will have to “re-introduce” pulldown, since 24P footage cannot be recorded on NTSC unless it has pulldown introduced, which rounds out the 24P sequence into a grouping of 60 NTSC fields. The same applies to high-definition 1080i; it must always be conformed to 60 fields (60Hz) or 50 fields (50Hz).

THE P2 WORKFLOW

In film postproduction, editors used to handle huge reels of film, poring over an editing bench while cranking the film through frame by frame, and using a razor blade and glue to cut and splice the film together. In the early days of video postproduction, editors used to connect two videocassette recorders together and edit tape-to-tape, copying from one tape to the other. Both workflows were tedious, slow, error-prone, and costly – mainly in hours and hours of labor.

The introduction of the nonlinear editing computer revolutionized video and film post-production. Editing on film (and tedious linear tape editing) have been obsoleted by newer nonlinear technologies. Editors now have instant access to all their clips, the ability to scan through and quickly select video clips, rearrange them instantly, experiment and try things out before committing to them – all things that were not possible using the old, traditional editing methods.

Some people resisted the change; they were uncomfortable with the idea of their footage existing only electronically, they missed the feel of the film in their hands and being able to hold the videotapes. Such people quickly found themselves on the outside, looking in at a marvelous new workflow, one with unparalleled efficiency and affordability. Those who were able to let go of the old workflow and
embrace the new were richly rewarded while those who could not let go of the old workflow found themselves obsolete.

Nonlinear editing revolutionized post-production. A similar revolution is underway for the actual acquisition of images. Since the first video cameras were introduced some 30 years ago, acquisition has always been to videotape. Tape is old, it's familiar, it's "comfortable" — and it's also extremely inefficient and very limiting. The physical issues with tape are well known -- the media is fragile, prone to head clogs and head wear, timecode breaks, it can crinkle or wrinkle or get chewed up in the deck or break, it can be erased by magnetic fields, tape formats come and go so quickly that you risk having obsolete media, and it's subject to particles flaking off causing "dropouts." But perhaps its biggest limitation is in its ability to access data. Tape is an inherently linear format, and you have to actually play the tape in order to know what's on it. This means you have to have at least two things: a compatible tape playback deck, and a lot of time. A third thing (comprehensive timecode logs) can help minimize the searching process, but the process is all too familiar: put the cassette in the machine, and hunt for footage: fast-forward, play, pause, rewind, play, fast forward, play, and then perhaps realize that this isn't the clip you really wanted, so you stop, fast forward, wait, then hit play, rewind, play... ad nauseam, all the while being aware that every time you play the tape, you run the risk of encountering more dropouts. Finding the clip you want on a tape can be slow, tedious, and (on an hourly-wage basis) expensive.

That's all changing. Tape is slowly but surely fading away. Just as computer cassette drives yielded to hard disk, audiocassettes yielded to CDs, professional digital audio tape is yielding to solid-state recording, and film photography cameras are being challenged by digital cameras employing solid-state memory chip recording, now videotape can be replaced by nonlinear acquisition media, such as the P2 memory card.

P2 recording brings all the benefits of nonlinear acquisition to the production community. No more tape, no more tape hassles, and
easier, more powerful postproduction processes are now possible. The P2 recording system is solid-state memory, based on the same SD memory cards behind the digital camera revolution. A P2 memory card is large enough to record standard-definition and high-definition video, storing it in such a way that it is instantly accessible for reviewing, editing and archiving. Additionally, P2 recording opens up options including the ability to keep only the “good” footage, instant review of prior clips, buffered pre-recording, variable format recording, loop recording and more, all with no moving parts, no head wear, no tape clogs, no timecode breaks, and no waiting.

Replacing tape is a challenging, even daunting idea for some people to accept. After all, tape has been the default medium of recording since the dawn of the video camera era. Taking away tape makes some people uncomfortable. But, just as word processors replaced typewriters, and telephones replaced telegraphs, solid state memory recording will replace tape. It's inevitable, it's already happening, and it's liberating. Among initial user reports from new HVX200 owners, most reviews say something along the lines of “I never want to see a tape again.”

Think about the revolution in digital cameras. From the beginning, cameras have used film. Film is a physical medium, very much like tape in appearance, and developed film led to a physical negative and a physical print. But with digital cameras, rarely is a print made. Images are shot digitally and stored on a memory card. Users can preview their shots, keep the shots they like, delete the shots that didn't work, and keep shooting until the card is full. If the card fills up, the user can either plug the card into a computer and off-load the images, or remove the card from the camera and insert a new card and keep shooting. Digital cameras let the user choose variable resolutions to photograph at - high resolution means sharper photographs, but less storage time on the card; lower resolution means lesser-quality photographs but more storage time on the card. Finally the user imports the footage into their computer (either via USB, or by plugging the card directly into the computer)
and can then edit the photos, e-mail them, archive them, or, for those who want a hard copy, they can print the photos out. All of this can be done with just one memory card, or maybe two. No longer does the photographer have to wait for film to be developed, or buy more rolls of film, or store the negatives, or make prints of shots that s/he won’t use. Nor does the photographer need to own dozens or hundreds of memory cards – the memory cards are re-usable.

Now let’s apply the same idea to video acquisition. The P2 card lets the video camera record directly to a memory card, just like the digital still camera does (in fact, the core components of the P2 card are four SD memory cards, striped together into a high-speed, high-capacity RAID array). The tape drive (and the limitations of tape) are completely eliminated. The card plugs into the camera just like a memory card plugs into a digital camera. The user shoots video onto the card, and can instantly access it/review it. No rewinding or hunting or searching for a clip is necessary; all clips are instantly available via “thumbnails.” Just select the clip you want to view and it will play back instantly. The user can choose to delete unnecessary clips right away – something that’s impractical (if not impossible) to do with tape. If you know for a fact that you can’t use a shot (perhaps there’s a boom mic throughout the clip) you can just delete it, freeing up room on the card. Instantaneous access is also a boon for continuity checking – no longer do you have to remember specifics of the shot (i.e., “did he carry the briefcase in his right hand or his left?”) Instead you can instantly review the shot in question, all with no rewinding, no fast-forwarding, no accidentally “taping” over your good footage, no hunting or skipping through clips. It’s instant, because it’s random-access memory.

Also, because it’s memory, data other than pure raw video can be stored as well. You can mark a clip as “good”, similar to a “circled” take by the script supervisor. You can make notes that get stored with the clip (very useful for searching your archives, discussed later). And, you can store various types of clips. Because the P2 system is not a tape system, it’s not bound to conform to the restrictions that tape imposes (such as recording a certain format
at a certain speed). You can store miniDV data, DVCPRO data, high-quality DVCPRO50 data, or even high-definition DVCPRO-HD data, all on the same card.

Again, just like the digital still camera memory card, the P2 card can be removed from the camera and inserted directly into a computer – the P2 card will appear to the computer as an external removable hard disk. From there you can edit the footage instantly! There is no process for “capturing” the data, because it’s already captured on the card. You can edit, organize, copy, archive, delete, annotate, or in any other way modify and manipulate the data, because it’s ready to go, in computer-readable format. The P2 card conforms to the PCMCIA/PC Card Type II Cardbus specification, so it is directly compatible with any laptop computer that has a Cardbus slot, and can be used with inexpensive (under $100) 32-bit PCI CardBus adapters on desktop computers. This is a tremendous cost savings for the production facility or independent producer, as it completely eliminates the need for expensive tape decks for digitizing. And even the cost of a card reader can be eliminated, as the cards can be left inserted in the camera, and the camera can be plugged into a Windows computer via USB2 or a Macintosh computer via 1394 (in which case the camera appears to the computer as an external hard disk, and the contents of all P2 cards inserted in the camera are available to the computer).

Just like with the digital still camera, you can then copy the files, transfer them across the network, edit them, organize them, sort them, archive them, delete them, or whatever needs to be done. And, just like how you can print out your digital still photos, you can always output your P2 card contents to tape (or hard disk, or DVD, or blu-ray or HD-DVD or any archival or delivery medium).

Digital still cameras have become an extremely hot consumer and professional product, threatening to obsolete film cameras in many applications. P2 provides all the same benefits to the video shooter, and many more.
Additional benefits of P2

Because the P2 card stores data (and any kind of data) it's capable of doing things that tape never could. For example, a P2 card can be set to continually loop record, recording the full capacity of the card as a "pre-roll" buffer. This can be incredibly useful for sports, news, and event coverage. In "Loop Record" mode, the available space on both cards is used as a rewritable recording buffer; you initially trigger recording and from then on the camera is constantly recording into that buffer; once you press "record" again, it commits that buffer onto the card. This way you can let the camera roll and roll and roll, and only stop recording once you know you’ve got the shot you were looking for. If you were covering an interview with farmers in a corn field, and a UFO landed behind them, there’s no need to panic and stab at the "record" button on the camera, worrying that you’d “missed the shot” – the camera would already have been recording! And because P2 is solid-state memory with no moving parts, there’s no head wear, and no reason not to take advantage of features such as continuous loop recording.

Another benefit is silent operation. The higher-capacity the tape drive in a camera, and the more heads in the tape mechanism (as well as the faster the heads spin), the more noise a camera makes. But with the P2 camera recording to P2 media, there are no moving parts in the recording mechanism, so recording is utterly silent.

Then there’s reliability – P2 is a solid-state, relatively indestructible medium. It's practically impervious to temperature, weather, condensation, dew, heat, vibration, magnets, x-rays, dust, dirt, or any of the other potential hazards that can affect tape (or hard disk or optical disk) recording methods. P2 recordings don’t suffer dropouts, dropped frames, or media errors, unlike hard disk/tape/optical disk recording mechanisms. P2 systems will also never have dirty recording heads or have to replace the heads, because there are no heads – which means lower maintenance costs and increased reliability.
Another benefit is space efficiency. P2 cards can potentially store more usable footage than one usually finds with tape. Consider that with DVCPRO-HD tape, when shooting 720p, the tape always records at 100 megabits regardless of the actual frame rate being shot (100 megabits equals approximately 13 megabytes per second), and the longest tape load is about 46 minutes. With P2 memory recording the camera can choose to only record the “Activ. Frames.” This means that when shooting 720/24p, you can get 46 minutes of footage on two 8GB cards, cards that might otherwise have been only able to store about 16 minutes of footage, at the exact same quality. And, considering that you can delete “bad clips” immediately, a P2 card may store more usable data than the equivalent tape would. On a 46-minute tape, after digitizing you may find that you only have maybe 12 to 20 minutes of usable footage. On the P2 cards you can delete the unusable data right away, leaving plenty of space to capture only the actual usable shots. You may find an increased recording efficiency of 2:1, 3:1 maybe even 4:1 on the card (i.e., on tape you may record only 20 minutes of usable data on a 46-minute tape. On P2, if you delete the unusable stuff, a single 8GB card may end up holding just as much usable data as you would have gotten on a 46-minute tape, using traditional workflow methods).

Infinite record times become possible with P2 as well. Because P2 cards are hot-swappable, and because all P2 cameras include multiple card slots, one could theoretically record perpetually on a P2 camera. As long as you have empty cards, you can pull out full cards and insert empty cards and keep recording continuously; the camera knows to roll over from a full card to an empty one and to link the footage together so that it can be reassembled into one long continuous clip in the edit bay. This is something that a single tape camera could never do – with P2 recording, you never have to stop recording, as long as you can keep swapping in cards. With tape, sooner or later you’ll have to stop the tape and swap it out, but with P2, you never have to stop. (You would, however, need a very sturdy tripod to keep from jiggling the camera when swapping cards!)
Finally, another benefit of P2 is that the media it records is raw data, not dependent on any other factor, so scalable camcorder formats become a possibility. Previously a camera's recording capability was determined by its tape format, as (for example) a miniDV tape transport couldn't record a DVCPRO-HD data stream. And a DVCPRO-HD recording system couldn't record a DV signal. But with P2, any type of data could be recorded. This makes possible cameras such as the AG-HVX200, which records DV, DVCPRO, DVCPRO50, and DVCPRO-HD formats, in all resolutions including SD 4:1:1, SD 4:2:2, HD 720p, HD 1080p and HD 1080i.

While a P2 card may appear to initially be expensive, one needs to consider that a P2 card is a one-time purchase. It is reusable, with no moving parts to wear out, and no worries about taping over the footage. It's not like tape, where you'd want to buy new tapes for every event. With a P2 card you shoot with the cards that you have, and offload the data to another medium to free up the card for more shooting (just like with a digital still camera). During a production you may be offloading the cards into a laptop computer or onto an external 1394 hard disk.

Delivering a hard disk full of P2-recorded data can also be less expensive than tape as well. Even if shooting at a 1:1 ratio (and not taking advantage of the efficiencies involved in deleting unusable clips during shooting), P2 recording to hard disk storage is less expensive than recording directly to high-definition videotape. Consider that three hours of DVCPRO-HD tape costs about $150; archiving three hours of P2 720/24p footage to hard disk could cost as little as $40. Even archiving three hours of P2 1080/60i footage to hard disk would cost as little as $100.

Furthermore, shooting on P2 provides more compatibility with NLEs and editing suites. No longer must you worry over whether the producer, his chosen post-production facility, or the town you're working in even has access to the right type of tape deck – a P2 card will plug into any laptop computer with a PCMCIA CardBus slot (or appropriate adapter.) Gone are the days when you'd turn over a
tape to a producer and he'd say "what format is this?" Now you can plug the card (or the camera as a card reader) directly into any computer, or offload onto an external IEEE 1394 hard disk in a file format that's compatible with any Mac-based or Windows-based computer operating system. Leading NLE systems such as Apple's Final Cut Pro, Canopus' EDIUS Broadcast, and Avid's Express Pro HD natively support the P2 cards and P2 data, including DVCPRO-HD, DVCPRO-50, DVCPRO and DV. For other NLE's, file conversion software exists to convert the P2 card's "MXF" data into standard Quicktime or AVI files.

**Shooting scenarios with P2**

How would P2 recording work in a real production environment? Considering that the cards are currently (May 2006) limited in capacity, can actual work be done on a 4GB or 8GB card? Let's examine P2 recording in the context of four typical production scenarios: the television commercial, the independent feature film, the news photographer, and the wedding videographer.

**The Television Commercial:** P2 recording works ideally for television commercial production. The 4GB P2 card and its capacity (4 minutes of 1080p, 10 minutes of 720/24p) bears quite a resemblance to the film workflow employed on high-end television commercials, such as national car commercials or restaurant commercials. On film shoots, the film camera may come equipped with perhaps two or three film magazines. A 2nd Assistant Cameraman will be assigned the job of loading the magazines with film, and unloading them when the film has been shot. The magazines will be kept loaded with film, so that the movie camera can quickly swap out a shot magazine for a fresh one. The 2nd AC will then take the shot magazine into the film tent, unload the film, and prepare it for delivery to the lab, and then re-load the empty magazine with fresh new film.

A 35mm film magazine typically comes in two sizes, 400-foot and 1,000-foot. A 400-foot magazine lasts for approximately four and a half minutes of shooting; a 1,000-ft magazine lasts for
approximately 11 minutes. With P2, a single 4GB card can store approximately four minutes of high-definition 1080/24p (about the same runtime as a 400-ft load of film), or approximately 10 minutes of high-definition 720/24p footage (roughly equivalent to a 1,000-ft load of film). Of course, that 1,000 feet of film will cost about $600, plus about $150 to process it, plus about $400 more to transfer it to video so it can be edited, whereas the P2 card costs less, incurs no additional costs, and the footage is immediately edit-ready. And the P2 card is re-usable, something that can’t be said for film. The film negative is an archival medium, so you would need to factor in costs to archive your P2 footage; consider that a 50-cent DVD-ROM can archive a 4GB card and there are many other archival options as well.

The P2 metaphor directly mimics the film metaphor: a P2 shooter would have two or three empty P2 cards at the start of the shoot, similar to freshly-loaded, unshot film magazines. As a card gets filled up, it would be handed over to an assistant who would “unload” the data (by copying it to hard disk or a P2 Store, and perhaps archiving to optical disk). The assistant would then erase the card (which is similar to loading it with fresh, unshot film) and stand ready to load it back in the camera. It’s a familiar, well-established workflow, and P2 fits very neatly into it, while optimizing costs and providing tremendous workflow benefits (such as the ability to immediately see and review shot footage, something that’s impossible with film).

*The Independent Feature Film:* again, P2 fits in perfectly with the film workflow. On an independent feature film, shooting on 16mm film, a 100’ spool of 16mm film will last for about 2:45 of shooting time. That’s less running time than a 4GB P2 card recording 1080/24p high-definition footage. A 400’ load of 16mm film will last for 11 minutes, again about the same as a 4GB P2 card shooting 720/24p, and an 8GB card shooting 1080/24p would provide almost as much runtime. When shooting film, long record times are usually not an issue, since the longest film magazine in conventional use will allow for only 11 minutes of record time (although 800’ magazines
do exist.) Magazine change-overs are directly comparable to the P2 offload/erase cycle, with the main difference being an incredible savings in money, plus immediate access to the footage. The P2 workflow is ideally suited for independent feature film production.

**The News Shoot:** here P2 recording is unparalleled. When shooting news, an overriding consideration is immediate turnaround. News shooters need to get the shot, get it to the editor, and get it on the air. P2 provides for instantaneous edit; the shooter could actually edit the spot right on a laptop during the ride back to the station, or even edit it in the truck and uplink right in the field. There's no need to digitize, or even to transfer the footage, footage can be edited directly from the card or directly from the camera. And news shooters find themselves in all sorts of inhospitable conditions – weather (tornado, hurricane, earthquake etc), disaster (flood, fire, etc), civil unrest, etc. The rugged, dropout-proof, heat-proof, vibration-proof, weather-proof P2 recording system gives the news shooter the most reliable recording system to get the shot; the recording will be clear and usable, and the footage will be instantly accessible.

**The Wedding Videographer:** wedding videography is a challenging environment, one in which dropouts and tape jams are completely unacceptable. The wedding videographer is tasked with capturing once-in-a-lifetime memories in a highly stressful situation – nobody wants to explain to the mother of the bride that there was a "dropout" during the vows, for example. P2 offers some benefits for these shooters. However, wedding videographers also need long record times, and until larger-capacity P2 cards become available, P2 may not be the ideal recording medium for long-form events. Wedding videographers may find that they may want to stick with a hard disk recording solution such as the Focus Enhancements FireStore™ FS-100 until larger P2 cards are introduced at a price where they are an affordable alternative. Because P2 cards are based on industry-standard (and widely-used) SD memory cards, P2 cards will benefit from the same downward pressure in price
that has accompanied SD memory cards, and large capacity P2
cards should become more available and more affordable in short
order. For event and wedding videographers, the smaller 4GB and
8GB cards may not provide enough runtime, but the FS-100 offers
over 100 minutes of continuous recording, with a similar style of
workflow, and would probably prove to be an acceptable alternative
for many long-form shooters.

**The P2 workflow**

Swapping cards and offloading them mean a change in workflow
from what tape shooters are used to. It’s different. In some ways,
it’s limiting; and a change from the familiar is always a little
uncomfortable. But there are benefits that can be realized from
shifting to the P2 workflow – not the least of which is that DVCPRO-
HD, a format previously found on camcorders costing upwards of
$32,000, is now available in an affordable handheld camera. At the
camera’s introduction, the 4GB card is the most common available
size. The 4GB card is also the smallest P2 card that can be used with
the HVX200. As such, the card-swapping workflow will be at its
most prevalent in the camera’s early days. As card capacity grows,
swapping will become less and less relevant. P2 cards are (as of
May 2006) available in 4GB and 8GB capacities, with 16GB, 32GB,
64GB and 128GB card sizes planned for introduction as soon as the
underlying SD memory card technology is developed. When the
128GB cards are available, two of those will allow a single HVX200
to record over four hours of continuous 1080i video, or over ten
hours (10 hours!) of 720/24p video in a single take! No tape-
base camera can come close to those running times. Obviously
128GB cards will be quite expensive when first introduced, but the
constant downward pressure being exhibited on SD card prices will
have a direct influence on P2 card pricing.

Delivering footage to a producer also requires a re-examination
of the workflow process. There’s no doubt that people are going to
have to get used to this new tapeless idea. Tape’s been with us since
the first cameras came out decades ago, and people are familiar
with the process of hiring a shooter and taking the tape from them
at the end of the shoot day. This tapeless/hard-disk approach is new. Tape represents a “comfort zone” for many people because it’s familiar. Not “better,” mind you, but “familiar.” But that’ll change. It’s like the changeover from the typewriter to the word processor -- really, how many of us use typewriters anymore? The first time you give a hard disk to the producer and the editor plugs it in and begins editing, that will be the last time you ever hear that producer say “we need a tape.”

The other thing to remember is, tape used to be compatible. Now that’s not necessarily so. Back in the “old days,” BetaSP meant BetaSP -- any BetaSP tape from any manufacturer would play in any BetaSP camera or any BetaSP deck, regardless of manufacturer (Ampex, Sony, Ikegami, etc). Now with HDV, it’s not that way. As of the time of this writing (May 2006) a JVC HDV tape won’t play in a Canon HDV camcorder, or vice versa. Now a Sony HDV tape won’t play in a JVC deck. Now a JVC or Canon 24F/30F tape can’t be played and/or digitized in a Sony deck. And, assuming that you actually do have a combination of camera/deck that actually is compatible, is your editing program? Even if you have equipment that can read the tapes, you may not be able to use them.

So while things are in such a state of transition, why not skip the whole tape mess and use this opportunity to go tapeless and reap the benefits? FCP, Avid, and Canopus are all P2-compliant and MXF-compliant. The hard disk eliminates the question marks about deck compatibility; a FAT32 hard disk will work on a PC or Mac system. The recorded file format is a SMPTE-codified standard: Op-Atom MXF. Even if the editor is using an editing program that doesn’t natively support it, there’s a file conversion program that can be used to convert the MXF files into standard .AVI or .MOV files. The same can’t be said for tape incompatibility -- if the Sony deck won’t play the Canon XLH1’s 24F footage, there’s no conversion program you can run to get past that -- instead, you’d have to go out and buy or rent an XLH1 to play that footage. By moving the footage into the data domain, incompatibilities like that can be rectified with software updates and driver downloads, rather than having to replace gear.
So during the transition to affordable high-definition production, delivering footage on tape is a workflow that's currently in flux. Yet with the HVX200, what other options are there? Three immediately spring to mind: hard disks, DVDs, and rented P2 cards.

If you're dealing with a short amount of footage, DVDs and dual-layer DVDs are one potential medium for handing to the producer. Most modern laptop computers include DVD burners; it's a simple matter to insert the P2 card into the laptop's PCMCIA slot and copy the contents onto the internal hard disk, and then to burn a data DVD-ROM of the contents when you're through. A single-layer DVD can easily hold the contents of a 4GB card, and a dual-layer DVD could hold the contents of an 8GB card (or two 4GB cards). DVD isn't necessarily the fastest means for delivering footage, of course, but it's certainly the least expensive way to go, and for small-footage projects a data DVD-ROM could be the right medium to hand over the footage to the producer.

For projects with more footage, a hard disk is probably the best choice. External hard disks are startlingly inexpensive now, and getting cheaper every week. Hard disks are less expensive than DVCPRO-HD tape already. For a longer-form workflow, one would shoot until the card was full and then load the card's clips onto the laptop's hard disk. At the end of the day, you could copy all the dubbed clips to an external drive, for handing to the producer to take to the editor. This gives you data redundancy as well: you'll have two copies of the footage -- one on the laptop, and one on the external 1394 or USB2 hard drive that you give to the producer. For workflow efficiency, it can make more sense to copy to the external drive as you go. If you save up to copy the entire contents at the end of the day, it can make for a long copy process. If you tell the laptop that as soon as it's done ingesting each card, to start copying that card's contents over to the external drive, then it's all done in a multitasking scenario and you'll have a producer's edit-ready drive full of footage within minutes of wrapping the shoot day.
Finally, the producer may choose to bring his/her own rented P2 cards to the shoot. While P2 cards may seem comparatively expensive to buy, they would be much more affordable to rent. The producer can budget how much footage s/he expects to acquire throughout the day, and rent enough cards to cover that amount of footage. You’d then shoot to the cards and hand each full one over to the producer (write-protected, of course). It would then be the producer’s responsibility to copy the card contents to their own hard disks or archival medium, and return the cards to where they had been rented.

Archiving
Just like shooting with P2 changes the acquisition method from linear to nonlinear, archiving your P2 footage requires you to change your perspective as well. In a tape-based environment shooters would frequently shelve their tapes and call that an “archive.” Many DV shooters have shelves and boxes full of camera-original tapes, and many of us have no specific idea exactly what is on those tapes! While we may vaguely remember that we have a certain shot somewhere on tape, actually locating and extracting that shot can be a tedious, laborious process. It involves pulling out tapes, playing, fast-forwarding, playing, scanning, stopping, rewinding, and then moving on to the next most likely tape candidate for our desired footage. This can take hours of searching. And, once the footage is found, it then needs to be captured back into the nonlinear editing system, hopefully without dropouts.

With the P2 system, there is no camera-original media to archive. P2 is not an archival medium, instead it’s a container that you fill and empty. P2 cards are meant to be re-used, and the footage on them should be archived off to some more permanent data storage medium. There are several potential archival systems, and we’ll discuss some of the more pertinent and viable solutions. However, the key thing to keep in mind is: you’re not archiving “video footage.” You’re archiving DATA. The footage is stored on the cards as data, and manipulated by your computer as data. It should be archived as data as well, in order to make the best use of it.
What do we mean by “archived as data?” To explain, let’s take the case of archiving the footage onto DVCPRO-HD tape. DVCPRO-HD tape is videotape – it’s digital videotape so it can be used to store a direct digital copy of your footage, but it’s not data tape, it’s videotape. Archiving your footage onto DVCPRO-HD tape, using a 1394-enabled deck such as the AJ-HD1200A, can result in making a permanent copy of your footage that can be retrieved in the future. However, there are some significant drawbacks to this technique, at least as compared to other archival techniques. For one, turning the P2 data on your hard disk back into videotape on the deck means that you’ll lose most of the metadata that’s associated with your clips – the location information, the notes, the thumbnails, all that information disappears. Only the video and audio data get archived, and the info that you’ve stored in the user bits. Additionally, putting the clips back on videotape eliminates the individual file-based nature of the clips (when the camera starts and stops recording, it creates a unique file on the hard disk for each clip. But when archiving to videotape, all those individual files instead become one long continuous stream of videotape). Restoring a clip from a videotape archive would mean having to search for “in” and “out” points and digitizing that section through a video capture application. And, last but not least, this whole process requires having a comparatively expensive deck! Not that you have to buy the deck, of course – you may choose to rent it on a job-by-job basis, but even that may add up quickly. So videotape is a way to archive your footage, but it’s not the best way. There are many options that are better for archiving. Videotape can be a great way to deliver footage though; if your broadcaster requests DVCPRO-HD tape masters, it’s nice to know you can make a tape copy that preserves the original digital picture information 100% accurately.

Now we’ll examine the concept of archiving as data. The footage the camera shoots is stored on the P2 card as data files – there are video data files, audio data files, and metadata data files. Those files can be accessed by the appropriate type of computer programs (such as a nonlinear editing program or the P2 Viewer program), and they can be copied and pasted and moved and duplicated and
archived and deleted just like any other type of data file. So when archiving, it makes the most sense to archive those files as data. One example would be to archive the contents of a 4GB P2 card onto a regular 4.7GB DVD-R disc. A DVD-R is very inexpensive and a single-layer DVD-R disc can hold the contents of a full 4GB P2 card. Using a DVD burning application, you could create a data DVD-ROM that archives all aspects of the P2 card footage – the video, the audio, the individual clip-based nature of the files, the metadata, the thumbnail pictures, everything. And restoring a project from this DVD would bring all those files back, or only the files that you chose to restore. Furthermore, in the metadata you can assign certain words that you could use as search terms – for example, you could look at a particular clip (say, a sunset clip) and then add metadata that describes it as “sunset over Santa Monica Pier, California, May 2006.” Years from now when you decide you need that sunset footage that you know you have archived “somewhere,” you can simply pop the various DVDs into your computer’s drive and tell the computer to search the metadata files for “sunset” or “pier” or whatever search term you remember to use. Instead of shuffling through hours of tape, the computer will complete its scan in seconds. It’ll find the metadata and point you towards the video clip. Or, alternately, you could put the DVD in the drive and view it in the P2 Viewer program – the computer will show you the thumbnails for each clip, helping remind you as to what clips are on that disc. And if you choose to restore one of those clips, you can simply drag and drop the clip back onto your computer. No need to worry about timecode or fast-forwarding or rewinding – the whole clip is instantly accessible to you.

DVD-R’s may not be the most practical way to archive large amounts of P2 data, but they do help to explain the basic idea behind archiving the clips as data, rather than as tape. There are many data archival technologies available at the time of this writing, and more on the horizon. Some archival systems to look at would include DVD-R (which can hold the contents of a 4GB card), dual-layer DVD-R (which can hold two 4GB cards or one 8GB card), or data tape such as DLT, LTO, or SAIT, or high-density optical discs such as Blu-Ray or HD-DVD (15 to 50 gigabytes per disc),
or the forthcoming holographic blue laser drives from companies like InPhase, which range from 300GB to 1600GB of storage. All of these technologies promise large quantities of storage at a low price, especially as compared to videotape: DVCPRO-HD tape costs about $46 for a 46-minute tape, or $1 per gigabyte. A 4-gigabyte DVD-ROM costs approximately 50 cents, or about 12 cents per gigabyte, 1/8 the cost of videotape.

DVD and dual-layer DVD can work for archiving small projects. They're small, quick, easy to store, and DVD-burning drives are very inexpensive. They do have their own share of drawbacks, of course—the long-term shelf life of DVD-Rs has yet to be proven, and DVDs are fairly slow to write and also slow to access. As your projects grow in size, though, you may find that you need more and more DVDs and dual-layer DVDs to back up all your data. There comes a point where DVD archival just isn't practical. At that point you may want to look into either Blu-Ray or HD-DVD optical recording. These are next-generation DVD technologies that are based on blue lasers rather than the current DVD's red laser technology. They can store much more data per disc: HD-DVDs can handle 15 to 30 gigabytes, and Blu-Ray players can store between 25 and 50 gigabytes. These new burners will offer more capacity than standard DVDs, although at a higher initial price point per gigabyte, and the drives will be more expensive than standard DVD burners, although less than data tape drives.

For large backup capacity at affordable prices, it's hard to beat data tape drives. It's important to understand that data tape (and archiving data onto tape) have been around for many years and the technology behind data tape archival is quite mature. Data tape archiving is used in major companies for all manner of data—the stock exchange, banks, credit card companies, major databases, all manner of companies who have massive data libraries have been using high-capacity data tape storage systems to archive their valuable data. DLT, LTO, and SAIT drives are common high-capacity data tape systems; while they're not cheap, they are all significantly less expensive than a DVCPRO-HD videotape deck, and substantially faster at writing and retrieving data as well. A
160-gigabyte Super-DLT drive can store around three hours of DVCPRO-HD 1080i footage, or around seven hours of 720/24p footage, on a single $40 cartridge, at a cost of about $0.25 per gigabyte (2006 pricing). The tape cartridges are about 1/2 as expensive as videotape, and the drive is about 1/8 the cost of a DVCPRO-HD videotape deck. LTO drives have even higher capacity, up to 400 gigabytes per $100 tape cartridge (meaning six and a half hours of 1080 footage, or around 16 hours of 720/24p footage per tape!) Note: when measuring tape drive capacities, you'll often see them listed as something like 200/400GB, which refers to the uncompressed and compressed capacity – data tape drives can employ compression when writing the data, so for normal computer data, the drive may be able to fit 400GB worth of data onto a 200GB tape. However, DVCPRO-HD data is already compressed and the tape drive's compression will gain little if any additional space, so always use the first number (i.e., the "200" in a capacity of "200/400") to know the true drive data size.

Finally, looking to the future, InPhase (and other companies) are developing holographic data storage systems. While that sounds like something out of a science-fiction TV series, it's actually a fascinating technology that takes optical disc to the next logical level – using three dimensions to store the data results in massive data storage capabilities while simultaneously providing extremely fast transfer rates. InPhase has announced that they expect to have the first generation of holographic burners on the market as soon as September 2006, with a 300GB capacity and a phenomenal 1 gigabit per second transfer rate (which is 50% faster than the transfer rate of a P2 card, and 10 times as fast as DVCPRO-HD videotape). Larger capacities are planned, an 800gb version is planned for 2007 and the format is planned to eventually evolve to almost 4 terabytes (4,000 gigabytes, or a single disc holding the contents of 1,000 4GB P2 cards).

For temporary storage, you can also consider archiving to hard discs. Hard disc storage is becoming incredibly inexpensive, rivaling the capacity and cost of a data tape cartridge. Archiving to hard discs would be one of the fastest ways to archive, and
search, and retrieve your data. However, long-term archiving to a hard disc is not necessarily the most reliable way to save your data, and a hard disc crash could render the entire contents of the drive inaccessible. If you need your footage readily accessible, hard disc archiving may be the way you want to go, but prudence would dictate having redundant copies of your data.

As for what to archive, the P2 acquisition method can cause you to think more carefully about what you choose to keep and what you discard. Going back to the “boxes of videotape” scenario – of the dozens or hundreds of hours of footage on those tapes, how much is actually valuable, and how much is just taking up space on the tapes? Do you need to keep every shot? Do you need all the “bad takes,” the ones that you know you will never, ever use? With videotape you really don’t have much of a choice, unless you were to stop the tape and rewind and then tape over the bad footage. But when archiving your P2 footage, it’s very easy to delete the stuff that you know you’re never going to use, the stuff you’ll never want to see again, and the stuff that you don’t want to have taking up space in your office or wasting your time when you’re sifting through footage trying to locate the actual shot you are searching for. Archiving your footage in this manner can help you to develop better habits – before committing the footage to the archive, you can annotate each clip to identify it later, and discard the useless footage, thus keeping only the “good stuff” and making your overall archive process take less time, less space, and less money.

When archiving, consider redundancy. A wise archival strategy would involve keeping more than one copy of your footage, ideally in more than one location (to protect against fires, or theft, or flood damage, etc). Perhaps a temporary archive on a readily-accessible external hard disk in your office, and a permanent archive on LTO tape stored offsite somewhere (your home, or perhaps in a safety deposit box, etc.) Having the footage on a local external hard disk makes accessing it instantaneous, and having a permanent backup or two on a crash-proof data tape can give you peace of mind.
Archiving takes work, there's no doubt about that. And it takes time. And some expense. But proper archiving will allow you much quicker retrieval of your footage, and save you hours of frustration in hunting for footage. And archiving your data as data, rather than as videotape, will let you easily restore your full project in a ready-to-edit form, rather than as clips on a tape that all need to be re-captured and reconstituted.

P2 CARD FILE NAMING

When you first explore a P2 card's contents, you'll see some filenames that look like random gobbledygook - for example, you'll probably see your clips being named something like 0038R2.mxf. Is there any rhyme or reason to these filenames? And is there anything useful you, the user, can derive from these filenames?

They're not as random as it may at first appear. The first four digits are the number of the clip in order of which clips got shot on that card. The very first clip you shoot will be 0001-something-something.MXF. The last two digits can be numbers or letters, so the first three clips might be:

0001QZ.mxf
0002Y5.mxf
0003EP.mxf

That's for the XML, VIDEO, and CLIP files; for the AUDIO files there are two additional digits which signify which audio channel they're from. So for 0001QZ.mxf, you can go in the audio directory and find four files:

0001QZ00.mxf (audio channel 1)
0001QZ01.mxf (audio channel 2)
0001QZ02.mxf (audio channel 3)
0001QZ03.mxf (audio channel 4)

The names should be distinct enough that you won't ever run into duplicate file names. But even if you do, there's a second layer of protection against duplication, which is that each card
gets assigned a unique identifier which is something like a 64-
character identifier, probably derived from the serial number of
the camera so it will be absolutely unique at all times. This unique
identifier is placed in a text file on the root directory of the card,
called “LASTCLIP.TXT”. It is vitally important that if you archive
or copy the card contents over to a computer, you must keep the
relationship of the LASTCLIP.TXT file with the CONTENTS folder
intact. Also, do not change the name of the CONTENTS folder, or
any of the folders within it.

If you throw all your clips in one big folder, the chances do exist
that you might get two clips with the same name (although those
chances should be something like one out of 1300 of the last
two letters lining up, and then compound that by the chances of
the first four digits being the same too... it’s going to be no more
common than a 1 in 5,000 or 1 in 10,000 chance of getting a
similar filename.)

Finally, remember that through the P2 Viewer program and the
metadata you can attach a unique user file name to each file, so
you can organize your clips with a more human-friendly filename.
It won’t rename the file on your hard disk, but it’ll attach it to
the XML metadata file and make it easier for you to organize and
search your clips.

ALTERNATIVE RECORDING TECHNOLOGIES

Perhaps the most common question that gets raised about the AG-
HVX200 centers around the concept of the P2 cards and, when
trying to comprehend the limitations around current-generation
P2 card recording times, the question frequently turns to: “is there
any other way to record?”

The answer is a resounding “yes.” Panasonic has provided the P2
cards as their preferred recording method, but they’ve also worked
hard to ensure that other recording technologies are available.
First, it's necessary to understand that the HVX sends every type of signal it records out its 1394 port. The HVX supports live streaming of DV, DVCPRO, DVCPRO50, and DVCPRO-HD in all its recording modes (except 720p "Native" modes, which are exclusively designed to work with the P2 cards). This means that any product that knows how to capture a video signal off the 1394 cable can potentially be used to record live streaming video from the HVX200. All that's necessary is that the product understand AV/C protocol, and that it understand the type of data that the HVX is sending to it.

For example: if you set the HVX into "DV" mode, its 1394 port will output DV data, which can be recorded by any DV camera, any DV deck, any DV-compatible FireStore (or similar hard-disk recorder), or any DV video capture application (such as a nonlinear editing program, or Serious Magic's "DV Rack" program).

"DV" is, of course, just one of the many shooting modes the HVX200 offers. Another mode is DVCPRO50. Several companies manufacture DVCPRO50-compatible recording equipment, including hard disk recorders, nonlinear editors, and DVCPRO50 tape decks. Using the 1394 cable, you could directly cable the camera to a DVCPRO50 tape deck and record on tape, or you could cable the camera to a laptop or desktop computer running Apple's Final Cut Pro or Avid Express Pro HD or Canopus ED(US Broadcast (or any comparable DVCPRO50-capable nonlinear editor) and capture the data directly to the computer's internal or external hard disk drive.

For DVCPRO-HD, several similar options exist. First, for direct-to-tape recording, you can connect the AG-HVX200 directly to Panasonic's AJ-HD1200A or AJ-HD1400 DVCPRO-HD tape deck and record directly to DVCPRO-HD tape. Or, you can connect the camera to a hard disk drive recorder, such as FocusEnhancements' FireStore FS-100, a special disk recorder manufactured specifically to be compatible with every mode the HVX200 shoots. Or, as an alternative, Specialized Communications will offer the CinePorter, a hard disk recorder that plugs in via the P2 slot and provides even longer recording times than the FireStore does. And, of course,
computers remain a viable option as well — major nonlinear editors such as Final Cut Pro, Avid Express Pro HD, and Canopus EDIUS Broadcast all support live capture of DVCPRO-HD directly from the camera. Serious Magic (www.seriousmagic.com) is also producing a DVCPRO-HD version of its DV Rack program, which will provide for direct-to-disk capture as well as a software waveform monitor, vectorscope, production monitor, and many other useful features.

This section of the book is not comprehensive nor complete, as the pace of new product introductions is anticipated to be far quicker than a printed book can keep ahead of. I suggest you point your internet browser towards www.HVXUser.com to keep track of new product introductions that will extend the flexibility of the HVX and its ability to record in a variety of circumstances and situations.

AN OVERVIEW OF HIGH DEFINITION VIDEO

What is High Definition ("high-def", or "HD") video, and how does it differ from "regular" video? Simply put, high-def is an all-digital television system, with three to six times as much information in each frame. Going forward, the U.S. Federal Communications Commission (FCC) intends to discontinue all regular television broadcast signals and only allow digital broadcasting. High-def is the highest-resolution, peak form of digital television.

In 1982, the Advanced Television System Committee (ATSC) was formed to explore and make recommendations regarding America's television broadcasting future. Standard-definition television (i.e., "regular TV") had been fundamentally unchanged since the adoption of color in the 1950s. The ATSC set out to standardize television broadcasts in the future, including recommendations for digital television (DTV) broadcasting, and specifying appropriate high-definition television (HDTV) formats.

In 1997 the FCC adopted the ATSC's recommendations on digital television broadcasting, and broadcasters and television manufacturers agreed to abide by two prevailing formats for high-definition television broadcasts: 720p (for "progressive") and 1080i (for "interlaced").
It's important to note that both 720p and 1080i are considered full-fledged high-definition television. People sometimes get distracted by the larger “1080” number and seem to feel that 1080i is the only “true” high-definition signal. Simply put, this is not so. In fact, the European Broadcasters Union (EBU) issued their recommendation for broadcast standards in Europe, and the EBU expressly endorsed 720p and discourages 1080i! While they acknowledge that the larger frame size is desirable, they felt that the interlaced scanning system is outdated, and that the European population would be better served with a progressive television system. The EBU’s eventual desire is to see 1080/50p adopted as the final high-definition standard, which would give the best of both worlds: the larger 1920x1080 frame size, as well as the benefits of progressive scanning.

In America, the two formats were formally endorsed, in several different frame rates: 720/24p, 720/30p, 720/60p, 1080/24p, 1080/30p, and 1080/60i are all codified broadcast standards. Of the six high-def broadcast standards approved by the ATSC, five are progressive-scan, and only one (1080/60i) is interlaced. As a practical matter though, only two of these formats are commonly broadcast: 720/60p and 1080/60i. In Europe, the EBU endorsed 720/50p but recognized that broadcasters are free to choose 1080/50i as well; the EBU will do nothing to prevent 1080/50i production or broadcasting, although they don't believe it's in the best interest of European consumers to perpetuate interlaced origination or broadcasting, and going with progressive-scan displays allows European consumers to buy less-costly computer-industry-based equipment rather than the more-expensive audio/video-industry-based gear. A European buyer may therefore be justified in having second thoughts about buying a 1080/50i camera, but for AG-HVX200 owners they are protected, as it shoots both 1080/50i and 720/50p, preserving broadcast options regardless of which signal broadcasters choose to transmit. The U.S. version of the AG-HVX200 is the first and only camera on the market that can shoot and record in all six ATSC-approved broadcast formats.
Both 720p and 1080p/i are native 16:9 formats (16:9 refers to the shape of the television screen, 16 units wide by 9 units tall, resulting in a widescreen frame that is about 1.77 times as wide as it is tall). All ATSC-compliant high-definition broadcasts are transmitted in 16:9. It is anticipated that all worldwide high-definition broadcasts will also be done in 16:9.

720p is transmitted in a pixel grid of 1280 x 720. 1080i is transmitted in a pixel grid of 1920 x 1080. Initially it may appear that 1080i has much more detail: after all, 1920x1080 = just over two million pixels per frame, whereas 1280x720 = less than one million pixels per frame. 1080i, however, is interlaced — meaning, it doesn’t ever transmit a full frame, instead it sequentially transmits half of the frame, and then the other half. The frame is split into even and odd horizontal scan lines; first the even lines are sent, and once all the even lines have been transmitted (and drawn on the television), then the odd lines are sent. This can result in some artifacting, especially during sports presentations. 720p, on the other hand, is always transmitted (and displayed on the television) as a full frame, similar to how movie film is shown — a full frame at a time. As a result, 720p has less visible artifacting and performs better under the heavy compression that ATSC signals undergo when being broadcast. Furthermore, interlaced scan has an inherent problem with flickering — thin horizontal lines that only show up in one field, but not the other, will flicker distractingly when shown on a tube-type television. Accordingly, interlace systems employ a resolution-robbing vertical blur process to smudge the lines from each field into the other field, to make the thin-line problem go away. The result is a lowering in observable resolution; a 1080i broadcast gets interline-blurred to the point where it can typically only resolve about 820 scan lines of resolution. That’s not much more than 720p’s 720 scan lines. And furthermore, since 1080i only updates half its frame every 1/60th of a second, and 720p updates its entire frame every 60th of a second, the net result is nearly the same: both systems push approximately 60 million pixels to the television display each second. 1080i provides more horizontal resolution, and 720p provides more temporal resolution without interlaced artifacts.
Some PAL users have commented that they don't think 720p qualifies as "real" high-def, simply because 720 lines aren't that much more than the 576 lines that PAL television currently provides. Nothing could be further from the truth. Such thinking doesn't take into account the fact that 720p has nearly twice as many pixels horizontally (1280 vs. 720), and that PAL television (being an interlaced system) suffers from the same vertical resolution-limiting flicker as high-definition interlaced television does. The result is that on a PAL system, only about 430 lines of resolution are discretely discernible, a huge drop from the 720 discrete lines of 720p or the 820 lines of 1080i. On top of that, 720/50p refreshes its entire frame every 1/50th of a second, whereas PAL refreshes only one field (half of the frame) every 1/50th of a second. The net result is that a PAL signal pushes less than 8 million discernible pixels through the television each second, whereas 720/50p sends more than 46 million pixels through the television each second! 720p offers nearly six times as much spatial and temporal resolution as standard PAL television, and certainly qualifies as genuine "high definition" even in PAL territories.

Speaking of "PAL" and "PAL territories," now would be a good time to point out that in the world of high-definition, the terms "PAL" and "NTSC" have no valid meaning. PAL is the name of the standard-definition television system in Europe (and Australia/NZ and much of Asia and the world), and NTSC is the name of the standard-definition television system in North America and Japan and some other territories. But there is no such thing as "PAL high-def" or "NTSC high-def." PAL and NTSC are strictly analog standard-definition systems. In the brave new world of digital high definition, much of the inherent incompatibility of PAL and NTSC is done away with. Now, that's not to say that European high-def and American high-def are one worldwide unified standard (nice as that would have been!) No, while both European and American high-def systems use the same frame dimensions and the same color space, there remains one glaring incompatibility: American high-def is based on the same 60Hz refresh rate that NTSC uses, and European high-def uses the same 50Hz refresh rate that PAL
television uses. As such, European high-def cannot be broadcast in the US, nor can American high-def be broadcast in Europe. And televisions may or may not be compatible with both systems; some televisions will be engineered to only support the 60Hz input, and some the 50Hz input. As such, there still needs to be some way to differentiate 50Hz HD from 60Hz HD. While it would be more appropriate to refer to them as exactly that (“50Hz HD” and “60Hz HD”), it seems that inevitably the common vernacular will choose to refer to them as “PAL HD” and “NTSC HD”, regardless of how inappropriate that terminology is. As a simple rule of thumb, if your country currently uses the NTSC television system, your high-def system will be 60Hz HD, and many people will simply (although incorrectly) refer to it as “NTSC HD.” And if your country uses the PAL television system, your high-def system will be 50Hz HD, and it will likely still be called “PAL HD.” Some television manufacturers will offer dual-standard television sets, but the differences will remain because the broadcasters have settled on differing frame rates (to maintain compatibility with the millions of hours of standard-def NTSC or PAL programming libraries that have been produced over the last 50 years!)

With either system, prepare to experience creating footage with a clarity, richness, sharpness and “wow” that you’ve never had before. Analog television involved many compromises, especially American NTSC television: NTSC is famous for its poor handling of the color red, and having colors bleed and bloom and for poor clarity on graphics. High-Definition television is all-digital and eliminates those problems. The footage is even sharper and clearer than the simple numbers would indicate.

**WHICH MODE TO SHOOT IN?**

The HVX200 presents an embarrassment of riches – never before has a camera offered so many different shooting modes. Through combinations of variable frame rates, 16:9 or 4:3, and P2 or Tape, the HVX200 offers dozens of different ways to record footage!
So which mode should you shoot in? And why would you pick one particular mode over another? Let's examine each mode and outline what it would be best for.

**Color sampling**

Before discussing each format, we should take a side trip to discuss color sampling. Color sampling plays a large role in how the various formats record their images, and color sampling is different for different recording formats. To understand color sampling, you first have to understand that the pictures that are recorded in all digital recording formats are recorded in a grid, or pixel array. For standard-definition ITU 601/DV video, this grid will be 720 x 480 pixels. This means 720 pixels wide, 480 pixels tall; or 480 rows of 720 pixels each. You can bring a frame of video into a picture editing application on your computer and see that it is indeed a 720 x 480 grid of pixels. But (and this is an important distinction to understand): that 720 x 480 only refers to the resolution of the luminance, or brightness, of each individual pixel. It does not specify the color resolution of the image! Color sampling gets recorded at a different resolution.

The human eye is more attuned to changes in brightness than it is to changes in color. You may remember a discussion of "rods & cones" from your high school biology class; "rods" in the eye are more sensitive than "cones" and are far more numerous, but "rods" cannot detect color, whereas "cones" can. Video engineers and compression specialists have been taking advantage of this inequality by severely restricting color resolution in video images under the notion that the viewer is less likely to notice lower color resolution.

Accordingly, color resolution (chroma) is almost always substantially lower than brightness (luma) resolution. When we speak of "720 x 480" or "1920 x 1080", we're always speaking only of the luma (brightness) resolution, and never referencing the color resolution. We describe color resolution in terms of color sampling, using terms such as "4:2:2" and "4:1:1."
In a 4:4:4 system the color resolution is the same as the brightness resolution: for every luminance sample there would be one chroma sample. That means that every pixel gets recorded with its own proper color. This would make for superb chroma keying capabilities, and obviously for the highest-resolution pictures. However, 4:4:4 recording is exceptionally rare; practically no commonly-used video format supports full 4:4:4 color resolution. 4:4:4 is typically used to reference RGB color space, which cannot (inherently) be sub-sampled. The two digital video broadcast standards (ITU 601 and ITU 709) both specify Y/Cb/Cr color space and 4:2:2 color sampling. RGB is common in computer graphics and film scans, but video signals are almost always Y/Cb/Cr and color-sub-sampled to at least 4:2:2.

Example of 4:4:4 color sampling, where each pixel is its own color. This sample is for illustration only; real-world video would normally never have this much distinct color detail for each pixel.

Chroma sub-sampling means that the chroma resolution is lower than the luma resolution. The three most common systems are 4:2:2, 4:1:1, and 4:2:0. The US/60Hz HVX is capable of shooting two of those sampling methods, and the European/50Hz model is capable of shooting in all three color sampling methods.

Let's use the example of 4:1:1 to explain color subsampling. In 4:1:1, there is one chroma sample for every four luma pixels. What this means is that on every scan line, each group of four pixels in a row will always be the same color(!) Sounds absurd, doesn't it? Yet it's true. On a 720-pixel scan line, there are 180 chroma samples, and chroma is sampled on every scan line, so the total chroma resolution for 4:1:1 DV is 180 x 480. So 720 x 480 luminance pixels are recorded, and 180 x 480 chroma samples are recorded. Four pixels in a row will all be forced to share the same color, and then the next four pixels will be forced to share the same color, and so on and so on until the full scan line is completed. However, just because they're the same color doesn't mean that they look exactly the same; there is brightness information recorded for each pixel. So the four pixels in a row can all be different shades of that same
color. And how is the color determined? Usually by averaging the four native pixels together. If you were shooting a scene of the sky and clouds, it's likely that the four original pixels will all be basically variations of blue and white, so the color sample for four of those pixels would likely be in the blue family, with the brightness information being used to differentiate between the pixels. But all four pixels will be the same basic, fundamental color. This is the reason that DV, and 4:1:1 in general, has such a tough time with performing chroma keys – the color edges of objects are very rough transitions, since each color extends for a run of four pixels wide. 4:1:1 sampling results in chroma resolution that is 1/4 as sharp as the luma resolution.

In PAL 50Hz territories, 4:1:1 is not typically used; rather 50Hz DV uses 4:2:0 color sampling. DVDs also use 4:2:0, although not all 4:2:0 systems are the same. For simplicity's sake we'll stick to describing simple 4:2:0 as employed in progressive scan imagery. 4:2:0 sampling also assigns one color sample per block of four pixels; however, instead of setting one sample for a group of four pixels on the same scan line like 4:1:1 does (essentially a 4x1 array), 4:2:0 color sampling assigns the same color to a 2x2 block of pixels. Each color sample affects two luma pixels next to each other, and also the two luma pixels on the next scan line below them. This color sampling scheme results in chroma sampling in a grid of 360 x 240 in 60Hz DV, or 360 x 288 in 50Hz DV. Like 4:1:1, it also delivers chroma resolution that's 1/4 as much as the luma resolution.

4:2:2, on the other hand, provides for twice as much chroma resolution as 4:1:1 or 4:2:0. 4:2:2 provides unique color samples on
every scan line, and provides one color sample for every two pixels. 4:2:2 is the highest-quality color sampling method in common use; top-line formats such as Digital Betacam™ and DVCPRO50 use 4:2:2 color sampling. 4:2:2 color sampling in 60Hz DVCPRO50 results in color resolution of 360 x 480, providing for dramatically superior image sharpness and substantially better chroma keying. In 50Hz DVCPRO50, the color sampling is 360 x 576.

Example of 4:2:2 color sampling: Each pair of pixels gets set to the same base color. 4:2:2 is much more accurate, with twice the color resolution of either 4:1:1 or 4:2:0.

Now, back to the formats, and when to choose which...

**DV format**

First, let's start at the bottom: DV. DV is the lowest-quality way to record on the AG-HVX200. It is also one of the most popular recording formats in the world, so there's plenty of reasons to consider shooting DV. DV is a worldwide standard, embraced by all the major camera and deck manufacturers. Furthermore, many higher-end professional decks, such as Sony's DVCAM™ and Panasonic's DVCPRO, are backwards-compatible with DV.

DV uses digital component recording and 4:1:1 color sampling, in a 720 x 480 pixel array in 60Hz/“NTSC” countries; the 50Hz/“PAL” territories use 4:2:0 color sampling in a 720 x 576 array. DV is a recording format for “standard definition” video, and is suitable for playback on a regular television or for mastering onto DVD. DV can be recorded on the HVX on either its miniDV tape drive, or on the P2 cards. On tape, DV supports two channels of 16-bit 48kHz audio, or four channels of lower-quality 12-bit, 32kHz audio. DV uses a data rate of 25 megabits per second, or about 13 gigabytes per hour of footage. While DV is the lowest-quality recording method on the HVX200, it is still considered quite high quality; professional formats such as Panasonic's DVCPRO and Sony's DVCAM use the identical same basic system and in fact are bit-for-bit identical when it comes to the image quality as compared to DV. The primary differences with DVCAM and DVCPRO are in the tape
formats and recording speeds; the actual compression and color sampling are identical to DV. DV is also an inherently interlaced format; all DV recording must be done in interlaced mode. The HVX200 has the ability to imbed progressive-scan images within those interlaced signals, of course: 480/24p and 480/30p in the 60Hz version; 576/25p in the 50Hz version. But the DV system itself is always interlaced.

In DV mode, you are free to choose either the 16:9 or 4:3 aspect ratio, for producing content for widescreen or "standard" televisions. The HVX200 uses native 16:9 chips for the highest-resolution 16:9 footage, and uses a "center extraction" for 4:3 origination.

When would you want to choose to shoot DV? DV would be a good choice for someone wanting to get the maximum recording time on a P2 card; you'll fit twice as much DV footage as you would DVCPRO50 footage, for example, and four times as much as you would in high-def mode. DV would also be the only choice if you're shooting to the internal tape drive, since the tape can only record DV format. Some external disk recorders (like the FireStore FS-4) only support DV, so if using a DV-only product you would want to set your camera in DV mode. Also, if you're shooting footage for hire, be sure to ask what format the producer requires; many producers are still working with the DV format.

**DVCPRO format**

The next format the HVX records is DVCPRO (sometimes called DVCPRO25). DVCPRO is Panasonic's professional variant of DV, and has been well received by television news departments in the US; the overwhelming majority of news stations in the US use DVCPRO equipment. On the 60Hz HVX200, DVCPRO is bitstream compatible with DV — it will produce an identical picture, at identical compression, and identical color sampling as DV would. There are two areas where DVCPRO differs from DV: first, DVCPRO cannot be recorded on the miniDV tape; and second, DVCPRO includes some proprietary flags that let it be 1394-compatible with early DVCPRO tape decks and editing equipment. If working in a DVCPRO environment, you should choose DVCPRO instead of DV; they will deliver identical quality and identical recording times,
but DVCPRO footage files are 1394-compatible with other existing DVCPRO gear.

On the 50Hz camera there's another substantial difference: PAL-compatible DVCPRO uses 4:1:1 color sampling, whereas DV in PAL uses 4:2:0. This means that the two are not bitstream compatible, and will look slightly different. Which one you choose is up to you; it's sort of a case of "six of one, a half dozen of the other"; both sampling methods deliver 1/4 the chroma resolution as compared to the luma resolution, they just do it in a different pattern.

DVCPRO also offers the choice of both aspect ratios, 4:3 and 16:9.

**DVCPRO50 format**

The HVX also includes the superb DVCPRO50 format. DVCPRO50 is Panasonic's answer to Sony's top-of-the-line Digital Betacam™, widely acknowledged as one of the highest-quality standard-definition recording formats in common use. While DVCPRO50 is still a standard-definition recording format, still using a luma grid of 720 x 480 (or 720 x 576 in 50Hz territories), there are two huge improvements as compared to DV or DVCPRO: first, DVCPRO50 uses the much-superior 4:2:2 color system; second, DVCPRO50 uses significantly milder compression.

In DV and DVCPRO, the final stage of compression uses a 5:1 compression ratio, shrinking the pre-processed data to 1/5 its normal size, resulting in a final data stream that takes up 25 megabits per second (or, again, about 13 gigabytes per hour). In DVCPRO50 they use twice as much bandwidth, or 50 megabits per second (26 gigabytes per hour). This allows for two major improvements in the video signal: lower overall compression, at a 3.3:1 ratio, and double the color resolution. DVCPRO50 also allows four channels of uncompressed 16-bit 48kHz audio recording.

DVCPRO50 is the highest-quality standard-definition recording system in the HVX200. It also holds up much better in post production, because the compression is milder; DVCPRO50 can sustain multiple generations of compression more resiliently than DV or DVCPRO can. Furthermore, with the higher color sampling,
DVCPRO50 will let you produce sharper images and provide much more accurate (and simpler) chroma keys.

Finally, DVCPRO50 will provide the best results for DVD origination; 4:2:2 color translates to the DVD player’s 4:2:0 system much better than 4:1:1 color does. Considering that the HVX lets you shoot native 16:9 in 4:2:2 with mild DVCPRO50 compression, DVCPRO50 would probably be the preferred format to shoot a direct-for-DVD project, and would also be the hands-down choice for any footage where you intend to do chroma key effects for a standard-def project.

DVCPRO50 can only be recorded to the P2 card (or through the 1394 port) -- it cannot be recorded on the miniDV tape. Also, DVCPRO50 takes up twice as much room on the P2 card as DVCPRO or DV would. DVCPRO50 is also an inherently interlaced format, but you can record true progressive scan footage at 480/30p or 480/24p (576/25p on 50Hz cameras) carried within the DVCPRO50 interlaced recording system.

DVCPRO50 also offers the choice of both aspect ratios, 4:3 and 16:9.

**DVCPRO-HD format(s)**

In high-definition DVCPRO-HD, there are two basic shooting modes: 720p and 1080i/p. Both share some common features: they are both 4:2:2 color sampling, and both use a 6:7:1 compression ratio.

In the luminance grid, both modes employ pre-filtering, which means that the pixel array is reduced in size before recording. Most high-definition recording formats do some manner of pre-filtering; HDCAM and HDV/1080i both start with a 1920 x 1080 luma grid but pre-filter to 1440 pixels wide before recording. Pre-filtering is quite common in high-definition recording, and DVCPRO-HD is no exception.

DVCPRO-HD 720p uses twice as many pixels as standard definition video to record its frame; 720p uses a luma grid of 960 x 720. This represents a pre-filter from the square-pixel HD standard of 1280 x 720; the image will be expanded back to 1280 x 720 on playback.
DVCPRO-HD uses 4:2:2 color sampling, so it results in chroma resolution of 480 x 720. DVCPRO-HD 720p is always progressive-scan; there is no such thing as "interlaced" 720i. DVCPRO-HD encodes 60 progressive frames per second (in the "Over 60" recording modes) in a 100-megabit data stream (approximately 56 gigabytes per hour). Each frame is individually recorded, so recording fewer frames per second can result in taking up less space on the P2 card when using the "Native" mode.

DVCPRO-HD 1080i/p uses four times as many pixels as standard definition video to record its frame; 1080i/p uses a luma grid of 1280 x 1080 pixels in the 60Hz model, or 1440 x 1080 pixels in the 50Hz model. The image is expanded back to 1920 x 1080 on playback. DVCPRO-HD 1080i/p uses 4:2:2 color sampling for chroma resolution of 640 x 1080 (60Hz model) or 720 x 1080 (50Hz model). Like DV, DVCPRO, and DVCPRO50, DVCPRO-HD 1080 always records 60 fields per second (in the 60Hz model, or 50 fields per second in the 50Hz model). There is no such thing as "Native" mode for 24P recording, instead DVCPRO-HD 1080 uses 2:3 or 2:3:3:2 (24PA) pulldown to embed a 24-frame progressive-scan sequence within its interlaced recording system. In the menus you'll see this referenced as "1080i/24P"; this means that the recording stream is interlaced, but the images are created as genuine 24P (and, in post, can be restored to the original 24P sequence). DVCPRO-HD 1080 takes up 100 megabits per second on the P2 card.

DVCPRO-HD can result in images with startling clarity, especially as compared to DV or DVCPRO imagery. Four times as many pixels, and twice the color resolution per pixel, lead to a true high-definition experience whether you choose 720p or 1080i/p. 720/60p and 1080/60i result in the exact same number of pixels per second; 720/60p has half as many pixels per frame, but twice as many frames per second.

The choice between 720p and 1080i/p can hinge on a few factors. First, do you need the ultimate resolution per frame? If so, 1080i/p retains somewhat higher resolution per frame than 720p does. The live image from the camera head starts with the same resolution in
both modes, but the prefiltering of 720p causes some lowering of the recorded horizontal resolution, whereas the larger spatial grid of the 1080i/p frame allows the full horizontal resolution of the signal to be recorded. The vertical resolution is approximately the same on the live feed, but the recorded 1080 image will retain a bit more resolution than the recorded 720p image.

Second, do you need to use variable frame rates? Variable frame rates are only really possible in 720p (although some very limited variable frame rate capability can be done in 1080p/i; see the article on VARIABLE FRAME RATES on page 39 for more info).

Third, are you concerned about limited recording time on the P2 cards? 720/24p Native takes up less than half as much space on the P2 card as 1080i/24p. A 4GB card delivers 4 minutes of 1080/24p, but that same card can record 10 minutes of 720/24p Native.

Finally, one factor that can sway your decision as to which format to shoot would be how you intend to distribute your work. If it’s being shot for a broadcast network, then selecting the same format as the network uses would seem prudent. In the US, broadcasters such as Fox, ABC, and ESPN all use the 720p format, and CBS, NBC, and PBS all use the 1080i format. If you’re doing a project specifically for one of the networks you would probably want to match your shooting format to the same format they broadcast in. Or if you’re doing a project without a specific network in mind but you think you might submit your project to one or more, it’d be a good idea to check with those networks to find out what their requirements are, and tailor your shooting to match the desired format. One nice aspect to the HVX is that it records all the formats specified by the ATSC (60Hz models) or EBU (50Hz models), so you can definitely match your shooting to whichever format any broadcaster requires.

**RECORDING TIME ON A P2 CARD**

How much footage can you fit on a P2 card? That’s a question that doesn’t have a very simple answer, from the perspective that
each shooting mode takes up a different amount of space on the card. For most of the shooting modes it’s a straight calculation and easy to fit in a table like the one below. Remember that the video stream, audio files, thumbnails and XML files are all being recorded and they all take up space, so the following chart times are approximate.

In 720p “Native” modes (720/24pN and 720/30pN) the amount of card space used is directly related to the number of frames per second you’re shooting. We’ll calculate the total space occupied for each frame rate and list them in the table.

<table>
<thead>
<tr>
<th>Recording Mode</th>
<th>Minutes On 4GB Card</th>
<th>Minutes On 8GB Card</th>
<th>Minutes On 16GB Card</th>
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<td>16:00</td>
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**DUBBING FOOTAGE**

A highly interesting feature of the HVX200 is its ability to dub the contents of its P2 cards to another device. You can have the camera copy its cards over to an external 1.394 hard disk, or you can tell it to downrez its high-definition files onto its internal DV tape.
Dubbing to hard disk

When copying to a hard disk, the camera has the capability to control the external hard disk by itself — no computer is necessary! This dubbing mode results in an exact file copy of all the contents of the P2 card over to the hard disk. The maximum transfer rate the camera can offload the contents of the cards to a hard disk is 50 megabytes per second (the maximum transfer rate of the 1394 interface).

How long does it take to offload the contents of a card? The speed of the hard disk is usually the limiting factor in file transfer/offload speed. Most hard disks are nowhere near capable of sustaining a 50 megabyte per second sustained writing speed; most 2.5” hard drives (so-called “notebook” hard drives) can sustain around 20 megabytes per second (MBps), and 3.5” hard drives are typically faster, they can usually sustain 25 to 30 MBps.

The chain of elements then run at the following theoretical speeds: the P2 card can sustain 80 MBps, the 1394 interface can sustain 50 MBps, and the hard disk — well, that’s the variable element. The faster the hard disk, the faster the cards will offload their data. If you were to connect a high-speed hard disk RAID array, which was capable of sustaining over 50 MBps in transfer speed, then you could expect to offload cards at the rate of approximately 20 - 25 seconds per gigabyte, or around 90 seconds for a 4GB card. As a practical matter, using most typical external hard disks, it’s more likely that you’ll see transfers on the order of one minute per gigabyte, or four to five minutes to offload a 4GB card. If you instruct the camera to verify the offloaded data, that will add considerably to your offload times (as well as add to your peace of mind in being assured that the data did indeed get transferred to the drive properly!)

Offloading to a hard disk requires just a little bit of setup, and then is a completely automated process. First, you need to select an appropriate hard drive to offload to. If you want the camera to control the external drive, then it cannot be a USB2 drive; the
camera only has device control when it’s connected to a 1394 drive. If the drive you’re using is a combination 1394/USB2 drive, you’ll want to connect it through the 1394 connection.

Second, be aware that the HVX200 cannot supply “bus power” to the drive. The drive must have its own power supply; that could mean a battery-powered drive or a drive that uses plug-in AC power.

Finally, before you can offload to the drive, it must at some point have been initialized or “formatted” by the camera. Formatting is a nearly instantaneous procedure, but it does erase the directory and partition structure of the drive. Therefore, you only want to use a data drive you have specifically dedicated for offloading; make sure that whatever drive you use can be completely erased. Don’t use a drive you already have data on, as that drive will have to be formatted before it can work with the camera.

The actual dubbing process is quite straightforward: first, make sure the Media switch is in P2 mode. Then, press the mode switch to go to MCR mode. If the thumbnail display is up, press the THUMBNAIL button to make it go away. Go into the OTHER FUNCTION menu and make sure that you’ve selected “1394 HOST” as the device mode in the PC MODE menu. Then, hold down the mode switch for a few seconds, until the PC/DUB light comes on. You’ll see the screen flash “1394 HOST.” Plug in your 1394 cable and your drive, and you’re ready to begin dubbing. If your drive hasn’t been formatted for use with P2 yet, you’ll have to execute the FORMAT command – and be aware, this will erase the entire contents of your drive! It only takes a second to format the drive. (For safety you can have the camera automatically verify that it copied everything correctly; just go into the SETUP menu and choose VERIFY ON.) Now, just execute the “COPY TO HDD command, and tell it which slot you want to copy, and it’ll automatically copy the contents of the card over. If you chose VERIFY ON, the camera will then read everything back from the drive and compare it to what’s on the card to make sure that the hard drive has an accurate copy of what was on the card.
Each time you tell it to copy a card over, the system will create a new FAT32 partition on the hard disk and copy the contents of the card to that new partition. This can leave quite a bit of unallocated space on your hard disk, as the system only creates new partitions as necessary, leaving the rest of the contents available and unallocated. If you bring the hard disk into a Windows XP computer and examine its properties, you’ll find one or more allocated partitions (that are full of P2 card data) and you’ll likely also find a large unallocated partition (accounting for the rest of the capacity of the drive). That section is not available to be used from Windows (although you could always use the disk manager and create your own partition and use it that way.) Normally you’d rely on the camera to create new partitions each time a card is copied over.

*Note:* FAT32 partitions can be read on both Windows and Macintosh computers.

There’s no need to worry about overwriting existing files; the camera assigns a fairly unique filename to each new clip it generates, and even if by some rare circumstance it managed to create a filename that’s the same as one that’s already on the hard disk, you still won’t run a risk of overwriting the existing file because the camera will create a new partition on the hard disk for each card that it copies over. That way you can be assured that each and every partition will contain the original, uncorrupted, complete contents of the P2 card you dubbed over.

When attaching the hard disk to a Windows computer, each of those partitions will show up as its own drive letter. This can result in a lot of drive letters on your system! A 60GB hard disk, when used to copy/offload 4GB cards, will create 15 different partitions, which will represent 15 different drive letters (i.e., “D:”, “E:”, “F:”, etc.) Note, this is the maximum number of partitions that the HVX allows; so if you’re using 4GB cards, using a drive larger than 60GB will not allow you access to the larger storage space. If you’re using 8GB cards, you can use up to 120GB of hard disk space (15 partitions of 8GB each).
Note: the camera creates each new partition at the capacity of the card that it’s dubbing. So, if you tell it to copy a slot that is currently occupied with a 4GB card, it will create a new 4GB partition on the hard disk for that card – regardless of how much data is actually stored on the card. You may have only 100 megabytes of data on a card, yet the camera will still create a 4GB partition as it prepares to copy that card. If you have an 8GB card in the slot, the camera will allocate a new 8GB partition on the hard disk.

There is another way to use a hard disk to copy the files off of a P2 card – you could use a USB2 hard disk that has the special “USB On-The-Go” protocol. With USB On-The-Go (OTG), the hard disk itself is the controlling entity. Usually these types of hard disks will have some sort of one-touch copy button on them. You could connect the USB2 OTG hard disk up to the camera’s USB2 port, and specify in the OTHER FUNCTIONS -> PC MODE menu that you want the camera to operate as a USB DEVICE. Then when you press the mode switch button to go into “dubbing mode,” the external hard disk can take control of the camera. Press the “copy” button on the hard disk and it will start copying all the contents of the first slot that it sees.

USB-OTG gives the potential advantage of using a battery-powered hard disk as an inexpensive offloading device. It is inferior to a 1394 option in a few ways though – first, in 1394 mode the camera can perform a verification function to verify that the data got copied over properly, and many (or most) USB-OTG devices don’t do that. Second, when using the camera as the 1394 host, you can examine the contents of the drive and see what’s already been copied; with a USB-OTG drive you don’t really have any feedback or any way to view the contents; typically these types of devices only offer a blinking light or two to relay their status. You’d need to attach a USB- OTG drive to a computer in order to view its contents; with a 1394 drive the camera itself can show you an overview of the contents (although obviously with a computer you can view the contents in much more detail).
One bonus of the USB-OTG approach is more efficient use of the space on the hard disk; USB-OTG doesn’t create a new partition for each card you copy; instead it creates a new subdirectory for each card. USB-OTG doesn’t allocate a minimum set amount of space for each card it copies either – each card copy will only take up as much room on the drive as it needs to; with the 1394 solution, each copy takes up as much space as the size of the card you’re copying.

If you have the choice, and the 15-partition limit is okay with you, 1394 is usually the superior choice. USB-OTG’s primary advantage is in that cheap, battery-powered hard disk enclosures are readily available, which can make for a cost-efficient field-portable offloading device; also, you can use larger hard disks more space-efficiently without worrying about being limited by the number of partitions you’re using on the drive.

Additionally, some companies are offering USB2 “bridge” products, which are designed to act as a go-between controller between two USB2 products. Using one of these devices you could use the USB2 port on the camera to copy files to any USB2 device, whether it has USB2 On-The-Go protocol or not. These “bridge” devices can also show you the filenames on the HVX’s cards and let you copy only specific files over. A laptop computer is obviously the ultimate “bridge” device, but if you need the ultimate in portability you may find these devices worth looking into.

**Dubbing to tape**

The other way you can offload the footage from the camera internally is to dub the high-definition contents of the P2 card onto DV tape. The camera has the capability to convert high-def footage into standard DV footage and write that footage to its internal tape drive; in addition, it can even preserve the variable-frame-rate effects if the footage you’re dubbing was shot in 720p Native mode.

Be aware though that dubbing the footage to tape means that the footage will be converted to DV. You cannot record high-definition footage onto the miniDV tape and expect it to still be
high-definition; only DV footage can be recorded onto the miniDV tape. So executing a tape dubbing operation will result in a copy of your footage being downrezzed to standard-definition DV when written to tape.

As to how the footage gets downconverted, it basically depends on how you shot it in the first place. If you shot 1080, that gets downrezzed directly to NTSC DV (or, obviously for the 50Hz camera, 1080 would be written to tape as standard interlaced PAL DV). Any 24p or 30p pulldown will remain intact.

For 720p, there are several ways you can shoot, and different ways you can dub. You can shoot in the "Over 60" modes, meaning 720/60p, 720/30p, or 720/24p, and that will get copied down to NTSC 480/60i (or PAL 576/50i). In the case of 720/60p, each frame will be converted to a single field of DV video. If you used off-speed frame rates (such as 12p, which results in each frame being recorded 5 times) then you'll see the same effect in your DV footage - those 12p frames will each be recorded to five DV video fields. (Obviously the same applies for the 50Hz camera; shooting 720/50p results in each frame being downconverted into a standard PAL DV field; if you shot 720/25p then each frame gets converted to two PAL DV fields, etc.)

If you shot in 720/25pN or 720/30pN, it'll be copied in that same mode to 576i or 480i, on a frame-for-frame basis; 720/30PN will be downrezzed and dubbed to 480/30p, and retain the look and feel of 30P; 720/25pN will be downrezzed and dubbed to 576/25p. If you shot variable frame rates in 720/30PN, it'll still get copied frame-for-frame to 480/30p, thus preserving the fast-motion or slow-motion effect (same for 720/25pN). For example, if you shot 720/25pN with a frame rate of 50fps, then each second of source footage will be dubbed down to two seconds of 576/25p. Using this technique you can actually produce standard-def DV footage that has film-style full variable frame rates!

Finally, if you shot 720/24pN, the same thing will happen except you get to specify the pulldown pattern to use -- 720 has no field-
based pulldown, but 480 still has to have 2-3 or 2-3-3-2, so there's a menu item that lets you specify 24p Standard or 24P Advanced pulldown. Once you establish that, it does a frame-for-frame copy, adding pulldown to the DV 60i signal as it goes.

One thing to keep in mind when downconverting to tape: the camera's REC FORMAT menu item must be set to the same mode that the clip was shot in. In other words, if the camera is currently configured to shoot 720/24PN footage, then the only clips you can dub to tape will be those that were shot in 720/24PN mode. No other clips will be allowed to be downconverted, unless you go back into camera mode and change the shooting mode. If you go back into camera mode, and change the RECORDING SETUP menu item to 1080/60i, you would then be able to go back to dubbing mode and dub all the clips on your cards that were originally shot in 1080/60i. But note, now the 720/24PN footage will no longer be available for dubbing! You have to match the camera mode to the type of footage you're trying to dub. In actual real-world practice, this is pretty much a non-issue; for the most part you won't likely be swapping camera modes frequently during any given project; usually the process would be that you'll select one shooting mode and stick with it for the duration of your project, so you'll usually only have one format of clips on the card at any given time anyway. But when you're experimenting with the camera at first, you may run into this issue, so we thought we'd spell it out so you understand what's happening.

**DEPTH OF FIELD**

Perhaps no effect is more sought-after by DVX/HVX shooters than the look of shallow depth of field (DOF) — when the subject is in sharp focus, and the background is out of focus. Unfortunately, the effect is quite difficult to achieve on a small CCD camcorder – there's a reason that the shallow-depth-of-field look reminds people of the movies! It's because you can usually only see that look in the movies. But there are ways to maximize the shallow depth-of-field look on the HVX.
First, let’s explain what depth of field is. A lens can only focus on one plane in space at any one time — there’s really only one infinitely-thin plane that’s ever truly “in focus”. Everything closer to the lens, or further from the lens, will be progressively more and more out of focus; but there’s a certain distance from that focal plane where objects are still acceptably sharp. That distance (that area in front of and behind the in-focus point) is called the “depth of field.” It’s interesting to note that the depth of field is not equally split: it extends for 1/3 of the distance in front of the subject, and 2/3 behind it. That means it’s easier to get objects out of focus in the foreground than it is to get them out of focus in the background.

Depth of field is controlled by three primary factors: distance to the subject, focal length, and aperture (also called iris, or f-stop). By changing any of these factors, you can deepen or narrow the depth of field. Some are more important than others. And, some work at cross purposes to each other. For example, getting closer to the subject will make for shallower depth of field. However, in order to get the same subject size, you have to zoom out, and zooming out to a wide-angle shot makes for deeper depth of field. The two somewhat cancel each other out, although, for any given subject size, the more telephoto the shot, the shallower the depth of field will appear to be.

The factors work to control depth of field like this:

<table>
<thead>
<tr>
<th>Shallow DOF</th>
<th>Deep DOF</th>
</tr>
</thead>
<tbody>
<tr>
<td>Close to subject</td>
<td>Far away from subject</td>
</tr>
<tr>
<td>Telephoto Lens</td>
<td>Wide-Angle Lens</td>
</tr>
<tr>
<td>Open Aperture (f/2.8)</td>
<td>Smaller Aperture (f/9.6)</td>
</tr>
</tbody>
</table>

So: to maximize the area that’s in focus (to get the deepest Depth Of Field), use a wider-angle on your lens, and stop down the iris as much as you can, and back away from the subject.

To minimize the Depth Of Field (to get the shallowest focus possible): zoom in as far as you can, get as close to the subject as you can, and open the iris up as much as possible.
While the optics and laws regarding depth of field are complex, for most circumstances there are really only two factors you need to pay attention to: f-stop and zoom setting. And even then, to get the shallowest depth of field possible, you usually only have to remember two numbers: f/2.8 and Z99 (or 55.0 millimeters). Treat your camera as if it has only one aperture, f/2.8, and the zoom is stuck at maximum telephoto, Z99 (or 55.0 mm), and you're well on your way to getting the shallowest depth of field the camera can deliver.

First, let's look at zoom setting. One of the key factors in getting the shallow depth of field look is to get a long telephoto lens. The HVX's maximum telephoto is fairly mild, at only 55mm, so that doesn't give us a tremendous amount of telephoto to work with. Other cameras have longer telephoto, and can get shallower DOF: the HD100 has an 88mm lens, and the XLH1 has a very long 110mm lens. With the HVX, you only have a maximum telephoto of 55mm. To get shallow DOF shots, you need to use all the telephoto you can get. Lock that lens at Z99/55.0 mm, and if you need to adjust the framing of your shot, do it by moving the camera, not by zooming out. Even zooming out a little bit may ruin the shallow DOF look you're trying so hard to create. You can also get a telephoto extender lens from Century Precision Optics that will give you even more telephoto reach, and shallower DOF.

Also, aperture is crucially important. You want the aperture as wide-open as you can get it. On the HVX, when zoomed all the way in, that means f/2.8 (or "OPEN"). If your shot is overexposed at f/2.8, don't stop down the iris; instead engage the Neutral Density filters to bring the exposure back where it should be. If you need more control over the exposure, get an external 1-stop and a 2-stop ND filter (also called an ND .3 and an ND .6). These, combined with the camera's built-in filters, will give you the ability to control exposure to f/2.8 under almost any lighting conditions.

Once you have your camera set at f/2.8 and Z99/55mm, and you've moved the camera so that your framing is appropriate and you've set the neutral density filters so that the exposure is correct,
there are a few more tricks you can employ to get the shallowest Depth of Field possible. First, remember that the depth of field extends for 1/3 in front of the subject and 2/3 behind it. We can take advantage of that to try to slide the whole zone of Depth of Field closer to the camera. Try to focus as close as possible while maintaining acceptable sharpness on your subject. This is a “cheat” that will help shorten the perceived depth of field. This works better in standard-def than in high-def, since high-def has stricter tolerances on what’s in focus or not (i.e., the higher resolving power of high-def is likely to show focus errors sooner than standard-def will).

Second, a very effective technique is to “cheat” the background away from your subject. Separate your subject as far away as possible from the background, and you can force the background outside the depth of field and push it further out of focus. Whenever possible, stage your shots so the subject is as far as you can get from the background – even if that means cheating the shot, or staging the shot such that the background is across the street. By using a long telephoto lens, the lens will optically compress the space between your subject and the background, making them look like they’re a lot closer than they really are.

In tight quarters it gets very difficult to achieve the shallow-Depth Of Field look. At some point you have to acknowledge that this just isn’t a 35mm movie camera, it’s a 1/3” CCD video camera and there’s only so far you can push it, but we’re not ready to give up yet: there are still a few tricks up our sleeve.

First, if the room is so small that you simply cannot use Z99/55mm to frame your shot, you can try going close instead. Zoom out and get as absolutely close to the subject as you can. Getting extremely close will narrow the depth of field and also expand the background, and allow you to open up the iris some, maybe even to f/1.6. This technique really only works for extreme close-up shots, but it can be very effective. If you have an object in the foreground too, it can really add depth to the shot: when at wide angle focal lengths, the lens will exaggerate the distance between
objects, so with a shallow-focus background and a shallow-focus foreground, and exaggerated depth between them, it can make for some compositionally interesting shots. Opening the iris and getting closer will compensate for some of the loss from not being able to zoom all the way in. The downside to this effect is that it can really exaggerate the size of a person’s nose, for example.

A “last-resort” thing you could consider is using a greenscreen or bluescreen technique to force the background out of focus. This is not really a good, easy or practical solution, but if you need to get the background out of focus and can’t do it any other way, you can consider this method as a last resort.

Set up a greenscreen behind your subject. Shoot your subject in the same place and the same light as if the greenscreen wasn’t there. Then, remove the greenscreen and the subject, and shoot a background shot as out-of-focus as you want. Then when you composite them in post, you can make for a somewhat convincing soft-background look. Greenscreen or bluescreen is quite difficult to pull off effectively with a DV camera; the low color sampling really doesn’t lend itself well to chroma keying. You’ll have better results in DVCPro50 or DVCPro-HD modes. Even so, the results with this technique can look forced or faked so we’re not recommending it, but you can consider it an option of last resort if none of the other techniques are working for you.

Finally, instead of shooting at your subject, shooting into a mirror may be a way to get enough distance that you can zoom all the way in. You’ll have to “flip” the footage in post (because the mirror will reverse the image) but it may help when in tight quarters.

In summary, for shallow depth of field, remember these four things: 299/55mm, f/2.8, get as close to the subject as possible, and separate the subject as far from the background as possible.

**Depth of field myths:**

**Myth 1:** “imaging size affects DOF, larger imagers = shallower DOF”. Technically speaking, this is false. The imaging size has nothing
to do with the depth of field. The imager size (whether larger like 35mm film, or small like 1/6" CCDs) affects the FIELD OF VIEW, but not the DEPTH OF FIELD. Larger imagers require longer lenses to deliver a usable field of view. Smaller imagers require shorter lenses. Consider a standard 12:1 zoom lens: on a 35mm camera, it would typically be something like a 25-300mm zoom, on a 16mm camera it would be 10mm-120mm, on the HVX it's 4.2mm-55mm, and on a 1/6" CCD camera it might use 2mm-24mm. The 35mm camera gets its shallower DOF from its longer lenses, not from its imager size. On the 35mm camera, the very widest it can zoom out with that lens is 25mm; on the 1/6" CCD video camera, the most telephoto it could get is maybe 25mm! It is the focal length, not the imager size, which dictates the deep depth of field. Sensor size is tangentially related to DOF in that the smaller sensor demands the wider angle lenses in order to get a usable field of view, but there's nothing inherent about a smaller sensor that is causing the depth of field to magically deepen.

As a practical matter, because of the field of view constraints, you're always going to have deeper depth of field on a small-sensor camera than you would from a larger sensor camera. But understanding why (the focal lengths) can help you to understand how to maximize what depth of field your camera is capable of.

Myth 2: "Focal length is irrelevant in DOF. To use telephoto, you have to back up (which increases DOF). To get close, you have to use wide-angle (which increases DOF). They cancel each other out completely." Not visually. Technically they do, but for any given subject size, the telephoto shot will clearly look like its background is more out of focus. Whether it's technically as "in-focus" or not is largely irrelevant; the telephoto lens delivers the optical illusion that the background is more out of focus, and that's what you're after: the APPEARANCE that the background is out of focus. The reason it delivers the appearance of a softer background is because the telephoto lens has a much narrower field of view, so for any given shot composition, the entire background will be made up of a smaller chunk of background, as compared to a wider-angle shot. So the background will be more optically magnified to fill the screen.
It is this optical magnification which makes the background look like it's more out of focus. With a wide-angle lens the background is actually shrunk down (because the perspective exaggeration of the wide angle forces the background to appear further away, thus fitting more background into the shot, which forces what background there is to be rendered smaller); with the telephoto lens the background is actually magnified. So even though technically the background may be just as out-of-focus in the wide-angle shot, it doesn't look like it's as blurry, because when shrunk smaller it looks sharper. Whereas with the telephoto shot the out-of-focus-ness of the background is magnified by the optical compression that the telephoto lens exhibits, so the background looks more out of focus than it actually is.

To illustrate, I put together this example. This is a shot where I kept the subject at the exact same size, at the same aperture. In the "TELE" shot on the left, I backed up and zoomed in as far as possible. In the "WIDE" shot, I zoomed out as much as possible, and then moved close to make the subject be the same size. As you can see, the background on the "TELE" shot is substantially more magnified, which makes it look more out of focus. The background on the "WIDE" shot is much wider, and correspondingly looks more in-focus.

BLUE MENU ITEMS

When navigating the HVX's menus, occasionally you'll come across a menu item that's displayed in blue, and cannot be changed. When a menu item is displayed in blue, it's letting you know that that particular function is disabled due to some other camera setting or mode. It means that you'd have to change some other menu
item before the "blue" menu item becomes functional again. It does not, however, mean that whatever is displayed in blue is "in effect" – rather, in fact, it means that the whole concept of that menu item is not relevant to your current shooting circumstances. As an example: in the RECORDING SETUP menu, there's a menu item called "480i REC MODE" (in the 50Hz model, it'd be called "576i REC MODE"). That menu item has choices of DVCPRO50, DVCPRO, and DV. Those choices are only valid, and only relevant, if you're shooting in 480i (i.e., standard definition) mode. When you have the recording format set to high definition mode, the "480i REC MODE" menu option becomes blue. Why? Because it's not active, and it's irrelevant – you're not currently shooting 480i, so why would it matter what the 480i recording mode was set to?

In order to change that menu setting, you'd have to make it relevant to the current camera mode. For the "480i REC MODE" menu setting, that means you'd first have to put the camera in a mode that uses 480i recording. You'd do this by changing the "REC FORMAT" menu item to one of the 480i recording options – either 480i/60i, 480i/30p, 480i/24p, or 480i/24pa. Choosing any of those puts the camera in 480i recording format – and immediately you'll see that the previously-blue "480i REC MODE" menu item is now white, and selectable. It is now relevant to your shooting mode, so now the menu item is active and you can change its setting.

Whenever you see a blue menu item, it means that that menu item has no bearing on the camera's current status, but could become relevant if you changed some other setting. Furthermore, blue menu items will show a status (such as the "480i REC MODE" menu showing "DVCPRO50"). That doesn't mean that you're currently set to record DVCPRO50 – it means that when this menu becomes re-enabled, the default will be DVCPRO50. What the words in blue tell you is what the setting will be if the menu becomes active again. For example, let's say that the "V DETAIL FREQ" menu item shows "THIN" in blue. It's blue because we've chosen to shoot interlaced 480i/60i, for example, and when shooting 480i/60i the internal operation will be THICK, regardless of what the menu item words say in blue – and currently, in our hypothetical example, the word
says “THIN”. As long as we're working in interlaced 480/60i, that “THIN” is irrelevant – we know that internally interlaced SD will always be processed in THICK – you cannot change that. Now, if we go into the “RRC FORMAT” menu option and choose one of the progressive-scan options (say, 480i/30P), the “V DETAIL FREQ” menu item will turn white. It’ll become active again, because now (in progressive scan) the menu item will directly affect the picture. And the value you will have will be THIN, because that’s what it was telling us when it was blue: it’s basically saying “the next time you activate me, this is the value I will default to.”

Following is a description of each menu item that goes blue, and what you have to change in order to enable the menu item (i.e., turn it from blue back to white):

**Scene File Settings**

**Syncro scan:** Syncro Scan will turn blue when the Syncro Scan speed is slower than your recording format’s frame rate. If you’re shooting 480/60i or 1080/60i or 720/60p, and the Syncro-Scan shutter speed is slower than 1/60 (i.e., the number is smaller than 60), then the Syncro Scan menu option will turn blue. If you attempt to change the speed, you’ll see it says something like “1/48.0 (1/60).” What that means is that the actual shutter speed it will use is 1/60 (which is displayed in white) even though you’re free to change the setting to a shutter speed slower than that (which is displayed in blue). If you later choose a different frame rate for recording (say, 480/24p) then the 1/48.0 shutter will now turn white and be valid, since the shutter speed is once again faster than the frame rate. In other words, when shooting 60 fields per second or 60 frames per second, you cannot have a Syncro Scan shutter speed slower than 1/60.0. When shooting 30 frames per second, you cannot have a Syncro Scan shutter speed slower than 1/30.0. And when shooting 24p, you cannot set the Syncro Scan slower than 1/24.0. Syncro Scan is unique among blue menu items in that you are still allowed to change its setting even while it’s blue; no other blue menu item can be changed at all.
Frame rate: Frame Rate can only be changed when the OPERATION TYPE is set to “FILM CAM” and the REC FORMAT is set to 720p.

News gamma: News Gamma can only be selected when shooting interlaced (480i/60i or 1080i/60i) or 720p/60p. Any other setting will disable News Gamma.

Gamma: the Gamma options are disabled when News Gamma is set to “ON.” Turn off News Gamma to enable these options.

Knee: The Knee menu item becomes disabled when you select CINELIKE-D or CINELIKE-V gamma.

V_detail_freq: This menu item is only valid when shooting standard-definition video at 480/24P or 480/30P or, for the 50Hz camera, 576/25P. When shooting interlaced or high-definition video in any mode, this menu item becomes disabled. This menu item defaults to THICK in standard-def interlaced video, and THIN in all high-definition modes.

Camera setup menu
Aspect conv: This item becomes blue when you’re shooting in high-definition. If you switch to standard-definition (480 or 576 mode) this menu item becomes enabled again.

Recording setup menu
480i rec mode (or, for 50Hz users: 576i rec mode): This menu item is blue when using a 1080 or 720 REC FORMAT.

Rec function: Disabled when you select FILM CAM mode. If you’ve selected VIDEO CAM mode it may still be disabled depending on what recording format you’ve chosen; it only works in 60i interlaced, 60p or 30p (50Hz models = 50i, 50p or 25p). It is disabled if shooting in 720/25pN, 720/30pN or in any 24p mode.

One shot time: disabled in FILM CAM mode, or when REC FUNCTION is set to anything other than ONE-SHOT.

Interval time: disabled in FILM CAM mode, or when REC FUNCTION is set to anything other than INTERVAL.
Prerrec mode: disabled in FILM CAM mode, or when REC FUNCTION is set to anything other than NORMAL, or in 24P modes or 720pN modes.

25M rec ch sel: disabled when in high-definition modes or DVCPRO50 mode. Enabled for DVCPRO or DV recording.

TC preset: disabled when FIRST REC TC is set to “REGEN” (tape mode only)

UB preset: disabled when UB MODE is set to anything other than “USER.”

UB mode: disabled when 1394 UB REGEN is set to “ON.”

TC mode, ICG, TC Preset, and 1394 IN Preset: disabled when 1394 TC REGEN is set to “ON.” TC MODE is also disabled and forced to NDF whenever 24P recording is selected.

Dubbing setup menu

Pulldown sel: This menu item goes blue when the FORMAT SEL is set to anything other than 720/24PN.

SYNCHRONIZING MULTIPLE CAMERAS IN A MULTI-CAMERA SHOOT

The HVX200 offers the ability to synchronize its timecode preset to any DV device – you can plug in a DV camera or DV deck into the HVX200 (through the 1394 jack) and the HVX200 can automatically read the timecode from the other device and synchronize to it (when shooting DV). This makes synchronizing timecode between multiple cameras a breeze. For a DV shoot, you don’t even have to be synchronizing with another HVX – it could be a DVX, or any other type of DV camera. In a DVCPRO50 or DVCPRO-HD shoot, you can synchronize to other HVX cameras.

The key to synchronizing the cameras is to use FREE RUN timecode. For most normal recording situations, it’s typical to use REC RUN.
However, for synchronizing multiple cameras, FREE RUN has some compelling advantages. If all the cameras are initialized with the same timecode preset, then the timecode will be identical on all the cameras throughout the day (barring any timecode drift.) This can make matching up takes in the edit bay easy and effortless.

You'll designate one camera as the "master timecode" camera, and all other cameras will sync to the master camera. (Note: for DV, the master camera does not have to be an HVX200; the HVX200 in DV mode can sync to any camera's DV timecode). Make sure the cameras are set in FREE RUN mode, and all the cameras need to be set equally to either DROP FRAME or NON DROP FRAME.

Make sure the master camera is in camera mode. In the RECORDING SETUP menu, make sure the HVX is configured to FREE RUN and PRESET mode (don't worry about setting the TC PRESET menu item; the HVX will automatically read that from the master camera through the 1394 cable). Also, make sure 1394 TC REGEN is set to OFF. Finally, switch to MCR/VCR mode and set the 1394 IN PRESET menu item to ON. Exit the menu system. You'll see "1394TC" displayed on the LCD indicating that the camera's ready to receive external timecode data.

Next, connect the HVX to the master camera via a 1394 cable. Press the TC SET button and the HVX will force its TC PRESET menu item to match the timecode it's receiving through the 1394 port. You can disconnect the 1394 cable, as from that point on the cameras should stay in sync. Note: the only data that gets transferred through the 1394 cable is the value that gets assigned to the TC PRESET menu setting; all other settings (such as DF/NDF, REC RUN/FREE RUN, etc) are not transferred when pressing the TC SET button. You have to make sure that those settings are compatible between cameras manually; or, if you're configuring timecode between two HVX cameras you can ensure that they're set equally by transferring the User File from the master camera to all the other HVXes via the SD card before setting the timecode itself. Transferring the User File will equalize the settings for all camera setup information (but not scene files) to the other camera; this includes setting all timecode-related settings equally.
**Sync Drift:** Once you set the timecode preset to be the same, all the cameras will record the exact same timecode for any scene, regardless of when you start or stop shooting, so when shooting with multiple cameras you can easily synchronize the footage by lining it up according to timecode. However, be aware that sync may drift slightly between the cameras throughout the day, and if you turn off one of the cameras, change batteries, or switch a camera to VCR mode, that can briefly interrupt the flow of timecode. To maintain perfect sync you will probably need to re-sync the cameras after doing so. It’s a simple matter of reconnecting the 1394 cable, switching to VCR/MCR mode and pressing the TC SBT button.

**EDITING OPTIONS**

One of the fascinating things about the HVX200 is the fact that its native codec, DVCPRO-HD, was designed from the ground up to be compatible with editing. Just like DV, DVCPRO-HD’s codec is available for desktop computers and nonlinear editing programs, to allow full-resolution native editing of the pure high-definition footage. While DVCPRO-HD’s main rival (Sony’s HDCAM format) requires either a Sony-proprietary edit station like the XPR1 or an uncompressed high-def edit suite, DVCPRO-HD is capable of being edited with full-screen, full-resolution, full-frame-rate power on inexpensive desktop computers running certain commonly-available nonlinear editing programs.

Apple Computer first brought high-definition editing to the consumer’s desktop with the introduction of Final Cut Pro 4.5, a breakthrough in desktop editing that worked in conjunction with the Panasonic AJ-HD1200A tape deck to provide desktop editors with the ability to capture, edit, and output native high-definition video back in 2004. While Final Cut Pro 4.5 (later renamed “Final Cut Pro HD”) was designed to work with Panasonic’s top-of-the-line VariCam DVCPRO-HD camcorder, it just so happens that the HVX200 uses the exact same format, the same variable-frame-rate capabilities, and the same codec. Because of this you can easily, natively edit HVX200 footage on an inexpensive Macintosh computer; a lowly 1GHz “G4” processor and 1GB of Ram will have you
cutting high-definition footage! With versions 5.0.4 and 5.1 Apple has extended Final Cut Pro to include full support for the HVX200’s P2 card system, MXF file format, and 1080i & 1080p recording modes (the HDC27F VariCam doesn’t support 1080 recording).

As of the time of this writing (May 2006), Apple’s Final Cut Pro doesn’t support MXF files directly. As such, you have to take an additional step to convert the MXF files into Quicktime movie files. This is a simple and easy process; just choose “Import->Panasonic P2” from the FILE menu, and Final Cut Pro will unwrap the MXF file and re-wrap them in Quicktime wrappers, which can then be edited in FCP. The unwrap/rewrap process is quick and involves no changes to your footage; it’s a lossless process which doesn’t perform any uncompresing or recompressing.

Final Cut Pro 5.0.4 supports every format the HVX200 shoots: DV, DVCPRO25, DVCPRO50, 720p DVCPRO-HD, and 1080i DVCPRO-HD, but not 720/25p or 720/50p DVCPRO-HD in the 50Hz camera. As of version 5.1 it also supports direct pulldown removal for 1080p/24pA DVCPRO-HD. Visit the Apple Final Cut Pro website at http://www.apple.com/finalcutstudio/finalcutpro/ for the latest information on features and upgrades for Final Cut Pro.

On the Windows™ platform, there are several options for editing the footage, including Avid, Canopus, and Avid/Pinnacle Liquid. Additionally, DVFilm.com’s RayLight program is a codec and file conversion program that allows HVX200 footage to be used in applications that don’t have native MXF & DVCPRO-HD support (programs such as Sony’s Vegas and Adobe’s Premiere Pro or After Effects, etc).

Avid Xpress Pro HD version 5.2.1 and later support the MXF files natively. You can insert a P2 card right from the camera into a PC Card slot on the computer, and import the MXF files into your projects. Avid also provides for importing and exporting footage via a 1394 connection to the camera or AJ-HD1200A tape deck. Avid supports all formats that the camera records. As of the time of this writing there is not direct support for a 1080/24p timeline, nor a 1080/30p timeline; you can use Avid to edit 1080p footage
but it would necessitate editing it on a 60i timeline, without pulldown removal.

Using MXF files on Avid is simple and straightforward; however it does require one additional step. You can’t just drag and drop the files from the card into a media bin; attempting to do so causes Avid to misinterpret the files as being Sony XDCAM MXF files. Instead, use the Media Tool to import or, alternately, copy the files into the “Avid MediaFiles\MXF\1” directory. The media manager will then properly interpret them as P2 MXF files, allowing for direct editing and export. Check the Avid website at http://www.avid.com/products/xpressFamily/ for the latest on Avid Xpress Pro HD. Note: while Avid markets Xpress Pro for the Macintosh platform, P2 and MXF support won’t be part of Avid’s Macintosh version of Xpress Pro until version 5.5 is released sometime in 2006.

Canopus Systems offers Canopus EDIUS Broadcast for the Windows platform. EDIUS Broadcast is built from Canopus’ EDIUS Pro software, and includes several option modules that make it particularly well-suited to editing HVX200 footage. Canopus has long offered optional add-on packs for EDIUS Pro, including a codec option pack for DVCPRO50 and DVCPRO-HD; a P2 support pack, and a Varicam variable-frame-rate support package. With EDIUS Broadcast, Canopus has bundled all of these options together with EDIUS Pro 3, and lowered the price significantly. The result is a complete HVX200-compatible editing system with end-to-end native support for every mode, every frame rate, every facet and every feature of the HVX200. Unlike FCP5 and Xpress Pro HD 5.2, Canopus’ EDIUS Broadcast maintains the metadata integration throughout the entire editing process. Canopus also allows you to export your timeline back to MXF files on the P2 cards. Canopus EDIUS Broadcast fully supports the P2/MXF system of the HVX200, including the ability to annotate metadata when writing files back to the cards! The website at http://www.canopus.com/products/EDIUSBroadcast/index.php can provide you with more information about EDIUS; be sure to look for EDIUS Broadcast, and not just EDIUS Pro.
Pinnacle Systems' Liquid software has recently been acquired by Avid. Avid Liquid 7 supports MXF file import, playback, and editing from P2 cards, and supports the DV, DVCPRO, and DVCPRO50 modes of the HVX200. As of the time of this writing it doesn't yet support the high-definition modes, but could be used to edit the HVX's standard-definition footage. Since Pinnacle is now a division of Avid, and since Avid has DVCPRO-HD support in other products, Liquid users may want to check the Avid Liquid website at http://www.avid.com/products/liquidfamily/index.asp for product updates and information.

There are two other nonlinear editors that have significant market share, but don't yet have native editing support for the DVCPRO-HD and P2/MXF systems: Sony's Vegas, and Adobe's Premiere Pro. While neither of these programs offer direct support in the current version as of May 2006, there are potential workarounds.

For Premiere Pro, Matrox Systems offers a hardware editing board system called AXIO which supports DVCPRO-HD. The AXIO system includes hardware codecs and support for multiple streams of realtime high-definition editing, using Premiere Pro as its nonlinear editor. Visit http://matrox.com/video/products/axio/home.cfm for more information on AXIO.

There are also some software options that can help users gain access to HVX200 footage. One option is DVFilm.com's RayLight program. RayLight is a DVCPRO-HD codec and file conversion utility that lets DVCPRO-HD footage be used on Windows systems – using RayLight, you can convert the MXF files into Windows-compatible AVI or MOV files, and the RayLight codec lets the editing application work with the footage just like any other video file. The RayLight codec was engineered specifically for Windows NLE compatibility, and Vegas and Premiere Pro are both compatible with RayLight. RayLight includes a RayMaker program which converts the MXF files into AVI files losslessly, retaining 100% integrity of the video data. The conversion step takes a small amount of time, but it does allow someone to use a nonlinear editor or support program (like Adobe After Effects 7) that would otherwise be unable to use the
HVX200's files. RayLight was also the first program to support 1080/24pA pulldown removal, and the first program to support 720/25pN and 720/50p editing modes on the 50Hz camera. To learn more about RayLight or to purchase, visit www.dvfilm.com and look for "RayLight."

In addition to RayLight, codec development company MainConcept is offering a DVCPRO-HD codec software development kit (SDK) for use in Windows systems. The MainConcept codec SDK should allow developers to create DVCPRO-HD-compatible software on any Windows DirectShow-compatible computer, to read and work with DVCPRO-HD files. However, unless a program is compatible with P2 MXF files, you may still need to take another step to convert your footage into a compatible format such as AVI or MOV. The product page for MainConcept is http://www.mainconcept.com/products.shtml, check back for updates and information regarding their releases.

Finally, Focus Enhancements, makers of the FireStore line of direct-to-disk recorders, offers a suite of file conversion utilities and is expanding its offerings to include support for DVCPRO50 and DVCPRO-HD files. Using a file conversion program in tandem with programs using the DVCPRO-HD codec from MainConcept should allow for importing HVX200 footage files into programs that don't otherwise support them natively. Check http://www.focusinfo.com/solutions/video_production.asp for news and announcements related to their file conversion utilities.

Serious Magic's DVC Rack program (the HVX200-enabled version of their award-winning DV Rack) offers the unique capability of recording while bypassing the P2/MXF file structure. Users of DVC Rack could record directly to Windows .AVI files, or to Quicktime .MOV files. Those files could then be directly edited by programs that support DVCPRO-HD files, whether the programs support MXF or not. Check www.seriousmagic.com for more details.

The HVX200 breaks new ground, being the very first camera to combine tapeless recording, DVCPRO-HD, and 1080/24p, all in
one low-cost package. It would be understandable if editing support lagged as NLE developers scrambled to implement these new features and options — after all, the first HDV-compatible camcorders were on the market for nearly two years before being embraced and supported by some of the biggest NLE applications! It is therefore quite refreshing to see that the HVX200 has fully-integrated support right away from Avid, Final Cut Pro, and Canopus, and within a few weeks of the HVX's release, the RayLight program appeared to provide a workflow option for users of Vegas and Premiere Pro. As time progresses, any gaps in support should be filled in as well, rounding out the post-production options for the HVX200.

OPTIMIZING FOR LOW VIDEO NOISE

One side effect of making a high-definition camera with 1/3” CCDs is that noise will usually be somewhat higher on a 1/3” camera than it would be on a larger-chip camera. No 1/3” chip camera is going to deliver the noise-free performance of a 2/3” camera. However, if low noise performance is important to you, there are several steps you can take to minimize the appearance of noise in the HVX200’s video signal. By taking advantage of the various menu settings, as well as employing proper lighting, you can reduce image noise. (Note: all these recommendations are implemented in the LONOIIZ scene file included on the CD-ROM that accompanies this book).

“Noise” in a video signal is a random variation in the color and intensity of each pixel. This random variation is very small compared to a strong signal (i.e., a bright part of the image), but becomes relatively more apparent as the signal level decreases (i.e., in dark parts of the image). Pixel size on the imager also affects perceived noise level; the larger the pixel, the more light it gathers, increasing the signal-to-noise ratio; and the larger the pixel area, the more these random variations average out towards zero. In general, a properly-exposed image will show much less noise than an underexposed image.

The HVX200 offers eight different gamma curves and four different color matrices, as well as settings for detail and coring and other
features that can combine to give you exceptional control over the images the camera produces. Many of these can influence the appearance of noise in the signal as well.

First, take into account the gamma curve. The different gamma curves lend different looks to your footage, and they all also play a part in how perceivable noise may be in the footage. CINELIKE-D may be the most powerful of the gamma curves, providing extended latitude and dynamic range, but the tradeoff (there's always a tradeoff, isn't there?) is that it introduces more noise into the image. If you're looking for the lowest-noise signal, the gamma curves are ranked here in terms of lowest-noise to most-noise: B.PRESS, CINELIKE-V, LOW, HD NORM, SD NORM, NEWS, HIGH, and CINELIKE-D.

Next, consider your color matrix. The more colorful matrices provide punchier, more saturated colors, but also introduce (you guessed it) a little noise. Not a lot, but a little. The matrices, in order from cleanest to noisiest, rank like this: NORMAL, ENRICHED, FLUORESCENT, and CINELIKE.

Also, the DETAIL LEVEL can have a large impact on the perception of noise. Lowering the DETAIL LEVEL can mask the visibility of noise. It doesn't really change the presence of noise, but the higher detail level settings will actually accentuate the edges of the noise, and can even draw edge-enhancement outlines around the noise, making it more noticeable. The lower you set your detail level, the less visible the noise will be (but, of course, the softer the image will look, too).

Hand in hand with DETAIL LEVEL is DETAIL CORING. Coring is designed to suppress edge enhancement on noise. What this means is, the higher you turn up DETAIL CORING, the less visible noise you'll see in your picture, but it really depends on your DETAIL LEVEL setting. If the DETAIL LEVEL is very low, then there won't be any edge enhancement happening on the noise, so there won't be anything for DETAIL CORING to do. So when you have DETAIL LEVEL really low (say, -5 or -6) then you really won't see any effect
from DETAIL CORING no matter what you set it to. But the higher you set the DETAIL LEVEL, the more effect DETAIL CORING will have in suppressing the visibility of the noise. DETAIL CORING can't tell the difference between fine high-frequency image detail and general noise though, so setting coring up to a high level may reduce the apparent sharpness of high-frequency detail too.

Also, the SKIN DTL function can help smooth out a little bit of noise in skin tones. It works just like DETAIL CORING but very mildly, and only on colors that it perceives to be skin tones (the general idea being to smooth out skin blemishes.) If you're aiming to minimize noise as much as possible, SKIN DTL may help a little.

And, it should be said: avoid electronic gain! Adding gain adds noise to the signal. The more gain, the more noise; +18dB can make for a very noisy image. If you need the picture brighter, adding light to the scene will do much more for the quality of your picture than gain ever would. Adding light will give you a cleaner picture and adequate light can help to suppress noise that might otherwise have been there. Underexposing video leads to increased noise in the signal; giving the camera proper exposure will clean up the signal nicely. A camera is a light-gathering device, so giving it enough light will help it perform its best. A camera feeds on light – feed it, and it will reward you with gorgeous imagery; starve it and you may not be as pleased by its results.
Scene File Settings

The Scene File Dial is also known in Panasonic literature as the CineSwitch™. The Scene File Dial allows you to store and recall groups of image-control settings, and with six positions on the dial, you can have six different “looks” pre-programmed into the camera. The settings that are controllable by the Scene File dial are contained in the SCENE FILE menu.

Note: the scene file dial can be changed even while recording, and most of the scene file menu options will take effect immediately; only OPERATION TYPE and FRAME RATE won’t change during recording.

The following descriptions of the scene file properties will give you a better understanding of how these settings affect the image.

Please note: the color photos included in this book are for reference purposes, but should not be taken as absolutely accurate—due to limitations in color printing capabilities, the photos are approximations. If you want to see the original source photos, please refer to the CD included with this guide.

OPERATION TYPE

The HVX200 offers two choices for OPERATION TYPE: VIDEO CAM and FILM CAM. Depending on which selection you choose, certain features will be enabled or disabled, and some will change their operation or their units of measure. VIDEO CAM is the normal
mode of operation for shooting live event video, news, or any type
of shooting where you want and expect the camera to operate as
a normal video camera. FILM CAM mode lends the camera more
operational functionality in the style of a film camera. Selecting
FILM CAM mode enables variable frame rate shooting (in 720p)
and film-style shutter angles in the Syncro Scan menu; selecting
VIDEO CAM mode enables standard fractional shutter speeds in
the Syncro Scan menu, News Gamma, One-Shot recording, Interval
Recording, Pre-Rec mode, Loop Recording, and slow shutter speeds
(1/12 in 50Hz, and 1/15 in 60Hz models; 1/12 in 720/24p mode
and 50Hz models). The OPERATION TYPE cannot be changed while
recording; switching to a new scene file will load new settings for all
other parameters but not for OPERATION TYPE or FRAME RATE.

FRAME RATE

When using FILM CAM mode and 720P recording, this menu item
lets you change the frame rate the camera captures images at. It
actually changes its capture frequency to acquire frames at a fixed,
discrete interval in time, just like a film camera would. The FRAME
RATE cannot be changed during recording, and you can’t do “speed
ramping” in-camera. An important note when using the “Native”
modes: sound is only recorded when the FRAME RATE matches
the frame rate of the mode you’ve selected (i.e., when recording
720/30pN, the FRAME RATE menu item should be set to 30 FPS
or DEFAULT if you want to record sound). Same for 720/24pN
and 24FPS. The “DEFAULT” setting will set the frame rate to the
appropriate sound-equivalent frame rate regardless of which mode
you’ve selected. For more discussion on the frame rate options
and why you’d want to use each one, see the Variable Frame Rates
discussion on page 39.

SYNCRO SCAN

The HVX200 has a wide variety of preset shutter speed settings,
from 1/12 up to 1/2000 of a second depending on which recording
mode you select. But by going into the SYNCRO SCAN menu, you
can specifically dial in exactly what shutter speed you want, in
increments as small as 1/1000 of a second. The SYNCRO SCAN function is useful for getting alternate shutter speeds, but it's also useful for shooting a scene with computer monitors (or other flickering displays or lights) in it. Computer monitors frequently have refresh rates that may not synchronize with the camera's standard shutter speed, and that can result in seeing a dark/scrolling bar on the computer monitors in your shot. To use the SYNCRO SCAN function, first use the SHUTTER and SPEED SEL buttons. Make sure that SHUTTER is not set to SHUTTER OFF, and then scroll through the options using the SPEED SEL button until you see a decimal fractional speed, such as "1/36.3" or "1/48.0" (in VIDEO CAM mode) or a shutter angle in degrees, such as "180.0d" (in FILM CAM mode). Those speeds with decimal points are the SYNCRO SCAN speeds. Once you have SYNCRO SCAN speeds selected, you can go into the SCENE FILE menu and choose SYNCRO SCAN and change the shutter speed. If you're trying to sync with a computer monitor, point the HVX at the computer monitor and then scroll through the shutter speeds until you find one that makes the monitor stop flickering. For television screens in the USA, you'll normally want to use a shutter speed of 1/60, and in PAL territories you may want to use 1/100. For computer monitors you will likely have to use the SYNCRO SCAN menu to find a speed that stops them from flickering.

In FILM CAM mode, the Syncro Scan option is chosen in terms of angle degrees, rather than as a fractional measurement in time. In order to understand the relationship between the angle and the exposure, you have to understand how film camera shutters work (see the discussion on film camera shutters on page 17). The faster the shutter rotates, the shorter the "shutter speed" that the film gets exposed for. Also, the narrower the angle of the hole, the shorter the shutter speed. In film cameras the shutter always rotates exactly once per frame, so when shooting 48 frames per second, the disc will be rotating twice as fast (and exposing for half as long) as it would when shooting 24 frames per second.

Because the disc always rotates at a fixed speed based on the film frame rate, the only way cinematographers have to control the
shutter speed is by making the wedge larger or smaller. The larger the wedge, the more time the film gets exposed; the smaller the wedge, the less time the film gets exposed. The size of the wedge is measured in "degrees," where 360 degrees form a circle. A very thin sliver of a wedge might mean an opening of only 10 degrees, whereas a massively open shutter might be as much as 350 degrees. Most movie cameras use shutters between 144 and 220 degrees, and 180 degrees is quite common (180 degrees would be exactly a half-circle, half-open and half-closed).

Movie cameras don’t all default to 180 degree shutters, and they don’t all default to 1/48 exposure (at 24 fps). Some cameras run at 1/48. Some run at 1/50. Some run at 1/43. Most modern cameras have variable shutter angles that let them run anywhere from 1/90 down to 1/40th, and many can select between 11 to 200 degrees.

When working with FILM CAM mode, it's vital to understand that the Syncro Scan shutter angles don't necessarily represent a fixed exposure time, which differs from VIDEO CAM mode, where, e.g., 1/80.0 exposure will mean the exact same amount of light exposure, whether you’re shooting 24 or 30 or 60 frames per second. But in FILM CAM mode, when using Syncro Scan shutter speeds expressed in terms of degrees, 180 degrees will deliver a different exposure at 24fps than it would at 30fps, or at 60fps. Remember again that in a film camera the shutter rotates at a speed directly fixed to the speed of the film; each frame gets exactly one rotation of the disc. That means that the faster the film moves through the camera, the faster the shutter disc must spin, and that means correspondingly shorter exposure times. The HVX200 emulates this behavior exactly, so shooting with a 180.0 degree shutter at 48 frames per second results in half as much exposure as it would at 24 frames per second. You, as the shooter, must compensate for that by opening up the iris or by adding light to the scene when shooting at faster frame rates.

If you don’t want to compensate for light levels, you don’t have to use the Syncro Scan shutter speeds, you can instead select a fixed shutter speed (such as 1/100). This will keep exposure constant
regardless of what your frame rate is; however, be aware that when shooting this way, your overcrank and undercrank footage will not look as filmlike as it otherwise could. The short exposure times when overcranking, and the long exposure times when undercranking, result in different amounts of crispness or motion blur. If you allow the shutter to operate as a film-style shutter, you’ll get film-style motion blur (but you’ll need to compensate for exposure). If you don’t use the shutter degrees of Syncro Scan (and instead opt for fixed exposure) you won’t have to compensate for exposure, but your footage won’t be nearly as filmlike.

**DETAIL LEVEL**

DETAIL LEVEL controls edge enhancement and overall sharpness of the picture. Video cameras use a sharpening circuit (or edge enhancement, or “detail”) to artificially increase the perceived contrast of the image. Humans use two main criteria to judge the sharpness of an image: resolution, and contrast. The HVX always delivers the same amount of resolution (within each given mode), but the DETAIL LEVEL function can be used to control how much additional contrast is added by the signal processor. With DETAIL LEVEL set all the way down to -7 the image may look somewhat blurry if there’s not adequate contrast in the scene already. With DETAIL LEVEL set up to +7 the image will look much sharper; but setting a higher DETAIL LEVEL brings in edge enhancement, which is an artificial video sharpening that can look unnatural, especially in standard-definition mode. Excess detail also starts to interact with the DV or
DVCPRO-HD compression algorithm: with DETAIL LEVEL turned up to a really high level, you may see an increase in "mosquito noise" artifactual in the picture. And, the higher the DETAIL LEVEL, the more noticeable image noise will be; the edge enhancement process actually sharpens the edges around the noise in the video signal, making it more noticeable!

Two more factors to consider, when deciding on what DETAIL LEVEL to use: first, consider how large your footage will be displayed. The larger the display, the less artificial detail you want to use. On a small screen a high detail setting can look fantastic, but on a movie theater screen it may look a bit artificial. Second, consider whether you're shooting standard-definition or high-definition; the detail circuit performs at different magnitudes depending on whether you're shooting high-def or standard-def. DETAIL LEVEL is much more noticeable in standard-def; in high-def you can usually use up to +5 or even +7 with little to no worries, but in standard-def a setting of +7 would show extreme edge enhancement. When shooting standard-def you should exercise much more caution with the DETAIL LEVEL, but when shooting high-def you can use it more liberally.

The smaller the DETAIL LEVEL number, the softer and more organic the image will look. The larger the DETAIL LEVEL, the sharper (but perhaps more electronic) it'll look. For most purposes, unless you're going for a soft-focus effect, some detail is good; when shooting high-def I usually use at least a setting of 0 and sometimes, depending on the shot, as much as +5 or even +7. For a film transfer you may want to go to as low as -7, but for normal use in high-def, the HVX benefits from a liberal dosage of detail; a positive detail setting can sharpen up the image nicely without creating large objectionable "outlining" around high-contrast edges (but watch for that when shooting standard-definition).
V DETAIL LEVEL affects perceived sharpness, similar to the DETAIL LEVEL control, but in a somewhat different way: it primarily enhances the contrast vertically, between horizontal lines. Whereas DETAIL LEVEL works with edge enhancement, perhaps artificially drawing outlines around objects to accentuate their edges, V DETAIL LEVEL works with the existing image, accentuating vertical contrast between horizontal elements. It will slightly sharpen (or slightly unsharpen) the contrast vertically between horizontal lines in the video image. V DETAIL LEVEL doesn’t draw new elements into the picture, but it will enhance the existing contrast vertically between horizontal lines (white edges become whiter, dark edges become darker). This enhanced contrast leads to the illusion that the picture is actually sharper. It’s a fine control; the V DETAIL LEVEL setting has a milder sharpening effect than DETAIL LEVEL. When shooting progressive-scan you can be more liberal with the sharpening, but when shooting interlaced video (50i/60i) you may want to watch this setting; turning it up higher may accentuate interlace flicker, and turning it down may help minimize flicker.
DETAIL CORING

DETAIL CORING can help to mask the appearance of noise in the image. To understand the effect of CORING, you have to understand the interaction between DETAIL LEVEL and noise in the image. DETAIL LEVEL tells the system to accentuate contrast between low-contrast elements of the picture, but DETAIL LEVEL doesn’t know the difference between fine high-contrast detail and noise in the signal. As such, a high DETAIL LEVEL makes the noise more visible; DETAIL LEVEL actually sharpens the edges of the noise. DETAIL CORING can help bypass that process. The higher the DETAIL CORING setting, the more it will cause the system to ignore sharpening of high-frequency detail. This means the noise won’t become sharpened/edge enhanced, making it less visible; the tradeoff is that your legitimate high-frequency detail won’t receive the contrast-enhancing effect either, so your image may not look as sharp as it otherwise could.

The effect of CORING is most noticeable when DETAIL LEVEL is set to a high value. At -2, DETAIL CORING has minimal effect on the noise. At +7 it has a significant smoothing effect, and really cleans up the noise in the video signal (again, perhaps at the expense of legitimate detail). The higher the DETAIL CORING setting, the smoother the image, and higher levels can lead to your picture looking a little softer. Also, the lower the DETAIL LEVEL setting, the less effect DETAIL CORING will have on the image. For maximum detail and resolution on your image you may want to set DETAIL CORING lower, but doing so will make noise more visible (noise
manifests itself in a crawling texture on the surface of the video, sort of like film grain). Higher levels (such as +7) help hide noise but look softer; lower settings (such as −2) help retain maximum detail sharpness at the expense of masking less noise.

**CHROMA LEVEL**

CHROMA LEVEL refers to the amount of color saturation the picture has. The lower the CHROMA LEVEL, the more pale and muted the colors will be. The higher the CHROMA LEVEL, the more saturated the colors become. At −7 the picture will have the least amount of color saturation, but there will still be quite a bit of chroma recorded (you can't get a black and white picture even with the CHROMA LEVEL turned all the way down). At +7 the colors will be very strong and rich and vibrant. Combining the CHROMA LEVEL with the color MATRIX function can give you a lot of control over the saturation, tonality, and vibrancy of the colors in the picture.

**CHROMA PHASE**

CHROMAPHASE adjusts the color along the yellow-green and purple axis. It works like the "TINT" control on NTSC televisions. At −7 the picture shifts slightly towards yellow/green hues, and at +7
the picture shifts towards purple/magenta hues. The effect is quite mild though—you won’t make the picture strongly greenish or strongly purple-ish, but you can mildly balance the picture.

COLOR TEMP

Whereas CHROMA PHASE lets you adjust the color between green and purple, COLOR TEMP lets you adjust the color between orange/red and blue. A negative setting makes the picture warmer and redder; a positive setting makes it cooler and bluer. The COLOR TEMP setting gives you a strong degree of influence over your picture, much stronger than CHROMA PHASE does: at −7 the picture will be very orange, and at +7 the picture will be very blue. At smaller increments you can use this setting to add a slight warming or cooling to your picture: a COLOR TEMP of −1 would provide a warming effect similar to using an 812 warming filter. Note: the COLOR TEMP setting has no effect when the white balance switch is set to “preset.” It only works if you manually white balance, or if the camera is set to Auto Tracking White balance mode. Using the 3.2K or
5.6K preset white balance will disable the COLOR TEMP function. For a brief definition, Color Temperature refers to the phenomenon of a “black body” (say, a piece of iron) glowing different colors as it is heated. At lower temperatures (say, 3200 degrees Kelvin) the iron will glow reddish, and at higher temperatures (such as 5500 degrees Kelvin) it will glow bluish-white. Color temperature generally expresses chromaticity of a source of light such as indoor or outdoor light. For example, if the color temperature is relatively low, the light appears reddish. As the color temperature increases, the light changes from red to orange to yellow to blue to white. This COLOR TEMP setting lets you shift the overall color of your video picture along this scale, from red to blue.

MASTER PEDESTAL

The MASTER PEDESTAL governs the way the camera handles the darker sections of the picture, and also acts similar to an overall “contrast” control. The lower you set the MASTER PEDESTAL, the more dark items will all blend together into black, giving you stronger, harsher contrast and a loss of detail in the shadow areas. The higher you set the MASTER PEDESTAL, the more the contrast washes out, and the overall contrast will look softer and flatter, but you’ll also preserve more detail in the shadows. A high MASTER PEDESTAL value will preserve detail in the darker areas of the picture,
but make the blacks "milky." The MASTER PBDESTAL governs the contrast of the darker sections of the picture, but doesn't affect the brighter sections. A low MASTER PED (such as -15) makes for a dramatic, harsh picture, more like reversal film: limited latitude and strong contrast. A higher MASTER PED (such as +15) results in a pastel, flat, extremely low-contrast look, with pale grays instead of sharp blacks in the picture. For high contrast, moody shots, a lower MASTER PBDESTAL setting might be appropriate, and for the maximum exposure latitude you might think about setting the MASTER PBDESTAL a bit higher. Master Pedestal can also help with controlling noise in the signal in the darker sections of the image; setting a lower master pedestal can crush the noisy sections together, eliminating the appearance of noise (but the tradeoff would be perhaps the loss of some shadow detail).

A. IRIS LEVEL

The AUTO IRIS LEVEL setting lets you instruct the automatic exposure system to bias the exposure to be darker or brighter. The range is from -4 to +4, and each increment represents roughly 1/3 of a stop of exposure. When using the camera's automatic iris control, an AUTO IRIS LEVEL setting of -4 will make the camera select an f-stop about 1.3 to 1.5 stops darker than it otherwise would, and a setting of +4 will make the camera choose about 1.3 to 1.5 stops brighter than it otherwise would. Use care with the AUTO IRIS LEVEL setting, especially with + values, as you can easily overexpose your video, leading to ugly "blown out" highlights. Take special care when using the CINELIKE gammas, as there is no blow-out protection
in the CINELIKE gamma curves. This is why the camera scene files default to an AUTO IRIS setting of -2 or -3 in scene files that specify CINELIKE gammas, to provide some protection against blowouts.

**NEWS GAMMA**

The HVX200 offers a total of eight different gamma curve settings. Seven arc discussed under the GAMMA menu item listed below; one gets its own menu setting. NEWS GAMMA is designed to deliver a flatter curve in the highlights, which results in an overall brighter picture with more attention allocated to the mid and high range. This also leads to a slightly lower picture contrast. News Gamma can preserve a wider range of highlights than some of the other gamma curves, but News Gamma is a little bit noisier than HD Norm. The idea behind News Gamma is that a news shooter may be placed in circumstances where they're moving from shadow areas to bright skies, and may not be able to adjust the exposure as quickly as the situation warrants; the News Gamma is designed to retain more overexposure/sky detail until the shooter can adjust for proper exposure.

**GAMMA**

The gamma curves in the HVX control how brightness information is distributed in the picture. Gamma correction can correct for the nonlinear light-output characteristics of a standard TV picture tube. Picture-tube gamma (like on your television) stretches the whites and compresses the blacks. Camera gamma compresses the whites and stretches the blacks. For the technically inclined, camera gamma can be properly set by using logarithmic gray scale charts and a waveform monitor. Camera gamma must be the reciprocal of picture gamma which is 2.2, so the camera gamma is
usually 0.45.
With HD NORM gamma, standard video-looking pictures are produced, and the camera responds like a typical video camera. HD NORM will be the base gamma curve that we compare all the others to. HD Norm produces a normal video-like picture, and has a medium level of image noise.

SD NORM is provided for when shooting in standard-definition modes, to retain compatibility with the DVX100 series of cameras. SD NORM handles highlights and dark tones similar to HD NORM, with slightly lifted midtones. It's also a little bit noisier than HD NORM.

LOW gamma offers similar highlight handling to HD Norm, but compresses some of the medium tones of the picture slightly, while preserving and even slightly boosting the darker parts. This may help you preserve shadow detail, at the expense of some contrast range in darkening the medium bright parts of the picture, but also gives you the ability to iris up a little, since the gamma curve will be compressing the highlights. Because of this, LOW gamma lets you get more detail in the darker sections of the picture. The video image looks a little sharper too, due to the change in the gamma curve, which adds more contrast to the scene. LOW is also slightly less noisy than HD Norm.

HIGH gamma brings up the brightness level of the darker parts of the picture, while maintaining the same level of brightness in the brighter levels. This raises the dark level, making for flatter contrast and an overall brighter-looking picture. It also provides some leeway for you to be able to iris down and still preserve detail in the shadow areas, thus extending the range of highlights that can be captured. HIGH gamma is noisier than HD Norm.
Unlike LOW and HIGH, B.PRESS affects primarily the midtones of the image. It leaves the highs alone, and presses the lows down a little, but raises up the midtones, providing for more dynamic range in the middle of the tonal scale. Midtones are brighter, and dark tones are darker, and this provides for stronger, punchier contrast. B.PRESS is also the quietest (i.e., "least-noisy") of the gamma curves.

CINELIKE-D changes the brightness response substantially. The overall contrast range is compressed and lowered, the brights
and midtones are pressed down, and more headroom is provided at the top of the scale. This actually gives the overall shot more latitude, especially in the brighter parts of the picture. While CINELIKE-D can provide more latitude (providing for more range from the darkest dark to the brightest bright), there’s a potential drawback as well: there’s no “knee” protection at the top end of the scale. In the other gamma curves, there’s a “knee” circuit that governs overexposure, ensuring that overexposure is gently rolled off, making for a smooth transition from bright to overexposed. In the CINELIKE gamma modes, no knee protection is available—brights are rendered smoothly and cleanly right until they smack into overexposure and blow out. This can ruin your shot if you’re not careful, but if you carefully control your shot and prevent overexposure, CINELIKE-D can result in the most latitude the camera can deliver. It has a characteristic soft-contrast look to it because of the linear flat gamma and the compression of the highlights. Because there is no “knee” protection, it is wise to underexpose about 1/2 stop to avoid going into overexposure on the highlights. Even though there’s no KNEE protection in CINE-D, CINE-D can preserve gradations in bright highlights even better than HD NORM gamma when using the KNEE on LOW setting. CINELIKE-D is optimized for Dynamic Range (hence the “D” in its name) but the side effect is an increase in noise in the picture. There is no free lunch, after all; if you want the extended latitude of CINELIKE-D, recognize that the image will be somewhat noisier than with the other gamma curves. CINELIKE-D gives you the most room to manipulate your image in post, and perhaps the most range for a potential film transfer; but the images on a television will be a little flatter because of the widened, flatter contrast.

CINELIKE-V is optimized for sharper contrast. The camera stretches both ends of the spectrum to exaggerate the distance between the darks and the brights, resulting in sharper, punchier contrast. More of the potential dynamic range is used so the image appears to have sharper contrast, but it’s done electronically by stretching the gamma curve. This means you actually may end up with a little less latitude than with some of the other curves, but it does make for sharp pictures on a television. CINELIKE-V is also less noisy than HD Norm.
KNEE

The KNEE helps prevent overexposure by rolling off the intensity of the brightest parts of the picture. With the KNEE circuit engaged, the camera will detect when the highlights are getting too bright and will start attenuating the signal to bring them back into the exposure range. This menu setting lets you decide at what point the knee begins working. When set to LOW, the knee will start attenuating signals at 80% of brightness. At MID, it'll leave 80% alone and start rolling off the signal at 90%. At HIGH, it doesn't affect the signal until it sees 100% brightness (out of 109% total). In AUTO, the camera decides what level it should set the knee at (and, like all auto settings, it may change in the middle of a shot, so exercise caution with AUTO.)

Obviously the sooner the knee begins working (i.e., LOW) the more it will be able to protect your image against overexposure. However, too much knee attenuation can look artificial, turning your whites to gray; whereas using a higher KNEE setting lets the image appear “natural” over more of the dynamic range of the camera. Using the knee is a way to extend the camera's dynamic range: the lower you set it the further you'll extend the dynamic range of the camera, at the potential expense of the highlights looking a bit gray.

Normally, as the intensity of light increases, so does the signal proportionally until the signal exceeds the ability of the camera to record it; any brighter and it just clips to solid white. That's how CINELIKE gamma works. The knee extends the dynamic range by compressing high intensity signals, somewhat like an audio limiter compresses audio signals to prevent overmodulation and distortion.
MATRIX

The MATRIX setting lets you choose different patterns of overall color response. The color matrix basically remaps the original colors to a new matrix of colors. Using the MATRIX you have a limited amount of control over how saturated the colors are, and which colors get enhanced and which do not.

NORM is a mild, normal color response. In NORM the colors are at their least saturated. This matrix is frequently used for shooting outdoors or under halogen lighting in the studio.

ENRICHED matrix brings down the brightness and saturation of the colors, making them a little deeper and perhaps a little truer than NORM. ENRICHED offers a little less green and a little more blue across the color spectrum.

In FLUO the colors are brighter and more vibrant than in NORM. The reds, magentas and blues get pumped up some, but the green component of the signal gets lowered. This matrix is designed to be used when shooting under fluorescent lighting conditions. Many fluorescent fixtures (especially older office fixtures) have a strong spike of green in their color spectrum. The FLUO setting
accentuates the other colors in such a way that the green spike of the lights themselves will compensate and bring the green up to a level comparable to how the other colors are boosted by the FLUO matrix.

In CINE-LIKE all the colors are strongly saturated, there's an especially big boost to green and to magenta. This matrix is used to produce richer, cinema like color.

SKIN TONE DTL

SKIN TONE DTL is designed to help smooth the appearance of mild imperfections on people’s skin. When set to ON, it avoids sharpening anything it perceives as “skin tones,” without affecting any other aspect of the picture. When set to OFF, it doesn’t try to smooth skin tones. For a description of how the SKIN TONE DTL function works, look at the description for DETAIL CORING. SKIN TONE DTL works like DETAIL CORING, except only on colors and tones that it perceives to be “skin.” The higher you have DETAIL LEVEL set, the more noticeable the effect will be. However, even at the highest setting, the effect of SKIN TONE DTL is very mild and subtle.

V DETAIL FREQ

V DETAIL FREQ setting is only applicable when shooting standard-definition video in progressive-scan mode, either 24P or 30P (25P PAL/50Hz). It has no effect on interlaced video (50i or 60i) or in high-definition modes (720p or 1080).
The reason this setting exists is because traditional television sets display an interlaced picture. Cathode Ray Tube (CRT) televisions don't display an entire frame all at once; rather they divide the frame up into even lines and odd lines (called "fields"), and display each field sequentially (i.e., the television draws all the odd lines, then starts over at the top and draws all the even lines, then draws the next field of odd lines, and repeats this pattern.) CRT televisions use glowing phosphors to display information, and once the phosphors are triggered, the brightness starts to decay and darken. If an image contains thin horizontal lines (lines that may only show up on one field and not the other), those lines can flicker very noticeably and very annoyingly (sometimes called "twitter.")

To compensate for this flickering/twittering artifact, all interlaced cameras employ a slight vertical blur (smearing data across fields to ensure that the image will be updated each field) to minimize the flicker that can happen when an object is drawn only on one field. The drawback to this method is that it results in a significant lowering of resolution: interlaced cameras are capable of a maximum of about 360 lines of resolution in NTSC, even though the DV frame is capable of holding a full 480 pixels of resolution.

Newer display devices are not interlaced: plasma and LCD TVs, for example, display full frames rather than dividing the frame up into alternating fields. So do computer monitors. And when footage is transferred to film, there's no interlacing in a film frame either.

The HVX is designed to work with all types of display devices, whether regular interlaced televisions or progressive-scan displays such as plasma or LCD televisions, computer monitors, or even transfers to film. In THIN mode the HVX can actually create video that is higher-resolution than an interlaced television can safely display. THIN mode produces the highest resolution possible, but interlaced televisions aren't designed to display that much resolution, so the image may suffer distracting flickering. Progressive-scan devices like computer monitors or LCD televisions have no problem displaying the high-resolution lines. THICK mode is designed to minimize the flickering on an interlaced television.
THICK mode employs the same type of blur filter used in interlaced cameras, lowering the resolution and blurring the lines across fields so there won't be flickering on an interlaced TV.

If a video is intended to be displayed on an interlaced standard-definition CRT TV, THICK mode is probably the right choice to shoot in. If the video will be transferred to film, or displayed on a computer screen or an LCD or Plasma television, THIN mode will deliver much higher resolution.

MID retains much of the resolution of THIN, but lessens the flicker somewhat. Horizontal lines are blurred a little bit vertically, but not as much as in THICK. The result is a compromise that yields high resolution, sharp contrast and not much flicker (but more than in THICK.)

Also, if you're unsure whether to use THIN or THICK, and you are shooting for perhaps multiple display devices (an example: you intend to transfer to film, and you also want to have a DVD version for release on interlaced televisions); the general advice is to shoot with THIN line detail. THIN preserves the most options, because THICK can be simulated in post, but if you shoot THICK, there's no way to simulate THIN in post. Shooting THIN gives you a master copy with the highest resolution possible (suitable for your potential film transfer or up-rez to high-def), and if the footage flickers on an interlaced television, you can fix that in most editing programs by employing either a "Reduce Interlace Flicker" option, or a very, very mild gaussian blur in the vertical direction.

NAME EDIT

You can assign a custom name to each position on the scene file dial, and save that name to camera memory. Select this option and you can use the menu buttons to spell out an individual name for your scene files. This name (along with all your other changes) will be "lost" when you power off the camera, unless you use the SAVE/INIT menu option to save your scene file.
SAVE/INIT

ALWAYS SAVE YOUR SCENE FILES! When you change settings in a scene file, they're only preserved until you turn the camera off (or switch into PC/DUB mode, or change the battery). Once you turn the camera off, all settings are re-set to whatever their last saved state was. If you like your settings and want to keep them during your shoot (or permanently), you must save them by using this setting. You have to save each scene file individually. Once you've saved your scene file, it will always hold your saved settings regardless of whether you turn the camera off, or remove the battery, etc. However, you can restore the factory original settings at any time, by using the INITIAL function.

You can also save all scene files to an SD memory card, or load all the scene files back from the SD memory card.

If you're experimenting with settings and don't save them, then you run the risk of losing your changes if you change the battery or turn the camera off. Saving your scene files frequently is the only way to keep control over what your settings are.
Camera Setup Settings

The rest of the menu settings apply to the camera regardless of what the Scene File dial is set to. These settings won’t change when you change scene files. These settings can be saved in the USER file, either to the internal camera memory or onto an SD memory card.

ASPECT CONV

(standard-definition modes only)
There are two aspect ratios that are common in the world of television: regular 4:3 televisions, and widescreen 16:9 televisions. These numbers refer to the width of the picture as compared to its height; a 4:3 television is four units wide and three units tall, whereas a 16:9 television is 16 units wide and 9 units tall (for comparison, a 4:3 television could also be expressed as a 12:9 television, which gives a better understanding of how it compares to a 16:9 television.) Displaying 4:3 video on a 16:9 television will result in video that’s horizontally stretched out. Displaying 16:9 video on a 4:3 television will result in a picture that’s horizontally squeezed together.

The HVX200 is a native 16:9 camera. Its CCDs (Charge Coupled Devices, the image sensors in the camera) are shaped 16:9. The HVX200 is optimized to create video suitable for a 16:9 television (or widescreen DVD, etc). When you use the SQUEEZE setting you get a 16:9 picture, utilizing the entire CCD. When shooting in high-definition 720 or 1080 modes, the camera will always shoot 16:9.
For standard-definition shooting (DVCPRO50, DVCPRO, or DV), you also have the choice of making 4:3 video. When you put the camera in NORMAL mode, it generates 4:3 video. The way it does this is by extracting a 4:3-shaped patch out of the center of the 16:9 CCD; it uses the full height of the CCD, and ignores the extra width on the sides.

(Note: this differs from the DVX100A/B cameras, where NORMAL meant the full surface of the 4:3 CCD, and SQUEEZE meant a digital 16:9 up-rez. The HVX200 doesn't work that way; in the HVX200 "SQUEEZE" is the full-frame, full-width, full-height, highest-quality image you can get, and it's natively 16:9. "NORMAL" is a smaller-size extraction from the wider "SQUEEZE" image.)

If you're shooting SD for widescreen televisions, or widescreen DVD release, you'll want to always use the 16:9/SQUEEZE mode.

If you're shooting for display on 4:3 televisions, you will want to use NORMAL mode for a fullscreen display.

There's a third choice as well: LETTERBOX gives you video that is suitable for display on a 4:3 television, but has black bars on the top and bottom, giving the video a widescreen look (like a letterboxed movie.) If you're aiming for release on a widescreen television, use SQUEEZE mode, but if you're aiming for release on a 4:3 television, and you want the widescreen look, LETTERBOX gives you that option.

When choosing which mode to use, you should first decide what type of device your video will be played back on. If it will be played on a 4:3 television, and you want to use the full screen, you'll want to select NORMAL. If your video will be played on a 4:3 TV, but you like the widescreen look, you can shoot in LETTERBOX mode. If your video will be displayed on a widescreen 16:9 television, you would want to shoot in SQUEEZE mode. But SQUEEZE mode is not suitable for display on a 4:3 television, as the image will look tall and skinny. And NORMAL wouldn't be suitable for display on a widescreen television, as it would look stretched-out and fat. If you're authoring your footage onto a DVD, you probably will always
want to use SQUEEZE mode; DVD players have built-in aspect-ratio-conversion hardware which can automatically convert the video to properly fit whatever type of television it's attached to.

**SETUP**

(Standard-definition NTSC ONLY)

SETUP is a very confusing subject for many users. It refers to the black level of standard-definition analog video, and the fact that in North American NTSC television, “black” isn’t necessarily “black.” In television signals brightness is measured in IRE units, using a scale from 0 (super-black) to 110 (super-white). In this system, “black” is actually pegged at 7.5 IRE, not at zero. The reasons are arcane, having to do with inaccuracies in picture reproduction on the earliest televisions – the TV engineers “fudged” a little bit, raising the level at which “black” would be perceived. With “setup” added, the black level of the video gets lifted up, which gives some headroom at the bottom end of the scale, but also results in darker elements of the picture looking “milky.” This is akin to raising the MASTER PED of the camera; in fact, the two are quite tied together: the 7.5 IRE setting is referred to as the Pedestal, and the MASTER PED control lets you raise or lower that Pedestal setting, which controls how dark/black areas of the picture are processed.

However, what’s necessary to understand about setup is that the 7.5 setting is really only relevant for analog signals. In digital recording (whether standard-def or high-def), all processing should be done with the menu setting set to zero. There is no such thing as “setup” in digital recording. In digital recording, the full dynamic range is used, and “black” is properly represented with no setup added. In a proper NTSC system, setup will should never be part of a digital recording, or of digital editing, and should only ever enter the picture when making a final dub of the finished video over to an analog format (such as BetaSP) or when broadcasting the signal over analog airwaves. In top-dollar broadcast cameras, the Setup option only exists as a menu option for analog output of digital video – broadcast cameras don’t modify the digital recording to add setup, because adding setup to a digital recording results in a
non-standard digital recording with the black level set too high. In a properly configured digital studio, the cameras would record with no setup, editing would be done with no setup, and mastering would be done with no setup. Then, when the product is finished and ready for broadcast, the final product would have setup added to it to make it compliant for analog broadcast. High-end professional decks have a menu setting for setup that will allow you to specify whether you want to add setup to the analog output, but it doesn’t modify the digital recording. That’s the “right way” to process setup.

And that’s the way the HVX works in P2 mode. When you select the SETUP - P2 menu option, you’ll see two choices: “0%” or “7.5%A.” That means that it will never record setup onto the P2 card, but it can add setup on the analog outputs if you want it to (for monitoring on an analog monitor, or recording directly to an analog tape deck). The 0% setting means no setup is added, and the 7.5%A setting means that setup is added to the analog outputs, but not to the recording. But note: 7.5% will be added to the camera’s LCD! The LCD is considered a standard-def analog display, so setting 7.5A will result in lifting the blacks on the camera’s built-in LCD panel.

But there’s another menu option, which is SETUP - TAPE, and it has two options: 0% or 7.5%. Unfortunately, changing this menu setting on the HVX to “7.5” actually changes the digital data as it’s recorded! This is not what you want. This is not “proper” setup. When you have the 7.5 setting engaged, the camera lifts all the black levels before recording to tape (as well as outputting that lifted-black signal on the analog outputs). If you then transfer this footage to an analog tape format for broadcasting, the analog format will add another dose of setup, and you’ll end up broadcasting a product with very milky blacks and flat contrast. Definitely not what you want.

There is a time where the 7.5 setup setting does make sense, and that would be if you were using your camera for a “live feed” to an analog deck. For example, if you were using the HVX as a camera-
head only (i.e., not recording on tape) and you plugged the s-video port on the camera into a BetaSP deck, then setting the SETUP menu item to 7.5 would make sense.

For digital recording, leave the SETUP settings at zero. In a digital studio, all capture, editing, and output would be done with SETUP at zero. Then for analog broadcast, the broadcaster would add setup themselves. Or, if authoring a DVD, you’d want to author the DVD with zero setup, because North American DVD players themselves add setup on the output analog signal.

0% is the default setting for the HVX cameras. Digital Video uses 0% setup (which is the ITU-R-601 Digital standard setting) and standard analog-recorded interlace video uses a 7.5% pedestal.
SW Mode Settings

SW Mode is a confusing name for this menu, but what it really means is, this menu controls what the physical switches on the camera do. SW is short for “switch.” The switches that are affected by this menu are: the Gain switch, the White Balance switch, the Handle Zoom switch, the Iris Dial, and the USER buttons.

MID GAIN

Before addressing what MID GAIN does, you should understand what Gain is. Gain is an electronic amplification of the video signal. In other words, it artificially makes the picture brighter. While brightness sounds good, you have to understand that the penalty for making it brighter is that the picture gets “noisier.” Electronic noise is a byproduct of electronic gain, and the more gain you apply, the brighter your picture will get, and the noisier your picture will get.

Gain is measured in decibels, or dB. Zero dB means that no gain is applied, the picture is unmodified and no brightness or noise is added. Every 6 dB of gain amounts to doubling the brightness of the picture, so 6 dB of gain would make the picture twice as bright, or 1 f-stop brighter. 12 dB of gain would be twice as bright again (or four times as bright as zero gain), and 18dB is twice as bright as that (for a maximum of eight times as bright as zero gain).
There are some limitations on when Gain cannot be engaged on the camera. First, if shooting in any progressive-scan mode, you cannot use 18dB of Gain. 18dB is only possible when shooting interlaced footage. Second, Gain doesn't work at all if using the 1/12 or 1/15 shutter speeds. Stick to 1/24 or 1/30 (50Hz model: 1/25) or faster. Also, when shooting in 720p/FILM CAM mode, Gain won't work at any frame rate slower than 24 fps. If you select 12, 18, 20, 22 or 23 frames per second, the gain will be forced to 0dB.

Also, notice that when the camera changes gain levels, it does it with a smooth, gradual transition, not a hard changeover.

The HVX has a physical switch for the amount of electronic gain, with three positions: L, M, and H (for “low”, “mid” and “high”). The “L” position is always set to 0 dB. The ‘M’ position can be set to 0, 3, 6, 9, or 12 dB. This MID GAIN menu setting lets you select what Gain value to assign to the ‘M’ position.

**HIGH GAIN**

Same as MID GAIN except that it applies to the “H” setting of the Gain switch. 18dB of gain is only possible through the USER buttons.

**ATW**

To understand the ATW (Auto Tracking White) function, one should first understand the concept of color temperatures and white balance. In the simplest explanation, light is not all the same color. Even though it may look the same to the human eye, the camera sees a particular light for what it is: reddish, greenish, blueish, etc. Light color is measured in degrees Kelvin, in accordance with what color a hunk of iron will glow when heated to certain temperatures. When heated to about 3200 degrees Kelvin (or 3200K), the iron will glow an orangish-red color (which is pretty much how regular household lamps work: they’re small filaments of metal that are heated until they glow that orangish-red color). If the iron is heated more, the color will shift towards the blues, and at 5600K the iron will glow blue-
white. These colors correspond to the colors on the rainbow, with red at one end of the spectrum, and blue at the other. These temperatures, and their corresponding colors, are referred to as "color temperature."

In general there are two color temperatures you need to be aware of: 3200k and 5600k. Daylight is typically said to be around 5600k (even though daylight can vary from about 3000K to about 10,000k). And tungsten (or most artificial) lights burn at around 3200k. Our eyes and brain adapt to perceive when something should be white, regardless of what color light is shining on it. The camera sees the actual color of the light reflecting off the object, and that may make it look different (on video) than it does to us in real life. Because of this, we have to tell the camera what "white" should be, by using White Balance.

The **White Balance** switch offers three basic modes of operation: preset, manual set, and automatic-tracking. In Preset mode, pressing the white-balance button on the front of the camera will toggle between 3200K and 5600K settings. In manual-set mode, you point the camera at the scene, filling the screen with something white in the scene, and hold the button down. The camera will analyze what it's looking at, and figure out how to manipulate the colors so that the object on the screen will actually look white. In automatic-tracking white (or ATW) mode, the camera continuously evaluates the scene and continuously adjusts the colors in a never-ending search for the proper white balance.

The **ATW** menu setting lets you choose a position on the switch that will trigger the automatic white balance tracking. The ATW is not assigned to this switch by default; normally you have two separate white balance settings you can keep in-camera (A Channel and B Channel), but this menu setting lets you assign ATW to one of those switch positions or to the PRST (Preset) position.

The white balance should typically be re-adjusted as the lighting conditions change. The ATW function can be used during the record mode to continually adjust the white balance automatically.
HANDLE ZOOM

The zoom motor on the HVX operates at three speeds: low, mid, and high. The HVX has two zoom rockers that control the zoom motor, the large one above the record switch, and one on the top of the handle. The one above the record switch is variable pressure: the harder you press it, the faster the zoom goes. But the zoom rocker on the handle only operates at one speed regardless of how hard you press it. It operates at the speed that’s set by the 1/2/3 switch on the camera’s handle.

The rocker on the handle has a control switch that selects the speed that will be employed when the handle zoom rocker is pressed. The “1” setting is always the slowest speed, and the “3” setting is always the fastest speed. This menu setting controls what happens when the 1/2/3 switch is set to “2”. It can either be set to “L/OFF/H”, which disables the handle zoom (when the 1/2/3 switch is set to “2”) or it can be set to “L/M/H”, in which case the handle zoom will run at 1=Low, 2=Medium, 3=High speed.

IRIS DIAL

This menu setting controls the relationship between the direction the iris wheel is turned, and the opening/closing of the iris. You can set it so that the iris opens up when the dial is rotated down, or so the iris closes down when the dial is rotated down. Broadcast cameras typically use down=open; newer users unfamiliar with broadcast gear may more intuitively feel that up should open the iris. With this setting you’re free to choose which way you prefer.

USER1 and USER2 and USER3

These buttons can each be customized to perform one of many different functions, including:
**Rec check:** This will play back the last couple of seconds of footage you shot, without having to switch the camera over to VCR/MCR mode. Note: if you've changed the recording mode since the last time you recorded something, REC CHECK will play the last footage back that was shot in the mode you just changed to (the camera can only play back footage that was shot in the same mode it's currently set in.) In P2 mode this may be a little confusing; in tape mode it's never an issue. As a side note, this function duplicates the REC CHECK function located next to the main zoom lever.

**Spotlight:** This function is similar to A. IRIS LEVEL -3. Pressing this button will cause the iris to stop down about one stop. If the camera was set in manual iris mode, pressing SPOTLIGHT will force it to go to auto-iris mode.

**Backlight:** This function is similar to A. IRIS LEVEL +4. Pressing this button will cause the iris to open up about two stops. If the camera was set in manual iris mode, pressing BACKLIGHT will force it to go to auto-iris mode.

**Blackfade:** Pressing and holding this button will cause the picture and sound to fade to black. The longer you hold the button, the more the picture will fade: you have to hold the button in until the picture is entirely black. For the next shot, if you want to execute a fade in from black, you would need to hold the button in while the camera is paused, until the screen is fully black. Then start recording and release the button, and the image will automatically fade up from black.

**Whitefade:** Same as BLACKFADE, except it fades to/from white.

**ATW:** Enables or disables Automatic Tracking White balance: see the discussion about ATW in the SW MODE switch settings above.

**ATWLock:** When using ATW, the system will constantly hunt for what it considers the optimal white balance. You can stop the camera from hunting and tell it to lock in the current white balance setting by using the ATWLOCK function. If you use ATWLOCK to lock in the white balance, and then press ATWLOCK again, it will un-lock and return to hunting in ATW mode.

**Gain:** 18db: The SW MODE switch settings for gain allow for setting electronic gain as high as 12db. The HVX is actually capable of going as high as 18dB of gain, but the only way to get to 18dB is to use the USER buttons. 18db will brighten your image by about 3 stops
(in other words, it’ll be about 8 times as bright as without gain), but 18db is quite noisy and should only be used when absolutely necessary, and when image noise is not a concern. 18dB Gain will not work in progressive scan modes.

**Focus ring:** Normally the focus ring controls manual focus of the camera. By assigning this function to one of the user buttons, you can change that – the focus ring can actually be used to control the iris of the camera instead. However, to use this feature, the camera must be set into autofocus mode.

**Index/memo:** This function performs differently depending on whether you’re recording to tape or to P2 cards. When in tape mode, assigning this function to one of the USER buttons will cause an Index signal to be written to the tape whenever this button is pressed. The index signal is an invisible marker that you can use to quickly locate a particular segment on tape. Using the remote you can perform an “index search”, which will fast-forward or rewind the tape until the camera senses the presence of an Index signal. This can be a way to mark “good takes” or especially interesting moments during recording. When recording to P2, this button doesn’t write an index, rather it attaches a text memo to the clip, indexed to the time when you pressed the button. You can assign up to 100 text memos per clip. When you view the clip in the P2 Viewer or in the thumbnail screen, you can see individual thumbnails that mark each point in the clip where you assigned a text memo (and you can delete unnecessary text memo assignments from the thumbnail screen.) The text of the text memo comes from the metadata you load into the camera via the SD card; you can edit the text memos in the P2 Viewer program and save them on an SD card for attaching to the clips while they’re being shot; alternately you can assign a position for a text memo in-camera, and then add the actual text afterwards by using the P2 Viewer program. See the chapter on Understanding Metadata (page 217) for more information.

**Slot set:** This function is only relevant when shooting to P2 cards. If you assign this function to one of the user buttons, pressing that user button will let you change which slot the camera will record the next clip to. You cannot change while recording, so you have to do this in-between takes.
**Shot mark:** This function is also only relevant to P2 recording. Assign this function to one of the user buttons, and then while recording you can press that button to add a “mark” to the clip you’re currently recording. That “mark” will show up when you view the clips in the thumbnail display, or when looking at the clips in the P2 Viewer program. You can mark “good takes” with this function – and the button works as a toggle, so if you’ve marked a take as good, and then a little while later during the recording you decide that it’s “no good,” you can press the button again and it’ll release the mark. This can be helpful in organizing takes as “keepers”; you can also configure your P2 card display so that it will only show marked takes. This can be handy for quickly sorting through the takes to see what you’ve got. You can also mark a shot after recording; when reviewing clips on the Thumbnail screen or when playing a clip back, pressing the USBR button that’s been assigned to SHOT MARK will cause a mark to be assigned to (or removed from) the currently-selected or currently-playing clip.
Auto SW Settings

The HVX has a handy switch called "AUTO/MANUAL." When you slide the switch towards AUTO, the camera can override all sorts of manual settings and go into fully-auto mode: useful if you need to grab the camera and start shooting something, with no time to adjust manual settings. The "AUTO" setting might help you guarantee that you get your shot, even if it's not the absolute best video quality (which can usually only be obtained with proper tuning of manual settings.) You can control which functions are operated in auto mode and which ones stay in manual mode. You can also implement auto picture gain through the use of the AUTO switch. This is the only way to get auto gain on the HVX.

A. IRIS

If you set this setting to ON, then when the "AUTO" button is pressed the camera will perform auto-iris functions, even if you have the camera set to manual iris. If this setting is OFF then the camera will only be able to use auto-iris if you had the camera in auto-iris mode before sliding the AUTO/MANUAL switch to AUTO: if you had the camera in manual iris mode, it will still be in manual iris mode after you slide the AUTO switch (when this setting is OFF.)

AGC

Normally the HVX only has manual gain control for the picture. In
AUTO mode, the camera can actually apply gain when it determines that gain is necessary. This switch lets you control how much gain is allowed: 0db (OFF), 6db or 12db. The camera will decide how much gain to use, up to the maximum that you specify. Setting it to OFF will leave the camera with no ability to automatically apply gain. All other restrictions about gain apply as well (i.e., no gain in FILM CAM mode at 23fps or slower, no gain in 1/15 or 1/12 shutter speeds, etc). Note that the gain being discussed is only for the picture; the HVX cameras have no automatic gain control circuitry for audio (only manual control through the potentiometers).

**ATW**

Two settings, ON or OFF, determine whether the camera will perform automatic tracking of white balance when in AUTO mode. If it’s set to ON, the camera will start automatically tracking white balance. If it’s set to OFF, the camera will be forced to use whatever setting the WHITE BAL switch is currently set to.

**AF**

This setting determines whether the camera goes into Autofocus mode when the AUTO/MANUAL switch is set to AUTO. If set to ON, the camera will go into autofocus mode, regardless of whether the FOCUS switch is set to Auto, Manual, Push Auto or Infinity. None of those switches will have any effect, because the camera will run in autofocus mode. When set to OFF, the FOCUS switch controls how focus operates: if it’s set to Auto, or Push Auto is held down, autofocus will continue to work.

When used with slow shutter speeds, Autofocus is much slower to respond. Also, when used with a slower frame rate (such as 24P), autofocus responds more slowly. Autofocus performs best in interlaced mode or 50p/60p modes, and under bright light conditions, with a 1/48 or faster shutter. Autofocus performs less efficiently in slower frame rates, under lower light conditions, or when using slow shutter speeds.
Recording Setup Menu Settings

REC FORMAT

The HVX offers unprecedented flexibility in recording modes. When recording in P2 you can select over a dozen different recording modes (in the 60Hz camera; 50Hz users have a choice of 7 different modes because 50Hz users don’t have to be concerned with “pulldown.”)

The main choices in the 60Hz camera are 480, 720, or 1080 line recording formats, at 24, 30, or 60 frames per second. In the 50Hz camera the main choices are 576, 720, or 1080 line recording modes, at 25 or 50 frames per second.

The difference between 24/25 progressive frames per second and 60/50 fields per second is startling – 24P looks much more like film, and interlaced (or 60p/50p) looks like video. In the 60Hz/NTSC version of the camera you can also select 30 progressive frames per second: 30P is somewhat of a middle ground – it looks somewhat filmlike, but the faster frame rate provides less strobing and smoother pans than 24P. However, 24P can be transferred easily to film or PAL television, whereas 30P cannot. 30P can be used to make for extremely smooth, mild slow motion in a 24P project as well.

In interlaced mode the camera captures 60 (NTSC) or 50 (PAL) fields per second. Each field is equivalent to half of a video frame,
either the even lines or the odd lines. CRT televisions are interlaced, and when set to 1080i/60i or 480i/60i (or, for 50Hz, 1080i/50i or 576i/50i), the HVX captures interlaced video like any video camera.

So in essence there are three main modes: 480i (or 576), 720, and 1080. In 720 mode, the image is always captured in progressive scan – meaning, the entire image is captured in one instant, like a film camera does; it’s not split into fields like interlaced video. In 720p mode, each frame is encoded distinctly and discretely as a frame in the recording format.

In 1080i and 480i (or 576i) modes the image can be captured either progressively or interlaced. The image is always recorded as an interlaced stream, because that’s how the formats work (for example, DV must always be recorded interlaced; there’s no provision in the DV format for progressive recording). However, Panasonic engineers have come up with a clever way of embedding true progressive-scan signals within an interlaced recording system, so you can get the full benefit of progressive scan even when using 1080i or 480i/576 modes.

When shooting 1080i/60i or 480i/60i (or, for the 50Hz camera, 1080i/50i or 576i/50i), the HVX captures regular interlaced video, just like any other video camera would. But when shooting progressive (1080i/24P, 1080i/25P, 1080i/30P; or 480i/24P, 480i/30P, or 576i/25P), the camera doesn’t capture fields, it instead captures an entire frame all at once, similar to the way a film camera does. Each frame is captured distinctly, and then divided into fields for recording on tape (but non-linear-editing programs can reconstitute the fields back into their full progressive frames).

In the 50Hz/PAL version of the camera, all progressive scan is done at 25P. In the 60Hz/NTSC camera, there are two options for 24P: either 24P mode, or 24P Advanced (24PA). There are advantages to each, and they’re discussed in more detail in the essay on page 28.

Note: when the media switch is in TAPE mode, only the DV options are available (i.e., 480i/24P, 480i/24PA, 480i/30P, or 480i/60i; or, for the 50Hz/PAL camera, 576i/25P and 576i/50i).
480i REC MODE (or 576i REC MODE)

The HVX200 is capable of recording in four different recording formats: DVCPRO-HD for high-definition footage at 100 megabits per second, DVCPRO50 for highest-quality standard-definition footage at 50 megabits per second, and DVCPRO and DV, both of which are standard-definition modes at 25 megabits per second. DVCPRO50, DVCPRO, and DV are all 480i formats (for 60Hz; they’re 576i formats for the 50Hz camera). This menu option lets you choose which format to record in, when the REC FORMAT menu item is set to any of the 480i/576i settings. Note: this function is only available when recording to P2; when recording to tape the recording mode is always miniDV.

REC FUNCTION (P2 only)

The nonlinear, random access, tapeless P2 system provides for some unique and powerful recording options which would be difficult or even impossible to implement on a tape-based system. This menu item lets you choose from several recording functions when in VIDEO CAM mode:

INTERVAL REC lets you perform time-lapse photography (such as photographing buildings under construction, clouds moving across the sky, or flowers opening up). When in INTERVAL REC mode, the camera will periodically capture one individual frame, at intervals that you specify (which can be as short as one frame every two frames, or as long one frame every 10 minutes). Once you set up for interval recording, and establish the interval you want to use, just press the record button and the HVX will capture and record frames at the predetermined intervals. Note: you cannot use 24P modes to record in INTERVAL REC: you have to use 25P/30P or 50i/60i; also INTERVAL REC won’t work in the 720p “Native” modes, you would have to use the 720p “Over 60” mode.

In ONE-SHOT mode the camera will start recording when you press the REC button, and will continue recording for the duration set in ONE SHOT TIME, after which it will automatically stop. This
is useful for stop-motion animation: set the camera in ONE-SHOT mode, set the ONE SHOT TIME to 1F ("one frame"), and press RECORD. The camera will shoot one frame and then automatically pause. You can then go in and move your subject a little bit, and press RECORD again, and the camera will record another frame of footage. Repeat until you’ve finished your sequence. Then, you can import the footage into your editing program and you’ll have frame-for-frame accurate stop-motion animation. Always use the remote control to trigger the camera when doing stop-motion animation, as you might bump the camera if you try to push the camera’s record buttons, which will disrupt your stop-motion framing. And you don’t have to record just a single frame; the ONE SHOT TIME can be as long as one second.

In LOOP recording, the camera is capable of looping through the same space on the cards until you tell it to stop. It basically functions as a very large pre-record buffer. It requires two cards to do this, and each card must have at least one minute of free space before you start loop recording. First, let’s clarify: when in normal recording the camera will record in the empty space on a card until it reaches full capacity, at which point it lets you know that the card is “full” and (if you have another card in the camera with free space on it), recording will automatically switch over to that card. When both cards are full, you can no longer record on them. LOOP recording is a bit different. What LOOP recording does is take all the available free space on both cards and create one big contiguous chunk of space to record into (which we’ll call the “record buffer.”) When you press RECORD it will begin recording in that record buffer until it’s entirely full, and then starts over at the beginning of the record buffer, overwriting the earlier contents of the buffer as it goes. When using LOOP recording, you won’t see how much time you have left on the cards, because such a concept is meaningless – it just keeps looping and looping, overwriting the buffer as it goes. It will never overwrite clips that have previously been recorded on the cards, it only overwrites its own buffer. When you want to stop recording, press RECORD again and it will stop looping and commit the current contents of the buffer to the card as a clip. So how is LOOP RECORD useful? Primarily as an endless
pre-record buffer. You can let the camera record endlessly until you get “the moment” or “the shot” that you’ve been waiting for, and then stop recording. You don’t have to worry about when the clip starts; just keep track of when it ends because when you stop recording it’ll commit the current contents of the entire buffer to the card as a clip. If you had three minutes of available free space between your two cards, LOOP RECORD would create a buffer of three minutes, and when you stop recording the clip would consist of the three minutes prior to when you stopped. If you had 40 minutes of available space, the clip that gets written to the card would consist of the most recent 40 minutes prior to you stopping recording. Of course, you may stop recording prior to the buffer being completely full, in which case the clip that gets written to the card would include everything from the time you started recording until the time you stopped recording, and the unused portion of the buffer gets allocated as the new recording buffer.

ONE SHOT TIME

When using ONE SHOT REC mode this setting controls how long each burst of recording will be. There are six settings, one frame (1F), 2F, 4F, 8F, 16F, and one second.

INTERVAL TIME

When using INTERVAL REC mode, this setting determines how long the camera will wait between triggering recording; intervals range from 2 frames to 10 minutes.

PREREC MODE

This menu item lets you enable or disable the pre-record function when recording to P2. When this function is enabled, the camera will continuously be buffering up to seven seconds of footage in standard-definition mode (up to three seconds in high-definition mode). Then when you press RECORD, the camera will commit the contents of that buffer to the card, and also begin recording everything from that moment onward. So, in effect, PREREC lets
you begin recording up to seven seconds BEFORE you pressed the record button! This can be very handy in news, sports, and nature photography; you may never miss a shot again because the camera will be recording even before you were ready! PREREREC doesn’t work in 24P modes or in 720P “Native” modes.

REC SPEED (tape only)

The HVX is capable of recording on the tape at two different speeds: SP (Standard Play) and LP (Long Play). In SP mode the HVX can record for approximately 13 minutes on a 63-minute cassette. In LP mode the HVX can record for about 94 minutes on a 63-minute cassette. The video quality recorded in both modes is identical: the exact same DV signal is recorded whether in SP or LP mode. LP does have drawbacks, however: a higher chance of dropouts/video glitches, and less compatibility with other cameras/decks. In LP mode the tape moves slower past the recording heads, so the data gets recorded into a smaller space on the tape. By moving the tape slower, it takes longer to run through the camera, which gives you longer recording times. However, the data has to be fit into a physically smaller section of tape, which makes LP recordings much more subject to dropouts or tape error than SP recordings. Also, because LP recordings are so tightly crammed onto the tape, there is no guarantee that an LP recording made on one camera will be able to play properly on another camera or deck: you may only be able to play back an LP recording on the same camera that recorded it. Finally, LP recordings cannot use 4-channel 12-bit audio, they can only use 2-channel 16-bit audio. Most professionals recommend avoiding LP mode whenever possible, and sticking with the more reliable (and more compatible) SP mode.

AUDIO REC (tape only)

The HVX can record audio in two different formats, either 12-bit or 16-bit. In 12-bit mode the HVX records two tracks of 12-bit/32kHz audio. 12-bit may work okay for dialogue, but is not well suited for recording music. In 16-bit mode the DVX records two tracks of 16-
bit, 48kHz audio. This is the highest-quality audio recording mode the camera offers, and is basically the same specifications as a DAT deck. If you record in 12-bit audio you can still only record two channels, but you can add two additional audio tracks to your tape in post (through the Audio Dub function). 12-bit audio is capable of storing four full tracks of audio, although they're all of the lesser-quality 12-bit 32kHz mode, and only two can be recorded live (the other two must be added in post). In high-quality 16-bit 48kHz mode, no audio dubbing is possible. And given that so much work in the DV format is edited in a nonlinear editor (where audio can be dubbed with more ease, precision, and quality) there are few circumstances where the 12-bit mode makes a lot of sense.

**MIC ALC**

The HVX camera does not have any sort of audio gain or automatic level control, but it does have a limiter. In other cameras "automatic level control" or "automatic gain control" will try to raise or lower the volume of the recorded sound, depending on whether the camera thinks the audio is too quiet or too loud. In the HVX there is no such automatic level control. There is, however, an Automatic Limiter Control (ALC). When the limiter is engaged, the camera will try to "clamp down" excessive volume to prevent clipping. It won't modify the overall signal level, it will just try to keep loud levels from distorting (sort of like the KNEE control for protecting against overexposure). The HVX's ALC starts attenuating signals at approximately -6dB, and tries to limit them to a maximum of -4.5dB. It doesn't catch brief transitory peaks (clapping close to the mic may defeat the limiter and result in overmodulated sound) but if the overall sound level is too high, for more than the briefest moment, the HVX's limiter will lower the volume to keep it below the maximum allowable threshold. When using mics directly hooked to the camera, it's usually a good idea to keep the limiter ON. When using an external mic-level mixer with its own limiter, you should set the HVX's limiter OFF.
MIC GAIN 1 (and 2)

Different microphones have different levels of output. If you find that the audio level coming from your microphone is too low, try changing the MIC GAIN setting to boost the audio levels. –60dB makes the mic input louder than –50dB, and would be appropriate for use with a less-sensitive microphone.

25M REC CH SEL (P2 only)

When recording either DVCPro or DV to the P2 card, you can choose to record two channels of audio or four. (Note: the audio recorded to P2 is always of the high-quality 16-bit 48kHz variety; you cannot record the lower-quality DV standard of 12-bit 32kHz to P2. 12-bit audio can only be recorded to tape.) Also, note that this setting only affects recordings done in camera mode; when dubbing footage in through the 1394 connection the audio will be recorded exactly as the 1394 stream sends it; so if you clone a DV tape from another camera or input footage via 1394 from your nonlinear editing program, this setting will have no effect: the audio that gets recorded will be exactly the same as in the footage being fed to the HVX via the 1394 port.

Time code options: Before discussing the timecode options, let's discuss timecode itself. Timecode is a system that numbers and counts every frame of video, in the format of HH:MM:SS:FF (hours: minutes:seconds:frames). A special internal timecode generator (TCG) stamps an 80-bit code on every recorded frame. The VCR or NLE will use this number for individually identifying every frame. This code is recorded with the video and audio signals and is stored invisibly in the sub code area on the DV tape or written to the P2 card. These 80 bits of time code contain a lot of information, such as drop frame information, frame rate information and user bit information. Timecode can be counted in either Drop Frame (DF) or Non-Drop Frame (NDF) mode. In NDF mode, every frame gets counted and numbered sequentially. In DF mode, some timecode entries are skipped in order to make the running time of the video...
match the timecode display (by way of explanation, NTSC video runs at 29.97 "frames" per second, but timecode counts at 30 frames per second. Drop Frame counting was invented to resolve this .1% discrepancy, so when an hour of footage has gone by, the DF timecode will read 1:00:00:00, whereas in NDF timecode, after one hour the timecode would read 0:59:56:12.) PAL/50Hz users don’t need to worry about this, since PAL televisions run at exactly 25,000 frames per second. PAL/50Hz cameras are always in NDF mode.

The 24p mode uses NDF only. There are 32 User Bits in each 80-bit code; these user bits can be used to identify the user information, the time the clip was shot, the date, the time code generator’s value, or the frame rate. It is strongly recommended that you leave the user bit setting on FRM. RATE unless you have a specific reason for setting it to something else.

1394 TC REGEN

This menu setting is applicable only when the camera is set in VCR/MCR mode, and is recording data from the IEEE-1394 port. This setting allows the user to clone a DV tape from another camera or deck, or from a DVCPRO or DVCPRO50 or DVCPRO-HD tape deck or from another HVX or a computer nonlinear editing system, and (depending on this menu setting) will either generate new timecode, or duplicate the timecode from the original footage. When this menu setting is set to OFF, the HVX will generate new timecode using the values set in its menu settings. When this menu setting is ON, the HVX will duplicate the timecode it finds in the 1394 data stream. If you hook the HVX up via IEEE-1394 to a deck (or other camera), and set that deck or camera to "play" and the HVX to "record," the HVX will be able to make a tape or P2 recording that duplicates the timecode on the original recording when this menu setting is ON. Note: setting 1394 TC REGEN to ON will preclude the option of using the 1394 IN PRESET function. If you want to use the ability to sync timecode through the 1394 port, you must set 1394 TC REGEN to OFF.
TC MODE

(60Hz camera only): This menu setting allows you to select Drop Frame (DF) or Non Drop Frame (NDF) timecode. (see discussion above under TIME CODE OPTIONS).

When in the 24P modes, NDF timecode counting is used regardless of the setting of this menu item. The menu item will turn blue and be non-selectable, and it may say DF or NDF, but regardless of what it says, the camera will be operating in NDF mode. When shooting in 24P or 24PA to tape, you need to be aware that the camera operates in groups of four frames which get written to tape as five frames (after 2:3 pulldown, or 2:3:3:2 pulldown). The camera will always start recording on the A frame (the first of the four frame “A-B-C-D” sequence.) When you stop the recorder, it may not stop on the last part of the D frame (last frame in each four/five-frame sequence) and so when you back up to review, the camera may leave a gap between the last recording and where it starts its new recording. The way to address this, if you review your footage as you go, is to leave an extra-long “tail” of footage before you stop the camera. Then you can review and park the camera over the “tail”; the camera will be able to find the end of the D frame and continue the sequence, cutting in the new A frame just after the last-recorded D frame.

TCG

TCG stands for Time Code Generator; this menu setting determines what kind of time code generator is employed: FREE RUN or REC RUN. In FREE RUN mode the timecode clock is constantly advancing whether the camera is recording or not. In REC RUN mode, the timecode clock advances only when actual recording is occurring. For tape, REC RUN mode can make a tape with continuous timecode regardless of how many times you start or stop the camera: the timecode will always pick up where the last shot left off. In FREE RUN mode, the timecode is derived from the clock of the camera regardless of how many times you start or stop
the tape. FREE RUN mode can be used to synchronize cameras in a multi-camera shoot: for more details, see the essay on page 109).

**FIRST REC TC (tape only)**

This menu setting determines how the camera will start timecode when it starts a new tape (or encounters a blank spot on a tape). The choices are REGEN or PRESET. In REGEN mode the camera will try to regenerate (i.e., pick up and continue) the existing time code and continue uninterrupted. If there is no existing time code on the tape, REGEN mode will start new timecode at 0:00:00:00. This is the default menu state: every new tape put in the camera will start at 0:00:00:00 timecode. With PRESET, the camera will not try to pick up existing time code; instead it will start each recording with the timecode setting held in the TC PRESET menu setting. By changing the setting in the TC PRESET menu you can change what starting timecode is assigned to each tape (or, each shot, if you wanted to...) Every shot will have continuous timecode thereafter. The camera keeps track of the TC PRESET and advances it automatically, so it will always pick up where the last time code left off, even if the tape is changed. When in P2 mode, the camera always runs in PRESET.

**TC PRESET**

When in tape mode, this menu setting works only in conjunction with FIRST REC TC. If FIRST REC TC is set to REGEN, this menu setting has no effect. If FIRST REC TC is set to PRESET, then this is the value that will be used as the starting timecode the next time you start recording. When in P2 mode, the TC PRESET is always used. This setting gets updated as the timecode runs, so the timecode on the next tape (or P2 clip) will continue where the last tape or clip left off (i.e., it won't be reset to what this setting was first set to, it continues where it left off). When shooting tape, TC PRESET can make a series of tapes with different timecode starting values for each tape. For example, if shooting an all-day lecture, and planning on using 8 tapes throughout the day, you could use the TC
PRESET to set the first timecode to 00:00:00:00, and begin taping. At the one-hour mark, stop the camera and change tapes. The next tape will start with timecode beginning where the last tape left off (approximately 01:00:00:00), and each subsequent tape would have timecode that begins where the last tape stopped. If instead you were to use REGEN, then every time you changed tapes, the timecode would start back at 00:00:00:00. Of course, if you were using FREE RUN timecode, every tape would have continuously-running timecode based on the time-of-day clock. Note: When the 24P or 24P ADV modes are used you must set the last digit to 0 or any other multiple of 5. P2 recording is always PRESET; there is no equivalent to REGEN when shooting P2.

1394 UB REGEN

This function is available only in VCR mode, and when recording from a signal on the 1394 port (for example, if you’re using the HVX to clone a tape from another camera or deck). To understand it, take a look at the description for 1394 TC REGEN. This function is very similar, except that instead of controlling how the camera records timecode, it controls how the camera records User Bits. When making a clone of a tape or other footage through its 1394 port, the HVX can either clone the source tape’s User Bit information, or generate new User Bit information (according to the UB MODE menu setting). When this setting is set to OFF, the HVX generates new User Bit information. When this setting is set to ON, the HVX will clone any existing User Bit information from the 1394 data stream attached to the HVX’s 1394 port.

UB MODE

This menu setting controls what type of information gets recorded in the User Bits. The User Bits allow you to specify a message to encode invisibly in your video stream. That message can be one that you specify for each camera, or it can be one of a number of pieces of technical information. The options are: User: this setting lets you specify an 8-digit sequence that gets recorded invisibly in the tape’s sub-code track or in the MXF
file. Using the numbers 0-9 and the letters A-F ("hexadecimal notation"), you can write an 8-character-long message. Example messages might be the name of your company (assuming you can spell it using just the letters A,B,C,D,E, and F) or perhaps you'd want to specify a unique identifier code for each camera in a multi-camera shoot, so in the editing bay, the editor could identify which camera shot which tape or clip. The message that you write is set in the UB PRESET menu item.

**Time:** The time-of-day clock gets recorded in the user's bits.

**Date:** The date gets recorded in the user's bits.

**TCC:** The camera records the contents of the time code generator. This would give you two copies of timecode on the tape, which is redundant.

**FRM rate:** In this mode the camera will record what frame rate it was in when it shot the footage. In 24P and 24PA mode, the readout will look something like "UB F2 04 24 81". In 60i mode, it will look something like "UB 27 OF 60 03". In 30P mode, it will look something like "UB 94 OF 30 82".

The first two letters are always "UB", meaning User Bits.

Next are two characters that you can ignore, they're used for "User's Bit value verification information." In the examples above, those would be the "F2", "27", and "94".

The next two characters depend on whether the camera is in 24P mode or not. In 24P mode, these two characters are a constantly cycling pair of numbers from 00 - 01 - 02 - 03 - 04. Those numbers are counting the individual frame within a five-frame grouping. When recording 24P footage, the camera maps four progressive-scan frames onto five interlaced frames. This counter shows where the frames exist within each five-frame block. For example, when recording 24PA mode, the frame enumerated "02" will always be the interlaced "split frame". When in 25P/30P or 50i/60i mode, these characters are always "0F".

The next two characters show the frame rate. In 60i, they'll be "60"; in 30P they'll be "30"; in 24P modes, they'll be "24". When shooting
variable frame rates, these digits will show the frame rate you shot the clip at (such as 12P or 18P, etc).

The last character is a constantly-changing digit that advances when the camera is rolling.

**UB PRESET**

This setting works in conjunction with the UB MODE setting of “USER.” When the UB MODE setting is set to “USER,” the camera will record the contents of UB PRESET in the tape’s sub-code track or in the MXF file on the P2 card. You can encode a specific message or identifying tag into your camera, so that all tapes shot with that camera will bear that message. This could be useful in a multi-camera shoot, to identify which camera shot which tapes or clips. The contents of the UB PRESET message can be 8 characters long, and those characters are limited to the numbers from “0” to “9” and letters from“A” to “F”.

**1394 IN PRESET**

(VCR/MCR only): This setting enables the camera’s ability to synchronize its timecode preset to an external 1394 device. If you plug a 1394 cable between an HVX200 (in DV mode) and another DV camera, the HVX200 can read the incoming timecode from the other camera and synchronize its TC PRESET to match the other camera’s. For matching DVCPRO50 or DVCPRO-HD, you can plug two compatibly-configured HVX200’s together and synchronize timecode. Use this function in conjunction with the RESET/TC SET button to synchronize the TC PRESET. If you want to enable the ability to synchronize timecode, you need to set this menu item to ON. See the essay on page 109 for more details.
Dubbing Setup

This menu is only available when the MEDIA switch is set to TAPE, and you've entered PC/DUB mode. This menu controls the way high-definition footage gets downconverted and dubbed from the P2 card down to the DV tape.

FORMAT SEL

This menu item sets which type of clips will be eligible for dubbing. You have to set the camera into the same mode that was used to shoot the clips you intend to dub. When you go to the thumbnail screen you'll see that the clips are numbered, and on some clips the number is shown in black, and on some it may be shown in red. The numbers shown in black are indicating that the camera is currently in the same mode that those particular clips were shot in, so they are eligible for dubbing. If the clip you want to dub has its number shown in red, that means you have to enter the FORMAT SEL menu and change the format to make it compatible with the format that was used to record the clip under discussion.

PULLDOWN SEL

This menu item is only applicable if you've chosen 720/24PN in the FORMAT SEL menu (obviously, only valid on the 60Hz/US model camera). If you've shot footage in 720/24PN mode, and want to dub it to DV, pulldown will need to be introduced to keep the recording...
NTSC-compliant. You can choose to have the camera introduce either 2:3 pulldown (24P) or 2:3:3:2 pulldown (24PA). If you intend to edit the footage on a 24P timeline in a 24P-aware editing application, you should choose 24PA. Otherwise, if you intend to edit the footage on a 60i timeline, or don’t know how the footage will be edited, or don’t intend to edit the footage, then you may want to choose 24P.

**SETUP**

This setting lets you decide whether to add “setup” to the dubbed video; in almost all cases for digital recording you would want to leave this set on 0%. For more details see the discussion on page 145.
Av In/Out Setup Settings

This menu is only active when the camera is set to VCR mode, and deals with settings related to the component, composite, and s-video input/output jacks, the 1394 connection, and the headphone jack.

CMPNT OUT SEL

This menu item controls what type of signal is output on the analog component output jacks (with some limitations). The exact effect depends on what mode the camera was in to start with. In 720P mode you can output the signal as either a 720P signal, or cross-converted to 1080i, or downconverted to 480i (576i for 50Hz users). In 1080 mode you can output the signal as either a 1080i signal, or as a downconverted 480i signal (or 576i for 50Hz users). When in 1080 mode, setting CMPNT OUT SEL to 720P has no effect; it continues to output a 1080 signal. And when in standard-definition mode (480i/576i) this menu item has no effect; the component output jacks will always output a standard-definition signal regardless of what you set this menu item to.

HP MODE

HP stands for HeadPhones. This menu item lets you control the source of audio that gets sent through the headphone jack – either LIVE, or from the RECORDING. LIVE means that the headphone jack will output the audio directly from the audio input circuitry
with no “buffering.” RECORDING means the audio plays back using the same delay that the audio recorded to tape/P2 receives (in progressive-scan mode). In practical terms, RECORDING can mean that you may hear an echo in the headphones when shooting progressive-scan 24P/25P; LIVE eliminates the echo.

A. DUB INPUT

(tape only)
The HVX offers an audio dubbing feature, which allows you to add narration or additional sound to a tape after it’s already been recorded. This feature is only possible if you recorded the original recording on DV tape in 12-bit, 32KHz audio mode, and SP video mode. Audio dubbing is not possible if you used 16-bit/48KHz audio, or if you recorded in LP mode. When audio dubbing, this menu lets you select where the source of the dubbed audio will come from: either from the camera’s built-in microphone, or from the red and white RCA audio in/out jacks.

1394 OUT

(tape only)
This setting determines whether the HVX functions as an on-the-fly analog-to-digital video converter for standard-definition video. When set to ON, the video and audio signals from the analog inputs (the red, white, and yellow A/V connectors and the S-Video jack) will be converted to DV video and output on the 1394 port. The component connector does not function as an input. Using this menu setting you can use the HVX to convert analog video to DV digital video, which could let you digitize analog sources into your 1394-equipped non-linear editor without having to record to tape first. When importing or converting footage through the analog video inputs, understand that it is not possible to convert that footage to 24P in the camera. The 24P mode only works on footage shot through the lens. Any dubs of footage will be copies of what the footage already looks like; no frame rate conversions are possible when the HVX is in VCR mode, and scene file settings and other options are not used when dubbing footage.
Display Setup Settings

This menu controls the text and graphics that show up on the camera’s LCD monitor and viewfinder, as well as whether that information shows up on the analog video outputs. (Note: there is no way to get this information to show up on the 1394 video output).

ZEbra DETECT 1 and 2

The “zebras” are an exposure guide you can use to judge the overall exposure level of your picture. When you enable the zebras, the camera will display a diagonally-striped black & white line pattern over sections of your video that exceed a specified brightness level. Using the zebra pattern will let you know what overall brightness levels your video is at, and help you to get proper exposure and more dynamic range out of your video. The zebras can be set from 50% to 105%. While this sounds impossible (how can brightness be at 105%?) keep in mind that the percentages are just a naming convention. Video brightness is measured in IRE units, with pure white registering at 110 IRE, so setting zebras at 105% means having the zebras trigger at 105 IRE.

There are two zebra settings, Zebra 1 and Zebra 2. They display different diagonal patterns on the LCD so you can tell them apart: Zebra 1 draws its lines from the upper-right to the lower left; Zebra 2 draws its lines from the upper-left to the lower right. You can’t display both at the same time, you choose one or the other to be onscreen. Common practice is to set Zebra 1 at 70% and Zebra 2 to the maximum value, 105%. Then use the zebras to guide your overall
exposure level. Typically when shooting faces, you’d like to see the brightest spots on a Caucasian face (usually the highlights on the forehead and maybe the nose) just bright enough to trigger the 70% zebras, but nothing should be so bright as to trigger the 105% zebras (unless you have something overly bright in the scene, like a light bulb or the sun or something else that you are willing to let “blow out” in order to preserve appropriate brightness in the rest of the image). You use Zebra 1 (at 70%) to guide overall exposure, and you use Zebra 2 (at 105%) to protect against “blowouts.” This is especially vital when using the CINELIKE gamma modes, which offer no knee protection against blowouts. Blown-out video happens when the brightness of some part of the image is too high for the CCD to resolve, so the video signal overloads the CCD and the blown-out portion turns to pure white (110 IRE), losing all detail. It looks ugly and should be avoided; the Zebras are a guide to letting you know when you are approaching blowout.

Of course, the zebra display is only drawn on the LCD and viewfinder, it doesn’t get recorded in the video signal.

This menu item lets you set a zebra level (or OFF) for zebra 1 and 2. You toggle between the zebras (and the MARKER) using the ZEBRA button on the camera’s body.

MARKER

The HVX offers an excellent tool for measuring the video brightness level of different parts of your shot: the MARKER. The MARKER acts something like a lightmeter’s spotmeter: it tells you the brightness of whatever’s in the frame within the box in the center. This menu item lets you turn the MARKER ON and OFF.

To use it, press the ZEBRA button to cycle through the Zebras until the Marker box comes up (it’s a white box in the center of the
screen, with a smaller in-set white box. The MARKER draws the larger box as a framing guide, and it measures the video level within that smaller inner box and reports it using a numerical percentage readout in the lower left corner of the screen. The Marker readout is specified as a percentage of brightness, with 0% representing solid black, and 99% representing the brightest possible luminance level. Note that these numbers are affected by the aperture and shutter speed that you currently have set: changing either the aperture or the shutter speed will affect the brightness level of the picture, and correspondingly all the MARKER values will change as well. The percentages the MARKER reports are percentages that are relevant to the shot that it sees at the time. If you change the light level or the iris or shutter speed, then the MARKER will of course report new numbers that reflect the new brightness levels the camera is seeing.

You can use the MARKER to see if the camera is discerning detail in the shadow areas of the picture, or to determine brightness ratios between key and fill lights, etc. Another excellent usage of the MARKER is to check for the overall evenness of lighting of a greenscreen, for example. Using the MARKER you can locate hot spots or dark areas that may not be easily discerned by eye, but will guide you towards creating a more overall evenly-lit surface, thus improving the quality of your greenscreen keys.

SAFETY ZONE

The HVX200's LCD and Viewfinder show a full-frame image, with little (if any) "overscan." On conventional CRT televisions you should understand that not all of the picture is typically visible; the edges may be cut off (a process called "overscanning.") On the HVX, the entire frame is always visible (also known as "underscanning.") In order to provide compatibility with overscanning televisions, the HVX can display a 90% "safety zone," a rectangle that indicates what parts of the image are likely to be cut off. You can use it as a guideline to know that your footage will show properly on an overscanning television. The HVX can also display 4:3 frame guidelines, so when you shoot 16:9 widescreen footage you can
"protect" for 4:3; this means you'd compose your shots such that vital information is kept in the 4:3 frame, in case you need to master a 4:3 version of your production.

**VIDEO OUT OSD**

This menu item dictates whether the text and graphics in the LCD display also get displayed on the analog component, composite, and S-video outputs. OSD refers to On Screen Display. If you set this menu item to ON, any text or graphics (menu displays, marker settings, level meters, etc) will also be displayed on a monitor or VCR connected to the analog video outputs. However, they will not be transmitted out the 1394 port. Zebras, EVF DTL, and the Focus Assist display are never output on the analog outputs.

**DATE/TIME**

This setting is obvious, it controls whether the date, the time, or both are displayed on the LCD and viewfinder. However, it's important to note that this setting WILL be displayed on the analog video outputs, regardless of what the VIDEO OUT OSD menu item is set to. It will not, however, be transmitted out the 1394 video output.

**LEVEL METER**

This menu setting governs whether the HVX's audio meters are displayed or not. The audio meters show the overall strength of the audio signal, for channel 1 and channel 2. The display is a horizontal graph of white dots, with two small vertical bars. The first bar denotes –20dB, and the second denotes –12dB. Each dot corresponds to 2 dB of signal strength. Absolute peak is at 0dB and should be avoided – audio that is so loud as to "peak" will likely be distorted when recorded. The graph will show a red mark at its rightmost edge
whenever the audio “peaks.” The smallest level shown is -34dB. For normal audio recording you want to have a good strong signal, with your loudest peaks filling much of the graph but not all the way to the red (0dB). You can use the ALC limiter to get some protection against peaking, but there is no provision in the camera for automatic level control (i.e., the camera cannot boost the audio levels during quiet portions, nor can it lower the audio level if the overall level is loud, other than the protection the ALC provides). You manually control the audio levels by using the two audio level dials. The only automatic intervention is the limiter.

ZOOM — FOCUS

This menu item lets you display or hide the zoom and focus readouts, and choose what form those readouts will take. The HVX features distance markings (in feet or meters) as well as percentage readouts that give you precise feedback about the mechanical position of the lens’ zoom and focus elements.

The zoom ring is purely mechanical, and because the zoom ring is an actual physical linkage to the lens, it’s important to not turn the zoom ring when the camera is in servo zoom mode, or you risk damaging the camera. Only manually turn the zoom ring when the zoom/servo switch is in “manual.”

The zoom readout ranges from 4.2mm to 55.0mm, or (on the percentage scale) Z00 to Z99. The mm scale is calibrated much more precisely than the Z00-Z99 scale is. Regardless of which set of numbers you choose to use, the numbers let you know exactly where you are in the zoom range, which is especially handy for establishing focus: you establish your shot composition and make a note of what Z setting you’re at, then zoom in all the way (Z99/55mm) on your subject to grab critical focus, and then you can zoom back out to the same zoom setting you started at.
<table>
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The focus ring is not a pure mechanical linkage, but it does give you precise control over the focus mechanism and repeatable focus marks. The distance scale readout (in feet or meters) lets you know exactly where the focus mechanism is at, and the MF00-MF99 number scale and distance readout scales provide for repeatable rack focus moves (where you shift focus from one point to another).

The focus readout can display numbers from 00 to 99, prefixed with either "AF" or "MF". "AF" means the camera is in autofocus mode, and MF means manual focus mode. MF00 means the lens is focused as close as it can possibly get; MF99 means it's focused at its furthest possible point (which is actually past infinity, as infinity...
focus is achieved at MF95). While the distance readout is certainly useful, Panasonic chose to include a numerical readout as well because the numbers-to-distance relationship changes depending on whether you have any additional lenses or close-focus diopters attached. For example, with no lens attachments, MF26 delivers proper focus for an object that’s 1’ 8” away from the front of the lens. But if you attach a wide-angle adapter, MF26 may actually be the proper focus point for something that’s 100’ away or more! Depending on the type of lens you use (wide-angle, telephoto, close-up diopter, etc) it may change the focus distance relationship between the lens and the scale. Normally the ft/meters readout is more precisely calibrated than the MF00-MF99, but in cases where you’re using lens adapters, it can be more useful to just use the MF00-MF99 scale. Using close-focus diopter lenses also changes the focus point, and using a close-focus diopter is a way to take advantage of the lens’ ability to seemingly focus past infinity: the full range up to MF99 is usable.

The focus ring also continues to work in autofocus mode: if the camera is set to autofocus, and you turn the focus ring, it will change the focus position of the lens (although the autofocus system will also try to compensate).

The focus ring doesn’t have hard stops at minimum or maximum focus points, but it is as precise and repeatable as if it did. You can use a follow focus or tape marks to the focus ring and hit your marks precisely, each and every time, regardless of how quickly or how slowly you move the ring. In fact, for pulling focus and for setting focus marks, you may find that the MF00-MF99 number scale is easier to remember than the actual distance markings, although the distance markings are more tightly enumerated and calibrated.

**CARD/TAPE – BATTERY**

This menu setting controls whether to display the remaining Tape Left or P2 Card recording time left, as well as the remaining Battery Life. Battery Life is shown with a little graph of a battery in the upper right corner, and Card/Tape Left is shown with a numerical readout right next to it. Some people confuse the “Card/Tape
Left" number with Battery Life, thinking that the number being displayed refers to the number of minutes of battery life left; it doesn’t. The battery life left is shown by the progressive depletion of the battery icon.

**OTHER DISPLAY**

The camera is capable of displaying many pieces of information in the viewfinder. While most of the most-common information is relegated to the black bars above and below the 16:9 image, not all of it can fit there. Displaying all of the information can make for a quite cluttered display, but not displaying enough of it may leave you without vital information during your shot. The OTHER DISPLAY menu item lets you selectively show this additional information. There are three settings: ALL, PARTIAL, and OFF. Regardless of how much information you choose to have active in your display, you’re never more than a button press away from clearing it all away, or making it all visible. The DISP/MODE CHK button can instantly bring up all the display items, and it can just as instantly remove it all, leaving you with a clear and uncluttered display.

**CAMERA DATA**

This menu item is only applicable in VCR playback mode. When you record DV footage, some information about the camera’s setup automatically records. In DV mode, the camera will record whether or not the Optical Image Stabilizer was used during the shot, what f-stop the camera was at, and what gain setting was used (0dB to 18dB). Knowing this information could come in handy if trying to recreate the look of a certain shot, for intercutting a pick-up shot into existing footage.

**LCD SET and EVF SET**

These settings let you control the brightness, color, and contrast of the viewfinder and LCD panel. When lighting conditions change significantly your existing settings may no longer be giving you an accurate representation of the recorded image. You should use the color bars to calibrate your LCD and EVF to continue being able to
rely on them to give you an accurate picture. Understand that no built-in LCD is going to show you the full range and full resolution of a high-definition image; only an external high-definition monitor can do that. But with proper calibration and attention to brightness and contrast, you can at least configure the LCD and EVF such that you can more accurately judge whether the shadows are crushed or the highlights are being blown out.

**DISPLAY ASPECT**

When shooting standard-definition footage this menu item gives you the ability to force the aspect ratio of the LCD and viewfinder to 4:3 mode. Normally you would have this set to AUTO, which will allow the camera to automatically adjust the aspect ratio when playing back footage - SQUEEZE footage will cause the display to automatically switch to 16:9 mode; LETTERBOX and NORM footage will be displayed in 4:3 mode. For most purposes, AUTO is the most useful setting. However, you can force the display to always be 4:3. This will cause SQUEEZE footage to display improperly (it will be stretched vertically, making everyone look tall and skinny). However, it may allow a little more precision in focusing, because the footage will be displayed in higher resolution (the 16:9 aspect ratio conversion process uses fewer pixels on the LCD display).

**EVF COLOR**

You can set the viewfinder (but not the flip-out LCD panel) to display in black & white or color. Setting this menu item to ON will enable color in the viewfinder; setting it to OFF will turn the viewfinder to black & white. Disabling the color in the viewfinder does not make the viewfinder the equivalent of a shoulder-mount professional video camera's CRT viewfinder; it will still be an LCD. However, with color disabled, many people find focusing to be a bit easier, and the effects of the EVF DTL "peaking" circuitry may be easier to see without the distraction of color in the picture. Turning the color off, and EVF DTL on, may make the viewfinder a more accurate tool for focusing.

The rest of the settings in this menu are adequately described in the camera's manual, and will not be duplicated here.
Card Functions

The HVX200 provides a slot for a standard SD Memory Card. This card provides the ability to store metadata that can be automatically attached to the clips on the P2 cards, formatting the SD card for use with the camera, saving scene files and user files to the card, and loading scene and user files from the card.

SCENE FILE

You can save all the camera's scene files to an SD card, or load all the scene files off of the SD card. You cannot load or save individual scene files to the card; instead it always writes out or reads in a complete package of all six scene files. You can name the package of scene files as well. Saving scene files to an SD card, and loading them in on another camera, lets you match cameras quickly and easily in a multi-camera shoot. When you save scene files to the SD card they will also be saved in the camera's internal memory. When you load the scene files from the card, the new scene files are also saved in the camera's internal memory at the same time. The settings that are affected are all the settings in the SCENE FILE menu, and only those settings. You can have a maximum of four "scene file packages" stored on an SD card. The CD that accompanies this guide includes four scene file packages that you can copy onto an SD card.
USER FILE

You can also save the user file settings to the SD card. The User File contains all the settings other than those in the scene file menu (so, your preferences for display setup, aspect ratio, recording mode, etc... basically every menu setting other than the scene file menu settings). Saving to the card, or loading from the card, will also cause the internal camera settings to be saved as well.

SD CARD FORMAT

Before you can use an SD card in the camera, it has to be properly formatted. This menu item lets you do that. Understand that anything and everything that was on the card will be erased when you format it. Make sure you know that it's okay to erase the card before you choose this menu option!
Other Functions Settings

REMOTE

The camera can be set to respond to two different infrared remote control units. Since the HVX's remote control is cross-compatible with many of Panasonic's other cameras, it's possible you may run into circumstances where more than one camera remote control is in use at the same time. If so, you can configure the remote (by pressing a certain button combination) and the HVX (using this menu item) to correspond to either VCR1 or VCR2. You can also set this menu item to OFF, which will cause the HVX to ignore all remote control signals. When using more than one HVX camera, this setting could be used to allow all the camcorders to be controlled from one remote control. This item makes sure that only that one button (VCR1 or VCR2) will operate this camcorder from the remote control.

1394 CONTROL

The HVX offers the ability to issue recording control commands through its 1394 connector. IEEE 1394 is an extremely high speed, high performance Serial Bus that provides for transferring data between digital devices, including audio and video data, time code, and also provides for remote control of a VCR. If you were to attach a 1394 cable to the HVX, and attach the other end to a deck, camera, hard disk recorder unit (such as the FireStore™) or a software-based hard disk recorder (such as DV Rack™) then the
HVX can send commands to that external recorder whenever you press the HVX's record button.

There are four possible settings:

**Off:** When set to OFF, the HVX will not try to control the external unit (camera, deck, or hard disk recorder). However, the data stream is still sent over the 1394 cable, and if you manually trigger the external recorder to start recording, it will be able to record the 1394 data stream regardless of whether the HVX is controlling it (and, in fact, regardless of whether the HVX is recording or not!)

**EXT:** When set to EXT, the HVX will not try to record anything on its internal tape or P2 card. It will only tell the external unit to record or pause. If you have a hard disk recorder or deck, this can save wear and tear on your camera's recording heads or be utilized instead of recording on the internal P2 cards. Also, this is a way to get much longer continuous record time: you can hook your HVX up to a computer or perhaps a large-format DV cassette deck, and be able to record several hours on one tape or hard disk without stopping. At all times, when recording to an external device, the data recorded will be at the full quality the HVX can provide.

**Both:** When set to BOTH, the HVX will record to its own tape/card, as well as instructing the external recorder to start recording. This way you'll have an automatic backup. The recording will be redundant, as you'll be recording the same image on two different devices; however, this is the best way to avoid dropouts on a tape. If a dropout (or "glitch") happens on one tape, you'll have a backup that will almost definitely not have a glitch at that same exact spot, so you'll have a clean copy you can use to repair any glitches in post.

**Chain:** In Chain mode, the HVX will start recording to its internal card or tape, until that media is almost full. When the camera gets close to the end of its media, it will automatically trigger the external recording deck to start recording. That way you can make a seamless recording across multiple tapes, or trigger an external device to record while you change out your P2 cards, etc. You can use the external recorder to cover the time while you're changing
tapes or cards in the HVX. Using the CHAIN method, you can theoretically record for hours without missing a single frame, although you'd need to patch the clips together in post to make a seamless recording.

**1394 CMD SEL**

This menu setting works if you have a camera, tape deck, or hard disk recorder hooked up to your HVX via a 1394 cable. What this menu option does is control what type of signal gets sent down the 1394 cable to the other device whenever you press the RECORD button. Once you're already recording, and you want to stop recording, you can tell the other device to go into either PAUSE or STOP mode when the RECORD button is pressed. Obviously PAUSE mode will allow for quicker restarting of recording when you press RECORD again, but it will also keep the other device's tape heads engaged. For the least wear and tear on your backup recording device, STOP mode will tell the backup camera to stop, rather than pause. The downside to using STOP is that when you tell it to start recording again, it may take a few seconds for the recording heads to get up to speed before recording actually begins, so you may lose the first few seconds of your shot.

**PC MODE**

This menu item controls what behavior the HVX exhibits when you set it into PC/DUB mode. The HVX has both USB2.0 and 1394 ports, and can act as either a 1394 host, a 1394 device, or a USB device.

**USB device:** When you choose this option, going into PC/DUB mode will cause the HVX to appear to a computer as if it is an external removable hard disk – actually, it will appear as two hard disks, one for each P2 card slot. The "contents" of these hard disks will be whatever happens to be on the P2 cards loaded in each slot. This method is recommended and supported for use with computers running the Windows operating system, and is not guaranteed for use with computers running the Macintosh operating system. When in USB DEVICE mode, the 1394 port is not active, and the camera effectively acts as a P2 slot-reading device. You can use this
mode to copy P2 cards onto computers that don't have PCMCIA/CardBus slots. Also, if you have a USB On The Go hard disk, you can use USB DEVICE mode to allow your USB On The Go hard disk to copy off the contents of the P2 card slots. Another device that can facilitate USB-based offloading is the Sima Hitch™ USB 101, a “bridge” device that can read data from one USB2 device and write it to another; using something like that would allow you to offload the contents of a P2 card onto any USB2 device.

1394 device: This setting will cause the HVX to appear as an external 1394 hard disk device when you choose PC/DUB mode. It will actually show up as two removable hard disks, one for each slot. This mode is recommended for use with Macintosh computers, and is not guaranteed for use with Windows computers.

1394 host: In this mode the camera can actually take control of an external 1394 hard disk and copy the contents of its P2 cards onto that hard disk. This can be an inexpensive way to offload the cards onto hard disk storage in the field, without even needing a computer! Offloading through 1394 has advantages, including the ability for the camera to perform a “verify” step to ensure that the cards were offloaded correctly and reliably. More information about this process is available in the essay on page 93.

RECLAMP

The camera has two “tally” lights, one at the front and one at the rear, that light up red whenever the camera’s recording. This menu option lets you choose how those lights behave: you can have them both turn on when recording, or neither, or just the front, or just the rear. If your on-camera subject gets nervous when they see the red light, you may want to turn the front light off. Another reason to disable the front light would be if you were shooting into a somewhat reflective surface and the red light is visible in the shot. Or, if you want to shoot in “stealth” mode, with nobody knowing the camera is running, you can disable both lights. Some on-camera subjects will prefer to see the red light active so they know the camera’s rolling and they’re being recorded.
ACCESS LED

This menu item controls whether the P2 card slot’s LEDs will light or not. The LEDs can glow orange or green, either solid or flashing, depending on their current status (see the owner’s manual for explanations of all the various status modes.) This menu item lets you turn those LEDs completely off if you so choose.

BEEP SOUND

The HVX is capable of “beeping” when certain events happen. The beeping can be considered unprofessional, but in certain circumstances it may come in handy; for example, if you find that you don’t always succeed in activating the camera when you press the RECORD button, you can enable the beep to give you audible feedback (one beep when you start recording, two beeps when you pause). One thing to be aware of: if you have an analog device connected to the audio output jacks of the camera (such as a VHS deck or DVD recorder, etc.) any BEEPS will also be output through the analog jacks. No beeps will be played through the headphones if the HP MODE setting is set to LIVE mode.

POWER SAVE

The HVX has a power-saving mode which can turn the camera off after five minutes of inactivity. This can be vexing when you’re setting up a shot, for example: you’re taking the time to frame your shot, set the lighting, and when you go to review how it looks on the monitor you find that the monitor is a black screen because the camera’s turned itself off! And worse, if you haven’t saved your scene file settings, they’ll be gone, and you’ll need to re-set your scene file (ALWAYS save your scene file settings!) This menu item lets you avoid the power-off – instead of powering itself off, you can set the camera to go into standby mode. When set to ON, after five minutes of inactivity it will power the camera down, saving wear on the heads (in DV tape mode) and saving battery life. When POWER SAVE is set to OFF, the camera stays powered on, but (in tape mode) after five minutes the tape drive mechanism is
powered down. This relieves stress and tension off the tape heads and protects them from excessive wear. This means it may take a bit longer to start recording to tape the next time you press the red RECORD button: the tape heads need to power up and get back up to speed, and that can take several seconds, so always watch the indicators in the viewfinder to verify that the camera is actually recording so you don’t miss the first few seconds of your shot.

**USER FILE**

The “user file” refers to all the camera settings that are not in the scene files. The HVX lets you save all your settings to the camera’s internal memory, or restore them to the factory defaults. If you were going to be using your camera in a mixed-camera environment, or loaning it to someone else, you might want to save all your settings before loaning it out. That way the new user could restore the camera defaults by going to the USER FILE menu and choosing “INITIAL” – that will restore the camera’s settings to the factory original. Then when you get the camera back, you can go to the USER FILE menu and choose “LOAD” – this will restore all the settings that you had saved. When the LOAD or INITIAL operation has been performed, turn the power OFF and then ON in order to enable the settings. Note: this menu item is unrelated to the SD card – you can also save the user file settings to, or load them from, an SD card; see the discussion on the CARD FUNCTIONS menu on page 191 for more information.
P2 Menus And Thumbnail Screen

Here's where things get really interesting. With the HVX200 you're probably working with your first P2 camcorder, and it's a whole different way of working. With digital clips, instant playback, and no tapes involved, you'll quickly discover just how revolutionary tapeless acquisition can be. In many ways it's just like working with a digital still camera, but it does take some explaining to fully understand the P2 menus and the thumbnail screen.

If you haven't worked with a tapeless video camera before, you may never have seen anything like this. This is a sample shot from the P2 thumbnail display, showing clips and other information on the card. Each P2 card basically acts as a solid-state "hard disk" full of clips that the camera has shot; each clip is fully "digitized" and ready to use the moment it's shot. In the thumbnail screen you can play clips, sort them, delete "bad takes," get more information about clips, play them in slow motion or fast motion, or preview the overcranking and undercranking effects of footage shot in 720p Native modes. From this screen you can also perform various housekeeping tasks such as getting information about the card's capacity, formatting P2 cards, formatting SD cards, importing P2 metadata from the
SD card to attach to your clips, viewing the metadata that’s been attached to your clips, and much more. For more information on the metadata, see the section on UNDERSTANDING METADATA on page 217.

The first thing to understand is that when the camera records footage to its card, it is completely unlike recording footage to tape. On tape it will record footage with a certain timecode, and that footage will at some point be “captured” into a computer for editing purposes. You’ll typically have to mark a “timecode in” point, and a “timecode out” point, and the computer will take control of the tape deck and rewind the footage, search for the “in” point, then begin capturing footage to the hard disk up until the “out” point. By the time this process is done you’ll have a file on the hard disk that consists of just that section of footage.

On the P2 card, everything is recorded to individual clips automatically. It’s like the whole “capture” process is done for you. When you record on the card, the camera creates a new file for each clip, and generates a “thumbnail” preview icon as well. The instant you’ve shot a clip you can toggle over to the Thumbnail screen and play it back – just use the navigation buttons to move the cursor to the clip you want to view, and press “play.” Playback begins immediately – there’s never any searching or hunting or rewinding or fast-forwarding. It’s truly nonlinear acquisition.

Another thing you do away with is the worry about taping over footage that you didn’t mean to tape over. When recording to videotape, if you want to review a shot you have to rewind the tape to the shot, and then play it. Most shooters have had the unfortunate experience of doing so only to forget to fast-forward the tape back to the next blank spot, so all future recording ends up recording over their own footage! That won’t ever happen with P2 recording: P2 works like a hard disk – it automatically finds empty space on the card to record more footage onto. You can play back any clip from anywhere on the card, and then instantly start recording (in fact, the “RECORD” button will instantly toggle you
back to camera mode and start recording even if you were in the middle of playing back a clip!) And it will never record over your footage; it will always record in empty space on the card.

You can also delete clips that you know you won't use. You can delete them for a variety of reasons: to recover additional recording space on the card, or to make your clip management easier when you get back to the edit bay (by getting rid of unnecessary clips right away); or for whatever reasons you choose. You're protected from deleting clips by accident; it takes three menu/button presses to delete a clip. But if you know that you want to delete a clip, it's quick and easy to erase unusable clips and recover that space. Deleting unusable clips keeps your project more organized, extends the recording times of your P2 cards, and minimizes the amount of time it takes to transfer your footage to a computer for editing, and further cuts down on the amount of space and time it takes to archive your footage when your project is complete. With that said, some people just can't bear to delete anything they've shot, but for those who know that they'll never use a particular shot or a particular clip, it's quick and easy and beneficial to delete those clips right in the field.

**WORKING WITH THE THUMBNAIL SCREEN**

The thumbnails are primarily only available in MCR mode (which means the MEDIA switch needs to be set to "P2"). You can also access limited thumbnail functionality when in DUB mode for selecting which clip to dub to tape.

Normally when you use the MODE switch to toggle into MCR (Memory Card Recorder) mode, the thumbnail display will automatically appear. If the thumbnail display isn't active in MCR mode (i.e., if you're facing a mainly blue screen
reminiscent of VCR mode when the MEDIA switch is in the “TAPE” position) then you can bring the thumbnail display up by pressing the AUDIO DUB/THUMBNAIL button.

Typically you’d navigate through the thumbnails using the left and right arrow keys (also known as the fast forward & rewind buttons). You cannot use the up & down arrow buttons to navigate on the thumbnail screen, because those buttons are used for different functions. The “up” arrow is actually the PLAY button, and the “down” arrow is the STOP button. Use the left and right buttons to move the yellow cursor to the clip you want to view. If you have a lot of clips to navigate through you can use the PAGE +/- buttons to jump through the thumbnails a page at a time.

While navigating, you can also SELECT a clip by pressing the PAUSE/SET button. When you press the SET button, whichever clip the cursor is currently over will toggle between SELECTED and not selected; the SELECTED state is shown by a light blue outline around the clip’s thumbnail. SELECTing a clip is a necessary step before you can delete that clip. You can SELECT multiple clips (and delete them all at once); SELECTing clips can also allow you to display only those clips by using the “SELECTED CLIPS” option in the THUMBNAIL menu.
PLAYING CLIPS

Once the cursor is highlighting the clip you want to play, just press the PLAY button (the “up” arrow). Playback will begin immediately. As a clip is playing you can pause it by pressing the PAUSE/SET button (the center button in the middle of the up/down/left/right menu buttons). When a clip is paused you can jump to the next clip (sort of like jumping to the next chapter on a DVD player) by pressing the right arrow, or to the previous clip by pressing the left arrow.

While a clip is playing, you can play it back at high speed by pressing the fast-forward or rewind buttons. Pressing those buttons during playback will cause the clip to play at 4x normal speed either forwards or backwards. You also have the option of playing a clip backwards or forwards at many various speeds. To do this you have to enter the variable playback speed mode, by pressing the PLAY button while the clip is already playing. You'll know you're in variable playback mode because “1x” will show up next to the playback arrow on the LCD screen; this indicates that the clip is playing back at 1x normal speed. Then use the PAGE/AUDIO MON/VAR +/- buttons to change the playback speed; you can choose from playback rates of 1/5 speed, 1x speed, 2x, 4x, 12x, or 24x fast motion in either forwards or reverse.

You can also step through a clip frame-by-frame. To do so, play the clip and then press PAUSE/SET. Then use the PAGE/AUDIO MON/VAR +/- buttons to step forward and backward through the clip a frame at a time.

While a clip is playing or paused, you can bring up the MCR menu options by pressing the MENU button.

When you play back clips, the system will sequentially play back all the clips that were recorded in the same REC FORMAT. As soon as one clip ends it will start playing the next clip (but it will skip clips that were recorded in different REC FORMATs). When the last clip finishes playing the Thumbnail screen will reappear. Only the clips
that were recorded in the same mode that the camera is currently in can be played back. That sounds confusing, so let me say it again: the thumbnail screen can only play clips that were recorded in the same mode that the camera’s RECORDING SETUP->REC FORMAT menu item is currently set to. Normally this is not an issue, since you typically will be recording your clips in the same format for the duration of a project, and playing back those clips from the camera will usually mean you’re playing back a clip that you just recorded, all in the same format. However, especially during the new-user testing phase, you may create clips in a variety of formats. When you try to play those clips back you’ll find that some just won’t play (and you’ll know which ones these are, because the little clip number on their thumbnails will turn red). This doesn’t mean there’s anything wrong with the clip or with the camera; it just means that you have to change the camera’s REC FORMAT to match what the clip’s recording format was. It’s a little inconvenient, but it only takes a few seconds, and again you’ll typically only run into this during your experimental testing; normally during a project your clips will all be recorded in the same format. You can identify what format a particular clip was shot in by highlighting the clip’s thumbnail; the lower left section of the thumbnail display screen will show what format the clip was recorded in. Then you press the MEDIA switch to go back to CAMERA mode, press the MENU button to enter the RECORDING SETUP menu, and change the REC FORMAT to match the format of the clip you want to play back. (Note: when playing back clips sequentially, the camera will only play back clips included on the current thumbnail display – so if you’ve limited the thumbnails to only show MARKED CLIPS, for example, then it will only play the clips that bear a shot mark.)
Thumbnail Screen Menu Options

Press the MENU button to bring up the P2 menu display. You’ll find four menus available which let you change the thumbnail display, perform operations on the clips or cards, get the status of a clip or of a card, or change the way you work with the metadata. You access menu items in the Thumbnail Menu the same way you do with any other menu, using the up/down/left/right buttons and the SET button to select a menu item.

THUMBNAIL MENU

The THUMBNAIL MENU lets you choose which thumbnails get displayed, which thumbnails don’t get displayed, what size the thumbnails are, and what attributes get displayed. There are a lot of options here, and some can be a bit dangerous, so you need to exercise caution when you change what clips get displayed. For example, if you have clips in multiple formats on your card, but you choose to display only the clips that correspond to the format that the camera is currently in, you won’t see any thumbnails for other clips – so you may forget that there are other clips on the card, and this may lead you to format a card thinking that there’s nothing else on it! Exercise caution when changing which thumbnails get displayed.
All clip

This selection instructs the camera to display a thumbnail for every clip that's on every card loaded in the camera. This will include clips that you can't currently play because they were recorded in different formats (denoted by their clip ID number being displayed in red.) It will take longer to navigate through the thumbnails because there are more of them; however, showing all the clips helps you keep track of what's on the card and helps prevent you from mistakenly thinking that a card is empty when in fact there may be other, undisplayed clips on it!

Same format clips

This selection will hide all thumbnails that were recorded in a format other than what the camera's REC FORMAT is currently set to. You can navigate through the clips much more quickly and play any clip that you see, and all clips' ID numbers will be black. Just remember that there may be other clips on the card besides the ones that you can currently see.

Selected clips

If you've highlighted any thumbnails by pressing the PAUSE/SET button (such that the thumbnail now has a light blue outline), then choosing SELECTED CLIPS will hide all thumbnails except for those you specifically selected. This can make it a lot easier to jump between two takes to determine which one you prefer, for example.

Marked clips

This function displays only the thumbnails of clips where you've set a MARK on the clip (by setting one of the USER buttons to SHOT MARK, and pressing that USER button either during recording, or when the clip is highlighted on the thumbnail screen, or while the clip is playing back.) You can also remove a mark from a marked clip; the mark toggles on and off each time you press the SHOT MARK USER button. This is a quick way to mark "good takes," so
when the Director asks to see playback on all the “good takes” you can quickly isolate them and play back only those clips.

**Text memo**

This setting lets you see only thumbnails for clips that have had text memos assigned to them (by assigning INDEX/MEMO to one of the USER buttons, and then pressing that USER button during recording or during playback; see page 221 for more details). When choosing this menu option, the Thumbnail Display will actually change: instead of three rows of four thumbnails of clips, it shows two rows of four thumbnails of clips, and the bottom row will show frames from the clip where the text memo was assigned. This lets you mark specific sections within a clip, and quickly see a thumbnail that represents the footage at that point in the clip. The thumbnail display doesn’t show you the actual text of the text memo that’s been assigned to that position, but it does show you a thumbnail of the associated frame (you can read the text memos by choosing PROPERTY->CLIP PROPERTY->MEMO; use the left/right arrows to scroll through the text memos. When in the TEXT MEMO thumbnail display, pressing PAUSE/SET will let you enter the bottom row of text memo thumbnails, and you can use the left/right arrows to scroll through the thumbnails that you’ve assigned text memos to. This lets you see frames of the clip that you’ve marked with text memos. You can also use the menu OPERATION->DELETE to delete individual text memo thumbnails; but be careful so you don’t delete the actual clip itself!

**Slot clips**

This setting lets you display only clips that are on a card in a particular slot.

**Setup**

In this menu you can customize the thumbnail display to show or hide icons for MARK, TEXT MEMO, VOICE MEMO, WIDESCREEN, and PROXY (these are little icons that display on the Thumbnail
picture of each individual clip to indicate whether a shot mark, text memo, voice memo, or proxy has been assigned to those clips, or whether the clip is a standard-definition clip that was shot in 16:9 Widescreen mode. You also can change what gets displayed under the thumbnail; normally the timecode of the clip gets displayed but you can change that to be the user's bits, the time the clip was shot, the date it was shot, or both the time & date. You can also change the size of the thumbnails display; NORMAL will give you three rows of four thumbnails; LARGE gives you two rows of three thumbnails; LARGE shows fewer thumbnails per screen but each is bigger and easier to see.

OPERATION MENU

Exercise care when using the OPERATION MENU. This menu lets you format SD or P2 cards (erasing everything on them) and delete or repair individual clips. These operations are irreversible, so be sure you intend to perform these operations before confirming to do so.

Delete

You can delete an individual clip (or a group of clips) off of the P2 card. Deleting is immediate, and the space that the deleted clips used to occupy will be made available for further recording. Steps have been taken to prevent accidental deleting of clips; it's a three-step process: first you must SELECT the clip (by pressing the PAUSE/ SET button, so that the clip gains a light-blue outline around its thumbnail); then you have to choose OPERATION->DELETE, and then you have to confirm by choosing YES. There is no way to undelete a deleted clip, so be sure that you have selected the proper clip to delete! Since it's possible to SELECT more than one clip at a time, you also need to pay careful attention to the dialog box that pops up: it will say "DELETE 1 CLIP?" or "DELETE 2 CLIPS?" etc; make sure that the message matches what you had intended. If you specifically mark one clip for deletion, and then the dialog box says "DELETE 2 CLIPS?" you'll want to cancel and go look back at the thumbnails; in this circumstance you will have actually selected two clips but forgotten about one. Make sure that when you choose
to delete clips that the message matches what you intended. You can choose to delete multiple clips; just choose PAUSE/SET to establish a blue outline around each clip’s thumbnail; then when you choose OPERATION->DELETE it’ll delete all selected clips.

**Format**

You can choose to format a P2 card or an SD card. Formatting the P2 card will erase every clip on it. It takes just a few seconds, and the process is irreversible. Make sure that you have backed up the footage from the card, or offloaded it onto a hard disk, or copied it onto a computer before you choose to format the card. Formatting an SD card also will erase every scene file, every user file, and all metadata from off the SD card (along with everything else that may have been on there; if you’ve used that SD card to store pictures from your digital camera and you choose to format the card from this menu, those pictures and everything else on the card will be erased). SD cards should be formatted before first being used in the camera.

**Repair clip**

Occasionally a clip’s thumbnail will show an “X” on it, signifying that something went wrong with the clip and it needs to be repaired. For example, if you’re recording a clip and the battery runs out while recording (so that the camera’s power is shut off), or if you eject a card while a clip is being recorded, that clip will need to be repaired. The P2 recording system commits data to the card every two seconds, so if you do lose power during recording (or eject the card while it’s being recorded onto) the most you will likely ever lose is the last two seconds of footage.

Select the clip (giving its thumbnail a blue outline) and choose REPAIR CLIP to restore it to useful status. If the “X” is red, that means the clip cannot be repaired.
PROPERTY MENU

The PROPERTY MENU lets you check the status of cards, clips, or the system's software revision number.

Clip property

This selection brings up a status screen full of information about the clip, including its name, starting timecode, user bits, date & time, duration, video format, frame rate, and variable frame rate setting (if any). It also shows whether any text memos or voice memos are attached (voice memos can only be done through the P2 Viewer program, and cannot be played back on the HVX200). You can also view the metadata attached to the clip. (see Understanding Metadata on page 217).

Card status

This menu item lets you view the status of the P2 cards currently loaded in the camera. Each slot gets its own bar graph to show the available time (or the amount of used space, depending on how you have the PROPERTY SETUP menu item set). The bar graph shows the percentage of card space that's used, and the REMAIN/ALL display lets you see how many minutes of free space remain on the card (in the current recording format) and the total amount of minutes possible on this card. Keep in mind that the number of minutes is dependent on what recording format you choose; you'll be able to record more footage in DV or DVCPRO mode than you will in DVCPRO50 or DVCPRO-HD modes. The CARD STATUS display shows each individual card, and it also shows the combined status across both cards.

Devices

This menu setting lets you show the status of the SD card (if any). You can see the total capacity of the card, the amount of space used, and the amount of space available, as well as whether the card is write-protected or not.
Property setup

This menu item lets you establish whether the CARD STATUS display shows the amount of free space remaining on the P2 cards, or the amount of space that's already been used on the cards.

System info

You can see what version of firmware your camera is running by displaying this menu item.

META DATA MENU

This menu lets you choose what user-defined metadata (if any) gets attached to your clips, and view the contents of the currently-loaded metadata file.

Load

You can load a metadata file off of your SD card into the camera. You can have multiple metadata files on a single SD card and swap between them easily by loading the one you want. Metadata files are text files; the easiest way to get a base metadata file is to create one in the Panasonic P2 Viewer program and save it onto your SD card.

Record

This menu item lets you determine whether you want to attach the loaded metadata file to your clips or not. If you've loaded a metadata file into the camera, you normally want to set this option to ON, but if for some reason you decide to discontinue attaching that metadata to your clips, you can set this menu item to OFF. The metadata will still be loaded, and ready to return when you choose ON, but will be ignored as long as this menu item is OFF.
**Initialize**

This menu item erases all metadata loaded internally in the camera. If the metadata file you last loaded isn’t relevant to your current shooting, this is the way you’d erase all internal metadata.

**Property**

This menu item lets you examine all the metadata currently loaded in the camera. If you have multiple metadata files on your SD card and don’t know which one to load, this menu item would let you review the metadata entries and determine if the current metadata file is the one you want to use.
Understanding Metadata

"Metadata" is an intimidating word that simply means "data about the data." It's data about your clips. You can choose to use it or not; if you don't want to concern yourself with it, you can use the HVX without ever using or knowing about metadata. But if you choose to use it you'll find you can organize and annotate your shots like never before possible.

The metadata comes in two flavors: there's data that the camera generates automatically (such as recording format, frame rate, links to previous & next clips, etc) and then there's data that you supply (via the SD card). The data that you supply can include all sorts of descriptive information, such as text memos, the name of the production, the name of the shooter, the location where the shot took place, the custom name you assign to the clip, and other information. If you're very organized during your shoot, and update the metadata frequently, you can enter the edit suite armed with substantial information about each and every shot (but it's up to you to keep on top of that during the shoot!) This metadata can come in handy when archiving the footage as well. You can assign text memos to the clips that you can then search in the future - i.e., rather than archiving a bunch of tapes, and having to scan through hour after hour of tape looking for that "one sunset shot with the boat" that you just know is out there somewhere on one of the 100+ tapes you have in your closet, you could instead assign a text memo to your footage prior to archiving that describes the shot as "sunset shot with boat." Then you archive your footage on whatever archive
medium you choose (DVD, high-definition optical disc, data tape, holographic laser disc, hard disk, or whatever). The metadata files get archived as well, so in the future when you’re looking for the “sunset shot with boat,” you can tell your computer to scan the metadata files until it finds the words “sunset shot with boat” — it’ll then tell you where it found the file, what the clip name is etc., and you can then restore that particular file and have quick access to exactly the shot you were looking for.

In order to create and edit metadata files you need to use the Panasonic P2 Viewer program, which is available as a free download from https://eww.pavc.panasonic.co.jp/pro-av/

The P2 Viewer program lets you edit metadata files and save them onto an SD memory card (assuming, of course, that your computer has an SD card reader; if not, you can get an inexpensive external USB SD card reader and use that). On a film-style shoot the script supervisor could be running the P2 Viewer program on their laptop computer and update the location, scene, director, camera operator, and all sorts of other info at the beginning of each scene and upload that to the SD card. Then every clip shot in that location would be automatically tagged with the proper metadata. When breaking down for the next scene the script supervisor could then pull the SD card and update the metadata for the new scene information. This type of shot logging is far more useful than simple timecode references! Of course you’ll also have timecode recorded in each clip, so you’re not forced to take advantage of the metadata, but for those who are organized enough to keep the metadata accurate they may find unprecedented organizational capabilities with their footage in the edit suite and when archiving.

As said before, there are two types of metadata; the first is the type that the camera generates automatically (and which you have no control over); the second is the type that you can customize using the P2 Viewer program and can attach to your clips. I’ll explain each parameter in each class; each metadata item name will be annotated by either CAMERA or USER, to indicate whether the item is generated by the camera or by the user’s metadata file on the SD card.
Global clip id (camera): This is a 64-character unique identifier assigned to each clip.

User clip name (user): You can assign a unique clip name to every file, or group of files, depending on how frequently you want to update the SD card information. The User Clip Name is not the same as the filename. The filename on the card will continue to be a camera-generated filename (such as “0001QB.MXF”); but in the metadata you can assign your own filename. This setting may be a bit cumbersome to change for each recording, and is probably best left for updating when the card is offloaded to a computer.

Video (camera): This gives information on the recording mode that the clip was shot in, including frame rate, pulldown method (2:2 for 30P or 25P, 2:3:3:2 for 24P, or 2:3:3:2 for 24PA, “OTHER” when used in variable frame rate recording, and not used for 720p Native modes or for interlaced recording).

Audio (camera): This reports the audio recording mode and number of channels recorded. The HVX will always record to the P2 card at a sampling rate of 48000 and at 16 bits per sample. In DVCPRO-HD and DVCPRO50 modes there will always be four tracks; in DVCPRO and DV modes you can choose to have two or four tracks, but again they will always be 48kHz/16-bit. There is no provision for 32kHz/12-bit recording to the P2 card; if for some reason you wanted to record in the lesser 32kHz/12-bit 4-channel DV recording system you’d have to switch to recording to DV tape.

Access: There are four sub-items under the ACCESS section, some are set by the camera and some are set from the user’s SD card file.

Creator (user): This field is typically used to identify the director or cinematographer or producer by name.

Creation date (camera): This is the date the clip was shot, as according to the camera’s internal calendar. This item is a sub-item found under the ACCESS metadata item.

Last update date (camera): This is the date the clip was last updated. This field is initially set to be the same as the CREATION DATE,
but will also be set automatically if someone uses the P2 Viewer program to change any of the metadata associated with the clip.

Last update person (user): This field can be set in the SD card, but probably shouldn’t. This is a field that’s best left blank and reserved for any changes made by someone using the P2 Viewer program.

Device (camera): This item includes three sub-items, all of which will be identical for any clip ever shot on this particular camera. Those items include the MANUFACTURER (which will always be set to “Panasonic”); the SERIAL NO. (which will be set to the serial number of the camera (or other P2 device) the clip was created on, and the MODEL NAME of the camera or device that created it.

Shoot: under this item there are a few sub-items that are generated by the camera, and some from the SD card.

Shooter (user): This field is typically used to identify the camera operator who shot the clip.

Start date (camera): This is the date the particular clip started recording.

End date (camera): This is the date the particular clip ended recording. In almost all cases this will be the same as the START DATE, unless the clip happens to span across midnight, or perhaps if you’re doing a long time-lapse clip.

Location (user): You can record the name of the location, the ALTITUDE (USER), the LONGITUDE (USER), the LATITUDE (USER) and information about the location SOURCE (USER). On the bigger cameras some of this information can be automatically filled in by getting a Global Positioning Satellite card; the HVX200 doesn’t have that option so all these fields would need to be logged manually in the P2 Viewer program.

Place name (user): Another field for recording the name of the location where this particular clip was shot.
Scenario (user): This item includes three sub-items that may be useful for dramatic narrative shooters (filmmakers, commercials, or where someone would typically use a slate to mark the scene and take number). There are fields for keeping track of the clip here: the PROGRAM NAME (or scene name), the SCENE NO., and the TAKE NO. You can try to set these before recording, but it may be a significant data management hassle to keep updating the P2 SD card info before each and every take. Instead you may want to update the P2 data each time a scene changes, but leave the annotation for TAKE NO. for the script supervisor to update in the P2 Viewer.

News (user): Where SCENARIO may be useful for narrative filmmaking purposes, this item may prove more useful for news shooters. Three sub-items allow you to identify the REPORTER by name, the PURPOSE of the shot (i.e., what news story you’re shooting this shot for), and the OBJECT of the shot (perhaps an interviewee’s name for an interview shot, or the name of the location for an establishing shot).

Memo (user): This item lets you attach a text memo to a shot. This field is entirely up to you as to what you want to do with it. The text memo function includes NO. (CAMERA) and OFFSET (CAMERA), and the name of the PERSON (USER) who created the text memo, as well as the TEXT (USER) of the memo itself. One example of how to use the text memo could be a description of the shot (such as “sunset with boat on lake”). Text memos get assigned to clips when the camera operator presses a USER BUTTON that has the INDEX/MEMO function assigned to it.

All of the above fields can be viewed (but not changed) right in the camera, using the PROPERTY-CLIP PROPERTY menu item. And all of the above fields can also be viewed in the P2 Viewer program. The P2 Viewer program also has provisions to attach low-res proxy video files to each clip. This is something that can be automatically generated by the more-expensive broadcast P2 cameras (such as the AJ-SPX800) but isn’t an option on the HVX200.
Physical Switches, Buttons and Jacks

This section will describe some of the features of the camera and observations about how those features work and how they can be best employed.

**Tape drive open/eject switch:** Pushing this switch forward will open the tape drive door, and may start the process that ejects the tape. However, there are two circumstances where the tape will not eject: 1) if the camera has no power source (i.e., no battery, and not plugged into AC power); or 2) if the camera is on, but the MEDIA switch is set to P2 instead of TAPE. If that's the case, you'd have to turn the camera off before you can eject the tape.

**Rec check button:** When the camera is in CAMERA mode, the REC CHECK button will rewind and review the last few seconds on the tape, or play back the last few seconds of the most-recently shot clip on the P2 card (but note: it will only play back the last clip that was shot in the mode that the camera is currently in; if you change the REC FORMAT or 480i/576i REC MODE settings, it may not play back the actual last clip you shot).
REC CHECK is especially handy in tape mode, for knowing that you've cued up the camera to the end of the tape, past your last "known good" take. It also helps prevent "timecode breaks" by making sure the camera picks up the timecode off the last shot of the tape. You can also manually review the tape when in camera mode by using the fast forward/rewind buttons; pushing to "rewind" will cause the tape to play backwards at real-time speed, pushing the "fast forward" button will cause the tape to play forward at real-time speed. For more control, switch to VCR/MCR mode, but for quick review/rewind/ play you can do a tape review in camera mode.

**Handle zoom:** This button controls what speed the camera’s top handle zoom rocker runs at. This doesn’t affect the main zoom rocker, only the one on top of the handle. The "2" setting can be changed in the SW MODE menu.

**Zoom rocker:** The power zoom is controlled by one of the zoom rockers, either the handle zoom or the main zoom rocker. The HVX is capable of three zoom speeds, slow - mid - fast. The main zoom rocker is pressure-sensitive, the harder you press it the faster it zooms. The handle zoom rocker is not pressure-sensitive, you tell it what speed you want to zoom at (by using the handle zoom switch) and it will zoom at only that fixed speed. Zoom can also be controlled by the wireless remote control (fixed at the "medium" speed) or by the CAM REMOTE/ZOOM S/S jack at any of the three fixed-rate zoom speeds. Note: neither zoom rocker will function if the MANU/SERVO ZOOM SWITCH is set in "MANU" mode.
**Zoom switch:** On the front of the camera under the lens is a switch labeled ZOOM: SERVO/MANU. This toggles between servo zoom (i.e., power zoom) and manual zoom operation. When in Servo zoom the zoom rockers on the camera (or the remote control) will drive the zoom motor, but when in MANU mode, the zoom rockers have no effect. When in MANU mode, zoom is controlled by turning the manual zoom ring. The HVX offers a true manual zoom, just like on a movie camera, where the zoom ring is physically connected to the lens elements. Smoother manual zooms are also possible by adding a longer zoom lever, which will effectively increase the diameter of the zoom ring and thus give finer control. When the lever is in SERVO mode you shouldn’t turn the manual zoom ring, or you risk breaking the camera.

**Remote control sensors:** The HVX has two sensors for the infrared remote control. While the remote is not typically used very frequently with the HVX, it is invaluable when doing stop-motion animation or other lock-down shots where it’s critical that the camera not be jiggled or bumped; you can trigger recording without touching the camera by using the remote control.

**Input1/input2 line/mic switch:** On the front of the camera are two often-forgotten switches that work in conjunction with the audio system. There are two LINE/MIC switches that control the signal level sensitivity of the XLR connectors, for mating the connector to the type of component attached to it. For example, when you have a mixer attached to the HVX, the mixer may be outputting a LINE
level signal, so you'd want to flip the LINE/MIC switch to LINE for that channel. If instead you hooked up a microphone directly, that mic would be outputting a MIC level signal, so you'd need to flip the LINE/MIC switch to MIC to match levels to the microphone. The MIC level is calibrated to -50 dBu or -60dBu, as determined by the menu setting on page 167. If you attach a device to the XLR input and you can't get satisfactory audio levels from it (like the audio is way too low, or too loud) then try changing the setting of the LINE/MIC switch for that audio channel to get a better level match.

P2 card access lamps: Each card slot has a glowing LED lamp next to it, and that lamp is designed to give you information or feedback about the status of the card. Unfortunately they can be quite confusing – each lamp can be either green or orange, and can glow steadily or flash quickly or slowly. There are about 14 different status reports that they try to convey, depending on which mode the camera is in. You can refer to the table in the camera’s manual on page 26 for what each of the flashing states signify; in general the only ones you have to be concerned about are blinking green (meaning the card is full or write-protected); blinking orange slowly (meaning the card is being accessed, so you must not eject it) and when both lamps blink orange at the same time (meaning that you ejected a card while it was being accessed; you really don't want to do that.)

P2 card slots: On the back of the camera under the viewfinder you’ll find a door that covers the two P2 Card slots. These slots hold the camera's primary recording media. The slots are fundamentally
identical to laptop computer PCMCIA slots; the spring-loaded eject buttons on the right side of the slots are used to eject the cards. While the form factor of P2 cards is identical to PCMCIA/CardBus 32-bit cards, the only type of card you should use in the camera is one that has been made specifically for use with a P2 system. Don’t try inserting a CompactFlash reader card or a PCMCIA modem in the slot, as it won’t be compatible.

**Viewfinder:** The HVX’s viewfinder is quite versatile, and even sharper (with more pixels) than the flip-out LCD panel. You can configure the eyecup for left-eye or right-eye viewing, focus it sharply using the diopter adjustment dial, and you can configure the camera to enable the viewfinder to stay active even if the flip-out LCD panel is active. This can come in handy if the camera operator needs to be viewing the scene and someone else (director, focus-puller, etc) needs to be viewing the LCD panel: you can turn the LCD panel so that it snaps into the side of the camera body, screen facing outwards, so others can view it while the camera operator has exclusive use of the viewfinder. Configuring the camera to use both the viewfinder and the LCD at the same time will result in the camera drawing more power, thus resulting in shorter battery life. The viewfinder can also be configured to be either black and white or color. Selecting black & white may make it easier to discern the effects of the EVF DTL function, which may make for easier critical focus when using the viewfinder. The viewfinder also shows the full “underscan” frame. The viewfinder rotates up to facilitate low-angle shooting, and when it’s lifted up you’ll see that your camera’s serial number plaque is under the viewfinder.

**Scene file dial:** The HVX provides a unique way to change the look of your video instantly, or pre-load several different looks. The Scene File Dial (also called the CineSwitch™) is a six-position dial on the
back of the camera that lets you store six customized scene files. The scene files are named F1 through F6, and come pre-loaded from the factory with certain presets that Panasonic thinks users would find useful. You can customize many settings in each scene file, and switch quickly between them even while recording. All the settings in the scene file will be updated on-the-fly except for the recording mode and frame rate: you cannot switch between frame rates, or between recording formats while the camera is actually recording. If you want to change the frame rate, you have to stop recording first. This means you can’t switch from 24P to 30P in the middle of a shot, for example, nor can you execute a “speed ramp.” However, all other settings will change, so you can switch from HD Norm Gamma to Low Gamma, high DETAIL LVL to zero DETAIL LVL, etc. all on the fly. Scene files can be customized and saved internally to the camera’s memory and they can also be saved to (or loaded off of) an SD Memory Card.

Mode button: The HVX has three distinct modes it can operate in: CAMERA mode, MCR/VCR mode, or PC/DUB mode. You use this MODE BUTTON to change which mode the camera is operating in. The particular mode it goes into also depends on the position of the MEDIA switch; when it’s set to P2 then the MODE BUTTON changes between CAMERA/MCR/PC mode; when the MEDIA switch is set to TAPE then the MODE BUTTON changes between CAMERA/VCR/DUB. When you first turn on the power, the HVX will be operating in CAMERA mode, which of course means it’s prepared to shoot footage. You’ll see a small red light under the word CAMERA.
you press and release the MODE BUTTON, it will switch to MCR (or VCR) mode, and a green light will appear between the words MCR and VCR. When in MCR/VCR mode you can play back the footage you’ve shot, rewind/fast-forward the tape, delete files off the P2 card, or instruct the camera to record footage from one of its inputs (either composite, S-video, or 1394). MCR/VCR mode makes the camera act more like a deck.

If the unit is already in MCR/VCR mode and you press the MODE button again briefly, it will toggle back to CAMERA mode. However, if it’s currently in MCR/VCR mode and you press and hold the MODE BUTTON for three seconds or more, it will shift into PC (or DUB) mode. An orange light will appear between the words PC and DUB. In PC mode the camera serves as either a P2 card reader for a computer, or as a host for controlling an external 1394 hard disk. In DUB mode, the camera allows you to convert high-definition footage on the P2 card into standard-definition footage on the miniDV tape. See the essay on page 93 for more information on how to dub footage. While the camera is in PC/DUB mode, the only way to exit PC/DUB mode is to turn the power off.

*Media switch:* This switch defines what type of recording media to use; P2 cards or miniDV tape. If you intend to shoot to P2 cards, you set the switch to P2. If you intend to shoot to miniDV tape, or you want to dub high-definition footage from your P2 cards and downconvert it to tape, you need to set the switch to TAPE. Note: you cannot record high-definition footage or DVCPRO or DVCPRO50 footage onto the miniDV tape; only DV footage can be recorded on the miniDV tape. The “dub” process will downconvert high-definition footage into DV and record that onto the tape.
**EVF DTL button:** this button controls the EVF (electronic viewfinder) DTL (“peaking”) function. This feature can help you focus more accurately by providing a “peaking” feature in the viewfinder and on the LCD.

When you have peaking turned on, any items that are in sharp focus will be outlined with a subtle white outline. The effect isn’t dramatic, but it is noticeable, especially when you know what to look for. You may have an easier time seeing the effect if you switch the viewfinder to black and white mode. Note that this “outlining” effect is not recorded on your footage; it’s only displayed on the viewfinder/LCD. Since the magnified focus assist isn’t available in standard-definition modes, EVF DTL is the main focus assist function for shooting 480i/576i footage.

**DC input terminal:** The HVX includes a 7.9V DC input jack in the battery compartment. If you have a compatible DC power supply you can power the HVX from this jack rather than from batteries or the AC power supply. Another way to get alternative power to the HVX is to use something like the Bescor CLC-D120, which allows you to plug the HVX into a 12V battery belt through the use of a cigarette-lighter plug.

**Audio controls:** There are two audio level control dials, one for each channel. These potentiometers control the volume assigned to channel 1 and channel 2, regardless of what source is attached (you cannot control the audio level of channels 3 and 4.) If you set the CH1 or 2 SELECT switches to INT, these dials will control the volume of audio coming from the internal microphone. If you set the CH1 or CH2 SELECT switches to INPUT 1 or INPUT 2, these dials will instead control
the volume being input through the XLR connectors. The audio control dials never control the volume for what gets recorded on CH3 or CH4; those channels are permanently set to an audio level that corresponds to setting the audio dials to center (as in the picture above). It should be noted that it's possible to record the same microphone input on both CH1 and CH2 (by setting both CH1 & CH2 SELECT switches to INPUT2); when doing so, you may find it advantageous to set one of these audio control switches to slightly lower volume; this can give you a clean track of audio that's more protected against clipping and distortion in case you need it in post.

**Focus assist button:** High definition video is very demanding in terms of focus. Whereas minor focus errors may be tolerable in standard-definition video, high-definition video provides no leeway - shots that are out-of-focus even just a little bit will show. Accordingly, Panasonic has included a very useful magnified Focus Assist for use when shooting high-definition video. The Focus Assist function pops up a window in the center of the viewfinder or LCD panel which shows a high-resolution magnified section of the image. You can also use the magnified Focus Assist even while recording, since the Focus Assist occupies a window in the center of the LCD, leaving you room outside of it to judge framing & composition of your shot (although admittedly this will take practice).

Practicing proper focus technique can assure you of getting sharp focus (even without a production monitor) in most circumstances. What you want to do is take advantage of both focus assist tools: the magnified Focus Assist, and the EVF DTL. If you have to focus on the run, you should find the combination of these two features can provide for very accurate focusing. However, if you have the luxury of setting up your shot before shooting, you can do even better by zooming in to 100% telephoto, and opening your iris up as wide as
reasonable before focusing. This will give you very shallow depth of field and, combined with the EVF DTL and Focus Assist, should let you get razor-sharp pinpoint focus even without having an external monitor. Zoom in, open up and grab focus, then zoom back out and stop the iris back down to proper exposure before shooting.

Magnified Focus Assist is not available in SD (480i or 576i).

**Focus switch:** On the side of the lens is a switch named "FOCUS", with three possible settings: “A”, “M”, and “∞”. This switch lets you control the autofocus capability of the camera. When set to “A”, the camera operates in full autofocus mode, automatically hunting for the best and sharpest focus. When set to “M”, the camera is set to strictly manual focus. When pushed to “∞” the camera is instantly set to “infinity” focus, the setting where even the furthest possible objects (such as the moon) should be in sharp focus. Infinity is not really a switch setting, it’s just a momentary push – when you push the switch down, the lens gets set to infinity and then the switch automatically returns to manual focus mode.

Autofocus works better at faster frame rates; it works best in 50i/60i interlaced mode or 50P/60P mode. When using slower frame rates (such as 24P or 30P), the autofocus system responds more slowly. The reasoning is simple: in interlaced mode or 50P/60P mode, the autofocus system gets fed sixty (or fifty in PAL/50Hz) updates per second. But in slower-frame-rate modes, the updates come far more slowly: in 24P mode, the autofocus system only gets 24 updates per second. With less-frequently-updated information to work from, the autofocus system cannot respond as quickly to changes in the image.

Autofocus works best under brightly lit conditions. Under low light and low contrast conditions autofocus has to work much harder, and
will respond much more slowly, and will be more prone to "hunt" for proper focus. Another factor to consider in autofocus performance is that the autofocus system relies on measuring contrast to determine proper focus points. If the scene you're shooting is very low in contrast the autofocus system will have a harder time determining the proper focus point. Autofocus works quickest when it can easily discern a transition between dark and bright elements, especially vertical elements (i.e., on a black and white picket fence, the autofocus system would perform superbly. Trying to find focus on a sold white sheet of paper would be extremely challenging for it.)

When the FOCUS switch is set on "M", the HVX enters manual focus mode. The focus readout in the LCD display changes from AF to MF to signify the change from Auto Focus to Manual Focus. In Manual Focus mode, the HVX offers one of the most precise focus systems of any servo-focus camera. The focus ring moves with precision and accuracy; focus marks are definite and repeatable. You can use professional follow-focus attachments and get completely repeatable focus performance. The distance measurements show up in the viewfinder rather than on the lens barrel (so they're more readily accessible to the camera operator), and those distance marks are delineated much more frequently than any lens barrel markings would be, which helps eliminate guesswork in judging distance. Rack focus moves are easily accomplished. The only substantial difference between how the HVX's focus ring works, and how a true manual linkage works, is that the HVX's focus ring doesn't have physical hard stops at infinity and at minimum focus distance.

When the FOCUS switch is pushed towards the Infinity symbol ("∞") the lens is set to infinity focus (MF95). However, as discussed in the section on ZOOM-FOCUS, infinity focus may not be the same depending on what accessory lenses you have installed on the camera. The Push-To-Infinity button is only practical if you have no additional lens adapters installed on the camera.

When in manual focus mode you can invoke the autofocus system
on a temporary basis by pressing and holding the PUSH AUTO button. The longer you hold the button, the longer autofocus will remain active; when you release the button it reverts to manual focus mode.

In autofocus mode, the manual focus ring remains active and you can adjust focus even while autofocus is working. Or, in the USER BUTTON setup, you can configure it such that the focus ring can be set to control the iris instead of focus.

iris dial and iris button: The iris dial allows you to set the f-stop manually. You can even use it when the camera’s in AUTO-IRIS mode; the iris dial will let you override the auto setting to a certain degree, although the camera will eventually compensate. A common technique is to let the auto-iris set the overall exposure level, then switch to MANUAL IRIS and fine-tune the exposure according to taste (or according to the zebras or referencing a production monitor or waveform). The IRIS BUTTON lets you toggle between auto-iris and manual mode.

To understand how the iris dial works, you first need to understand what f-stops are. F-stops are basically a way to describe the amount of light the iris STOPS from getting into the lens. In simple terms, f/1 would be admitting as much light as the lens is possibly capable of (think of it as “f/1” = “f divided by one”... “f” = the maximum amount of light, so “f” divided by 1 would still be “f”). F-stops are numbered according to the following sequence: f/1, f/1.4, f/2, f/2.8, f/4, f/5.6, f/8, and f/11. Each additional f-stop cuts in half the amount of light admitted by the previous f-stop; f/1.4 admits half as much light as f/1 does, f/2 admits half as much light as f/1.4, and so on. F-stop numbers are based off of two base numbers, f/1.0 and f/1.4. Each new f/stop number is a double of the previous number:
1.0 1.4
2.0 2.8
4.0 5.6
8.0 11 (rounded down from 11.2)

So if you remember 1.0 and 1.4, you can calculate the rest of the sequence easily.

You can think of the f/stop notation as a diameter formula for the lens iris. Whatever "f" stands for, when expressed in the term of "f/2.0," would mean an iris size of "f" divided by 2, which would let in 1/4 as much light as an "f" divided by 1. Think in terms of a square: if you divide the length of a side of a square by 2, the overall square is 1/4 the size as the original: a 2" x 2" square has an area of 4 sq inches, but cut those sides in half and you get a 1" x 1" square, with an area of 1 square inch, which is 1/4 the area of the 2x2 square.

So to get half as much area, you don’t divide by two, you need to divide by 1.4 (or the square root of 2). If you take the 2" side of the square and divide that by 1.4, you’d get a square of 1.42" x 1.42", which has an area of 2 square inches (1.42 x 1.42 = 2.0). And 2 sq. in. is 1/2 as much area as the original 2x2 square’s 4 square inches. So to get half as much coming in, you need to divide by 1.4.

Therefore, the numbers you divide "f" by are:
1, 1.4, 2, 2.8, 4, 5.6, 8, 11

Each successive number lets in half as much as the previous number.

The iris display shows those whole f-stop numbers, but it also shows other numbers in-between. The other numbers are half-stop increments, so between 2.0 and 2.8 (which are both “whole” stops) you’ll find 2.4 listed, which is a half-stop, which is equivalent to halfway between 2.0 and 2.8, and lets in 75% as much light as f/2.0 does (since f/2.8 lets in 50% as much light as f/2.0 does).

The full sequence of f-stop numbers that the HVX displays are:
OPEN (f/1.6), 1.7, 2.0, 2.4, 2.8, 3.4, 4.0, 4.8, 5.6, 6.8, 8.0, 9.6, 11, and CLOSE

The iris wheel is actually calibrated much finer than half-stops though. The HVX iris is calibrated in 1/6 stops. By very carefully rotating the iris wheel, and watching a monitor, you can discern that there will be three changes of brightness before the f-stop display changes (i.e., when at f/2.0, you can stop the lens down two visible ticks and the readout will still show f/2.0, but when you stop down one more tick then the display will change to f/2.4). Knowing this, you can make very fine and very precise exposure adjustments.

The HVX’s iris can be more open at wide-angle than it can at full telephoto. At full wide angle (Z00/4.2mm) the maximum iris opening is f/1.6, but at full telephoto (Z99/55.0mm) the maximum iris opening is f/2.8. If you’re shooting in extremely low light conditions and need the brightest picture you can get, you may want to avoid zooming in very much, as the most telephoto position of the lens is a full 1.5 f-stops slower than the full wide angle position.

A note on iris and high-definition: it is vital to control the iris and keep it from going too small. Aim for F/8 as your smallest iris whenever possible; stopping down to F/9.6 will result in losing some resolution due to diffraction. F/11 will result in quite soft footage. I would advise to never allow the camera to shoot at F/11 when shooting high-definition footage.

**Nd filter switch:** The camera comes with two Neutral Density (ND) filters. Neutral Density filters are used to control exposure, and ND filters act like “sunglasses” for your camera: they help cut down the amount of light entering the camera, so in bright conditions you can engage the ND filters to lower the light level and get proper exposure. They’re called “neutral” density filters because they add
no color shift to the image: they’re a neutral shade of gray, so the only image effect is to lower brightness.

The switch has three settings:
- **Off**: no ND filters (best used in lower light conditions);
- **1/8**: one stage of ND filter, reducing the amount of light coming into the camera by 3 f-stops;
- **1/64**: two stages of ND filter, reducing the amount of light coming into the camera by 6 f-stops.

The ND filters can be thought of as two 3-stop filters. ND filters are named according to how many thirds of an f-stop they reduce the incoming light, and typical ND strengths are ND .3 (three thirds, or one full f-stop), ND .6 (two stops) and ND .9 (three stops). An ND .3 reduces light by 3 thirds of an f-stop (or one full f-stop.) Put another way, an ND .3 reduces the amount of light coming into the camera by half. The exposure compensation of an ND .3 is the equivalent of closing down the lens by one f-stop; for example, a camera shooting at f/4 with an ND .3 filter will deliver the same exposure as a camera shooting at f/5.6 with no ND filter.

The HVX includes two 3-stop ND filters (or ND .9 filters). Three stops of light reduction results in the amount of light being cut to 1/8 its intensity (one stop = 1/2 the light, another stop = 1/4 the light, and a third stop = 1/8 the light). So the switch is named “ND 1/8” for position one. The second position results in three more stops of ND being applied, so the light is reduced to approximately 1/64 its intensity: From ND 1/8, one stop would be ND 1/16, two stops would be ND 1/32, and three stops delivers ND 1/64.

The HVX is a light-sensitive video camera, rating at approximately 320 ISO. Because of this high speed you need to use the ND filters to control the amount of light that enters the camera. For indoors shooting you’ll usually want the ND filter off, but outdoors will almost always dictate using at least ND 1/8 and usually ND 1/64. Follow the recommendations of the auto-iris and your zebra display to determine which ND setting to use, and keep your eye on the f/stop — in standard-definition (480i/576i) all f-stops are appropriate, but in high-definition shooting you don’t want to see the iris stop down past f/8, so you may need to use the ND filters to get that iris more open.
Gain switch: The HVX has a 3-position toggle switch for controlling picture gain. Gain is an electronic amplification of the video signal, which means that by using gain you can make the picture brighter than it otherwise would look. The downside to using gain is that it introduces more noise into the picture. The more gain you use, the brighter the picture becomes, and the noisier the image gets. The switch provides for three positions: L(ow), M(id) and H(igh). LOW means that no gain is applied. The factory defaults for MID and HIGH are 6dB (twice as bright) and 12dB (four times as bright). You can change those settings in the SW MODE menu. The HVX also provides for a very strong 18dB of gain, which would give you a picture eight times as bright as with no gain (but the picture will be very noisy). You cannot assign 18dB of gain to the GAIN SWITCH; the only way to get 18dB of gain is to assign it to one of the USER buttons. 18dB only works in interlaced mode, or 720p60/720p50 modes. Also, gain doesn't work in combination with the slow shutter speeds (1/12 for PAL/50Hz, 1/12 for 720/24p, or 1/15 for US/60Hz): you can have slow shutter speeds OR gain, but not both at the same time. Another thing to understand about Gain is that it can only amplify the signal that the camera is currently seeing; it cannot add detail that can't be currently seen. If you're shooting under low light conditions and need to employ gain to get the picture bright enough, you should understand that your video is in all likelihood underexposed, and using gain will artificially brighten up the picture, but it will not restore detail that wasn't properly captured due to the underexposure. Gain is usually used as a "last resort" – when shooting under dim conditions you should take other measures to increase the brightness of the scene first, including removing all neutral density filters, opening up the iris to its maximum opening, and adding light whenever possible.
**White bal switch:** The HVX offers a 3-position switch for white balance. The positions are PRST, A, and B. Using this switch, in connection with the menus and the AWB button on the front of the camera, you can choose from a wide variety of white balance possibilities: either a 3200k preset, a 5600k preset, up to two channels of manual white balance, or an automatically-tracking white balance mode (ATW). For a discussion on color temperatures and white balance, see the discussion under menu item ATW (page 150).

To white-balance the camera, first decide if you want to use one of the existing presets or if you want to use a manual white balance. The presets are selected by setting the WHITE BAL switch to PRST, and then toggled by pressing the AWB button on the front of the camera. The presets are P3.2K and P5.6K. Those correspond to indoor lighting (3200 Kelvin) and outdoors (5600 Kelvin). While the presets are perhaps a good starting point, there are many circumstances where a preset will not deliver the most accurate color rendition. For example, many incandescent and halogen lamps burn at color temperatures different from 3200 Kelvin; some may burn as low as 2700 K. If you're using 2700 K lamps to light your scene, and you have the white balance set to P3.2K, your lamps will not look white, they'll look orange-ish. Also, daylight varies tremendously in color temperature, from around 3000 K during sunrise/sunset to over 10,000 K on an overcast, cloudy day. So the presets are a good starting point, and good for on-the-run shooting, but if you have the time to take a manual white balance you can get more accurate color rendition. Also, using the presets will disable the COLOR TEMP feature in the scene file menus.

The HVX provides two channels of manual white balance, A and B. Both function identically. To set a white balance, place a white
card (or other white object - a sheet of paper, a T-shirt, whatever you have, although the whiter the better) into the light where you intend to be shooting. Ideally you'd have your subject hold a white card up in front of their face, etc. Zoom in until that white card fills the screen. Set the WHITE BAL switch to either A or B, and press and hold the AWB switch until the camera displays “AWB Ach ACTIVE” (or “AWB Bch Active”), which lets you know that either A-channel or B-channel is being calibrated to an accurate white balance. Any time your lighting conditions change, you'll need to re-white balance if you want your colors to continue to be rendered accurately.

Another white balance option is to set one of the WHITE BAL switch options to ATW in the SW MODE menu. You can set any one of the WHITE BAL switch settings to ATW mode (either PRST, A or B). For example, you could configure your camera so that PRST = presets, A is reserved for manual white balance, and B is set to ATW. Then when you move the WHITE BAL switch to "B", the camera will automatically start tracking white balance by itself, updating as lighting conditions change. For professional shooting situations you may not want that, but for run ‘n’ gun type situations it may come in handy. However, the ATW response rate is fairly slow (it can take a few seconds to respond to changing lighting conditions).

Changing the white balance switch doesn't immediately force a hard image change; rather the camera smoothly transitions from the old white balance setting to the new one.

The manual specifically says to not block the White Balance Sensor “or the ATW function will not operate properly.” During manual white balancing the camera makes its determination by looking through the lens (which is why you want to zoom in on a white object). But during auto-tracking white balance (ATW), the
camera doesn’t get its color temperature information through the lens; rather it relies on a little window near the S-video port. If you block that window then the camera won’t be able to track the white balance, but it will have no effect on your ability to manually white balance. Furthermore, understanding the different ways the camera gathers light to judge a white balance can explain why auto-white balance might fail under certain circumstances. If the scene the camera’s lens is seeing is lit with a certain color of light, but the light striking the White Balance Sensor is a different color, the ATW system will balance towards the light striking the White Balance Sensor, which will render your scene in the wrong colors. An example may be if you were standing outside in full sunlight, shooting into a house through a window, and the scene inside the house is lit with tungsten lighting. In this case the daylight will be hitting the White Balance Sensor, causing the camera to believe that daylight is the prevailing lighting color, whereas your scene indoors is lit with tungsten light. In circumstances such as that you would be much better off to perform a manual white balance.

**User buttons:** These buttons allow you to instantly switch in certain features, such as color bars, 18dB gain, spotlight or backlight compensation, or fade to white or black, etc. For a discussion of what the various USER buttons can do, please see the discussion in the SW MODE menu section on page 152.

**Auto/manual switch:** The HVX cameras have a wide variety of manual controls and capabilities. But what if you’re in a situation where you just have to grab the camera and shoot (say, a breaking news story?) For circumstances like that, where you simply don’t have time to set all the manual settings in time to get the shot, you can slide the AUTO/MANUAL switch to AUTO and the camera will take over many of the functions automatically. You can configure it to switch into auto-focus, auto-exposure, auto-iris, auto-gain,
and auto-white balance... or you can tell it to go into auto-mode for any combination of those settings (see the discussion on the AUTO SW menu for more information). Another good use of the AUTO switch might be if you need to hand the camera to someone who's not skilled on the HVX, to get a shot you need. The results will likely not be as good as if you'd manually set up the camera, but the AUTO switch may make the difference between getting a shot, and not getting it at all.

**LCD monitor:** The HVX's LCD flip-out monitor is a large, 210,000-pixel screen useful for monitoring your shots and gauging overall exposure and color levels. It is not as high-resolution as a pure dedicated production monitor, nor is it going to be as accurate at gauging exposure or contrast or focus as a dedicated production monitor. The LCD monitor can be rotated 180 degrees so that it can be seen from the front of the camera, and it can also be closed against the body of the camera in either screen-in (normal closed state) or screen-out position. With it screen-out against the body of the camera, an assistant can be viewing the footage from the side while the camera operator uses the viewfinder, and an assistant camera operator could track focus (using the MF manual focus display).

The LCD monitor (and the viewfinder) both display the full image that the camera is recording. They both display “underscan.” This is not how most CRT television sets display the picture; most monitors “overscan,” which means that somewhere between 5% to 10% of the image is lost on the edges. All consumer camcorders and most “prosumer” camcorders show the “overscan” frame, under the notion that it will most accurately match a consumer television. The HVX200 is a professional tool and shows the entire frame. If you're planning on showing your footage on a consumer television, you can compensate for the consumer TV's “overscan” by turning on the 90% Safety Zone in the DISPLAY SETUP menu.

The LCD SET menu gives you some control over the LCD display, including brightness, contrast and color. While it is tempting to think that you could calibrate the LCD to the color bars to match a professional monitor, it's not really practical because a slight
change in viewing angle will change how the LCD’s display looks. It’s much better and safer to rely on a true external production monitor to gauge color, exposure and contrast. The LCD is good for reference, but no on-camera LCD is up to the task of showing what your recorded video will really, truly look like on a television. And, keep in mind that the look of an LCD will change based on the different lighting conditions it’s used in, and the angle that you view the LCD at. If you want to use the LCD to judge exposure or other image factors, first turn on the color bars and spot-check that you’re seeing the bars accurately presented; that will give you a better assurance of what you’re seeing on the LCD screen. If the bars are not accurately represented, use the LCD SET menu to try to better match proper color bar rendition on the LCD before relying on it to make color or exposure decisions.

Audio dub/thumbnail button: This is one of the buttons you’ll be pressing frequently, primarily in its capacity as the THUMBNAIL button. When you first enter MCR mode (with the MEDIA switch set to “P2”), the screen will fill with the thumbnail display of the clips on the P2 card. But there’s a whole list of menu settings available in MCR mode that cannot be accessed while the thumbnails are active. You have to press the AUDIO DUB/THUMBNAIL button to remove the thumbnail screen and bring up the MCR mode. When in MCR mode you can press the MENU button to bring up the menus, or you can monitor video signals that are input through the composite, S-video, or 1394 input ports, and you can have the camera record any such video input to its P2 cards. Press the button again to return to thumbnail mode.

When the MEDIA switch is in TAPE mode, and the MODE switch is in VCR mode, this button functions as AUDIO DUB instead of THUMBNAIL, and allows you to dub in two tracks of external audio in addition to the audio you’ve already recorded on tape
(assuming that you recorded in SP mode with your audio options set to 32kHz/12-bit).

Page/audio mon/var buttons: These multipurpose buttons do different things depending on what mode the camera is currently in. In P2 Thumbnail mode, they allow you to navigate through the thumbnail screen quickly; the "-" button jumps backwards by a full page, the "+" button jumps forward a full page. If you're already playing a clip or tape, these buttons control the playback rate of the clip, allowing you to play back clips in fast-motion or slow-motion. Finally, when you're monitoring live video, these buttons let you control the volume of the headphones or the speaker.

End search: This button is only used when in DV tape mode. When the camera is in VCR mode, you can use the END SEARCH button to find the end of the tape. The camera will automatically fast-forward or rewind until it finds what it thinks is the last recorded segment on the tape, and then position the tape to start recording after the last shot. Using this feature can help avoid timecode breaks by making sure the camera picks up from the end of the last shot (also see REC CHK for avoiding timecode breaks). You can also perform an end search even while in camera mode; just hold down the button for a few seconds and it will begin the end search process.

Bars: The HVX can display SMPTE (Society of Motion Picture and Television Engineers) color bars, suitable for use in calibrating a professional monitor. When hooking the HVX up to a professional monitor, you can calibrate the monitor to know precisely what the recorded image looks like. All too often shooters will try to judge color, contrast, saturation or other picture elements based on how the image looks on a television, or on the camera's viewfinder or LCD. Those are not accurate representations of what the recorded
image really looks like. The only way to know exactly what the image looks like is to use a professional monitor, or software such as Serious Magic’s DV Rack, which provides a professional monitor emulator. Once they are calibrated correctly, informed decisions can be made on picture adjustments and settings.

Audio ch1/ch2 select: The HVX camera has the ability to record audio from three potential sources: the built-in microphone, XLR connector 1, or XLR connector 2. You can mix and match these to suit your circumstances (i.e., connect a wireless microphone on audio channel 1, and use the built-in microphone on audio channel 2 for ambience/backup purposes). You can also choose to have one input be recorded on both audio channels, by plugging in an audio source into XLR connector 2 and setting both inputs to INPUT 2. When using the built-in stereo microphone, only the left side can be recorded on channel 1, and only the right side can be recorded on channel 2. When recording on the P2 card, you can record four channels of audio; DVCPRO-HD and DVCPRO50 always record four channels, and you can configure DVCPRO and DV modes to record four channels. When recording four channels, two will come from the XLR connectors, and the other two will come from the built-in stereo microphone. On tape you can only record two channels at a time, even when recording in 32kHz/12-bit mode.

input1/input2 mic power: When using external microphones or external audio feeds into the XLR ports, the HVX can supply +48v "phantom
power.” When using a line-level device (typically a feed from a mixer) you’d want these switches set to OFF. When using external microphones you may or may not need to set these switches to ON. Some types of microphones (such as Dynamic or self-powered) should not have phantom power supplied. Other types of mics, such as condensor mics, require phantom power in order to function. And some types of mics (such as electret condensers) can operate as either self-powered or from phantom power; frequently those mics will perform better from phantom power. Make sure you check your microphones to verify whether they should or should not have phantom power supplied.

**Shutter button and speed set:** The HVX gives you extensive control over the exposure through gamma curves, the iris dial, the ND filters, and also through complete control of the shutter speed. The SHUTTER button lets you choose between default (“SHUTTER OFF”) and user-controlled shutter speeds. When in “SHUTTER OFF” mode, the HVX selects a default shutter speed depending on what mode the camera is in: 1/60 for 60i and 1/50 for 24P or 30P (in PAL, SHUTTER OFF always defaults to 1/50 for progressive or interlaced). SHUTTER OFF is really a misnomer, as it implies that there is no shutter, when in fact there is a default shutter speed being selected. Perhaps it’s best to think of it as “custom shutter speed off.” If the camera is not set to “shutter off” then it’s able to have the shutter speed set by the user. There are stock shutter speeds (1/15, 1/30, 1/60, 1/100, 1/120, 1/250, 1/500, 1/1000, 1/2000) and SYNCRO-SCAN (discussed in the menu options, page 121). It should be noted that these shutter settings are relative to the progressive-scan mode that’s selected: for
example, if you select 1/1000 as a shutter speed when in 24P mode, but then you change to 60i mode, the shutter will no longer be 1/1000, it’ll be 1/2000! Keep an eye on the shutter speed whenever changing modes, to make sure you’re getting the shutter speed you want.

Shutter speed affects motion blur. Aperture affects Depth Of Field, and shutter speed affects motion blur. Both can be used to control exposure, but not without side effects (i.e., changing motion blur or changing depth of field). In almost all normal circumstances, you’d want to use the default shutter speeds (1/60 for 60i, 1/50 for progressive or 50i) for normal-looking video. Small variations in shutter speed won’t affect the look of your video much (i.e., 1/60 will pretty much look the same as 1/50 or 1/48). Film cameras use anywhere from 1/43 to 1/60 as a standard, and it all pretty much looks like film motion, so small variations won’t matter much.

Shutter speed affects exposure. If you cut the shutter duration in half (i.e., use 1/120 instead of 1/60) you will need twice as much light. If you double the shutter duration (i.e., 1/24 instead of 1/48) you’ll need half as much light for the same exposure.

There are certain circumstances where you’d want to use alternate shutter speeds:

1) the “Saving Private Ryan”/“Gladiator” stutter effect: try 1/1000 (or 45 degrees in FILM CAM mode, or even 22.5 degrees).

2) Overcranking and Undercranking: try 180 degrees. A film camera running at 60 frames per second would have a shutter speed of about 1/120, so if you’re shooting 60fps to slow down in post, you probably want to match the shutter speed for film-style motion blur; choosing 180 degrees keeps the shutter speed relative to the frame rate.

3) Syncing with monitors: use the Syncro-scan, or 1/60, to match the HVX’s refresh rate with computer monitors or televisions in the shot and stop the “rolling dark band” syndrome.
4) Special blur effects: the opposite of the “Saving Private Ryan” effect. Use a slower shutter speed (like 1/24 or slower, or 350 degrees) to add smear and blur to the motion in your shot.

5) Minimize strobing: If you think there’s too much strobing in your 24P/25P footage, you can try a slower shutter speed to introduce a little blur into your footage. 1/43 or 1/36 are popular choices.

6) Extreme low light situations: when in 24P mode, using 1/36 instead of 1/50 will gain you half a stop of low-light performance, and still look reasonably like film. Using 1/24 will gain you a whole stop of light performance, but with smeary motion.

7) To simulate additional frame rates. See page 43 for a discussion on how to simulate frame rates such as 15P.

8) When shooting under older magnetic-ballast fluorescent or HMI lights, you may have to select certain shutter speeds to avoid pulsing or cycling of the lights. Similarly, when shooting NTSC under 50hz lights, or PAL under 60hz lights, you may have to adjust the shutter speed to avoid flicker or pulsing.

9) Freezing water droplets or rain: for specific instances like shooting a food commercial where someone squirts a lemon, etc., and you want to show the individual droplets clearly, you might try using a very short shutter speed (like 1/2000). Typically these shots are done using strobe lights, but you may be able to get a satisfactory facsimile of the effect by using a super-fast shutter speed.

The 1/15 slow shutter speed (1/12 in 50Hz/PAL, or in 720/24P mode) in progressive mode retains full resolution to the progressive picture, unlike on other cameras where setting a slower shutter speed results in getting only one field’s worth of resolution. The slower the shutter speed, the more motion blur you’ll see as well.

**COUNTER & RESET/TC SET:** These buttons are used to control the display of the timecode (or counter) and to set or reset the timecode preset value. Pressing the COUNTER button will cycle through
the timecode/counter displays in the viewfinder/LCD; the possible counter displays include Timecode, User Bits, Frame Rate, or Counter. Also, the only way to remove the timecode from the display is to use the COUNTER button; using DISP OFF won't remove the counter display. The RESET/TC SET button functions differently depending on what mode the camera is in. When entering a timecode or User Bit preset in the RECORDING SETUP/TC PRESET or RECORDING SETUP/UB PRESET menus, you can zero out the preset by pressing the RESET button. This makes it simple to update the preset every time you change a tape, for example—you can zero out the timecode quickly, and then just change the hour setting for each tape.

The RESET/TC SET button functions differently if you’re using it to sync timecode to an external 1394 device. If you’ve configured the camera to run in TC PRESET mode (rather than REGEN), and you’ve enabled 1394 TC INPUT, then pressing the RESET/TC SET button (while in VCR/MCR mode) will read the incoming timecode through the 1394 port and synchronize the TC PRESET to match.

Zebra button: the Zebras are discussed in the menu settings section, page 181.

OIS button: The HVX includes an Optical Image Stabilization (OIS) system, which helps smooth out shaky handheld shots. The OIS system consists of a series of prisms and gyros in the lens that actually move and redirect the image coming into the lens, to detect motion and compensate for it. The OIS effect can be most easily seen when at full telephoto: at full telephoto it’s harder to hold the camera still without some
shake, as the picture is magnified and so any corresponding shake will be similarly magnified. The OIS tracks any movement of the frame and moves the prisms to track the original framing, trying to keep the frame as still as possible. There's a limited amount of compensation it can do, but it works well at full telephoto.

There are times when you will want to turn the OIS off. First, you will want to disable OIS when using the HVX on a tripod (or other image stabilizing device). When mounted on a tripod, the image will already be adequately stabilized, and any motion that occurs in the frame will be intentional (i.e., if you start panning the camera). But if OIS is enabled, the OIS system will see that motion and try to "compensate", actually canceling out your panning motion. The result is that the OIS will try to "stabilize" your shot, and the further you pan the further it will try to stabilize it, up until the point where it can no longer compensate (remember that the prism can only move so far before it reaches its limit). The result will then be a noticeably jerky motion in the pan. If you're using a tripod, there's no reason to have two image stabilization devices trying to do the same job, so turn OIS off and you'll get cleaner, smoother pans and tilts.

Also, if using a lens adapter such as the P+5 Technik Mini35™ or similar device, you most definitely need to turn optical image stabilization off. Leaving OIS enabled while using a ground-glass image adapter will result in a very weird effect of the whole frame "floating." When using those adapters, definitely turn the OIS off.

Cam remote jacks: There are two remote-control ports labeled CAM REMOTE for attaching third-party controllers. There is a small 2.5mm mini-plug socket labeled "ZOOM/SS". This socket allows for a remote zoom controller to be used. Note: it is not a LANC-type of jack, and there is no provision for remote focus control through this.
socket. The only functions that can be controlled through this socket are zoom and record start/stop. Note: this port is backward-compatible with DVX100-series remote controls (such as the Zoc™ or Varizoom™ DVX zoom controllers). Below the ZOOM S/S port is a 3.5mm mini-plug socket labeled “FOCUS/IRIS”. This jack allows the use of a remote controller to control the focus and iris settings. Manufacturers such as VariZoom are now supplying remote controllers that allow the operator to control zoom, start/stop, focus, and iris. Note that both these ports are compatible with the DVX100B, so if you find a controller that is made for the DVX100B it will also work with the HVX200.

**Phones jack:** The headphones jack allows you to connect a set of headphones (obviously). One comment on headphones is that if you’re not using noise-isolated headphones you may hear an “echo” when shooting in 24p/25p modes. This is a byproduct of the way frames get buffered before written out to the card or tape; you can actually hear the “live” audio leaking through the headphones, and the “delayed” audio that’s written to the card or tape. If this bothers you, you can change the HP MODE menu setting in the AV IN/OUT SETUP menu; setting this menu to LIVE will eliminate any echo.

**Audio/video in/out connectors:** The camera features an s-video port and yellow-red-white jacks for connecting to standard-definition video devices, such as external monitors or decks. These ports are bi-directional for input/output, so you can display the HVX’s image on an external monitor, or you could feed the HVX a video signal from an external deck or camera. You can also configure the camera to perform
on-the-fly analog-to-digital conversion, by feeding a video signal into the video connectors, and the HVX will output a digital signal from its 1394 port. The s-video connector takes precedence over the composite (yellow) video port, and in order to record analog audio there must be a video signal present as well (you can't record audio without video). The HVX also has a connector for component video. This connector is output-only; there is no provision for inputting component video through this connector. The HVX can use the component connector to output either high-definition or standard-definition signals. In addition, the HVX can downconvert high-definition footage to standard-definition output on all its video connectors. While the composite and s-video connectors can be used to pass a 1394 input stream out to an analog output display, the component connectors cannot pass through an analog output of a 1394 input. The component connector overrides and disables the other video outputs.

XLR audio connectors: The HVX features two XLR audio connectors for attaching microphones, wireless mic receivers, mixers, or other professional audio devices to the camera. These XLR connectors are input-only, no audio can be output from them. Also, the XLR connectors only function for input when in camera mode. You cannot record an audio signal from the XLR connectors when in MCR/VCR mode.

USB terminal: A USB 2.0 mini-B terminal is included for allowing the HVX to serve as a P2 card reader when attached to a computer running the Windows XP™ operating system. The USB terminal is Mass Storage Class compliant. When you set the PC MODE function
to "USB DEVICE" and use the MODE button to enter PC mode, the camera appears as an external hard disk on the Windows™ desktop (actually, it shows up as two hard disks; one for each P2 slot). You can copy files, play footage from the cards in the camera, or copy files to the cards through the USB 2.0 port. It’s also possible to offload P2 card contents directly to a USB2 On-The-Go portable hard disk (a special class of USB external hard disks which have the ability to go into "host mode.") USB On-The-Go drives can connect to USB Devices and copy their contents automatically with the push of a button. While a 1394 drive is preferable for many reasons, USB On The Go can also be utilized to copy the card contents.

While it may or may not function to use the HVX in USB Device mode with a Macintosh computer, it is not recommended or guaranteed; when connecting to a Mac, please use the 1394 terminal instead. The USB terminal is guaranteed to work with Windows PCs.

1394 Terminal: A standard 400-megabit 4-pin 1394 port is included to serve multiple purposes: for streaming live content, for offloading cards to an external 1394 drive, for inputting footage to record, and for connection to a computer running the Macintosh™ operating system. When functioning as a camera, the 1394 port will stream video, audio, and timecode data in the codec that corresponds to the mode you’re shooting in: either DVCPRO-HD 1080, DVCPRO-HD 720, DVCPRO50, DVCPRO, or DV. Note: the camera cannot output 720pN modes; only 720p “Over 60” modes can be carried on the 1394 cable. When functioning as a VCR or MCR, the camera can output or input any 1394 signal compatible with the above modes. This streaming data can be captured on a computer running an appropriate video capture program (such as Avid Express Pro HD 5.2.1 or later, or Apple’s Final Cut Pro 4.5 or later, or Canopus EDIUS Broadcast, or Serious Magic’s DVC Rack, or others). The
streaming data can also be recorded on an external 1394 recorder, such as the Focus Enhancements FireStore FS-100.

Additionally, the camera can use this terminal to function as a 1394 Device - this lets the camera serve as a P2 card reader for Macintosh-compatible computers. And, this terminal can be used to control a 1394 external hard disk, for offloading P2 card data directly to a hard disk (no computer necessary). For details on using the 1394 port for offloading card data, see page 93.

Note: while 1394 is designed to be “hot swappable,” it is strongly recommended to turn off the power before connecting the camera to a computer through the 1394 port.

SD memory card slot: An “SD” Memory Card slot is provided for loading and saving camera data, and for attaching P2 metadata to recorded footage. The camera is compatible with the same type of SD cards as used in digital cameras, cell phones, and many other devices.

You can load and save scene files, the camera’s “user file,” and P2 metadata onto the card. Scene files can be saved and copied on a computer so you can build a library of scene files, exchange them with other users, or archive them. Before an SD card can be used with the camera it first must be formatted -- you can do that in-camera, or by downloading a special SD Formatting Program from Panasonic's website.
Scene files are very small text files (4K bytes), so you don't need a large SD card; the smallest SD cards would work fine with the HVX200. Scene files are stored in text files named SCENE1.TXT, SCENE2.TXT, SCENE3.TXT, or SCENE4.TXT. You can view these files in any standard text editor. The P2 metadata is stored in files with names such as MTDT00.P2. You should only use an MXF-aware application (such as the Panasonic P2 Viewer program) to load, change, and save metadata onto the SD card. The P2 metadata files are indeed text files and it's possible that you could edit them with a text editor, but creating, loading, and storing them is easier and more practical with a metadata-aware program such as P2 Viewer.
Sample Scene Files

We've put together two dozen scene files to show what can be accomplished with using the camera’s settings. The full-size pictures, as well as the camera-loadable scene file .TXT files, are included on the CD that accompanies this book. To illustrate these scene files, we shot a sample scene using the default scene file (all settings at zero/normal), and also using each of the included scene files. The different looks are due entirely to the camera settings, and not to any lighting changes or filtering or post manipulation, or otherwise changing anything about the way the scene was set up.

The first six scene files (in the scene file package named “EXTREMES”) are scene files designed to extract the maximum performance from the camera in one category or another.

The remaining 18 scene files (in the scene file packages named “FILM LK1”, “FILM LK2”, and “FILM LK3”) are examples of various looks and styles, and attempt to emulate common looks from popular films or popular post-production techniques.
To get the full effect of these scene files, set the camera in manual white balance mode and use the auto iris feature to establish your exposure settings. The scene files make extensive use of the A.IRIS and COLOR TEMP menu settings, and those settings only take effect if you use auto-iris (for A. IRIS) and manual white balance (for COLOR TEMP). If you set the camera on PRST white balance, the COLOR TEMP portion of the scene file will be rendered inactive, and accordingly your results will differ from the results posted here.

This is the default scene file with all settings at default.
EXTREMES

LONOIZ ("Low Noise") - optimized to minimize noise in the picture.

DETAIL - optimized for maximum "sharpness."

LOLITE ("Low Light") - for brighter pictures and deeper shadow detail in low light conditions (left); for comparison, the picture on the right is the "default" scene file setting under the same minimal light conditions.
DYNRNG ("Dynamic Range") – for providing maximum shadow detail and highlight retention.

COLOR - maximum color saturation.

CIRAST ("Contrast") – maximum image contrast.
CAFE - a bright, saturated, colorful filmlike setting.

SFTBLK ("Soft Black") - a diffused scene file meant to mimic the effect of a black diffusion filter.

SFTWHT ("Soft White") - a diffused scene file meant to mimic the effect of a white diffusion filter.
RVRSAT. ("Reversal") – designed to mimic the stark contrast and rich color saturation of color reversal film.

COOL – a filmish look with primarily cooler tones.

WARM – a filmish look biased towards deep warm tones.
FILMIC - moderate settings to deliver a filmlike look.

DRKNEO ("Dark Neo") - a desaturated, dark look with a greenish tint, inspired by the "Matrix" movies.

LT NEO ("Light Neo") - a desaturated, brighter look with a greenish tint, inspired by the "Matrix" movies.
BLUE - a dark, rich scene file with a deep blue hue.

CORAL - a dark, saturated, rich scene file with a strong coral hue.

WAREPC ("War Epic") - a stark, contrasty scene file inspired by war movies and epic films.
SKPBL ("Skip Bleach")—a desaturated, contrasty scene file meant to emulate some of the effect of the "skip bleach" film processing technique.

BRONZE—a desaturated, contrasty scene file like WAREPC, but with a warmer bronze tint.

MOODY—dark, contrasty, and moody.
BRIGHT - a bright, lively scene file with rich color saturation.

DESERT - a deep orange cast reminds the audience of a dusty desert.

DAYNYT ("Day For Night") - when you need to shoot a nighttime shot during daylight or under tungsten lighting, this scene file adds a dark blue tint and underexposure to sell that "nighttime look." Note that the lighting is exactly the same for this scene file as for all the others. Only the camera settings have changed.
About The Author

Barry W. Green is the author of the highly successful _The DVX Book_ and _DVX DVD_. He's an Emmy®-award-winning producer with four Emmy nominations for writing and producing television commercials and public service announcements. His technical background includes 13 years as a professional computer programmer and producer for Westwood Studios, creating some of the most popular video games in history. Since leaving the videogame industry in 1999, he now writes and produces award-winning corporate and industrial films, commercials, screenplays and films for Fiercely Independent Films Inc. He's an instructor in the HD Bootcamp series of HD training seminars, and also serves as a moderator for DVXUser.com, one of the world's largest online communities for users of the DVX100 and HVX200 cameras.
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