High Definition

Report from Cilect Standing Committee for New Technologies

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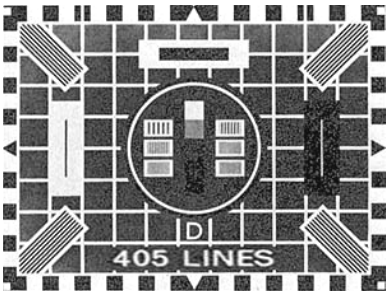
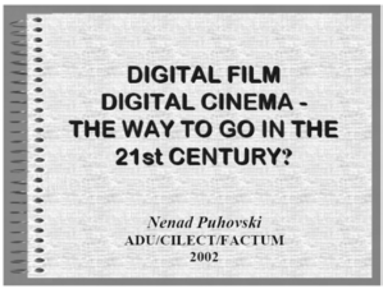
INTRODUCTION

What, in fact, is High Definition? Although this Report deals with a number of precise technical data, specifications and definitions, the actual term "high definition" is completely arbitrary. As the following text will show, in the thirties, even **EMI 405 lines** television proposal was considered high definition - of course, in comparison with the Baird 240: "*In mid-1934, the government set up the Selsdon Committee, under the chairmanship of Postmaster General Sir William Mitchell-Thompson, and including* BBC*, government and GPO representatives. Its job was to evaluate the possibility of replacing the existing 30-line low-definition service with a high-definition successor, and which system to use to do so. ...* EMI*, having now set up a joint operation with Marconi to provide it with transmission capability, was officially offering 240-line mechanically scanned telecine and little else - its electronic system was still effectively in its infancy. In an almost incredible leap of faith, Shoenberg decided to take the plunge and committed the* Marconi-EMI *team to delivering 405 lines, 50 interlaced fields per second - and, giving up drum scanning, to all-electronic signal generation. It was a major milestone."* It is probably also interesting to mention that the first Baird's system had progressive scanning and 2:1 picture aspect ratio.



So, what awe are dealing with in this Report is the actual situation in the high definition arena, specially regarding the process of film making. But, what is really the difference between Digital cinema (or Digital film) and High Definition?



Although we dealt with this issue comprehensively in the Standing Committee's Report at the Melbourne Congress (and Joost Hunningher's workshops that followed) let's tackle it again. Basically it is the same phenomena - use of the high definition sensor based devices to record moving images in the electronic form. For the film people, it is *digital cinema* - with this term they describe their *differentia specifica* - digital versus classical, chemical based, film process. For the people in television, it's high definition since for them this is what is important - high versus standard definition.

Of course, there are a number of other differences - all, or at least most, of them will be tackled in this Report - like using the single chip, films lens mount and uncompressed storage in the digital film systems.

However, the reality in the film/television schools is mostly shaped by the economics and there are only few that can afford to use digital cinema or even high end high definition gears in their everyday work. Because of that, I focused in the major part of this Report on HDV and other affordable high definition systems.

Also, since High definition is relatively new as the mainstream production tool, I incorporated in this Report a number of short (mostly web based) articles in which various people are expressing their views on different, HD related topics. I called them ***POV*** (point of view) to distinct them from more objective bat also more faceless (and maybe more boring) material.

It also has to be said that High Definition is in no way a new topic in the world of Cilect schools. The first conference I remember to tackle this issue took place in Milan, in 1993 and was organized by Roberto Provenzano, member of our Standing Committee and director of Centro Formazione Professionale per la Tecnica Cinetelevisiva.

Apart from the conference itself which was really interesting, I remember sitting with Roberto in his flat and frustratingly looking at the huge beast - his new HiDef Sony television. The television was there, but no hi def program to watch.

It is much better now. But, we are still at the beginning. And this is why everything is still so exiting.

HIGH DEFINITION - THE BASICS

ADVANTAGES OF HDTV

More scanning lines

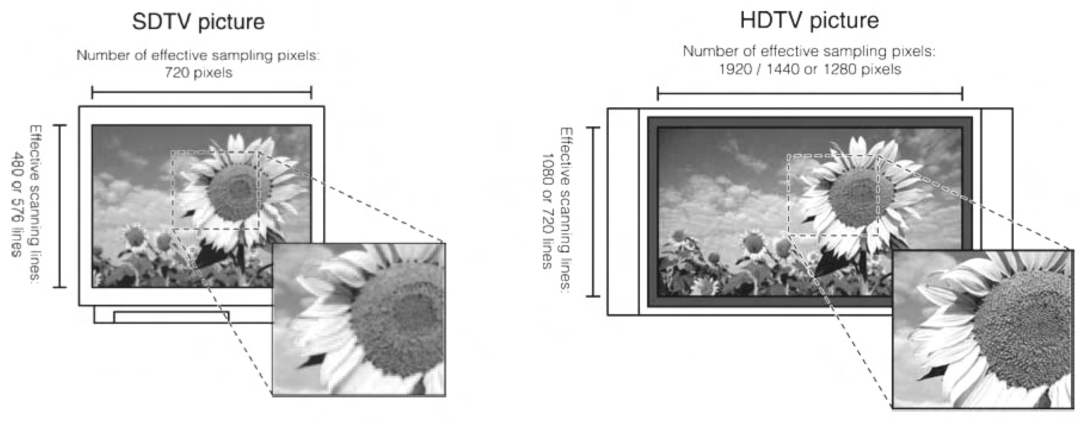
In the early days of television, the camera had a pickup tube with an electron beam that scanned a photosensitive surface to generate the television picture. This scan followed a specified pattern of "horizontal scanning lines," beginning at the top right, tracing across to the left, and then moving down to trace the next line, and so on. In the home, the picture tube of the television set followed the camera's scan pattern, using its own electron beam to recreate the picture on the screen.

In Japan, the United States and other countries that use the NTSC system, the Standard Definition TV picture includes 525 horizontal scanning lines, of which about 480 "effective" scanning lines appear on the screen. In countries that use the PAL and SECAM systems, the numbers are 625 total scanning lines and 576 "effective."

High Definition goes way beyond this, with a choice of 720 or 1080 effective scanning lines. This enables the High Definition picture to have far more detail.

More pixels per scanning line

In the early decades of television, the picture was not defined in terms of discrete "picture elements"—pixels. As you know, more pixels in a video image equal more detail available for viewing. In the late 1980s, when professional digital video systems became available, both the PAL and NTSC picture were defined as having 720 pixels per line (ITU-R.BT-601 standard).

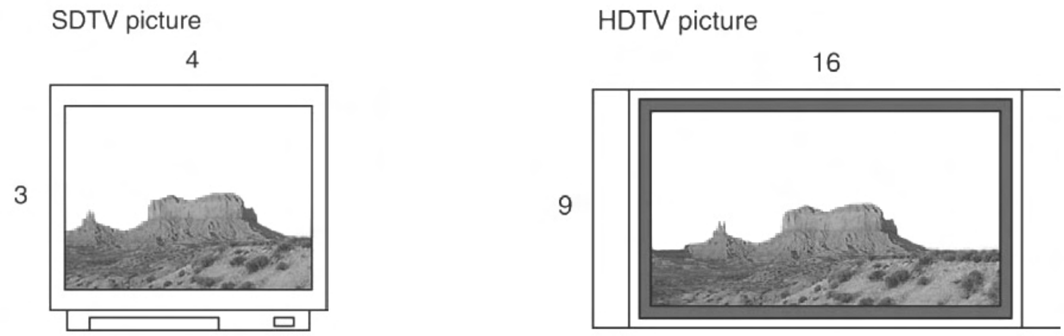


The Standard Definition picture (left) has fewer scanning lines and far fewer pixels per scanning line than the High Definition picture (right).

High Definition systems go far beyond this benchmark. The 720-line HD system provides 1280 pixels per line. And depending on implementation, 1080-line HD offers 1440 or 1920 pixels per line. The effect is vastly greater picture information, making television come alive with detail. This type of television picture is also perfect for big-screen viewing, where the increased detail can have maximum impact.

Widescreen 16:9 picture

The shape of the television screen is measured by the "aspect ratio," the proportion of screen width to screen height. Conventional television uses an aspect ratio of 4:3. This means that the screen is 4/3 or 1.333 times wider than it is high. This screen shape is almost square. In contrast, the human field of vision substantially wider, about 140 degrees wide by 90 degrees high. That's why High Definition television uses a wider screen, with an aspect ratio of 16:9. This wider screen is 16/9 or 1.778 times wider than it is high. In this way, the wider 16:9 screen is a better match for the human visual field. The result is an even more lifelike, more immersive experience—closer to the feeling of "being there."



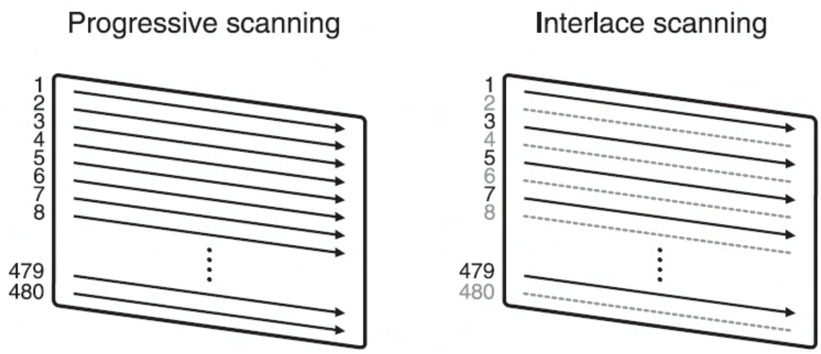
Standard Definition (left) uses a 4:3 aspect ratio that's almost square. High Definition (right) uses a 16:9 aspect ratio that's more panoramic—and closer to the actual field of human vision.

Interlace and progressive scanning

In video, what appears to be a continuously moving image is actually a series of discrete still pictures, called frames. In NTSC Standard Definition, each frame lasts 1/30 second and contains 480 effective scanning lines that appear on the screen.

Because of limitations in the early days of television, these 480 lines were divided into two "fields," each of which lasts 1/60 second. At the studio camera; the first field captures the odd-numbered scanning lines, skipping every other line. The second field comes back and captures the even-numbered scanning lines. This is "interlace" scanning and it displays only 240 scanning lines at any one time. Interlace scanning in the studio camera is mirrored by interlace scanning in the home television, for accurate display of motion.

In PAL and SECAM countries, interlace works the same way, but the specific numbers are different. Each frame lasts for 1/25 second and includes 576 effective scanning lines. These are divided into fields that last 1/50 second and contain 288 scanning lines, each.



Interlace scanning (right) displays the video frame in two fields, one for the odd-numbered scanning lines and one for the evens.

Depending on the country and the implementation, High Definition retains interlace scanning, but adds the additional option of "progressive scanning." In the progressive system, every scanning line is shown in sequence. The video frames are not subdivided into fields.

The 1080-line interlace High Definition system offers superior horizontal resolution. But because the interlace process sacrifices some clarity in the vertical direction, the 720-line progressive system has slightly better vertical resolution.

With line rate, frame rate and scanning type all variable, special notation, such as "1080/60i" is used to describe each choice. This expression defines the picture as 1080 effective scanning lines, 60 fields per second with interlace scan.

Digital video instead of analog

Conventional television broadcasting is analog, a system that exposes the picture to distortions and noise that can degrade picture quality. In particular, analog composite video broadcasting degrades the color. Digital video can deliver a far cleaner, more convincing picture. And because digital video systems em-

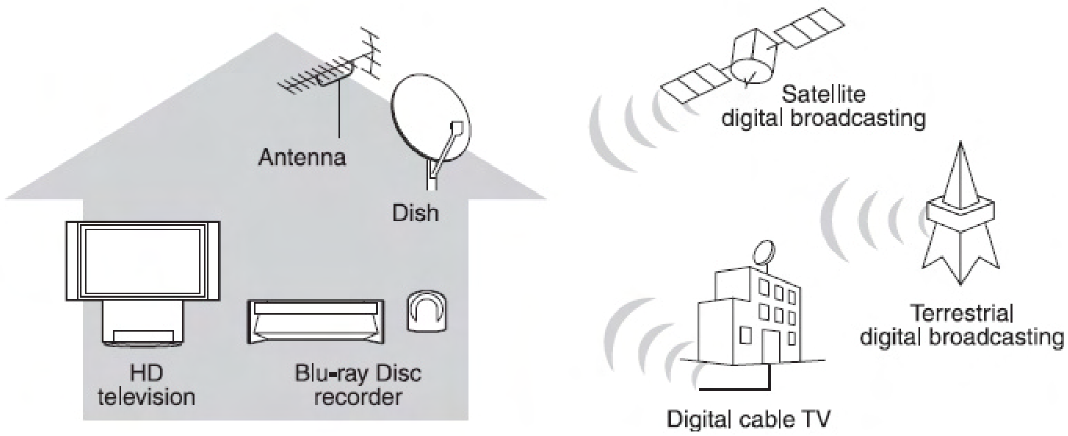
ploy separate channels for the Y/B-Y/R-Y components, the color reproduction can be far superior. Even a standard Definition digital source, such as a DVD-Video movie, can deliver noticeably higher quality than typical analog broadcasting, and dramatically higher quality than analog VHS tape.
High Definition offers all these digital video advantages. You'll see pictures with low noise, high accuracy and rich, vivid color.

Digital audio instead of analog

As with DVD, High Definition is accompanied by digital audio, with options for digital surround sound. You'll hear dialog, background music and sound effects with a frequency response and dynamic range comparable to Compact Disc.

Wide availability of the programs

As HDTV becomes accepted in country after country, it is also becoming available through more and more delivery pipelines:



Over-the-air (terrestrial) HDTV broadcasting is bringing the benefits of High Definition to hundreds of millions of potential viewers.

- HDTV satellite broadcasting is helping to speed the acceptance of High Definition.
- HDTV cable service can provide a rich range of programming.
- HDTV personal video recorders (PVRs) let you capture HD programming on a hard disk drive for playback at a later time.
- HD Blu-ray Disc and/ or HD DVD recorders enable you to build your own, personal library of High Definition content.

As the home entertainment system increasingly makes the move to High Definition, the next stage will be HD personal content creation, with the consumer HD camcorder. That's the idea behind the HDV standard.

SDTV and HDTV compared

	SDTV		HDTV	
	NTSC	PAL/SECAM	720p	1080i
Total scanning lines	525	625	750	1125
Effective scanning lines	480	576	720	1080
Effective pixels per line	720		1280	1440 or 1920
Scanning format	Interlace		Progressive	Interlace
Aspect Ratio	4:3		16:9	

HDTV - A BIT OF HISTORY

The early years of HDTV

Research into HDTV started in the 1960s at the NHK Science and Technical Research Laboratories (NHK STRL) in Japan. The lab began looking at viewing angles and aspect ratios that enhance realism. Eventually, researchers determined the screen size, the number of scanning lines, and the standard viewing distance to achieve the next generation of realism. In 1984 after 20 years of research, the NHK STRL established the MUSE system, an analog method of HDTV broadcasting. The laboratory also suggested the term "Hi-Vision," as a popular name for HDTV.

Conventional TV broadcasting fragments the world into three camps: the NTSC system adopted by North America and Japan; the PAL system adopted by the UK, Germany, and China; and the SECAM system adopted by France, Eastern Europe, and Russia. Unfortunately, these systems differ in the number of scanning lines, which define the resolution of the images. Television content needed to be produced using the standard of the corresponding regional broadcasting system. International distribution of programming often required clumsy scanning line and frame rate conversions.

Japanese technologists were concerned that these incompatibilities from country to country could be repeated in the new age of HDTV. To facilitate international program distribution, the Japanese suggested that a single, global standard should be developed for HD studio production. These discussions started in the Comité Consultatif International Radiophonique (CCIR), which has since become the International Telecommunications Union – Radiocommunication Sector (ITU-R). Although the HD standard for studio production was established in 1990, major issues such as the number of scanning lines remained unresolved. After three versions, the number of scanning lines was unified in the fourth revision, approved in 2000.

Today, even though the world's major HDTV broadcasting formats differ in their specifics, they all adopt the number of scanning lines determined in the HD studio standard. The approval of the HD studio standard provided the foundation for HDTV.

HDTV and digital broadcasting converge

The idea behind digital video broadcasting began with the NHK Science and Technical Laboratories in Japan in 1982. Their concept was Integrated Services Digital Broadcasting (ISDB), which combines moving images, sound, text, and still pictures into a digital broadcast signal.

The technologies required for digital video broadcasting, including data compression and error correction were developed by the late 1980s. Today, digital terrestrial broadcasting, digital satellite broadcasting, and digital cable services are all marketplace realities. HDTV technology is also digital. Currently major digital HDTV broadcasting systems include the ISDB format developed in Japan, the Digital Video Broadcasting (DVB) format developed in Europe, and the Advanced Television Systems Committee (ATSC) format developed in the US. Over-the-air terrestrial digital broadcasts in these formats have begun in 12 countries. Digital HDTV has gone global.

HD in movie production

For years, producers in Hollywood and elsewhere have been hoping to take advantage of digital technologies to supplement or replace conventional production on 35mm motion picture film. Film-based production requires chemical development and the creation of "dailies," film prints that the director reviews the following day. In contrast, digital production is immediate. Directors enjoy what-you-see-is-what-you-get feedback, with full-resolution real-time monitoring and playback, right on the set. And digital production is perfectly suited for today's digital effects, including green-screen compositing, Computer-Generated Imagery (CGI) and digital color correction. In 1999, Sony introduced the first production system to combine the advantages of digital High Definition with the 24 frames per second capture rate of motion picture film. Sony's CineAlta 1080/24p system was quickly adopted by Hollywood directors such as George Lucas, Robert Rodriguez and Robert Altman for movies as diverse as "Star Wars: Episode 2, Attack of the Clones," "Once Upon a Time in Mexico" and "The Company."

UNDERSTANDING AND USING HIGH-DEFINITION VIDEO

What is high definition?

After years of anticipation, high definition (HD) video production has become widespread. Over-the-air HDTV is rapidly building an audience, and high definition DVD development is proceeding quickly. Even people not producing for an HD audience are using HD formats during production and post-production.

The myth is that HD is very expensive and difficult to author. The reality is that HD has become cheaper and easier to use than standard definition (SD) was only a few years ago. Today, you can build a complete entry-level HD production system, including storage, software, and camera, for under U.S.$ 10,000. Higher-end and uncompressed HD editing systems can be much more expensive, but they are also declining in price as more options enter the market.

Types of HD

High definition simply means more than standard definition (SD). The highest resolution SD format is PAL, with 576 lines. Thus, almost any video frame with a vertical size greater than 576 lines is considered HD. If a final video is destined for playback on a computer monitor or a custom device, you can create your own frame dimensions. However, most HD video is either 1920 x 1080 or 1280 x 720, with a 16:9 aspect ratio.

Broadcasters have established the following standard HD formats:

TYPE	DIMENSIONS	FRAMES PER SECOND	SCANNING METHOD
720 24p	1280 x 720 pixels	23.976	Progressive
720 25p	1280 x 720 pixels	25	Progressive
720 30p	1280 x 720 pixels	29.97	Progressive
720 50p	1280 x 720 pixels	50	Progressive
720 60p	1280 x 720 pixels	59.94	Progressive
1080 24p	1920 x 1080 pixels	23.976	Progressive
1080 25p	1920 x 1080 pixels	25	Progressive
1080 30p	1920 x 1080 pixels	29.97	Progressive
1080 60p	1920 x 1080 pixels	59.94	Progressive
1080 50i	1920 x 1080 pixels	25 (50 fields per second)	Interlaced
1080 60i	1920 x 1080 pixels	29.97 (59.94 fields per second)	Interlaced

HD formats

The 720 formats all are progressive, but the 1080 formats have a mixture of progressive and interlaced frame types. Computers and computer monitors are inherently progressive, but television broadcasting is based on interlaced techniques and standards. For computer playback, progressive offers faster decoding and better compression than interlaced and should be used if possible. In NTSC formats, the frame/field rate is actually 0.1% lower than listed, so 24P is really 23.976 frames per second, and 60i is really 59.94 fields per second. PAL formats use the listed frame rate—25p is really 25 frames per second.

In some documentation, 720 60p is called 720p and 1080 60i is called 1080i. However, those labels are ambiguous as to frame rate. 720 can run at 24P, and 1080 can run at 50i in its European version.

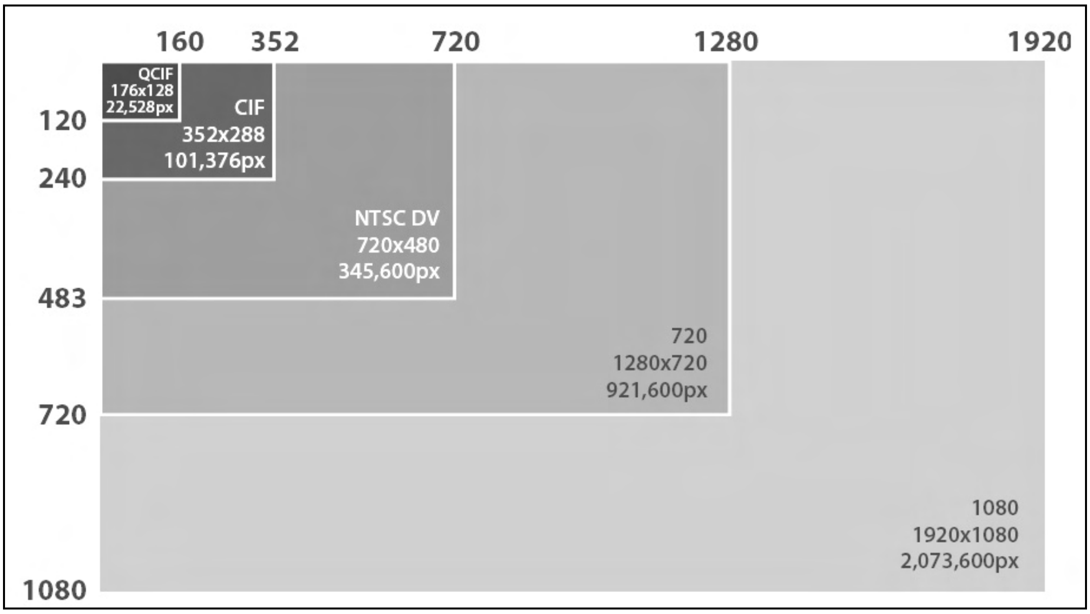


Chart illustrating the relative frame dimensions of different video formats, showing the total number of pixels for each.

Frame Rates

HD frame rates are 24, 25, 30, or 60 fps, with optional National Television Systems Committee (NTSC) variants that run at a 0.1 percent lower frame rate, to match the 30 fps versus 29.97 fps difference. Note that those derivatives are best calculated as 30000/1001 (commonly written as 29.97), 24000/1001 (commonly written as 23.976), and 60000/1001 (commonly written as 59.94).

Frame rates also have a substantial effect on performance. A value of 60p requires 2.5 times more bandwidth and processing power throughout than a value of 24p.

8-Bit vs. 10-Bit Formats

Video formats are either 8-bit per channel or 10-bit per color channel. The 8-bit formats have 256 steps from black to white, and 10-bit has 1024 steps. This extra detail can improve video quality when the source is heavily processed during editing or post-production. Today, the final Windows Media file is 8-bit, so there isn't any need to capture HD content in 10-bit format if the video is going to be compressed as a Windows Media file.

There are many resources that describe color spaces and sampling techniques. Color information can be expressed in RGB values, whether the color is at the point of capture (for example, image sensor) or at display (for example, CRT monitor). Another color space, known as YUV or Y'CbCr represents brightness, or luminance (Y), and the color difference signals (Cb,Cr). This Y'CbCr color space is better suited to describe the way color is perceived.

The eye is more sensitive to brightness in green tones, less sensitive in red tones, and least sensitive in blue tones. The Y'CbCr color space can take advantage of that fact by allocating more bandwidth for Y, and less bandwidth for Cb and Cr. When color is sampled at 8 bits or 10 bits per sample per component, depending on the technology, it can use varying amounts of bandwidth for each component.

For example, video may use one of the following sampling rates:

- **4:4:4.** Y, Cb, and Cr are sampled equally along each field or frame line with one Cb sample and one Cr sample for each Y sample. High-end video editing systems use 4:4:4, often together with uncompressed video.
- **4:2:2.** Y is sampled at every pixel, but Cb and Cr color information is only sampled at every other pixel. While this sampling rate significantly reduces the bandwidth requirements, only a slight loss of color fidelity occurs. Many editing systems process this level of color information.
- **4:1:1.** Y is sampled at every pixel, but the Cb and Cr color information is only sampled at every fourth pixel, saving even more bandwidth. This sampling rate is used in consumer DV cameras and is currently the default sampling rate for the interlaced mode in the Microsoft Windows Media Video 9 codec.

- **4:2:0.** This sampling rate uses a different technique known as a spatial sampling that takes a 2 x 2 square of pixels. 4:2:0 is used by default in the progressive mode of the Windows Media Video 9 codec and by most HD tape formats, as described in the "Storage Requirements for HD Capture" topic later in this article.

One other complication is that the values of Y, Cb, and Cr are displayed somewhat differently with HD formats than with standard definition (SD) video formats. Specifically, HD formats use the 709 color format instead of the Consultative Committee for International Radio (CCIR) 601 color format. I will describe how to deal with this difference in color formats in a future article.

Audio in HD

HD can be authored with virtually any audio format. The old standards of 48 kHz 16-bit audio are used in many cases. Higher bit depths like 20-bit and 24-bit are common, and higher sampling rates like 96 kHz occur as well.

HD is typically mastered in multichannel, like 5.1 (five speakers plus a subwoofer) or 7.1 (seven speakers plus a subwoofer). Most HD tape formats support at least four channels of audio, and many support eight channels. The Windows Media Audio 9 Professional codec can compress streams that are up to 24 bit and 96 kHz at data rates well below the current audio standards. For more information about audio in HD, see the upcoming articles about 5.1-channel audio production and the How-To Create section on the Windows Media 9 Series Web site.

HD in film production and the post-production industry

The film industry has been moving toward digital post-production for a while. Originally, people used digital video for a few special effects shots; now, digital color correction and other techniques are becoming standard. The new digital cinema cameras provide quality that goes beyond that of the HD broadcast formats. Broadcast HD uses a process called subsampling to decrease color resolution in order to reduce bandwidth needs. But, in digital cinema production, bandwidth is not an issue—quality is. Movies can be shot without subsampling (4:4:4) and with 10-bit precision per color channel.

HD in film production uses the 2K and 4K standards—respectively 2048 and 4096 pixels wide. Most professionals feel that 2K is more than good enough for typical productions, and an increasing number of producers are using 1080 24p HD video cameras and equipment.

Not all HD production for film must be done with expensive, high-end hardware. The HDV format was created to enable almost any video producer or hobbyist to enter the world of HD. HDV-based camcorders provide great results at a fraction of the price of high-end equipment. A camcorder with native support for 1080 24p rivals the image quality of 16mm film without all of the costs of film processing and other hassles associated with film.

Almost all HD production for film is done in 24P. At 24P, each video frame can be easily transferred to a frame of film. The 6.5 times increase in the number of pixels makes a huge difference, and finishing in film's native 24P frame rate makes motion much smoother.

In the post-production business, HD video is an effective method for distributing intermediates, proofs, and clips for review. A downloadable HD file looks substantially better and can be available much sooner than a Beta SP tape sent by overnight express mail.

HD and digital cinema

If an entire film can be produced digitally, why go back to film at all? Digital projectors are rapidly dropping in price and improving in quality. It is expensive to print and distribute film. A complete digital movie could be distributed to theaters on inexpensive DVDs, or transmitted via satellite or a high-speed network. In addition, a digital print doesn't lose quality each time it's played. While it's not economically feasible for every theater owner to make a complete transition to digital projection right away, the move to digital projection has started, and it will no doubt become a standard system for distribution within this decade.

The definition of digital cinema is still evolving. The quality requirements are much higher than they are for consumer HD, and Hollywood likes it this way. Producers want the theatrical experience to have an advantage over the home experience. Expect whatever standard is adopted for theatrical HD projection to go well beyond the standard that will be affordable for the mass market.

A digital projection system can equal or exceed the quality of film projection. It's just a matter of making those projectors affordable for theater owners. Even though this point hasn't been reached yet, many theaters are putting in lower quality video projectors for showing premovie loops, slide shows, and other content. Though the resolution is far from 1920 x 1080, many viewers don't notice the difference between this resolution and that of film.

But digital cinema is far more than a low-cost, more expedient alternative to film. Digital delivery offers choices and flexibility in everything from frame size to distribution media. For example, it would be a simple matter to transition to higher frame rates. Since the beginning of sound on film, 24 frames per second (fps) has been the standard. Any move away from that standard would require expensive updates to film cameras, projectors, and other equipment. With digital cinema, 60p isn't that much more expensive to create, distribute, or project than 24P or any other frame rate or format, and 60p can provide a vivid immediacy that is currently impossible with film. The latest Sony HDCAM supports 1080 60p and it won't be long before more equipment makers jump on board. In the future, not only will digital cinema make production and distribution more affordable, it may add a whole new dimension of realism and clarity to the movie-going experience

HD and computer playback

Modern personal computers are viable HD playback systems, capable of rendering frame sizes of 720 or 1080. One benefit of computer playback is that the frame size of the movie can precisely match that of the display, resulting in a crystal-clear, pixel accurate image.

Microsoft has developed a playback format for distribution of HD content on a conventional DVD-ROM that uses Windows Media 9 technology. Content producers can distribute their products in two-disc sets that include a conventional DVD version of their movie and a DVD-ROM that contains an HD version in the Windows Media High Definition Video format. The technology is not exclusive to Microsoft; any content creator can make similar discs, and end-users can play the discs on their computers or a small number of compatible DVD players.

HD and consumer electronics

The number of mass-market consumer options for storing HD is increasing all the time. Many cable companies now offer HD personal video recorders (PVRs) for short-term storage. For long-term storage and distribution, the most promising solution is through the adoption of a DVD format that supports HD. At this point, two formats, HD-DVD and Blu-ray, are vying for support among the major movie studios. HD-DVD, developed by Toshiba and NEC, has the support of the DVD Forum. Regardless of which format emerges the winner, the industry and consumers are counting on DVDs to provide the impetus for moving HD out to a wide audience.

HD in production

Options for HD production have exploded in the last few years. As with SD, there is a broad range of products with wildly different price points and features. The HD experience is functionally very similar to SD, except for the additional bits and pixels. Equivalent cameras, monitors, and workflows are available for SD and HD, but with a higher price point for HD. Even the formats are similar with derivatives of DVCAM and D5 as the dominant high-end production formats.

HD cameras

There is a wide variety of HD cameras. Prosumer HDV camcorders, such as the Sony HDR-HC1, make high-quality HD accessible to almost any producer with prices starting at US$ 2,000. At the other end of the spectrum are high-end cameras used in film production that cost in excess of U.S. $100,000.

To achieve the highest possible quality, the data stream from a high-end camera is recorded directly to hard disc arrays instead of tape. Even professional grade tape formats, like HDCam and D5, use some compression or subsampling. By transferring data directly from the camera's HD-SDI port to a hard disc array, uncompressed data can be recorded at the full 4:4:4 sample rate.

HD techniques and issues

The main difference between HD and SD is the significant increase in the number of pixels. Experienced SD video professionals are often startled by the detail in an HD image that SD video doesn't have. These professionals often need to tune sets, makeup, and framing to make them work well in HD. The level of detail used in film is a good starting benchmark for tuning.

The targeted 16:9 aspect ratio of HD is also different. The combination of 16:9 and HD can be a boon for sports because much less panning is required to see the details of the action. Well-shot HD hockey and basketball can be a true revelation—HD sports is one of the major drivers for consumers upgrading to HD.

HD tape formats

Like SD television, only a handful of HD productions are broadcast live. Most HD is shot to tape, and then edited nonlinearly on personal computers and workstations.

Currently, there is a variety of digital tape formats used for professional HD production, with the predominant formats being Sony HDCAM and Panasonic D5. All formats use the existing physical tape formats originally designed to record SD video, but with new compressed bitstream techniques to store the additional data HD requires. Fortunately, there isn't a significant archive of analog HD tape content.

Post-production for HD content

After you've acquired the content, post-production begins. Post-production for HD is similar to post-production for SD. One difference is that with HD you're dealing with significantly more data and consequently increasing the load on the CPU and video card.

A complete HD post-production suite can include a workstation for acquisition and editing, and another for scene-by-scene color correction and effects. With two workstations, an Editor and Colorist can work on different parts of the production at the same time. One or more videotape playback decks may be located near the editing workstation for acquisition, depending on the formats used in production. To ensure that high quality is maintained throughout the process, a suite should include at least one high-resolution monitor. High performance computers and a RAID array are used for fast processing, and reliable mass storage.

HD and distribution

True mass distribution of HD content is awaiting the emergence of technologies that have all the qualities necessary to make it succeed in the marketplace; there are many different medias and formats to choose from, depending on workflow needs.

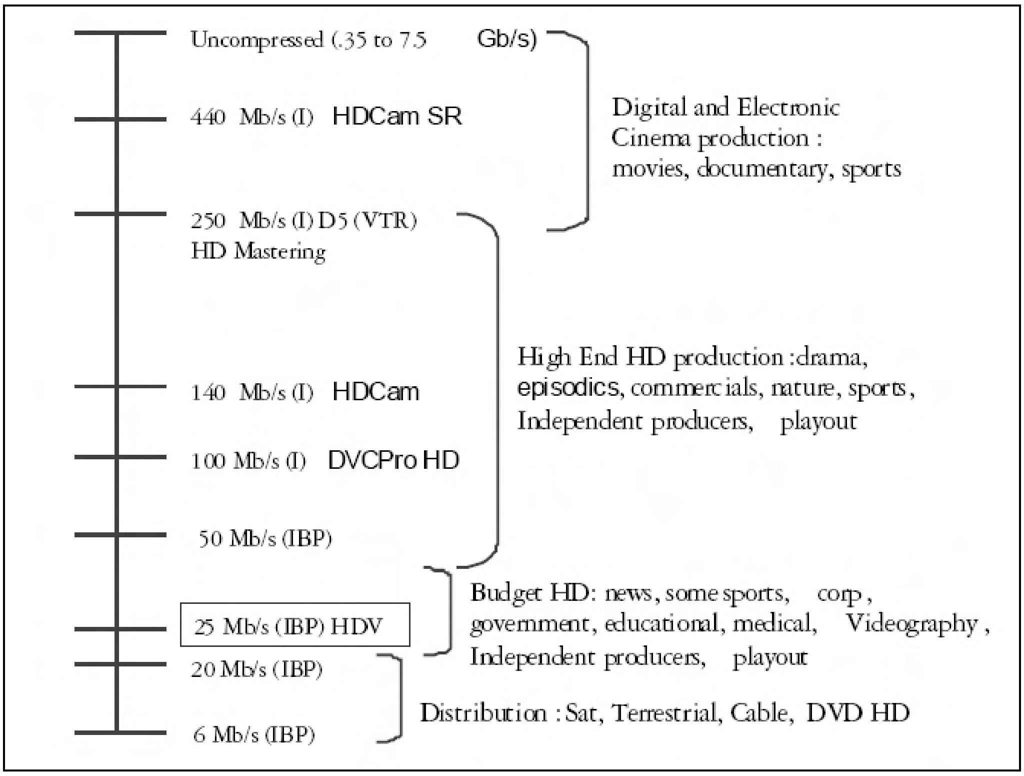
INTERESTING COMPRESSION NUMBERS

ALL HD FORMATS ARE EQUAL BUT SOME ARE MORE EQUAL THAN THE OTHERS!

Most High definition formats do have the same resolution - 1280 x720 or 1920 x 1080 pixels. However, there are significant difference between, for example, HDCAM and HDV. Simply put, there are a number of elements related to the actual quality of the final product - bit depth, sampling rates, data rates, etc. Here is an overview of the major formats:

Formats	HDCAM SR	HDCAM	D-5HD	DVCPRO HD	HDV
Image Quality					
Bit Depth	▪ 10-bit	▪ 8 bit	▪ 8- or 10-bit	▪ 8 bit	▪ 8-bit
Raster Sampling	▪ 4:2:2 or 4:4:4	▪ 3:1:1	▪ 4:2:2	▪ 4:2:2	▪ 4:1:1: or 4:2:0
Data Rate	▪ 440/880 Mb/sec	▪ 135 Mb/sec	▪ 235 Mb/sec	▪ 100 Mb/sec	▪ 18-25 Mb/sec
Native Support					
Acquisition	▪ Yes	▪ Yes	▪ No	▪ Yes	▪ Yes
Postproduction	▪ No	▪ Yes (Sony only)	▪ No	▪ Yes	▪ No
Frame Size & Raster Issues	▪ 1080	▪ 1080	▪ 720 ▪ 1080	▪ 720 ▪ 1080 with raster decimation	▪ 720 ▪ 1080 with raster decimation
Storage	▪ 521 GB / hr	▪ 781GB / hr	▪ 521 GB / hr	▪ 44 GB / hr	▪ 55 GB / hr
Production/ Post Equipment	▪ Cameras/decks $100K range ▪ NLEs $5K-100K [sw-hw]	▪ Cameras/decks $60K range ▪ NLEs $5K-100K [sw- hw]	▪ No cameras; decks $60K range ▪ NLEs $5K-100K [sw- hw]	▪ Cameras $5-$10K range ▪ NLEs $5K-100K [sw - hw]	▪ Cameras $3-5K range ▪ NLEs $5K -100K [sw-hw]
Workflow	▪ 4:2:2 1:1 HD-SDI capture to NLEs, output to HD SDI for master ▪ 4:4:4 requires massive processing power ▪ Ties up gear rendering	▪ Similar to SD: 1:1 HD-SDI capture to NLEs, output to HD SDI for master	▪ Similar to SD: 1:1 HD-SDI capture to NLEs, output to HD SDI for master	▪ Two approaches ▪ Firewire via DV ▪ 1:1 HD-SDI capture to NLEs, output to HD SDI for master ▪ Multi-generation issues in post	▪ Same as SD/DV ▪ Multi-generation issues in post

Here is another way to illustrate this issue, by stressing the data rate in Mb/s :



HOW TO COMPARE FILM AND VIDEO RESOLUTION

There are two basic *Video High Definition* standards:

- **1280 x720** and
- **1920 x 1080**, often subsampled to 1440x1080

Now, let's see *Film frame sizes expressed as Pixels*

Cineon systems use the following sizes (pixels across the 35mm frame x lines per picture):

- '4K' Full app **4096 x 3112** pixels
- '2K' Full app **2096 x 1556** pixels

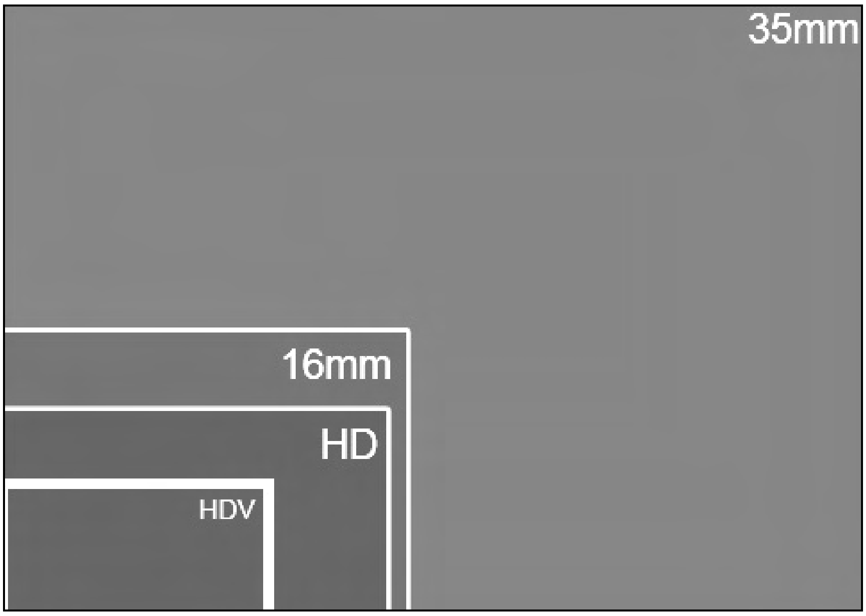
In the *Cinemascope* format it looks like:

- '4K' scope **3656 x 3112** pixels
- '2K' scope **1828 x 1556** pixels

But, in the *Academy* format it is:

- '4K' Academy **3656 x 2664** pixels
- '2K' Academy **1828 x 1332** pixels

However, when talking about the physical size of the imager, the situation is this:



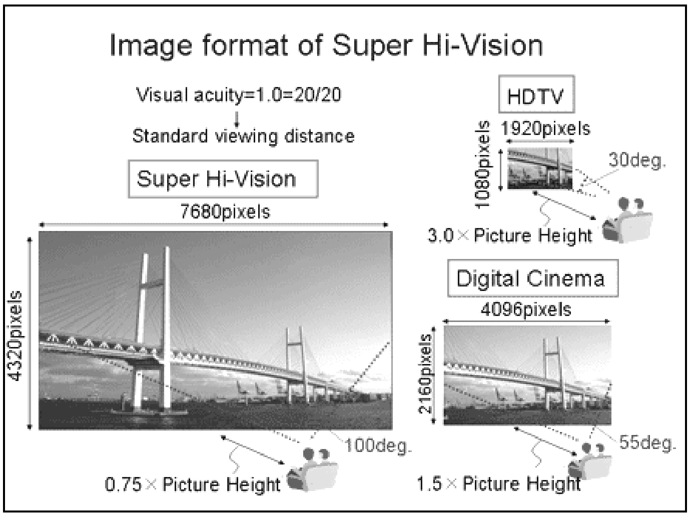
UHDV - THE HIGHEST EXISTING VIDEO RESOLUTION

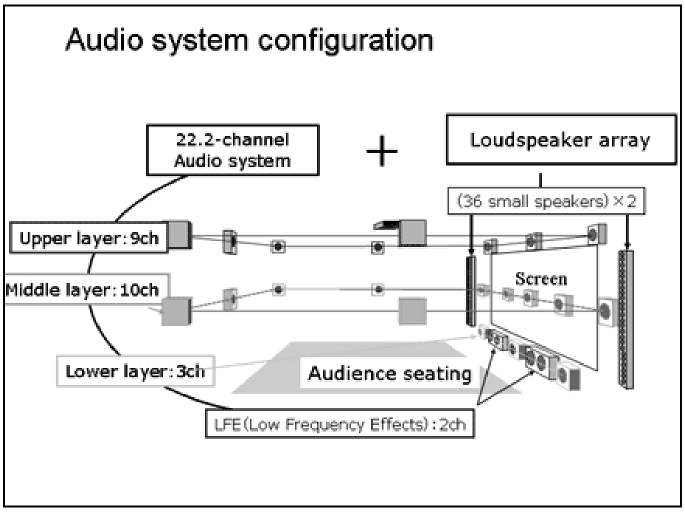
Ultra High Definition Video or **UHDV** is a new digital video format, currently proposed by NHK of Japan. First prototyped in 2003 using a custom-built camera, recorder and monitor, UHDV provides 4,000 lines of resolution. Its 33 megapixel frames require 3.5 terabytes of storage for a mere 18 minutes of material. Action scenes are so realistic that some people experience nausea similar to being seasick. This technology is expected to take some time to become mainstream.

The new format (called in early days of development Super High Vision) is four times as wide and four times as high as existing HDTV with a resolution of 1920 × 1080 pixels. Because this format is highly experimental, NHK researchers had to build their own prototype from scratch. They used an array of 16 HDTV recorders to capture the 18-minute-long test footage. The camera itself was built with four 2.5 inch (64 mm) CCDs. According to people who saw a demonstration, UHDV is so life-like it could cause motion sickness if the camera moves too much.

TECHNICAL DATA

- Resolution: 7,680 × 4,320 pixels.
- Frame rate: 60 frame/s.
- 22.2-channel audio:
    - 9 - above ear level
    - 10 - ear level
    - 3 - below ear level
    - 2 - low frequency effects





DIGITAL CINEMA SYSTEMS

Digital cinematography is the process of capturing motion pictures on digital video in place of (or as a substitute for) traditional film. Although this subject has received a good deal of publicity in recent years, it is certainly not a new concept: before it was reintroduced as "Digital cinematography" in the late 1990s it was known for many years as "Electronic cinematography". Sony had been trying to market this concept using tube-based analog HDTV cameras since the late 1980s, with very little success. It was not until 1998 when they were able to introduce workable 1920 x 1080 pixel CCD cameras with attached HD Digital Betacam recorders that the industry began to take the medium seriously.

There are frequent disputes regarding what actually constitutes "cinematography", since in its normal sense the word implies something that exhibitors think worth displaying on a giant screen in a cinema, usually with the goal of attracting paying customers. At the moment, many of the projects shot using electronic cameras do not face this market. Public airings are generally at non-profit film festivals, and are frequently projected as video rather than film. If such projects are ever released for sale, it is nearly always on DVD or videotape, so they might be more accurately called "non-broadcast television productions". It's important to note that the majority of lower-budget television programs have been shot this way for the past two decades, using TV-resolution Betacam camcorders. Although these were based on older analog technologies, the actual principles involved differ little from the "digital" counterparts; certainly the average viewer would be hard put to pick any difference in the received image quality.

Around the turn of the last century, several directors, including James Cameron and George Lucas, stated that they would probably never shoot on traditional film again. Nonetheless, the overwhelming majority of commercial movies are still shot on film, as are most American prime-time television programs and commercials.

Lower-budget and limited-release movies are increasingly being shot using digital video cameras (although usually not those equipped with high-definition sensors), but the preferred medium for that is still 16mm film.

Since the late 1980s there have been a variety of experimental "Cinematographic" projects that used both electronic cameras and electronic projection, although these used earlier analog HD technology; none was commercially successful.

Technology

The basic idea of digital filmmaking is simple: to use digital video cameras to capture and store motion images in binary data, as well as to record synchronized digital audio. Thereafter, the image and sound are edited via non-linear editing and then sent for projection in a digital cinema, a theater with digital projectors, or pressed straight for video in playback capacities like DVDs. In many cases, though, digital is transferred back to film for distribution, although this would lead to higher cost of production.

At this point, few high-end movie productions are using HD cameras to make theatrical films, as they still do not rival the resolution of film. Only a few directors, including Robert Rodriguez are using high-end digital cameras to do original shooting in cinema (films such as *Sin City* were shot using HD cameras), as the cost for the equipment at all stages of production is so high. For the time being, films are mostly shot on film, and perhaps composited to a digital intermediate (**DI**). From the DI, they can go to film or digital release.

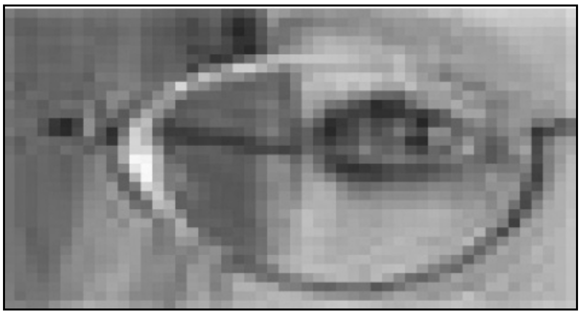
HD vs. 2K and 4K formats

HD refers to High definition television and means a resolution of either 1280 × 720 pixels or 1920 × 1080 pixels at various scanning rates. **2K** means video with 2048 pixels on its longest side, and **4K** means video with 4096 pixels on its longest side.

Digital release of films may progress with **2K** technology, but it is more likely that it wouldn't. Sony has developed and released **4K** projectors using their SXRD technology, with one of the major purchasers being Mark Cuban's Landmark Theatres. 2K digital 3D only works well on fairly small screens. 4K, being four times bigger in file size, will allow much bigger and brighter 3D images.

Native 4k x 2k

SDTV



HDTV

D-Cinema 4k x 2k

DIGITAL CINEMA EQUIPMENT

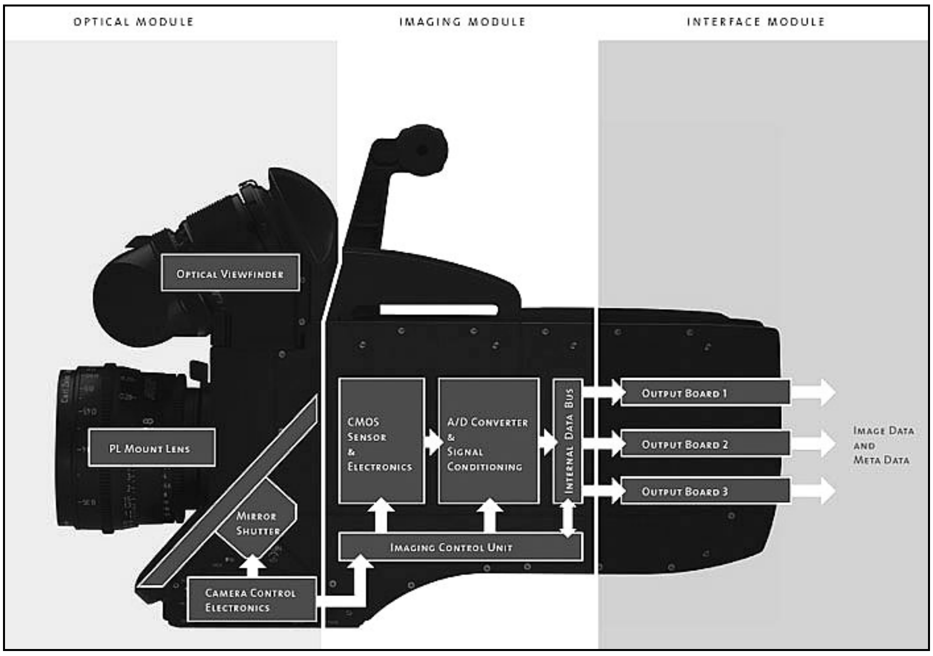
ARRIFLEX D-20

The ARRIFLEX D-20 is film style digital camera. Because of its single, Super 35 sized CMOS sensor, the D-20 uses the same lenses as 35 mm film cameras and has the same depth of field as 35 mm film. It has an optical viewfinder, is capable of variable frame rates and is compatible with ARRI film camera accessories. It outputs either an HDTV signal in Video Mode or the raw sensor data in Film Mode. The ARRIFLEX D-20 is film style digital camera.

A MODULAR AND FUTURE PROOF APPROACH

To ensure that the D-20 is an economically viable investment it is designed in a modular fashion; the sensor can be upgraded when advances in technology offer better performance, and the signal output boards can be exchanged to accommodate future file based interface and storage options. The rest of the D-20, including the housing, the Optical Module (containing the lens mount, mirror shutter, optical viewfinder and camera control electronics) and the internal data bus have been designed to last through many upgrade cycles.

To further future proof the D-20, many components have been designed for capabilities far greater than the currently available recording technologies can accommodate. The sensor and the internal data bus, for example, are prepared for frame rates up to 150 fps.

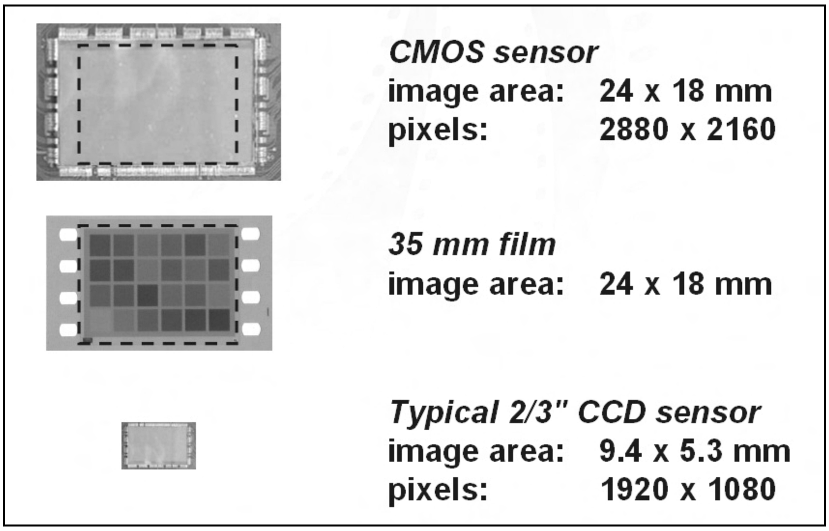


THE OPTICAL MODULE

ARRI D 20 resemble genuine film camera with the optical viewfinder and the rotating mirror shutter borrowed from the ARRICAM. The optical viewfinder provides not only the color image for evaluating focus and composition but also allows the operator to see a larger image area than the sensor is capturing. The optical video assist, which is optional, consists of the IVS II optics and electronics from the ARRIFLEX 435 Xtreme. The Optical Module can be expanded to provide interfaces for many of the extensive range of cine accessories, including wireless lens and camera control or speed ramps with the Remote Control Unit RCU-1. These accessories integrate with the D-20 just like they do with any other ARRI camera.

IMAGING MODULE

Since the D-20 sensor is an ARRI specified design, its performance is custom tailored to digital cinematography and gives ARRI tremendous freedom for future developments. CMOS sensors inherently have superior power efficiency and a natural blooming immunity, plus it is possible to read out any portion of the sensor at any time. This has a wide range of advantages, including the ability to read out high frame rates despite the high pixel count and the ability to run speed ramps. It also means that the recording format can be freely chosen, so it is possible to trade spatial resolution for frame rate. Because CMOS is essentially a more flexible technology than CCDs, ARRI can experiment in the future with new and sophisticated features like higher frame rates or a double read-out of each frame to further increase dynamic range.



FLEXIBLE OUTPUT OPTIONS: VIDEO OR FILM MODE

Different productions have different needs, and the D-20 can be used in two different output modes: Video or Film Mode.

In Video Mode, the data coming from the D-20 sensor is processed live in the camera. Color reconstruction is performed simultaneously as the 2880 x 1620 pixel grid is converted to 1920 x 1080 resolution. An on-board color management system has been implemented to optimize the camera's performance for different lighting situations including blue and green screen work. In Video Mode, the D-20 can supply a variety of standard HD video signals for different recording formats, including HDCAM SR, thus allowing the D-20 to integrate into existing HD infrastructures.

In Film Mode, the unprocessed data from the sensor is output directly to the recorder. Similar to a film negative, this data must first be „developed“ in an off-line process involving complex 3D Look Up Tables (LUTs) before it is usable or even viewable. The advantage is that all the image information captured by the sensor is retained, and being able to use more processing power in post production results in higher image quality. The live HD output can still be used for monitoring and as a guide for color grading. The grading parameters can be stored as metadata with the unprocessed image data.

DALSA ORIGIN

Although it is a relative newcomer into the field of motion-picture and video equipment, Dalsa are a respected manufacturer of extremely high resolution imaging systems, known for their satellite and military imaging products. The Origin uses a 4K x 2K pixel Frame Transfer CCD sensor, having the same height as a 35mm film frame but more than 1.5 times its width.

Perhaps the most unique characteristic of the Origin is its dynamic range. The raw output of the camera records 16 bits per pixel with 12 f-stops of latitude on a nearly linear response curve. Like the Arri D-20, the Origin uses a rotating mirror shutter to give an optical viewfinder option, although its real purpose is to blank the CCD sensor chip during the frame readout period. The present incarnation of the Dalsa camera body is also extremely large, resembling a desktop computer.

The Origin offers several data output options including uncompressed RGB, but at present there is no provision for on-board recording, and to date no major feature projects have been shot using the camera.

In the centre of Origin's design is Dalsa's own **chip** that has an optically active resolution of 4046(H) x 2048(V). - 8.2 million pixels. Four times more resolution than standard HD. But not only does it have more pixels, each pixel is almost three times as big as a 2/3" format HD pixel. Origin digitizes 14 bits of image data per pixel in each color - this means superior image quality in difficult situations —shadowy night scenes as well as extremely bright scenes such as snow or backlit water.

Origin is not limited to a fixed **frame rate**. One can "overcrank" to shoot slow motion or "undercrank" for lower frame rate effects. The sensor is designed to operate at 0 - 48 frames per second - at full resolution and full image quality.

Dalsa is using PL mount for **cinema lenses** so that camera can be equipped with a wide range of lenses DPO's are used to work with in the standard film environment.

Although providing HD and DVI outputs for viewers or monitors, Dalsa constructed an optical **viewfinder** system for clarity and precision vital to serious cinematography.

Origin makes its main photography options simply and easily accessible through a large color touch screen **camera interface,** putting frame rate, data format, sensitivity and color gamut. Cinematographer can also snap test frames to the camera's user flash card or other network locations. More "technical" settings - time code, network address, and others not directly related to the look of the shot can also be configured through the touch screen. And all camera settings can be customized, saved to a compact flash card, and tweaked offline on a computer.

Origin's resolution and bit depth require tremendous **storage** capacity and throughput. In 4k x 2k 4:4:4 16 - bit linear mode, Origin produces 1.2 Gbytes/s, almost ten times the data volume of a HD 4:4:4 10 -bit camera. Recording this data requires an ultra -high performance RAID hard drive array, with multiple high -speed drives recording in parallel. Since 1.2 Gbyte/s fills a Terabyte in less than 15 minutes, this RAID must be large as well as fast. Fortunately, Origin allows 12 - and 10 -bit log output and perfectly lossless in -camera compression to reduce both the bandwidth and storage needed.

However, the only compression acceptable for digital masters and archival is perfectly lossless compression. Perfectly, mathematically lossless means an image compressed and uncompressed will be bit - identical to the original. DALSA uses a compression algorithm known as L3, for Layered Low -complexity Lossless. L3 provides mathematically lossless compression, and achieves a higher compression ratio (2.5:1) than any other lossless scheme that has been considered by the MPEG committee, including JPEG 2000, JPEG LS, and any of the existing MPEG standards. The low complexity of the L3 algorithm will also allow real-time hardware implementation (necessary to handle Origin's throughput).

DRAKE DIGITAL FILM CAMERA

Drake is a digital film camera system for recording high quality digital movies. At the moment it exist only as a prototype model 1.2 that will not go into series production, but some of the footage shot with it are very good, indeed.

Camera is based on a 2/3“ HD CMOS sensor with full frame shutter (1/48 preset, adjustable up to 1/1000). Resolution is 1280 x 720 square pixel (720p) - true resolution, not interlaced or anamorphly jolted. Frame rate is 24 / 25 full frames (progressive) per second, quartz precise.

Footage is recorded in a camera specific RAW format on Drake Drive removable hard disk (approx. 50 minutes capacity, with hard drive mobile rack). A 10bit lookup table and a 8 bit data stream are recorded in real time. An export program converts the RAW data to 8 bit or 10bit single frame sequences or video files (uncompressed or packed with "lossless avi codec"). The typical data rate of the uncompressed export video streams with 8 bit color depth and 24 frames: 66 megabyte/sec. and 528 megabit/sec. respectively.

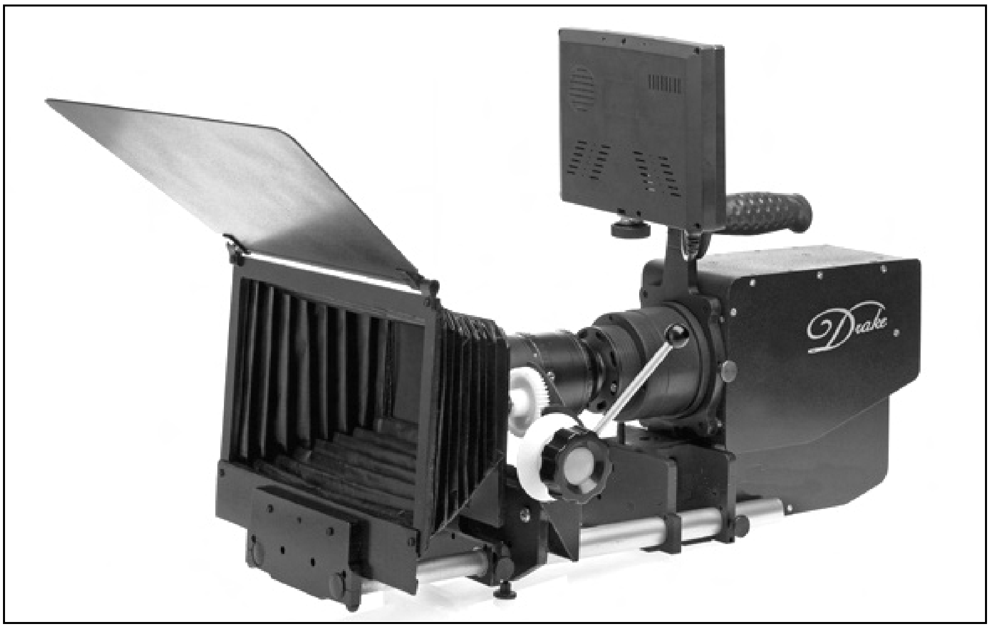
Camera is relatively small wit the weight of some 4,5 kg (including Drake Drive, 7" view finder. matte box, supporting rods and rechargeable battery, without lens). It has also to be said that the camera head is mechanically separable from the body and comes with a 10 meter extension cable in order to facilitate complicated crane movements and Steadycam operation.

Camera is using 2/3" lenses with c-mount adapter and an electric back-focus is provided, remote controlled and with memory function.

Manually adjustable picture parameter (gamma curve, black level, gain etc.) can be saved and accessed as any number of presets.

2 parallel display devices are simultaneously possible, e.g. view finder and HD monitor or standard monitor (PAL) and HD monitor. The HD picture and the scaled PAL picture are displayed in real time.

Camera is also equipped with the real time histogram, digital zoom (to control the focus), digital single frame memory and a "Control brightness enhancer " which brightens the picture when the shutter is closed to control whether there are unwanted elements in the picture.



GENESIS DIGITAL CAMERA SYSTEM

The **Genesis** is Panavision's high-end digital movie camera, which uses a proprietary, full frame 35mm-width, 1.78 (16:9) aspect ratio, 12.4-megapixel RGB CCD. It is being used for the first time to shoot Bryan Singer's *Superman Returns* and was shortly followed up by the British WWI film *Flyboys*.

Unlike the 2/3" 3-CCD RGB imaging system used in the CineAlta HD-900F (used in *Attack of the Clones*), the Genesis uses a single 12.4 megapixel CCD chip with the same width (but not the same height) as a standard 35mm film frame. The CineAlta presented a number of unwelcome compromises, as the holy grail had always been to produce an electronic camera that could utilize Panavision's existing film-type lenses that their customers were already familiar with, producing similar on-screen images with an equivalent depth-of-field characteristic.

Unfortunately, most lenses designed for film cameras cannot be adapted to work on 3-chip (or 3-tube) video cameras, because of the need to allow room for a dichroic color separation prism. On a typical 2/3" 3-CCD video camera the clearance between the rear lens element and the focal plane needs to be at least 50 mm (2"). Most cine lenses have far less clearance than this, as they have only ever needed to allow room for the shutter, so on a video camera, the image will want to focus somewhere in the middle of the prism block. Panavision originally tried to overcome this problem with optical adaptors that fitted between the cine lens and the video camera but these have all produced an unacceptable drop in image quality.

Apart from this, there were a number of operational problems with both the lenses and cameras used for *Attack of the Clones*, and so for *Revenge of the Sith*, George Lucas severed his long-standing relationship with Panavision in 2003, obtaining newer-model Sony HD cameras and lenses from Plus8Digital instead, highlighting the perennial problem of rapid obsolescence of video formats.

In an attempt to address these problems, Panavision followed this up in 2004 with the Genesis HD camera, a full bandwidth (4:4:4) HD SDI camera with improved colorimetry and sensitometry -related specs and a Super 35-sized recording area, thus making it focally compatible with regular Cine Primo lenses and giving a true 35 mm depth of field.

Unlike the 2/3" 3-CCD RGB imaging system used in the CineAlta, the Genesis uses a single 12 megapixel CCD chip (although it only actually outputs 6 Megapixels - 2M each of red, green and blue) with the same width (but not the same height) as a standard 35mm film frame. This is a significant breakthrough in that it allows just about any Panavision spherical 35mm cine lens to be used. The main imaging module of the Genesis is made by Sony, but the exact relationship between the two companies is unclear, since their joint partnership was dissolved in 2004 with Panavision's re-purchase of the 8% shareholding Sony bought in 2000.

The nominal ISO T400 sensitivity can readily be extended to ISO 1600 for low light situations. Shutter angles from 0.8 to 360° and frame rates from 1 to 50 fps will enable further compatibility with Panavision's family of film cameras.

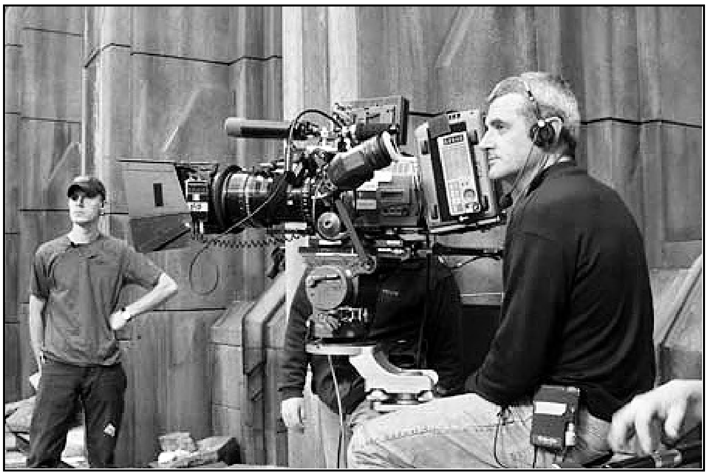
Genesis can use special, Ultaview Color viewfinder delivering 3 Megapixel resolution. It uses singles chip ferro-electric SXVGA (1280x1024 pixels) and LED light source.

Genesis docks directly (top or rear) to the latest Sony HDCAM-SR digital field recorder, ensuring a totally portable package without cables to external recording or power.

Genesis was also displayed at the last NAB as a new generation Sony Cine Alta camera.

Genesis features:

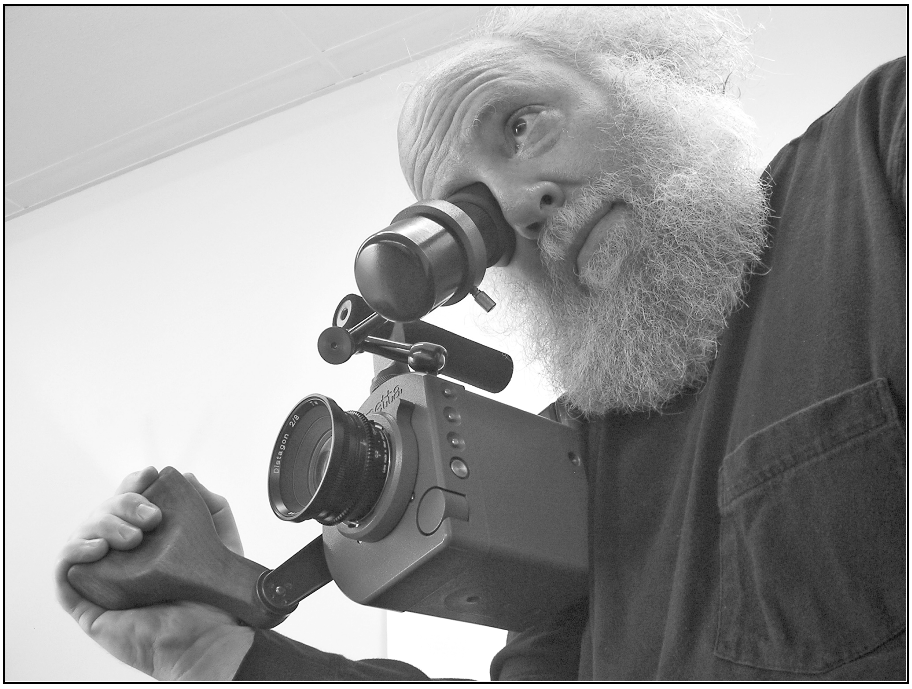
- Super 35mm sized sensor
- Equivalent to 35mm depth of field
- Utilizes all existing spherical 35mm lenses, including Primo Primes and Zooms
- Size, weight and ergonomics suitable for hand-held, studio or Steadicam
- Utilizes many of the existing Panaflex accessories
- Dockable Sony SRW-1 VTR (no cables)
- 1 to 50 frames per second
- 12.4 mega pixel, true RGB sensor (not Bayer pattern)
- Nominal exposure index of 400
- 10 bit log per color output
- Wide color gamut for film intercut applications
- Dual viewfinder outputs
- Full bandwidth, dual link 4:4:4 HDSDI outputs
- Single 4:2:2 HDSDI monitor output
- Fiber optic camera adapter for off-camera control and recording
- Integrated lens control for focus, zoom and iris
- Camera control via Panavision RDC or Sony MSU, RMB series controllers
- Digital lateral color aberration compensation for improved visual effects
- Integrated display provides user-definable access to camera functions
- User-selectable menu terminologies (i.e., shutter angle or shutter speed)



AND NOW, SOMETHING COMPLETELY DIFFERENT - KINETTA!

Jeff Kreines, designer of the Kinetta digital camera: *At the recent Geneva Auto Show, Volvo showed a new concept car, designed by women, for women. Most of the press treated this with bemused condescension – the BBC said, "if the Calendar Girls were making cars, this is what they would look like". But shouldn't this approach be dreadfully obvious? Pay attention to the people you are making cars for!*

The same, of course, could be said of the manufacturers of HD/digital cinema cameras. Look at the Sony F900 or the Panasonic Varicam and what do you see? An overgrown TV news camera. While the current generation of TV news cameras might be good for… well, shooting TV news, this doesn't necessarily makes them suitable for making films.



There are so many reasons why. The ergonomics are terrible. Way too many controls, most of them in the wrong places. If you want to use a matte box or follow focus, you can't reach any of the controls on the front of the HDCam, as they're obscured by the rods. If your sound recordist needs to see the audio level meters on the camera, they can't, because your head is in the way. There are way too many switches and connectors.

Use all the connectors at once and you end up with a Medusa. I pity the poor techs that devote their lives to building custom snakes for these messy rigs. And before you can shoot, you have to tweak all sorts of menus, setting color matrix, gamma, sharpness, and more – because if you don't, you may not have enough latitude in post to color correct. That's because the recorded image is not only heavily compressed, it's filtered down to 1440x1080 – and with 3:1:1 color sampling in the case of the F900.

This leads to the disaster of trying to set up a de-facto color-correction station in the field, with accurate monitoring – because it's important to capture an image that is as close to final as possible.

Even Viper looks like a video camera, and uses the dreaded B4 lens mount. It's not the mount that's dreaded; it's the block of glass behind it. Sony pioneered the B4 mount, and in doing so spec'd a special glass for the prism that focuses the red image a few microns behind the blue and green images – meaning that all lenses designed for this mount must also throw the red image out by 10 microns.

Big deal, you say. Let the lens manufacturers deal with this. They have. Zeiss makes the marvelous Digiprimes. Wonderful lenses. But a set of them costs about US$ 115,000. That's a lot more than a set of S16 Zeiss Superspeeds, which also have pretty decent optics. Even with great lenses, prism cameras tend to have problems with chromatic aberrations – ever notice the blue stripe on the right side of any contrasty image captured with an HDCam?

It's subtle, but once you've seen it, you'll never be able to ignore it. Of course, you won't see it in the mediocre viewfinders that these HD cameras come with. They're low-res, flickery monochrome CRTs. Of *course, there are better aftermarket finders, from Sony and ccu scene, but they're not cheap – prices start at $10,000.*

The housings of these cameras all feel cheap – lots of plastic and lots of pressed tin. Not solid, like a film camera. Some rental companies, such as Clairmont Camera, have had to ruggedized these cameras so they can stand the rigors of rental use.

I could go on. But I won't. I've been shooting film since the late 60s, and I like the way film cameras look and feel and, most importantly, work. Some of my favorite film cameras have only two switches – on/off and frames-per second – and one connector, for power. You have to think a bit when you use these cameras, but you don't have to fight the camera's personality in order to use it.

So, what can you do about this miserable state of affairs? Well, you can look to the past for inspiration. In 1914, Carl Akeley couldn't find a suitable camera for shooting his African expeditions, so he built his own – and the Pancake Akeley remained popular for over 30 years. In the mid-60s, Jean-Pierre Beauviala wanted to make a film about architecture – a film that required several cameras in different locations running in absolute sync. He asked Éclair, and they said it was impossible, because at the time there were no commercially available crystal controlled motors. Not to be deterred, Jean-Pierre designed and built one.

Inspired by Akeley, Beauviala, and others, we chose to make a digital cinema camera that completely ignored the past 30 years of TV-news-camera design. We instead looked to 100 years of film camera design for inspiration.

One great thing about film cameras is that they get a free upgrade whenever Kodak or Fuji introduces a new emulsion. We designed the Kinetta HD camera to be sensoragnostic – the camera's architecture will support future CCD and CMOS sensors with resolutions up to 16 megapixels (over 4K). Just replace the sensor and its daughterboard – very simple. No planned obsolescence.

Film cameras are completely variable speed – they can even be hand-cranked. There's a hand-crank option for the Kinetta camera as well – and you can change just framerate or framerate and exposure, like a film camera. Of course, you can also do conventional speed ramps and time lapse.

We record RAW data – 4:4:4, 10- bit log, uncompressed – to a magazine that contains 12x40Gb hard drives – the same drives that are used in iPods. Tiny and rugged. Each magazine, recording in a parity-protected RAID-3 format, will store 110 minutes of 1920x1080 material at 24p. The magazine can be used on the camera, for shoulder-mounted use, or it can be separated from the camera head by a thin 3mm fiber-optic cable by over a kilometer. Combined, the camera, magazine and battery weigh about 6.5 Kg. You can attach a magazine to a non-linear editing system via single or dual HD-SDI links and digitize, or you can export data directly as DXF files if you'd prefer.

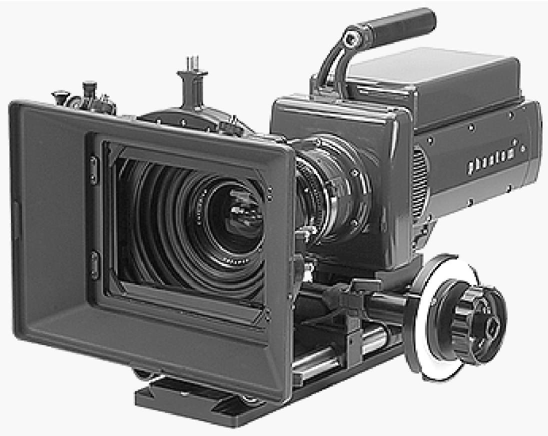
Since we record RAW data – everything the sensor puts out, we record, unaltered – all you have to do is make sure you don't overexpose any pixels you want detail in – and you can tweak the rest in post. The camera has multiple user-defined zebras – you can do the zone system if you'd like – and a histogram. All are available in the finder when desired. We use a standard PL lens mount and a single sensor – so all of your favorite film lenses can be used. No prisms.

Our high-resolution color viewfinder is OLED-based – it's compact and consumes very little power. It can be positioned anywhere on the camera (or a few feet away), and includes controls for finder zoom and various display options.

Kinetta is a single-chip, PL-mount digital cinema cameras. Designed for documentary and low-budget filmmaking, it is based on the 2/3 in., 2.2-megapixel (1920×1080) "system-on-a-chip" CMOS sensors. The user can choose between "Cine Mode" and "Ramp Mode." Cine Mode will vary both frame rate and exposure, which will add frame-by-frame exposure variations (or flicker) to the image. Ramp Mode will vary only the frame rate, but keep exposure constant (within certain constraints).

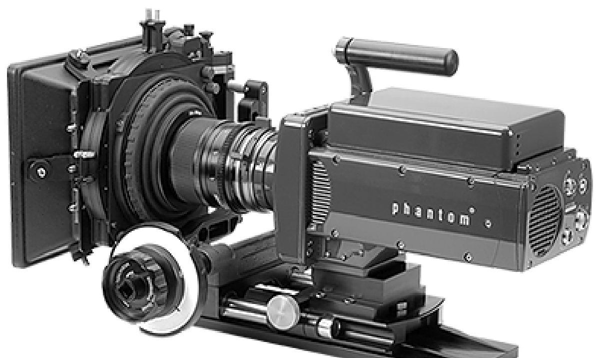
PHANTOM HD

With its new 2,048 x 2,048 active pixel CMOS sensor (pixels measure 12.5 microns) and using PL-mount lenses, Phantom HD supplies a maximum of resolution of 2048 x 1152. The dimension of the sensor is 24 mm x 13.5 mm, which is .89 mm smaller than the width and .36 mm smaller than the height of the 3-perf S35 mm format. Camera is capable of selecting any frame rate from 1 to 1,000 fps in increments of one frame per second. It's sensor is can deliver 2K imaging for cinema, or HD for projects geared towards television production, and the vertical image size can also be changed in 8 pixel increments. 14-bit A/D converter works together with the EDR (Extreme Dynamic Range) feature to provide high contrast, sensitivity and image quality that rivals best digital film cameras. It is said that an 11-stop dynamic range was achieved in the testing models. In addition Phantom camera's shutter is variable to 2 microseconds.



PhantomHD has allocated formats for standard HD 16:9 (1920x1080 pixels) and 35mm mopic at 1.85:1 using an active pixel area of 24 mm x 13.5 mm (1920x1038 pixels) making this camera fully compatible with all 35mm equipment as well. The HD can be configured for "live" broadcast or studio production and has a continuous video output that includes NTSC, PAL, HD-SDI (720p, 1080p, 1080i, 1080 psf) standards. Phantom HD is compatible with any +12vdc YPrPb on-camera viewfinder or monitor making shooting any subject clear and precise. The camera can also be controlled and image files downloaded using a 10/100/Gigabit Ethernet to PC connection, and files can be converted TIFF stacks, MOV, or AVI formats using the included Phantom software package.

Camera uses HD's SMPTE but is also compatible with IRIG-B time code, modulated or un-modulated input, with the ability to "lock" or "phase shift" camera synchronization to IRIG time input, and a Sync connection allows multiple coordinated camera coverage.



Phantom HD arrives with 4 Gigabytes of internal memory standard, 8 Gigabytes as an option. In the future there will also be an option of the hot-swappable non-volatile solid state recorders. These low profile modules mount snugly to the to the top of the camera body and store 128 or 256 Gigabytes each. When one of these storage magazines is filled, its docking station allows downloading of the images to a PC running the Phantom application. Replacing a memory magazine with a 4:4:4 module will allow the camera to write directly to a deck or hard disk recorder via its 4 HD-SDI outputs.

phantom New HD

RED DIGITAL CINEMA CAMERA

One of the hottest, not-really-yet-buyable digital film camera is attracting the attention not only with great features but also with the promised price of $ 17.500!. But, while waiting for the actual camera, let's see the promises:

The heart of RED camera is a full frame, Super 35 size CMOS sensor called *Mysterium*. The chip measures 24.5x13.5mm and features 4520x2540 active pixels which ads to 11,4 Mp. A real 4K camera! Mysterium. boasts a greater than 66 db Signal to Noise Ratio thanks to its large 29 sq. micron pixels.

Camera can record in 60 fps at full 4520x2540 resolution (progressive) and also in 1080p or 720p. All at variable frame rates; 1-60 fps.

As far as RED codec is concerned, camera can output RAW 4:4:4 through dual fiber channel output, 4:2:2 out the HD-SDI output, or record to RED codec, the whole taster 2540p, 1080p/i, 720p, 24p, 30p etc. One can select the bitrate of 100, 80, 60, 50, 25 or 19 Mbps.

Super 35mm size chip allows the use of any 35mm or S16mm, PL mount film lenses, or the lenses that will be developed specifically for the RED camera.

The footage will be recorded onto RED flash system. external hard drives, BlueRay, tape or other formats.

RED ONE is a **modular design** that easily accepts upgrades in hardware, software, storage, handling and monitoring accessories. The camera body weights less than 7 lbs and is constructed from rugged magnesium alloy. Initial options will include RED-CAGE for mounting accessories and "growing" the camera body.

Viewfinder - 720p resolution viewfinder can be bolted on anywhere on the camera. There will be some kind of focus assist that isn't being discussed yet.

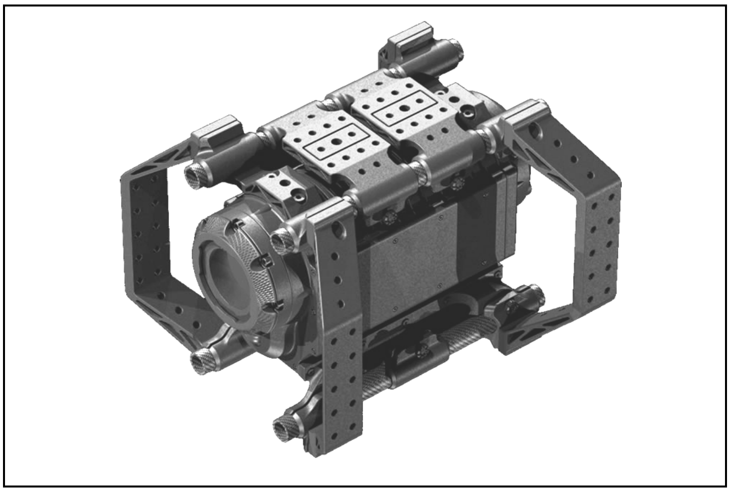
Red Rail System - is built to be able to finely adjust where stuff goes and how it balances for shoulder mount, and flexible in mounting options - put stuff on side, on top, flip it under/over, all kinds of options.

Red Cage - It is a cage for mounting the small camera on big stuff, or mounting stuff to the small camera. All those holes are for mounting anything anywhere.

LCD Panel - no details given, but it is built to be mounted anywhere, and is on a doubly articulated arm to swing around and angle how you want it.

Recording and power - the hard drive unit and battery have been taken out of the camera body, and put together to go at the back of the Red Rail system, or bolted to top or bottom of the camera body itself.

Red Zoom Lens - 18-85 mm, f2.8, under $10,000.



RED CAMERA WORKFLOW

Red recently announced a cross platform (Mac/PC) application - ***REDCINE*** - to read in the data from a Red camera and convert it to something useful - like a codec your NLE can work with.

Here are the options:

Step 1. Shoot 4K

This can be done either to 4K REDCODE RAW to an onboard recorder (Digital Magazine (hard drive) or Digital Micro Magazine (solid state memory)), for a roughly 28 MB/sec data stream at 24 fps. OR ... shoot uncompressed RAW and record to get a 12 bit linear 323 MB/sec data rate at 24 fps for completely loss-less quality.

Step 2: Import and process the footage in REDCINE**: Demosaic, Mysterium Profile**

Demosaic is the process of converting the checkerboard of the grayscale RAW image, where some squares are from green pixels, some are from red, some from blue, and converting that into an RGB color image. The next step is to choose a Mysterium Profile ... most likely Rec 709 (standard for HD) for most folks.

Step 3: Correct white balance, gamma, gain, color, saturation contrast and curves:

You'll have normal color correction tools at this point. The benefit here is that you're still working with un-compressed, debayered 4:4:4 RGB at this point.

Step 4: Select output size to 4.5k (2540P), 4k, 2k, 1080P, 720P or 480P:

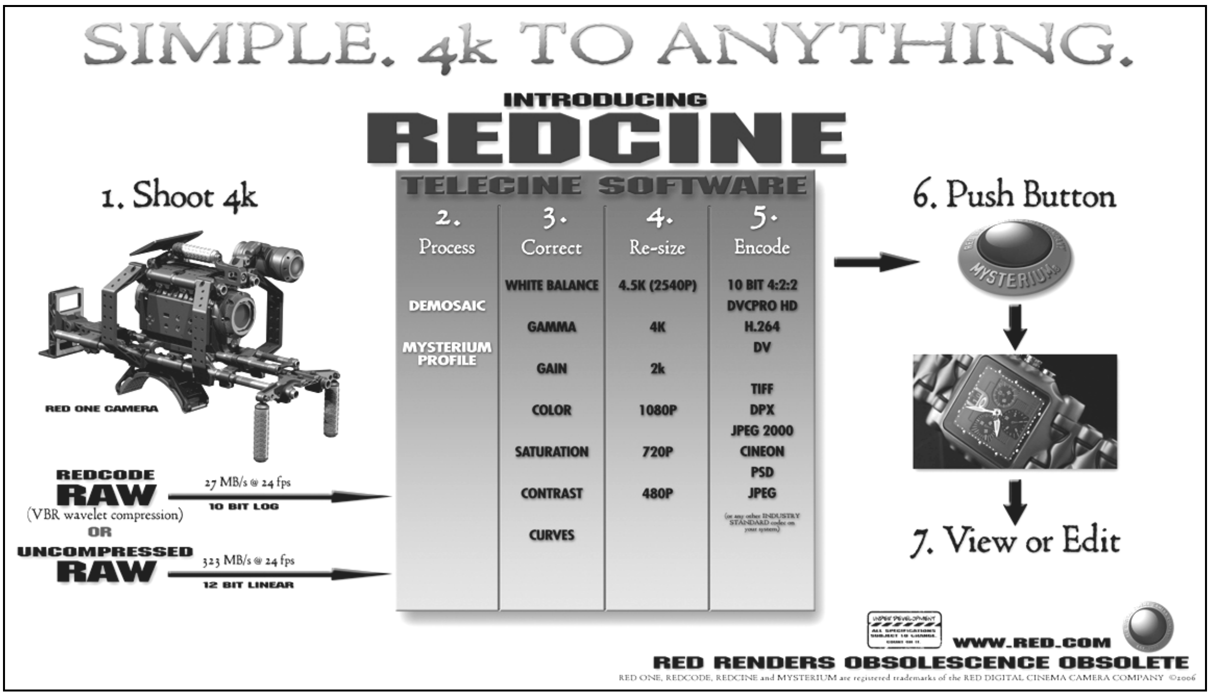
At this point you select what resolution you want to deliver. Video deliverable? Choose 480p/i, 720p, 1080p, 1080i. For feature workflows, you have further options of 2K, 4K, or the full 4.5K resolution (4520x2540). Your choice. Or, if you want to do offline/online, do an SD or HD for the offline, and higher resolution for the online.

Step 5: Encode to the video:

(10 bit 4:2:2, DVCPRO HD, H.264, DV) or still codec of your choice (TIFF, DPX, JPEG 2000, CINEON, PSD, JPEG). You can encode stills and video into ANY industry standard codec on your system.

For video workflows, - ANY codec you have installed that any regular app can encode to. For your offline you might want DV or DVCPRO HD, but for your online you might want DNxHD or uncompressed 10 bit 4:2:2 or 4:4:4.

But if you want DVCPRO HD for your final, or 8 bit 4:2:2, that's all doable - again, any codec you have installed.



SILICON IMAGING SI-1920HDVR

Silicon Imaging SI-1920HDVR is a 1080/24p camera that should be priced under $20,000. The camera uses a2/3" CMOS sensor with 12-bit A to D conversion. The 1080/24p signal is recorded as 10-bit linear data in CineForm RAW, a wavelet codec that compresses the 74.6MB/s signal to 12MB/s for recording. SI claims a 10-stop dynamic range and an exposure index between 160 and 300 for its camera which uses S16mm PL mount cinematography lenses and C or F mount industrial lenses.

The camera records in 1080/24P, 25P, 30P and 720P up to 72 fps in CineForm RAW Digital Intermediate format.

What's most unusual are camera settings accessible via a swing-out touch screen 7" LCD monitor and a removable camera head connected via Gigabit Ethernet. Instead of a displaying a waveform or histogram on the LCD monitor, there are 6 levels of false color zebras that indicate exposure, also viewable in the monitor are 2x digital zoom for fine focus adjustment, safe-zone markers for 16:9 / 4:3 / 1.85:1 / 2.35:1 sizes and a full-screen viewing mode. Camera controls and indicators include white balance, exposure, gain, pedestal, frame rate, resolution, CineForm compression quality, and SMPTE timecode.

There are no buttons on the SI-1920HDVR; software running under Windows XP adjusts the camera via touch screen menus. To separate the camera head from the body, you simply remove two screws and slide out the lens mount/sensor housing. The head weighs about 3 pounds and a complete camera (head and body) weighs about 13 pounds.

The camera body is essentially a computer-driven hard drive recorder that records on 2.5" SATA drives, with 4 USB and Gigabit Ethernet connections. Four hours of footage fit on 160G drives that can be hot-swapped for continuous recording.

The recording technology in the SI-1920HDVR abandons fixed bitrate DCT codec formats, such as DVCPRO HD and HDCAM. 12-bit RAW digital information from the camera's sensor is recorded directly into the CineForm RAW format, which preserves the original pixel data.

SI-1920HDVR SPECIFICATIONS

DIGITAL CINEMA 1080P HD CAMERA

- 2/3" 16:9 high-sensitivity CMOS Imaging sensor with 5um pitch
- Full-raster 1920 x 1080 Native Resolution with Progressive scan
- Direct-to-Disk Recording with Hot-swap USB2.0 HDD Cartridges
- Direct-to-Edit .AVI files compatible with Cineform Prospect HD
- Removable Optical Low Pass Filter with IR Cut Filter
- 12-bit A/D conversion and 48-bit digital signal processing
- 10-F Stops Dynamic Range, 4.5 F-stops over-exposure latitude in WDR
- Low-Noise LUT for special effects shooting and post-processing
- 180-degree film shutter equivalent with variable speed control

- **HD & VARIABLE SPEED RECORDER**
- HD Formats: 1080/24p, 1080/25p 1080/30p, 720p (variable)
- 72 fps/720P for slow-Motion Special effects
- Overcranking and undercranking for special effects (12~72fps)
- Time-Lapse Recording with programmable images per minute
- Visually lossless CineForm RAW wavelet-based codec
- Three variable bit-rate quality encoding CineForm RAW settings
- Auto-file naming and project management with metadata
- Up to 4 hours of recording on 160GB HDD in Filmscan quality mode

DSP COLOR PROCESSING

- Pixel-by-pixel Adaptive noise reduction and black calibration
- White Balance Modes: 3200K, 5600K, User and None
- Selectable color matrix for optimized color management in post
- Proprietary Adaptive Bayer processing for ultra-high quality output
- 48-bit RGB (16bpp) color processed rendered output
- Non-destructive color matrix post-processing using CineForm RAW

TOUCH SCREEN LCD DISPLAY & USER INTERFACE

- 7" Touch screen LCD with Advanced Image-Scaling
- 5-wire resistive Interface with Integrated USB controller
- 1280x720 WSXGA Video Output with VGA/DVI Connection
- Exposure Meter with 6-level false-color zebras
- 2x Digital Zoom for fine focus adjustment
- Safe-zone Markers for 16:9 / 4:3 / 1.85:1 / 2.35:1
- Thumbnail display for easy searching and file information
- Instant playback and review via built-in Virtual VTR interface

AUDIO & SMPTE TIME CODE

- Stereo Mic/Line Level Inputs with 48kHz 16-bit Sampling
- Audio Recording multiplexed into .AVI
- Speaker/Headphone Output
- SMPTE time-code embedded into AVI files
- SMPTE time-code syncing to external LTC USB devices
- On-screen Audio Level Left/Right Indicators

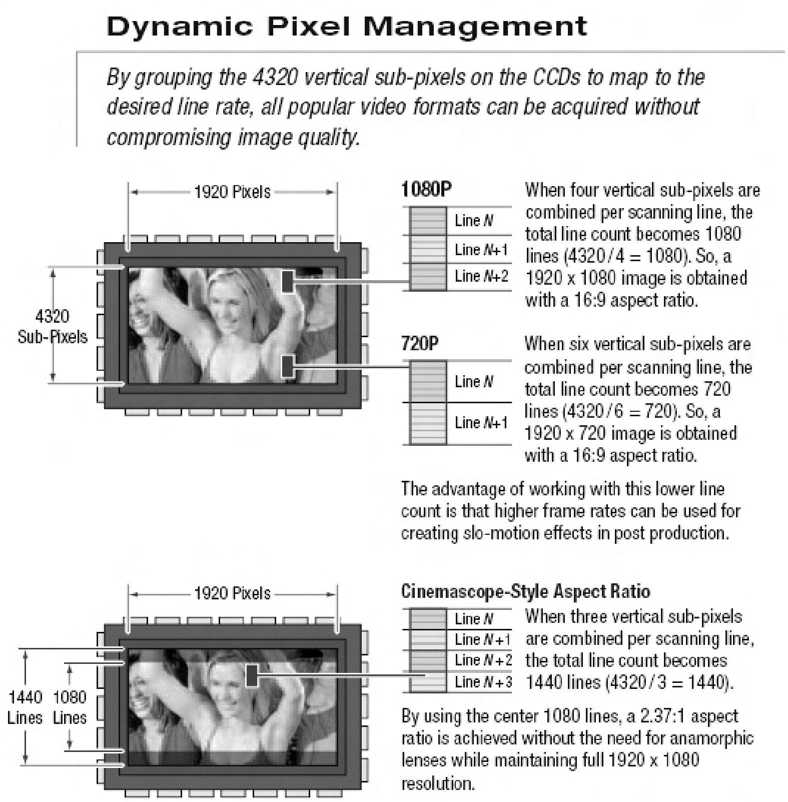
OPTICAL, MECHANICAL & POWER

- Anton Bauer Gold-Mount battery system (14.4V Nominal)
- DC Power Regulation 11.5~19V.
- 65W total system power consumption
- Remote-Head operation: 12VDC and GigE Connection
- Hot-swap between battery and external power-supplies
- 4 USB 2.0 ports with hot-swap 2.5” HDD cartridge system
- 10/100/1000 Gigabit Ethernet connectivity to IT networks
- C, F and PL Interchangeable Optical Mounts
- Ultra-tough aluminum alloy chassis
- Size/Weight: 13lbs | (LxWxH) 12"x4"x8"

VIPER FILMSTREAM

The Viper FilmStream camera by Thomson Grass Valley has the same resolution and frame rate as a high definition video camera like the CineAlta, but captures an uncompressed video image, unlike many earlier HD cameras, which applied lossy compression to the video stream. The Viper was first used on Rudolf B.'s short movie *Indoor Fireworks*. The first major motion picture shot using the Thomson Viper was Michael Mann's *Collateral*. and the first feature film to be shot entirely in the uncompressed digital data format is *Zodiac* directed by David Fincher. One of the major strengths of this camera is the capability to shoot in extremely low light levels, allowing much of Collateral to be shot on the streets of Los Angeles at night without the need for large supplemental lighting equipment.

The Viper FilmStream camera can be operated in four different modes: a FilmStream 4:4:4 log output, which offers uncompressed, uncompromised, unprocessed output; a 4:4:4 RGB video output that adds video processing to create a full-bandwidth, full-resolution camera with color balance, colorimetry, gamma, highlight handling, and detail enhancement at the camera; an HDStream mode, which still benefits from the wide-latitude image capture, but provides an output as 4:2:2 HD, which is very similar to the FilmStream output, but with color balancing to true 3200° or 5600°; and a YUV mode, which offers superior image quality for fully processed HD productions. In FilmStream mode, because there is no video signal processing, the output on a monitor appears flat and with a pronounced green cast. To view this output on set, the camera includes digital HD and analog standard-definition monitoring outputs.



The signals from the Viper may be recorded to either a tape format or a disk array. It is sometimes incorrectly assumed that the images from the Viper must be recorded uncompressed to a disk recorder. Many feature production is recorded 4:4:4 to Sony HDCAM SR tape for practical reasons with no perceptive differences in quality to disk systems.

Of all features available to the Viper user, the most unique is Dynamic Pixel Management . The camera can be adjusted to change its aspect ratio by vertically ganging pixels. The pixels can be made taller/shorter thus consistently delivering a standard line count with different relative picture heights.

In addition to a TV standard 16:9 aspect ratio, the Thomson Viper can shoot with a 1:2.37 - true cinema aspect ratio while still recording at the industry standard 1080 lines of picture height. Other CCD camera technologies must crop the 16:9 picture and blow up slightly more than 800 lines to achieve a 2:40 aspect ratio.

Key Features

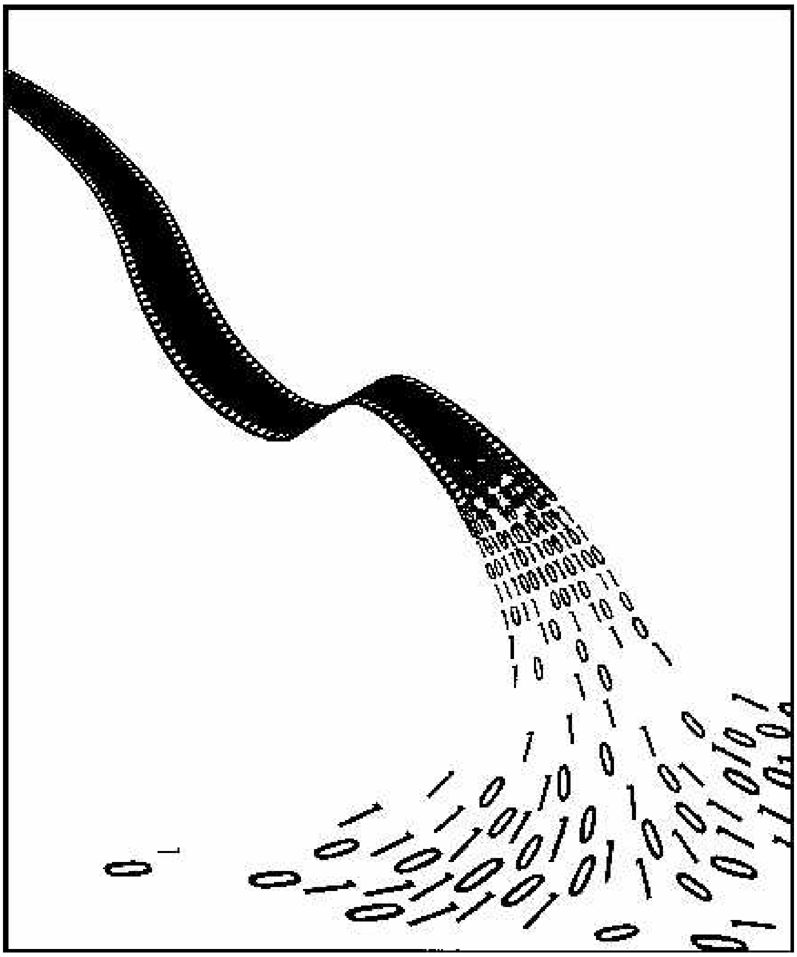
- 9.2 million pixel CCD sensor for each color channel
- Captures raw data directly from CCDs without video-style signal processing
- Unique 4:4:4 RGB dual link FilmStream output
- Native 16:9 or 2.37:1 aspect ratios without vertical resolution loss using Dynamic Pixel Management technology (HD-DPM)
- 12-bit linear A-D conversion, mapped to 10-bit logarithmic signals for downstream processing
- Patented Frame Transfer (FT) CCD technology
- Mechanical shutter guarantees no vertical smear
- Multiple format support:
    - 1080p @ 23.98, 24, 25, and 29.97 frames per second (fps)
    - 1080i @ 50 and 59.94 Hz
    - 720p @ 23.98, 24, 25, 29.97, 50, and 59.94 fps
- Electronic viewfinder focus assist tools: crawler and zoom
- Standard B4 lens mount for popular digital cinematography prime and zoom lenses
- Multiple field recording options:
    - Solid-state, on-camera RAM recorder for cable-free operation
    - High-capacity field recorder with exchangeable disk packs
    - Third-party field recording support
- Full range of third-party accessories, including extension viewfinder tubes, matte boxes, filters, color viewfinders, additional power taps, Steadicam low/high mounts, and more

Feature Films shot with Viper

- Collateral (majority Viper camera)
- Domino
- Final Days of Planet Earth
- Freezerburn (opening sequence Viper camera)
- Gray Matters
- Highlander: The Source
- Noo-Hin The Movie (Thai)
- Home of the Brave
- Killer Bash
- Killer Pad
- Le Poulain
- Miami Vice (majority Viper camera)
- Mirror Mask
- Notebook of Life (Japan)
- Nos chères têtes blondes
- Oliver Twist (portions)
- Prima Classe
- Red Riding Hood
- Scorpion
- Silence Becomes You
- What Love Is
- Zodiac

OVERVIEW OF DIGITAL FILM CAMERAS

CAMERA	CHIP	SIZE	PIXEL RESOLUTION	TOTAL RES.
ARRIFLEX D-20	CMOS	24x18mm	2880 x 2160	6.2 Mp
DALSA ORIGIN	CCD	34x17,2mm	4046 x 2048	8,2 Mp
DRAKE	CMOS	9,6x5.4mm	1280 x 720	0,92Mp
PANAVISION GENESIS	CCD	24x18	no official data - apparently, 1920 RGB triplet across, and 2160 rows of them.	6,2Mp, outputs - 2M each of red, green and blue
KINETTA	CMOS	9,6x5.4mm	1920×1080	2Mp
PHANTOM	CMOS	24 x 13.5mm	2048 x 2048	4,2 Mp
RED	CMOS	24.5x13.7mm	4520x2540	11,5 Mp
SILICON	CMOS	9,6x5.4mm	1920 x 1080	2Mp
VIPER	3x CCD	3x9,6x5.4mm	3x 1920 x 4320	8,2MP



POV _ On Digital Film Cameras.

***Mike Curtis**, writer and owner of one of (at least in my mind) best blogs dealing with the high definition issues as seen from the view of independent filmmakers - /http://www.hdforindies.com/, wrote recently this text on pros & cons of some of the Digital Cinema cameras. Although totally personal, I find it interesting and include in this Report.*

... Cameras, and products in general, are a reflection of the values and priorities of their makers. So the priorities of the makers come through in the product, either as a direct, intentional creation, or as a byproduct of the innate talents and capabilities of the companies and individuals producing them. After spending some time in LA visiting with camera makers, rental houses, DPs, colorists, etc., here are some of my thoughts and observations on some products out there:

Panavision has values of interoperability and compatibility with their extensive (and extensively field proven) range of accessories and gear while generating a very professional image in a self contained package.

The **Dalsa Origin** is the product of folks who make extremely good imaging sensors - so the camera is a no compromises image generation device. And it rocks at that task. The problem is, some compromises might be nice to have - 4K or the highway seems to be their unspoken mantra at this time. Smaller form factor, dual link HD-SDI, onboard recording capabilities, etc. would make this a much more flexibly capable system.

ARRI made a digital version of one of their film cameras (the D-20), down to through the lens viewfinder with mechanical spinning shutter. **Dalsa** does that part too, giving a certain lovely characteristic to motion blur you don't get with non-shuttered imagers I've seen..

The **Thomson/Grass Valley Viper** is a very nice, technically astute camera with some clever details to the workflow - HD-SDI outputs with a log curve, it was AFAIK one of the first to do this. It is the product of a video technology company, and as such is has 3 2/3" CCDs and uses B4 mount lenses - so isn't quite the film camera replacement from a lens and DoF perspective.

Some pros and cons of the various cameras:

PANAVISION GENESIS:

Pros: shipping, multiple features already shot with it. Good looking image, FULL Panavision accessories integration and compatibility, HD deliverable (makes post easier), log curve (they call it Panalog, resets white to 70% and arcs/tapers it off above that level), compact form factor with recorder (integrates with SRW-1 without need or SRPC-1, which is built into camera). Also has dual link HD-SDI outputs if fully uncompressed is desired. Super 35mm sized image sensor. Panavision is a trusted name - see the long list of features already shooting on it. The name brand, and the quality that implies, clearly carries significant weight in Hollywood, as evinced by the list of projects already shot on it. Can record audio in sync with video. Single sensor CCD for cine lens compatibility.

Cons: 1080p is highest resolution, max frame rate is presently 50 fps, but can shoot variable frame rates, rental only from Panavision, limited availability (about 40 some odd worldwide right now). No mechanical shutter, and no through the lens viewfinding.

DALSA ORIGIN:

PROS: Shipping product. Extremely sharp images, extremely high resolution (4Kx2K, 2:1 aspect ratio), the only shipping 4K camera of the bunch. Also, extremely good dynamic range, perhaps the best of the shipping bunch from my personal observations. Super 35mm sized image sensor. Rotating mechanical shutter and through the lens viewfinding for film like motion rendering and DP familiar operation. Single sensor CMOS for cine lens compatibility. If you want to go 4K, this is the one to beat. The workflow for 4K is also VERY well thought out, and the Codex device makes the much more manageable.

CONS: At present, it is BIG and unwieldy, and is something they need to work on. It can be handheld, as proven by some test footage I saw, but is a daunting beast to behold. But to my mind, the biggest detriment they face is the workflow - they shoot 4K, and they ONLY shoot 4K. At present, there is no HD-SDI out. You can only record 4K RAW Bayer pattern data out of the camera. Their currently recommended solution is to record to the Codex recorder, which is itself a model of flexibility and capability (more on it later, but it rocks). Which is fortunate for Dalsa, because they need all the flexibility then can get. 4K or the highway seems to be their unspoken credo. It would be nice to have options with this camera - such as 2K or ANY flavor of HD-SDI, or to at least have the option of any kind of compression for a smaller form factor. At present, if you wanted a DigiBeta or SR copy, it would require some kind of processed output off of the Codex box. I feel they've overshot the market - but if they could shrink the form factor, add onboard recording, add 4K downsampled to 2K/HD/HD-SDI recording options, I think they'd have a real winner, more in line with the market's needs and desires. 36fps max recording rate (camera capable of 50fps, but no recording solution capable of those speeds). Dual sound audio - no provision for recording audio with picture, have to sync audio in post.

The camera is also rental only - which helps for support (since the rates also includes support all through production into post production), but also means there is only one source to rent these from - Dalsa.

THOMSON/GRASS VALLEY VIPER:

PROS: good dynamic range (see Collateral or Miami Vice), nice color representation, can shoot 4:2:2 linear or 4:4:4 FilmStream mode (utterly uncorrected RGB output from sensor). HD workflow with LUTs, keeps the post more flexible and affordable than data or 2K. Can record audio in sync with video.

CONS: A video technology based device - 3 CCD design with a prism beam splitter, requires video style lenses, 30fps progressive max fps, 60 fields (half res) maximum frame rate. 2/3" not 35 or Super35 sized sensor...but that can be useful at times as well (Michael Mann liked it for Miami Vice). No mechanical viewfinder, and no through the lens viewfinding.

ARRI D-20:

PROS: from Arri, who has a strong rep for form factor, ergonomics, and accessories. 35mm or Super35mm sized image sensor (forget which), DOES have spinning mechanical shutter (has benefits for motion blur), and they are working on a direct data recording option as well. Can record audio in sync. Single sensor for cine lens compatibility.

CONS: HD resolution max, video frame rates, HD-SDI only recording, no onboard recording, no data recording as yet, how does off-speed work (recording and post extraction). Rental only.

SILICON IMAGING:

PROS: 2/3" sized image sensor, detachable image block is tiny; very high quality, full raster, 10 bit highly efficient, relatively low data rate wavelet based codec (Cineform wavelet RAW codec). Very flexible frame rate modes 1-72 or so fps possible, and since disk recording it is cake to deal with off-speed in post. Mac support for codec expected this fall (maybe IBC?). Can record to the fully built up portable unit or just the image block and run a GigE cable back to a laptop or computer. With the (large) exception of Premiere Pro only editing, very indie viable workflow - low cost storage, low data rate native codec editing, affordable camera, etc.

Cons: you're married to Adobe Premiere for native codec editing right now. No HD-SDI recording option that I'm aware of. For editing or posting on non-WinXP environment, gotta export to other formats - is possible but cumbersome. Altasens sensor is decent but not outstanding, not in same league with Dalsa, ARRI, Panavision, or Red samples seen to date...then again, this is a very nearly shipping camera for $20K (w/o lenses), the price is entirely reasonable for the quality you get.

RED ONE:

Red One, if ships with specs as stated (YES unfair to compare shipping to unfinished, but let's just project forward a year and assume these are all still the same specs from everybody for the moment).

Pros: Can record up to 4520x2540 in data mode, purchasable for $17,500 for the body (Viper is circa $80K I think), Super35mm sized sensor, windowable sensor, works with PL mount S35 and S16 to start with, Nikon and B4 mounts to follow for compatibility, 1-60 fps recording in 4K, 1-120fps recording in 2K w/S16 lenses, data, onboard, or HD-SDI recording options, records audio as well (at least 4 channels). Record RAW data to REDRAID, record Redcode full raster wavelet based codec to either solid state memory device or RedDrive devices (based on 2.5" SATA disk), or to any standard HD-SDI type device (if shooting HD resolutions). Shoot 720p, 1080p, 1080i, 2K, 4K, or 4.5K. Record (depending on format you're shooting) to the above list. Purchasable or rentable. I've seen some test images and....WOW.

Cons: New entrant, no working prototype seen or even test footage publicly screened as yet, unproven track record, brand new company and product. LONG way from shipping, working, proven reliable product. In terms of workflow...I can't think of a downside, knowing what I know. The final image quality, after compression and whatnot is still unknown, but I'd imagine it'll be possible to record images even better looking than what I saw (and remember, those were some of the very first tests) to a Codex or similar type device. Wait, that's not a con.

DIGITAL CINEMA STORAGE

The ascend of the digital cinema brought exciting developments in camera design and a couple of more or less finished products - Arri D-20, Panasonic Genesis and Thompson's Viper - just no name a few. However, all of these cameras produce quantity of data (up to 4K in the case of Dalsa) which is impossible to store in conventional method without sacrificing the quality.

Here is an overview of solutions to solve this problem that exist at the time of the writing of this Report.

TAPE SOLUTIONS

Although it is sure that in the future tapeless devices will be the real choice, for practical reasons (cost/duration benefit, ease of use, etc) some of the tape recorders are still used to record digital cinema footage.

This goes specially for the Sony HDCAM-SR portable recorder because it provides a very good quality, mild compression, portability, etc. It was introduced in 2003, uses a higher particle density tape than original HDCAM and is capable of recording in 4:4:4 RGB with a bitrate of 440 Mbit/s.

Sony SRW-1

The SRW-1 looks like a traditional record unit that could attach to an HD camera head, but rather, it actually requires the combination of the SRPC-1 HD Processor unit to function, as shown on the left. In the Panavision/Sony Genesis digital camcorder system, the HD processor is built inside the Genesis itself. But to those who would otherwise want to operate the SRW-1 the SRPC-1 is required. HDCAM SR uses the new MPEG-4 Studio Profile for compression, and expands the number of audio channels up to 12. The compression ratio in 4:2:2 YCbCr recording SQ (Standard Quality) Mode at 440 Mb/s is 2.7:1, and in 4:4:4 RGB the compression ratio is 4.2:1 in the SQ (Standard Quality) Mode at 440 Mb/s. In the SRW-1, 2x record speed is possible in either the SQ Mode, for synchronized 4:2:2 HD camera "stereo" HD recording, or, for special and unique 4:4:4 RGB recording in HQ (High Quality) Mode. In the HQ Mode RGB compression is only 2.1:1. This HQ mode is only supported on the SRW-1, and is not supported on the SRW-5000 series in record or playback. Therefore, post facilities wishing to accommodate Genesis SRW-1 recordings made in the HQ Mode should consider the SRW-1/SRPC-1 as well as the SRW-5000 series as the only way at this time to support all of the possibilities of HDCAM-SR. The Sony S-Cassette (Small cassette) can record up to 50 minutes of content at 1080/24PsF at 440Mb/s in the SQ Mode. When recording in the 2x SQ Mode 1080/24PsF at 880Mb/s (such as in a stereo 4:2:2 HD application) or in the SRW-1 HQ mode (which also runs at 880Mb/s) the running time is cut in half to about 25 minutes.

Panasonic D5

Apart from the standard HDCAM which will be more dealt with in the next chapter of this Report, the only other interesting solution for Digital cinema could be Panasonic's D5 which is only available as a standard studio machine, but with rather impressive characteristics - AJ-HD3700B provides full bandwidth (1920x1080) and 4:2:2 digital 10-bit component video in HD plus standard definition non-compressed 525i (NTSC) and 625i (PAL). It also records in multiple formats - including 1080i, 1080p, 1080PsF, 720p.

HARD DISK SOLUTIONS

Hard disks with their huge capacities, speed and random access capabilities are sure one of the best mediums for the storage of Digital Cinema footage. However, they are (if offering adequate storage capacity) big and heavy and still mechanically complicated and fragile.

In a way, they represent a transition between the tape systems and (near) future solid state based systems. Here are some of the existing solutions:

Codex Digital

Codex is a high-resolution digital media recording system and can record in a variety of formats, from High-Definition video and 2K 'digital film' all the way up to full 4K for the ultimate digital picture quality available today. Codex can record uncompressed 4K, 2 x channels of 4:4:4 HD (for A & B camera, or 3D-configuration shoots), or even a single HD digital film camera at speeds of up to 60fps. Codex always records images in the camera source's native format - e.g. if recording from a Panavision Genesis, it records in uncompressed HD and if recording from a Dalsa Origin it records the raw Bayer pattern data from that camera.

It's compact, ruggedized design and removable media DiskPacks puts Codex is just as much at home on a location film shoot as it is in a studio machine room, and its built-in touch screen interface and dedicated transport controls make Codex an easy-to-use and totally self-contained recording system.

Codex is provided with a couple of media DiskPacks which are in fact RAID arrays, and the system allows mirroring of the footage as it is shot.

However, Codex is not just a recorder - it can be configured in a number of different ways, providing anything from location media recording and shot-logging, or acting as a dedicated 'screening system' and production server on-set, or even as a fast, efficient media/metadata transfer and management system in a post-production environment.

S.two

S.two is rather popular system of "digital magazines", removable hard drives which are used to capture Digital cinema footage. In addition, S.twod developed a complete set of products that address the Digital Cinema Workflow, from capture through to film out.

D.MAG.

Digital Film Magazine. The heart of the system. The D.MAG is available in 18 and 36 minute lengths (uncompressed 10 bit RGB DPX file data @ 24 FPS). A robust, rugged digital data removable cartridge, mountable, sharable, re-useable. HD, HD RGB, 2K any image or data files .

DFR

The DFR is a field portable, DC or AC powered recorder. Designed to be portable, the DFR differs from any other product in that it is robust, made to be shipped, carried or used anywhere providing years of rugged service. The DFR captures uncompressed images and stores them directly as DPX image files ready to be accessed or used by any image application, real time or computer based.

Records HD, HD RGB, 2K and beyond, Records to native DPX file format.

TAKE 2

The TAKE 2 is a new field portable, DC powered recorder. It utilizes a new smaller Digital Film Magazine, The D.MAG2. D.MAG2 has 24 minutes recording time at 24 FPS uncompressed RGB DPX. A simplified connection panel is featured on the side panel with a transport and record panel on the front plate allowing instant use. It utilizes multiple control surfaces including camera trigger and tally, HD, HD RGB, 2K resolutions, records to native DPX file format, etc.

A.Doc, C.Dox. E.Dox & F.Doc

These are rack mount "stations" that ensure cloning, archiving and networking with the footage originally captured on D.Mags.

SOLID STATE SOLUTIONS

Grass Valley Venom FlashPak represents just a beginning (in the world of highest definition) of storage media systems that will not use any movable mechanical parts. Although limited by the storage space and price, these devices surely represent the future of Digital cinema storage.

FlashPak is a dockable solid-state recorder that designed for the Viper FilmStream Digital Cinematography Camera but also for other Digital Cinema cameras.

Venom FlashPak is a solid-state recorder that has no moving parts, making it durable and rugged for production work. It captures the uncompressed output of the Viper camera. When shooting with the camera in FilmStream mode each Venom FlashPak has a 10-minute capacity; shooting in the 4:2:2 HD mode of the Viper camera extends this capacity to 18 minutes.

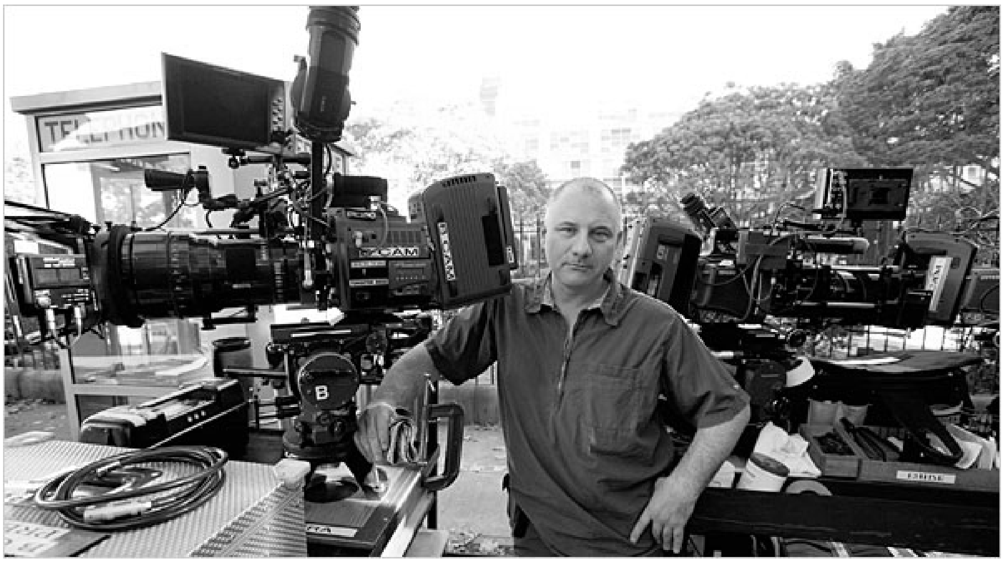
Venom FlashPak can output to a range of devices. Equipped with a Bluetooth interface, it also allows a production assistant to wirelessly create and edit metadata which is recorded and permanently associated with the content.

Storage capacity is as follows:

Aspect Ratio, Temporal Frequencies	HDTV, single HD SDI	FilmStream, dual HD SDI
16:9, 720p, 4:2:2 mode	23.98/25/29.97/50/59.94 Hz	
16:9, 1080p, 4:2:2 mode	23.98/24/25/29.97 Hz	
16:9, 1080i, 4:2:2 mode	50/59.94 Hz	
16:9, 1080p, 4:4:4 mode		23.98/24/25/29.97 Hz
2.37:1, 1080p, 4:4:4 mode		23.98/24/25/29.97 Hz

POV _Studios Shift to Digital Movies, but Not Without Resistance

By SCOTT KIRSNER



Newton Thomas Sigel, the cinematographer of "Superman Returns," with Panavision digital cameras.

Every weekend through the summer, big-budget movies compete for dominance at the box office. On movie sets, a quieter sort of contest is taking place as a handful of companies are angling to have their digital movie cameras used to capture the action, supplanting the traditional 35-millimeter film camera.

Many of this summer's most prominent releases have relied on digital movie cameras, including "Superman Returns" from Warner Brothers, "Click" from Sony Pictures and "Miami Vice," a Universal Pictures offering that opens Friday.

But while the changeover to digital filmmaking has long been predicted, these companies are encountering an unusual degree of resistance from producers, directors and cinematographers. A majority of feature films are still shot with film cameras and some well-known directors, including Steven Spielberg and M. Night Shyamalan, have been vocal about their intention to continue shooting on film.

"People involved with big-budget features are usually risk-averse," said Marker Karahadian, the president of Plus8 Digital, a company in Burbank, Calif., that rents digital cameras. "Delays are very costly when you've got stars on the set, and that means no trailblazing." Mr. Karahadian's company supplied six digital cameras made by Thomson Grass Valley for "Miami Vice."

Unlike the market for consumer digital photography, the market for professional digital movie cameras is relatively small: the major American studios released only 194 films in 2005, according to the Motion Picture Association of America. And while Panavision and Thomson Grass Valley, both based in California, have an early edge, many new cameras are on the way, from established companies like the ARRI Group of Germany and a start-up, Red Digital Cinema.

Digital cinematography first appeared as a faint spot on Hollywood's radar in 1999, when George Lucas announced his plan to shoot "Star Wars: Episode II" with a new kind of digital camera adapted from Sony Electronics' television news cameras. The Lucas experiment, released in 2002, persuaded a few directors to dabble with digital cameras, but it was not until this year that the roster of movies using digital photography began to grow.

"We've reached what may be looked at, five years from now, as a tipping point in the use of digital cameras," said Curtis Clark, a cinematographer who is chairman of the American Society of Cinematographers' technology committee.

Manufacturers have promoted the potential cost savings of the new technology. Digital cameras eliminate the need to buy and develop film, and the need later to scan that film into a computer, add digital special effects or adjust the color. Robert L. Beitcher, Panavision's chief executive, estimates that even though renting his company's Genesis digital camera at a typical rate of about $3,000 a day is nearly twice as expensive as renting a film camera, they can help save about $600,000 on film costs and processing in a big-budget feature.

But producers and cinematographers say that cutting production budgets is not the main motivation for switching to digital moviemaking.

“It saves a little money, but that was not the driving force,” said Dean Devlin, the producer of “Flyboys,” a $60 million World War I picture being released in September, which used the Genesis camera.

Rather, Mr. Devlin said the main advantage was the ability to shoot for nearly an hour during airborne dogfight sequences, with the camera mounted on a replica biplane or a helicopter and linked to a digital tape deck. Tony Bill, the movie’s director, estimated that a film camera would have been limited to shooting takes perhaps five minutes long, before requiring a new load of film.

Others are gravitating toward the digital cameras because of their aesthetic qualities. Dion Beebe, the cinematographer for “Miami Vice,” said that he and the director, Michael Mann, chose a camera from Thomson Grass Valley called the Viper to create a particular look for the movie.

“We made use of the Viper’s amazing depth of field,” Mr. Beebe said. “You’re seeing clearly from two inches to infinity.”

But Mr. Beebe says that film cameras are still superior to their digital brethren for capturing bright sunlight in a more nuanced way, and other cinematographers acknowledge that digital cameras do not have the resolution found in film.

Dean Semler, who shot “Click” and “Apocalypto,” a Mayan historical adventure movie directed by Mel Gibson, said he was impressed by the Panavision camera’s sensitivity in low-light situations when he was in the Mexican jungle. Some cinematographers may hold out for higher-resolution digital cameras, Mr. Semler said, but then added: “I’m looking at my images, and it doesn’t matter. It looks fabulous on the screen to me.”

Still, executives at Panavision and Thomson Grass Valley are not expecting an abrupt fade-out for celluloid. The bulk of Panavision’s $233 million in 2005 revenue came from renting film cameras and accessories to movie and television producers. Panavision does not sell its cameras. (The company is controlled by the investor Ronald O. Perelman, who is in the midst of taking it private, Mr. Beitcher, the chief executive, said.)

“We’ve got 1,000 film cameras in our warehouse, and we expect to be renting them for a long time,” Mr. Beitcher said.

Thomson Grass Valley is a division of Thomson, the French-based media products and services company, and is a corporate sister to Technicolor, which develops film for motion pictures.

“It’s not our job to push the market,” said Mark Chiolis, senior marketing manager for Thomson Grass Valley. “It’s our job to provide tool sets for the market to select from. If you like the look of film, shoot film.” Thomson Grass Valley and Panavision also face a cattle call of new digital movie cameras, some being sold for much lower prices. Red Digital Cinema, founded by Jim Jannard, a billionaire who started the sunglasses company Oakley, is developing a higher-resolution digital camera that will sell for $17,500.

“For the cost of a few days’ rental of their products, you can own ours,” said Ted Schilowitz, a Red Digital executive.

Mr. Karahadian, the camera rental entrepreneur, has five cameras from Red Digital on order. Complicating the market for digital cameras, he said, is their quicker path to obsolescence, and the small size of the feature film and television market in Hollywood, which does not support the cost efficiencies of high-volume manufacturing .

But camera companies like Panavision, which was founded in 1953 and supplied lenses for films like “Lawrence of Arabia” and “Ben-Hur,” may have no choice but to wade into the swift waters of digital competition.

“We don’t envision developing or building a new film camera,” Mr. Beitcher said.

POV _ FEATURE FILM HD CHOICES

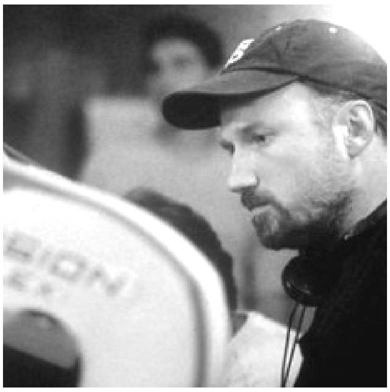
By Michael Goldman

As major feature films captured using HD cameras proliferate, it's interesting to take note of the nature of the decision-making process that major filmmakers have used to decide what systems, formats, and workflows to use for their particular projects.

As detailed in *HD Focus*, *Millimeter*, and *Digital Content Producer*, movies as diverse as Bryan Singer's *Superman Returns*, Robert Altman's *A Prairie Home Companion*, Michael Mann's *Miami Vice*, and David Fincher's upcoming *Zodiac*, among others, are combining to make 2006 the year that so-called HD movies became fairly common. But all those filmmakers had widely different reasons for choosing HD, creative needs to fulfill, and approaches to using the technology, as our series of articles illustrate.

Following are a few telling comments from Fincher and Singer about their particular (and very different) HD choices, excerpted from *Millimeter*'s and *DCP*'s ongoing series of recent feature articles on this topic.

*Director **David Fincher** on the tapeless direction he took the production of* Zodiac *using Grass Valley Viper FilmStream cameras recording to D.MAG digital film magazines, and the reaction he received from studio executives about making this kind of radical change from their traditional process:*



"We had seen the D.MAG hard drives work (on commercial projects in recent months), and we decided that was the way to go, because of random access and the ability to constantly review it," Fincher explains. "But I wanted to get totally away from tape while doing it. It never made sense to me to have a 4:4:4-capable camera that records to any kind of compression on a tape format that you can't immediately play back. … If you have a stable and reliable platform upon which to record, and immediate replay of what you just did in 1920/1080p, 4:4:4, why would you even consider putting a tape deck on top or on back of your camera? Therefore, a 35lb. camera, like Genesis, with a tape deck stuck on the top, just wasn't something I was going to embrace. Plus, we wanted this to be a widescreen movie, and Viper has a nice way of dealing with anamorphizing the 16x9 pixel array to give us full use of 1920/1080p across the 2.37:1 anamorphic aspect ratio. We really wanted to get as much resolution out of it as we could, since I did not want to crop the frame top to bottom. Why start out with a 2k image, and then throw a third of the frame away?

"But the studios often had what, for me, was a surreal response early on [to this tapeless workflow]. They were trying to understand who, exactly, would take the digital media from the set and get it cloned and archived safely for them. I said, 'the same, totally underpaid PA's who normally take your film from the set in the middle of the night to the lab. Now, instead, they will be taking an anvil case with a D.MAG in it back to the editing room.' When we started working on it, a lot of people had trouble understanding what we were doing in that sense."

*Director **Bryan Singer** on his grudging movement toward HD, culminating in his use of Panavision's Genesis Digital Camera System for shooting* Superman Returns *onto HDCAM-SR tape:*

"It took me a while to convert to the Avid, let alone shoot a big, romantic movie, which *Superman Returns* is, with digital cameras," Singer explains. "I'm kind of surprised we went this way, to be honest, but we did. I talked to all the guys (shooting with digital cameras)—George Lucas, Michael Mann, Jim Cameron. I was at Lucas' ranch with all those other filmmakers a few years ago when he had his digital summit to educate everybody about HD. That was before I made [*X-Men 2*], and I was hardly a convert at that point. I wasn't ready. But I got to talk to a lot of filmmakers about this process, and I became more open-minded by the time I took over this project.

"At first, it was scary. I mean, you put your $200 million movie all on $80 HDCAM-SR cassettes—that's a little unsettling. But the truth is, it translated beautifully and gave us that rich look we wanted. By that time, I had been real blessed to have so much interaction with filmmakers exploring HD ahead of me. Jim Cameron, who is a friend of mine, was developing his 3D digital system at the time, for instance, and he showed me some early stuff from his documentary work. That kind of exposure gave me the confidence to make this change, and for *Superman Returns*, I think it worked out great."

POV _ ROBERT ALTMAN'S TAKE ON HD

A Prairie Home Companion marks the second straight feature shot using high-definition cameras from director Robert Altman. Coming on the heels of *The Company* in 2003, *A Prairie Home Companion* debuts in June. It was shot over the course of five weeks last year at the Fitzgerald Theater in St. Paul, Minn.—the location where the real *Prairie Home Companion* radio show, upon which the movie is based, is produced.

Altman's team, led by DP Ed Lachman, ASC, shot the movie using several Sony HDW-F900 cameras, all outfitted with Fujinon HD Cine Style lenses, and recording to three Sony SRW-1 HDCAM-SR portable digital recorders.

But technical details aside, Altman says he largely adopted HD for his last two films because of his preferred shooting style—improvisational, lengthy, uninterrupted takes. "I don't want the actors to always know when the camera is on them—with high definition, I can just keep going, and I like that," Altman explains.

Through meticulous testing, the development of proprietary lookup tables in pre-production, strategic lighting and shooting, the use of the film-style Fujinon lenses, and a lengthy digital intermediate process at Technicolor, New York, Lachman made sure to maintain a stylized film sensibility for the imagery, per Altman's mandate.

Altman claims the result is a film that few people could tell was shot digitally. Since digital exhibition remains far from ubiquitous, at least for now, the 81-year-old director emphasizes that this is an important distinction—most people who see *Prairie* will see it on film. Altman says production of most modern movies, whether shot on film or HD, leads to the creation of fresh film negatives and release prints that may bear little direct connection to the original in-camera negative or data. The notion of getting rid of or replacing film is irrelevant, Altman says.

"The point is, I'm interested in using HD now because it suits my style," he says. "A movie like *Prairie* doesn't have many exteriors or big, sweeping vistas and all that. It's an ensemble piece shot inside a theater with lots of cameras rolling all the time. We had one take, in fact, that was about 17 or 18 minutes long with three cameras, without stopping. Shooting anything of that nature with something other than HD, now that HD is available to us, would be silly really. HD definitely makes improvisation easier, which is something that is important in my films.

"But I believe that it does not make a difference whether you acquire a film negative on set or make one later, after shooting digitally, in a sense," he adds. "Many people shoot on film, throw that original negative away, edit and process or do effects in digital space, and then go back and finish on film. That makes it a new piece of film. This is no different than that. We have a new negative, just like they do. People very rarely use the original negative for the final version of the film—they make a new one. So I'm happy the technology lets me shoot the way I want to, but I don't look at it like I've changed or whatever. I'm using the tools that work best for the material and the way I want to work. It's about giving me more ways to do things."

Left to right, Jimmy McMillan, key grip, Steve Speers, first assistant camera operator, Robert Reed Altman, camera operator.

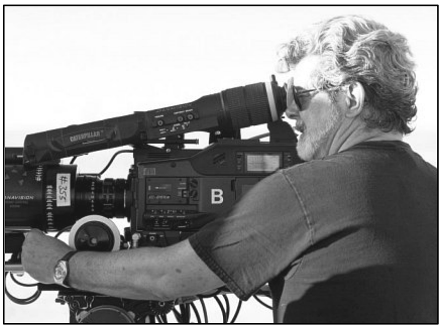
POV _ DIALOGUE: GEORGE LUCAS

The movie business is changing, but not fast enough for ILM's founder.

George Lucas does not dwell in the past - he's more of a forward-looking type. But he also has created a bit of history during his 35-year career, and as a result, Lucas frequently is asked to revisit the events that got him where he is today: running, under his Lucasfilm umbrella, a network of companies that includes not only Industrial Light + Magic and Skywalker Sound but also the gaming firm LucasArts, the George Lucas Educational Foundation and Lucasfilm Animation, which opened its doors last month in Singapore. Lucas sat down recently with The Hollywood Reporter's Paula Parisi over breakfast at Hotel Bel-Air to reflect on his empire and, more to his current taste, talk about the challenges facing the theatrical-release model and why the industry is missing the boat on digital cinema.

The Hollywood Reporter: Things have changed a lot during the 30 years since you formed ILM: Back when you were making 1977's original "Star Wars," you had to wait days to see your effects shots. In general, how does the process compare with today?

George Lucas: Steven (Spielberg) was just up visiting on Monday; we're doing (Universal's upcoming drama release) "Munich," and I was showing him the new facility. He arrived in the morning, at about 9 o'clock, and we looked as some of his dailies. He indicated some things he wanted differently in the effects. Then we went off and I showed him around, and we worked on some other projects and stuff. By the time we got back to ILM, before lunch, we were able to look at his shot again, with the change. In the old days, that would have taken weeks to do; now, you can do it in a matter of hours.



THR: Now there is a whole movement toward real-time previsualization. Can you composite right there on the set?

Lucas: Yeah - not in quality that would be in the (finished film), but we can do it roughly. We can even build digital sets and things and have them move in real time. So if we're shooting bluescreen, we can pan around and see what you're going to see, a rough version of what the final shot would look like.

THR: What was the industry like when you started preproduction on "Star Wars" in 1975, and why did you open your own effects firm?

Lucas: None of the studios had special-effects departments. The Walt Disney Co. had Harrison Ellenshaw, a matte painter, and a little bit of a special-effects department, and Universal had Albert Whitlock, also a matte painter. But once you got beyond matte painting, the departments weren't really there - (and) I needed something much more complicated. The only person who had actually done some special effects in the last 10 years was Stanley Kubrick, so I started looking around for people who had worked on (1968's "2001: A Space Odyssey"), and then it just grew from there.

THR: Can you describe your vision for what you were going for in "Star Wars," in terms of sound and effects?

Lucas: I wanted a really kinetic film, visually - lots of quick cuts and camera movement. Soundwise, I've always felt sound was an extremely important part of the process of making a film; I had worked as a sound editor, and for a couple of years I had worked as an editor, so I was very attuned to that sort of thing. Ultimately, I wanted to be able to do sound work right in our offices - I didn't want to go into (San Francisco) - so we started setting up our little mixing room. I had hired Ben Burtt, and he was creating all of the sound effects and voices. I had to start from scratch - What does R2-D2 sound like? What does C-3PO sound like? What does a Wookiee sound like? A spaceship? A laser sword? - because I was creating a space opera, a fantasy film. I wasn't making a science fiction film - it was a movie. And believe it or not, one of the most important elements to making something move is sound.

THR: You invested a half-million dollars of your own money to develop technology for "Star Wars." That was a pretty big gamble at the time.

Lucas: At that point, I didn't have any choice. The original film, "Star Wars - Episode IV: A New Hope," was very carefully written around the technology. I felt that the one thing I could accomplish technologically, the one hurdle I was willing to try to jump over besides the normal stuff of getting a film made, was being able to pan in space, so I could make a very kinetic experience out of it - I thought that was important to the vision. Everything else was carefully written so I could shoot in deserts, and I didn't have to build a lot of sets. We didn't have a lot of costumes; we didn't have a lot of extras. Everything was stripped down so I could do it as inexpensively as possible.

THR: What was the budget?

Lucas: Originally, when I was writing the script, we were hoping we would be able to do it for $3 million or $4 million. But it came out closer to $10 million.

THR: That's a far cry from the budgets of today.

Lucas: The average is something like $60 million, (but) the average cost of making a movie in Europe is $3.5 million. That's the way things are really competing. I think the American film industry is going to become like the rest of the world - and people won't get paid as much.

THR: There are definitely some dynamics that are changing the economics of the business. What do you think of

Mark Cuban's idea of releasing films simultaneously at home and in theaters?

Lucas: I think it'll happen - it'll have to happen.

THR: Really? Because of the economics?

Lucas: Because of piracy. It's the only way you can stop piracy; there is no other way. You have to get a very, very aggressive enforcement program so that people do have consequences to stealing, but you also have to be able to offer it to them (in the home) for the same price they can get it on the street. It won't be DVDs - DVDs aren't going to be around too much longer. If you can get it at home for $2, then why would you go on the street and get a bad version?

THR: What do you think will replace DVD?

Lucas: Pay-per-view.

THR: Something that streams in, not prerecorded media?

Lucas: It's the way kids do it today. It's how you do it on your iPod: They just download it. You pay 99 cents for music, and movies will be like two bucks. That will definitely change the economics of the business because (studios) are losing money now.

THR: Somebody was telling me that the studios' profit margins are only about 10%.

Lucas: I don't even think it's that: If you look at the (theatrical) divisions, I don't think they make any money. I don't think they've made money for five or six years.

THR: So it's basically a loss leader for DVD, television, etc.?

Lucas: Yup, all of the ancillary markets. For studios, the fact is that the theatrical film market is less than 10% of their business - it's very, very small. I mean, you could chop that off in a second, and it wouldn't even bother them - they're just doing it as a promotional thing.

THR: Do you think the industry will survive that way?

Lucas: I don't think the theatrical exhibition business will go away because I think people will always want to go to the movies, just as they go to the opera, they go to the ballet, and they go to football games. Football is a perfect example, where you can stay at home and watch it in the comfort of your own home and see a much better presentation, but people still sit out in the cold and cheer on (their teams) ... and you can't see anything because it's all distant. And now they have giant screens so you can watch it on television right there - but they still fill up 100,000-seat (stadiums). We'll end up with fewer theaters with bigger screens and better presentations, and the theater owners will work very hard to make the whole thing an event.

THR: How will the industry deal with that?

Lucas: I don't know, but they'd better go faster. They're very slow in their reaction time: If they had started releasing movies digitally in 1999, when we released "(Star Wars: Episode I -) The Phantom Menace," which was the first digital film, released digitally, then they would have saved $5 billion or $6 billion by now. Of course, that kind of money doesn't mean much to the studios. But the filmmakers won't have a problem: They can always make films. They just have to figure out how to get them shown. As more and more people switch to digital and realize they can make films for nothing, really, then you can either show them on the Internet or in movie theaters if you get digital distribution. Right now, on an A-class movie, just making prints at the lab is $20 million, then there are costs for shipping those prints and eventually destroying them.

THR: Now that you have scaled the mountain in terms of visual presentation, are these the things you'd like to see accomplished?

Lucas: Well, we've become very efficient in terms of how you design shots and the creative side of things. But then, at the same time, we've become very efficient on the production side of things: We move things through the process very fast and still have the highest possible quality.

THR: So you're not really compositing "elements" anymore but building up these shots in the computer ...

Lucas: You do build things in digital: You build your characters, your sets, your vehicles, props and everything that goes into it.

THR: So you're building a library of digital assets?

Lucas: That may happen at some point. Generally, now, we build the dinosaurs for (1993's) "Jurassic Park," but by the time (1997's "The Lost World") rolls around, we've moved the sophistication of the technology so far forward that those dinosaurs are dinosaurs. There's a better, faster way of doing it, so you have to build new ones, using new software. But eventually it'll get to a point where that will settle down, the technology will stabilize, and once you build elements, you can reuse them. But once you get those things built, they get brought in, and then the live-action elements get brought in, and you combine it all. Your animation elements are done. It's just like making a movie.

THR: It's just like making a movie? (Laughs) It is making a movie!

Lucas: It's just that you're doing it in the computer instead of on a back lot somewhere.

PROFESSIONAL HI-DEF SYSTEMS

DVCPRO HD

DVCPRO HD, and specially its top version Varicam is today a standard tool for many cinematographers and their projects. Apart from Sony's HDCam it is probably **the** HD format mostly used in the industry. Besides the undisputed quality (specially for a broadcast HD format) the decisive arguments was the fact that it was a development on the basis of the proven DVCPRO format and backed by Panasonic - one of the largest players in the industry.

Panasonic originally created the **DVCPRO** family based on DV format for ENG use with better linear editing capabilities and robustness. It has track width of 18 micrometers and uses *Metal Particle* instead of *Metal Evaporated* tape. Additionally, the tape has a longitudinal analog audio cue track. Audio is only available in the 16 bit/48 kHz variant, there is no EP mode, and DVCPRO always uses 4:1:1 color subsampling (even in PAL mode). Apart from that, standard DVCPRO (also known as DVCPRO25) is otherwise identical to DV at a bitstream level.

DVCPRO50 is often described as two DV-codecs in parallel. The DVCPRO50 standard doubles the coded video bitrate from 25 Mbit/s to 50 Mbit/s, and improves color-sampling resolution by using a 4:2:2 structure. DVCPRO50 was created for high-value ENG compatibility. The higher data rate cuts recording-time in half (compared to DVCPRO25), but the resulting picture-quality is reputed to rival Digital Betacam.

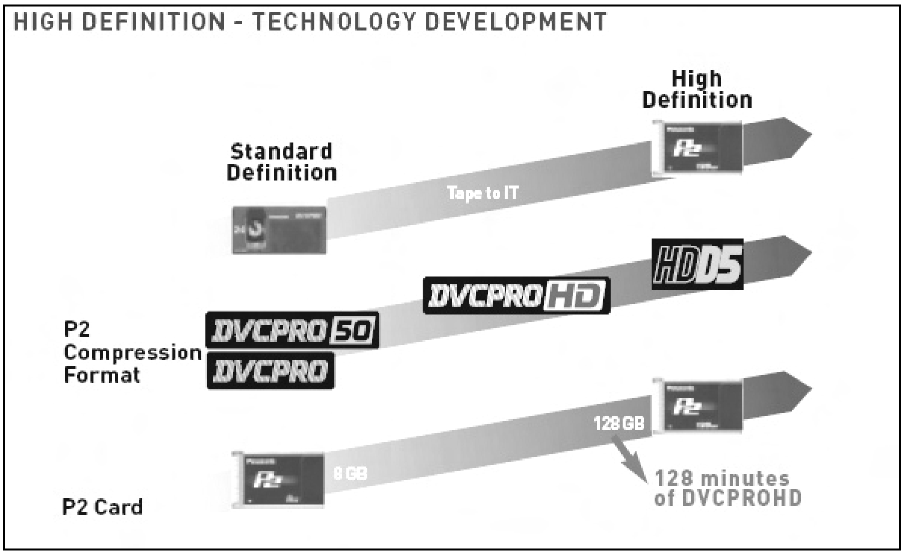
DVCPRO HD, also known as **DVCPRO100**, uses four parallel codecs and a coded video bitrate of 100 Mbit/s. Despite *HD* in its name, to maintain compatibility with HDSDI, DVCPRO100 equipment internally downsamples video during recording, and subsequently upsamples video during playback. 720p is downsampled from 1280x720 to 960x720, and 1080i is downsampled from 1920x1080 to 1280x1080 for 59.94i and 1440x1080 for 50i. Quantization is 8 bits and compression ratio 6.7:1. A camcorder using a special variable-framerate (from 4 to 60 frame/s) variant of DVCPRO HD called *VariCam* is also available. All these variants are backward but not forward compatible.

DVCPRO HD's eight channels of high-quality, non-compressed digital audio, with 16-bit quantization and 48-kHz sampling, provide all that's needed for 5.1-channel surround sound and multilingual productions. HD images can be recorded and played in either 1080i or 720p. This accommodates 720p production using VARICAM, and allows the HD format to handle both broadcasting and cinema work.

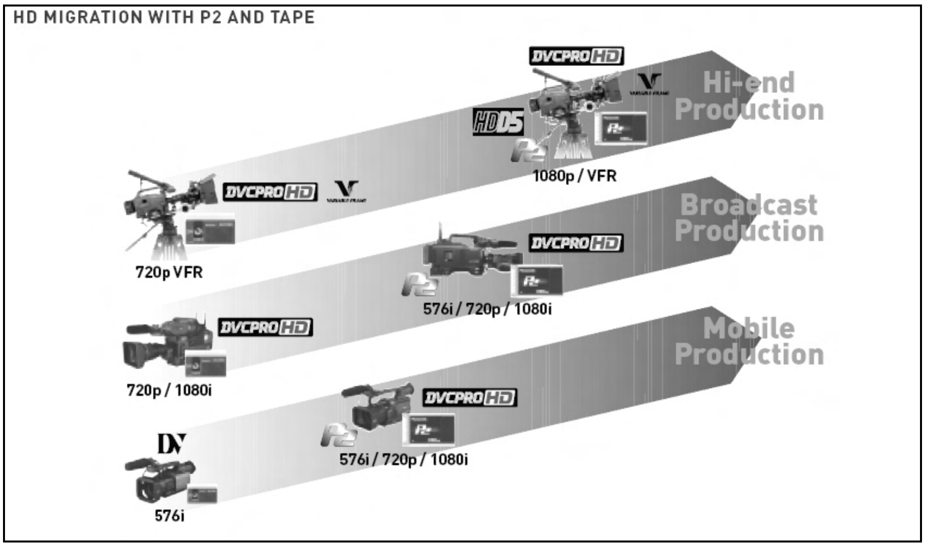
The newest addition to the format family - **DVCPRO HD-LP**, has twice the recording density of DVCPRO HD, employing 9-µm recording track. Using the L cassette cameras can record 92, and with the new XL cassette, some of the devices can provide up to 124 minutes of recording or playback.

A major boost for the DVCPRO HD camp was the introduction of highly interesting and (already) popular small camcorder AG-HVX200 that is clearly showing the path of the future Panasonic technological developments.

As the diagrams on the next page show, Panasonic is committed to two issues - HD (in t he format of further development of DVCPRO HD) and its P2 tapeless (solid state cards) solutions. Although only the first step in this direction, AG-HVX200 is an important proof that such a philosophy is not only realistic but also that can produce affordable devices.



The migration from SD to HD takes place against a range of major technological issues for the industry. Traditional tape technology is starting to be replaced by tapeless technology in acquisition, although tape will remain an important storage medium for the coming years. HD production standards are still evolving with both interlaced and progressive production enjoying support. HD's large bandwidth requirements and file sizes pose challenges as the industry moves gradually to a networked environment based on commodity IT products.



The migration from SD to HD with tape and P2, is not a single pathway with one route and outcome. In fact there are a range of options depending on existing infrastructure and markets served. For many broadcasters and production companies over the next few years, there is going to be a mixed production environment of SD and HD as well as tape and tapeless. Panasonic believes that tape will play an important role in the HD production environment for the immediate future, as new production solutions such as 720/50p will be available in DVCPROHD and HDD5 as a tape based solution. P2 equipment is becoming the main production tool in the SD environment. Building on development trends in the IT sector, P2 is ideally placed to link both legacy investment in tape with new IT operating methods and standards. Looking to the future, P2 will link HD development in the same seamless way.

DVCPRO HD - the equipment

CAMCORDERS

AJ-HDC27 Varicam

The AJ-HDC27 VariCam is a flagship of the whole DVCPRO HD range. It serves a triple role: 1.) as a 24-fps camera, 2.) as a standard 60-fps video camera, and 3.) as a variable frame rate special effects camera.

VariCam earned its name by bringing variable frame rate acquisition to the DVCPRO HD product line. Individual frame rates may be selected from: 4-fps to 60-fps in single frame increments. Frame rates may be changed during recording. Designed as a high quality production camera, this native 720p camcorder can be used for 60-fps or the film-like 24-fps acquisition. When acquiring for 24-fps projects, higher than 24-fps operation can be processed for slow motion effects while slower than 24-fps operation can be processed to speed up motion.

It is important to understand that only the camera section operates at variable frame rates. The VTR and the camera HD-SDI output operate at a constant 60-fps rate. If you set the camera for 60-fps with no shutter, the exposure time is 1/60th of a second and each camera frame is recorded once on tape. As soon as the frame rate becomes lower than 60, exposure time increases proportionally and redundant frames are recorded on tape. For example, if the camera operates at 30-fps, each new frame is recorded twice to ensure 60-fps on tape. 24-fps is a non-evenly-divisible frame rate and requires the classic 3:2 type pulldown frame sequence with one frame recorded three times and the next two times. This technique generates redundant frames used to pad the data to maintain a constant 60-fps on tape including both new frames and redundant (repeated) frames.

By keeping the VTR frame rate at 60-fps no new DVCPRO HD studio VTRs or specialized video monitors are necessary. By recording standard 720p60, tape can be run through a standard linear tape based post production chain, yet still deliver "film look" video.

The camera has the capability to emulate film's gradual transfer function performance i.e. CineGamma. This function greatly increases the camera's usable dynamic range, especially in traditionally limiting areas such as highlight handling. Camera works with three Gamma Curves - **Video gamma:** The conventional gamma curve used for broadcast video cameras. - **Cine gamma (V.REC)**: Designed for creating film-like TV programs or videos, - **Cine gamma (F.REC):** Designed for moviemaking. Takes full advantage of cine gamma capabilities to let you shoot in the same way as when using a film camera.

For 24 fps non-linear editing one should use DVCPRO HD VTR that is capable of playing back a 720/24p over 60p source and directly convert it to 1080/24p output On the other hand, AJ-HD1200A DVCPRO HD VTR can facilitate HD data transfer via an IEEE 1394 digital interface to enable integration various makes of IEEE 1394 HD compatible nonlinear editors.

AJ-HDX900

Basically, HDX900 is a Varicam camcorder without complete variable frame rate and some other features that are not necessary in the everyday production. In such a way, Panasonic produced an HD camcorder of the high picture quality and relatively affordable price. The basic features include:

- Full-size 2/3" CCD block provides compatibility with all manufacturers 2/3" lenses for ENG, EFP and digital cinema production
- Multi-format recording system that supports 1080 at 59.94i, 50i, 29.97p, 25p, 23.98p, 23.98pA and 720 at 59.94p, 50p, 29.97p, 25p, 23.98p
- 14-bit A/D DSP circuits that provide optimum picture quality, color reproduction and luminance gradation
- 4:2:2 color sampling and independent frame compression
- Records 48kHz/16-bit digital audio on all four channels
- Three CineGamma modes
- Built-in IEEE 1394 digital output allowing direct transfer HD video to NLEs or other VTRs
- Standard HD SDI output for monitoring and line recording
- Built-in downconverter produces a SD output, allowing the use of low-cost SDI accessories
- Low-light shooting down to 0.032 lux (at+62 dB gain)
- Two 4-position optical filters (ND: clear, 1/4, 1/16, 1/64; CC: Cross, 3200K, 4300k and 6300K)
- Electronic shutter (1/100 to 1/2000 sec.) with synchro scan shutter (1/60.3 to 1/249.8 sec.)

AJ-HDX400

AJ-HDX400 is an older version of the mid range DVCPRO HD camcorder and will, probably, soon be discontinued. However, the camera is equipped with a host of interesting functions, including digital super gain (frame cumulative mode) and digital zoom. Basic features:

- 12-bit A/D signal processing
- 2/3" 3-CCD HD shooting system
- Cine-like gamma curve
- Precise color management with linear matrix color, 12-axis color correction, and shading correction
- Standard HD-SDI output
- Digital Zoom provides image size up to 400%
- Four built-in user scene files and SD Memory Card slot for storing up to eight files
- Versatile DTL functions, including skin DTL and continuously variable DTL peak frequency
- Auto knee circuit produces wide dynamic range
- SynchroScan electronic shutter
- Four-channel 48 kHz, 16-bit digital audio and 5-pin XLR mic jack
- Pre-recording (up to 10 seconds), retake, and interval recording
- Power-save management
- Color bars
- Built-in SMPTE timecode generator/reader with timecode in/out terminal

AG-HVX200

This, often called revolutionary, camcorder for under $ 6.000 was surely one of the "hottest" news in HD video in the last year. The ability for such a small and affordable camcorder to record in intraframe 4:2:2 DVCAM HD is surely amazing. However, the P2 modules which are the provided media HD footage can be recorded on, is at the moment rather expensive and with limited storage capacity. But, before addressing this issue, let's see the major features of **AG-HVX200:**

- True high definition image quality with low-compression DVCPRO HD intraframe recording

- Multiple formats: DVCPRO HD, DVCPRO 50, DVCPRO, DV selectable
- High definition recording formats: 1080/60i, 1080/24p, 1080/24pA, 1080/30p, 720p (variable frame rates)

- Standard definition recording formats: 480/60i, 480/24p, 480pA, 480/30p
- CineSwitch technology for variable frame rates in 720p mode: 12, 18, 20, 22, 24, 26, 30, 32, 36, 48, 60fps
- 1/3" 16:9 native high-sensitivity progressive 3-CCD with 1080/60p scanning
- New DSP with 14-bit A/D conversion and 19-bit internal processing
- 16:9/4:3 switchable for standard definition recording, 16:9 native for HD
- Wide angle Leica Dicomar HD lens with optical image stabilizer
- High resolution 0.44" electronic viewfinder (EVF) & high resolution 3.5" LCD display
- Auto and manual focus with focus assist and Cam-driven manual zoom
- 13X zoom range: focal length = 4.2 to 55mm (35mm equivalent: 32.5 to 423)
- Advanced gamma functions and eight gamma settings including CineGamma & NewsGamma
- Advanced image adjustments: color matrix, detail, chroma phase, color temp, knee points
- Two P2 card slots with hot swap capability
- Hot swap, loop, pre-record (3 seconds in HD, 7 seconds in SD), one shot, and interval recording functions
- Mini-DV tape transport for DV recording
- Internal downconversion and frame rate conversion from HD footage on P2 cards to Mini-DV tape
- 48kHz 16-bit 4-channel PCM audio (2 XLRs with phantom power)
- Analog component (Y, Pb, Pr) output
- Standard IEEE 1394 interface
- Host mode for transferring previously recorded content on P2 cards to an external hard drive via IEEE 1394
- SD memory card slot for sharing scene files
- Remote control for zoom, record, focus, iris control
- SMPTE timecode reader & SMPTE color bars
- Slow, synchro and high speed shutter
- Ultra-tough magnesium alloy chassis

AG-HVX200 Storage problem & solutions

As said, the major problem with this camcorder lays in the fact that HD footage could be recorded only on the P2 cards which are expensive and limited in the capacity. Since 1Gb of storage is approximately enough for 1 minute of HD video, it is easy to calculate that two 8Gb P2 cards (maximum capacity at the moment) give some 16 minutes of HD footage and that for a price of $ 1.200 each! But, there already are a number of solutions:

FOCUS FireStore FS-100

Weighing about one pound and only 1.5 inches thick, FireStore FS-100 is supporting DVCPRO HD, DVCPRO 50, and DVCPRO/DV recording formats. The FireStore FS-100 comes standard with a 100GB hard drive that provides 1.5 hours of DVCPRO HD recording time. One can also extend recording time by linking multiple FireStore FS-100 units together. A 10-second electronic shock cache ensures that footage is never lost. And the FireStore FS-100 makes it easy to categorize clips by placing them in prenamed folders on the disk. When in DVCPRO HD or DVCPRO 50 mode, files are recorded to disk in P2 MXF format. When in DVCPRO/DV mode, files are recorded as different NLE file formats.

CinePorter by *Specialized Communications*

The CinePorter CP-2 is a small external hard disc recorder that works like a very large P2 card while writing data to a shock-mounted on-board hard drive with capacities of 160 GB (single disc) to 360GB (two discs) and the option of data redundancy when 2 discs are stripped together in RAID level 3. CinePorter is located below the camcorder and connected via P2 card slot. It is able to capture native frame rates and also all meta-data.

The CinePorter has an independent power source. When long record times are needed and battery time may become an issue, one can hot-swap batteries or switch to 12 volt external power with a minimum of one minute between swaps.

CitiDISK HD - FireWire by *Shining Technology*

Citidisk HD is hard drive based solution that is connected with the camcorder via a FireWire cable. It records video streams via camera's REC button with tape, or by CitiDISK HD's REC button without tape. CitiDisk HD stores the video streams into MXF (Panasonic P2) file format. With a “QPLAY” option, the last captured video streams can be viewed on viewfinder when setting camera to VCR mode. Navigating history clips is also possible by press and holding the QPLAY button for 3 seconds. It automatically detects incoming video stream formats and audio sampling rates, and provides record/playback in either format. Video stream is buffered in internal memory and instantly recorded to the unit's hard drive when the REC button is pressed or REC command is selected.

DVCPRO HD VTRs

AJ-HD1700

Top of the line of the recorders. Full 19" size, with the following features:

- Up to two hours recording time;
- Multiple HD recording formats - 1080/60i, 1080/59.94i, 1080/50i, 720/60p, and 720/59.94
- Eight channels of discreet audio recording, supporting 5.1 channel surround sound and SAP
- Universal DV format playback compatibility - DV, DVCAM, DVCPRO25/50, DVCPRO HD
- DVCPRO HD-LP format offers twice the recording density of DVCPRO HD
- Allows direct playback of 720/24fps VariCam-recorded tapes, converting them to 1080/24p for editing or dubbing
- HD-SD format downconversion, optional SD-HD upconversion
- Output screen aspect ratio conversion
- Advanced slow motion and built in LCD monitor on front panel
- Compact 4RU footprint with 100x shuttle and jog in both forward and reverse
- Wide range and slow motion playback
- Optional MetaData and SDTI capabilities

AJ-HD1400

A smaller recorder designed for the field work, NLE support and other functions. Features:

- Multi-format - records in 1080/59.94p, 1080/50i, 720/60p, 720/59.94p and 720/50p
- Converts from a VariCam 50p recording (over 60p) source with native 720p/50 or PAL output
- IEEE 1394 input/output interface transfers DVCPRO HD native video to NLE systems
- HD-SDI input/output and SDI output
- Built-in up/down/cross converter for playing back DVCPRO

50/DVCPRO/DV/DVCAM tapes and for outputting a converted HD signal
- Accepts DVCPRO (L/M) and Mini-DV cassettes (AJ-CS455 cassette adaptor required for Mini-DV cassette playback.)
- AC or DC operation
- High-quality 16-bit digital audio with up to eight embedded channels

AJ-HD1200A

AC/DC-powered AJ-HD1200A plays all DVCPRO formats (both NTSC and PAL), including DVCPRO HD-LP, and can downconvert HD signals for output as SD signals, allowing its use as both an HD and SD viewer. With its 1080/24p (25p) conversion and output function for Varicam sources, the AJ-HD1200A also meets needs in HD cinema production. With an optional board, and the AJ-HD1200A can serve as a recorder in a space-saving, low-cost HD production system. Can be outfitted with either an SDI type optional board (HD-SDI in/out, SDI out) or an IEEE 1394 type board. With the IEEE 1394 board, the AJ-HD1200A HD becomes the world's first VTR to offer HD input and output via an IEEE 1394 digital interface.

AJ-PCD20

This drive for P2 cards can be operated either as an internal drive using a standard 5.25” drive bay, or as an external drive connected via either USB 2.0 or IEEE1394b to a LAN or directly to a PC. It can mount five P2 cards at the same time, allowing instant access to footage shot continuously across multiple cards. Loaded with five 8GB P2 it can handle up to 160' of DVCPRO footage, 80' of DVCPRO50 and 40' of DVCPRO HD.

AJ-PCS060G

The AJ-PCS060G is a portable hard disk unit with a P2 card slot that quickly transfers the content of P2 cards to an internal hard disk drive. The 2.5" 60GB hard disk drive can hold the contents of up to 15 4GB P2 cards, and the entire contents of a 4GB P2 card can be transferred to the internal hard disk drive in about four minutes. After the P2 content has been transferred, the AJ-PCS060G can connect to a nonlinear editing system or server ingests PC via a USB 2.0 interface and appears as an external disk drive. The AJ-PCS060G has a shock-resistant magnesium alloy body and is equipped with special impact-absorbing materials to cushion the hard disk against shock and vibration.

SONY HDCAM

HDCam is today a kind of *de facto* standard in high definition acquisition and processing. Although (on paper) vastly compressed and with relatively low color space details, HDCam, and specially it's CineAlata range of products are responsible for the real advent of digital cinematography and the penetration of digital technology in mainstream Hollywood productions.

Ultimately, HDCAM is a time-tested format that produces visually impressive results. The compression system has not proved to be much of a practical limitation, and, HDCAM is reasonably priced.

HDCAM format

HDCAM aka SMPTE D-11 format was developed and introduced by Sony in 1997 to meet the needs for a high quality, portable, rugged and (relatively) affordable high definition format. The HDCAM format features Digital High Definition - 1920 horizontal and 1080 vertical lines of active pixel picture (Common Image Format) - to provide increased contrast, sharpness and detail.

High Definition video's most noticeable attributes are a wide-screen 16:9 aspect ratio that is four times the width and three times the height of the Standard Definition 4:3 video. The HDCAM format also features frame rate switchability to various digital broadcasting formats and the motion picture industry's film-like 24fps (frames per second) format. The complete list of the supported frame rates, in both progressive and interlaced modes, is - 23.976P, 24P, 25P, 29.97P, 30P, 50i, 59.97i and 60i.

Some of the HDCAM VTRs offers playback compatibility with tapes recorded in an analog BETACAM / BETACAM SP, BETACAM SX and BETACAM IMX recorders, providing a natural migration path for users of older BETACAM formats who wish to upgrade to High Definition Digital.

Additionally, the HDCAM format supports four channels of 20-bit/48kHz AES/EBU digital audio or can record Dolby-E bit streams onto each pair of AES/EBU audio channels.

It uses half inch tape in a cassette similar to that used by Digital Betacam.

CineAlta range of products added true 24p for compliance with the film industry and easy transfers.

MYSTERY BEHIND THE FORMAT

For years, Sony was rather secretive about the actual numbers and data of the HDCAM format. It was obvious that the pictures looked great but that there is some heavy compression behind it. To be fair, the task was, specially more than ten years ago, really complicated - to squeeze HiDef information into a 1/2 tape format, maintain its portability, economics and ruggedness.

Sony did a great job. But, let's see how. Here is the excerpt from the article by **Dr. Peter Utz** from http://videoexpert.home.att.ne

The ATSC (Advanced Television Systems Committee) tables indicate that a 4:2:2 sampled 1080i image should have 1920 luminance pixels in the image. Chroma should be 960 pixels. Put another way, the 4:2:2 sampling should translate to 1920:960:960. Sony's HDCAM is said to record only 1440:480:480 pixels. If you do the math, this translates to 3:1:1, a number worse than 4:2:2. The numbers don't tell you everything, however; the HDCAM image is gorgeous and Sony challenges anyone to see the difference between the HDCAM output and that of its rivals.

The 3:1:1 numbers would also imply that the image is worse than a consumer DV camera (4:1:1) and this definitely not the case. A home DV camcorder has a sampling of 13.5 MHz yielding 720 pixels per line. According to the ATSC, HD is sampled at 74.25 MHz (true whether the format is 1080i, 1035i, or 720p) yielding 1920 pixels for luminance per line. Thus, 4:1:1 in the SD DV world means 720:180:180 pixels. In the HD world, 4:1:1 would mean 1920:480:480 pixels. So you can't compare DV's 4:1:1 with HDCAM's purported 3:1:1; that would be comparing grapes to grapefruit.

Now here's the real concern: HDCAM supposedly uses a 55.68 MHz sampling rate which should technically resolve to 1440 luminance and 480 chrominance pixels per channel. Comparing these numbers to the ATSC HD specs, we would come up with the number 3:1:1 which looks below par. When pressed on the issue of how many pixels are being recorded by the HDCAM machines, Robert Ott could only state; "The HD SDI signal from an HD SDI standpoint, based on the SMPTE 292M standard, facilitates a 1920 x 1080 pixel baseband digital capability." The author conjectures that the VCR manufac-

tures the missing pixels. Whether they're visually missed is a tough question. ...

The HDCAM is an eight bit machine, but Robert Ott goes on the explain, "HDCAM uses eight bit data reduction, but from a quantization standpoint, the inputs and outputs are ten bits. So, from a compression standpoint, we're eight bit data reduction. But from a quantization standpoint in the video, we're ten bits on the inputs and the outputs. "

So, HDCAM specifications are...

HDCAM is using an 8-bit (10 bit in-out) DCT compressed 3:1:1 recording, in 720p or 1080i-compatible resolution. Although capable of 1920x1080 output, HDCAM internally stores the video at 1440 x 1080, and has a 7:1 compression ratio. The recorded video bitrate is 144 Mbit/s.

HDCAM EQUIPMENT

Camcorders

HDW-730

The HDW-730 features three 2/3-inch IT CCDs each with 2.2 million-pixels and Advanced Digital Signal Processing (ADSP). The camcorder is switchable between 1080/50i and 1080/59.94i operation with signal-to-noise ratio of 54 dB and a minimum illumination of 0.31 lux. The HDW-730 outputs HD-SDI as standard. Camera setup data can be stored in a "Memory Stick". An optional picture cache board can capture pictures and sound in advance of pressing the record button. TruEye processing virtually eliminates hue distortion, especially in extreme lighting conditions.

HDW-750

The HDW-750 is a version of HDW-730 with the additional capability of shooting in both 25p and 50i. Although not a CineAlta product - it doesn't have 24p mode, it is a great camcorder that enables user to combine high quality of HDCam format with real progressive recording. The HDW-750P has a sensitivity of f10 at 2000 Lux. When fitted with an optional HKDW-705 Slow Shutter board, the camcorder can slow its shutter speed to a 64 frame period.

HDW-F900R

Sony HDCAM has become firmly established as High Definition production format worldwide, with a unique track record for production of the highest quality programming. Much of this reputation has been built upon the HDW-F900, the world's first 24P CineAlta HD camcorder, which received a Primetime Emmy Engineering Award in 2004.

The highly respected HDW-F900 camcorder has recently been refined into the next-generation HDW-F900R, offering a variety of further enhanced functionalities. The HDW-F900R combines the imaging performance of the original HDW-F900 in a smaller, lighter chassis. Power consumption has been reduced, new features have been added and the new camcorder meets the latest environmental legislation.

The HDW-F900R camcorder records images in accordance with the CIF (Common Image Format) standard, which specifies a sampling structure of 1920 x 1080 active pixels (horizontal x vertical). Plus, as well as recording at 24P, the HDW-F900R camcorder is switchable to record at 25P, 29.97P progressive scan, and also at 50 or 59.94 Hz interlaced scan.

The HDW-F900R features 12-bit A/D conversion, can record four channels of digital audio and provides HD-SDI output as standard.

The camcorder also provides a comprehensive range of features for creative shooting such as enhanced gamma features and colorimetry controls. To further enhance the creative and operational versatility of the camcorder, a wide range of optional accessories are available. These include a picture cache board, a 2-3 Pull-down and down converter board, and a slow-shutter board. In combination with its renowned 24P capability and attractive cost efficiency, all of these great functionalities make the HDW-F900R the perfect solution for shooting television series , documentaries, commercials, as well as motion pictures.

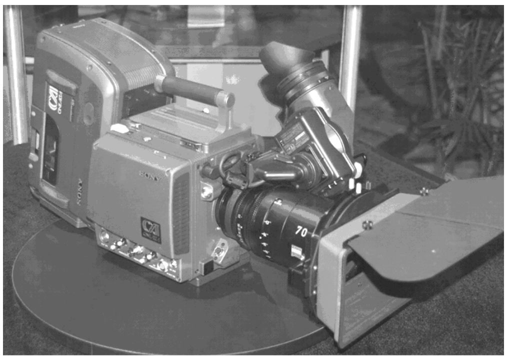
Panavision version of HDW-F900

"Panavising" the Sony HDW-F900 camera required a disassembly of the stock camera and replacement of the top cover, carrying handle, bottom supports and mounts with more robust and flexible mounts and handles. Also, a complete new faceplate, lens lock and iris rod support system have been installed. A newly designed Ultraview Viewfinder with enhanced optical performance and easier to use controls replaces the standard viewfinder. These changes and more were made in order to produce a film friendly system that utilizes many of the standard Panavision accessories, such as the follow focus, matte box, heads, etc.

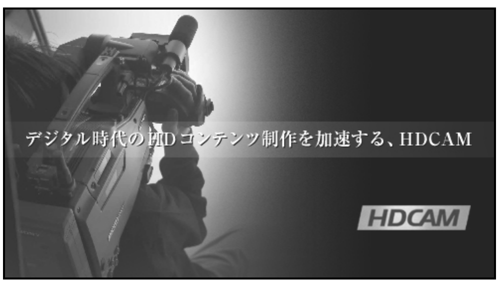
The whole new range of Primo Digital lenses ere developed to accommodate the camera. They are optimized for maximum image quality at fast maximum apertures of T1.6-1.9 (F1.45-1.75), thus enabling depths of field similar to 35mm cine formats. The range includes **9.5-105mm** T1.6 Primo Digital Zoom, **8-72mm** T1.9 Primo Digital, **6-27mm** T1.6 Primo Digital Zoom, **6-27mm** T1.8 Primo Digital Zoom Lens and **25-112mm** T1.9 Primo Digital Zoom Lens. Also, **5mm** T1.8 Primo Digital Lens, **7mm** T1.6 Primo Digital Lens, **10mm** T1.6 Primo Digital Lens, **14mm** T1.6 Primo Digital Lens, **20mm** T1.6 Primo Digital Lens and **35mm** T1.6 Primo Digital Lens.

Future developments

It is not a secret that Panavision "Genesis" was electronically designed by Sony. Naturally, Sony also wanted to participate in this development and created it's own version of the camera based on the 2/3" imager. Here is what ***Bryant Frazer*** was reporting from the last NAB:



Sony brought a an engineering prototype of a new RGB 4:4:4 multi-frame-rate camera. This camera will shoot 1080p video at from 1 fps to 30 fps in 4:4:4 mode and up to 60 fps in 4:2:2 mode. It records to an SRW1 mounted on the camera's top or back, or via a dual-link tether to keep the camera's weight at a minimum. The variable frame rates are achieved by adjusting the actual speed of the SRW1 recorder during acquisition; when the tape is played back at nominal speed the desired undercrank or overcrank effect is apparent. The camera uses a 2/3-inch CCD with a 1920x1080 resolution and boasts a 14-bit A-to-D converter for extra dynamic range. In response to feedback from cinematographers, Sony added brackets to the camera body that can hold Arriflex-compatible accessories (powered, if necessary, by 12V and 24V sources on the camera) and developed a more ruggedized B4 lens mount to withstand lots of lens-switching.



HDCAM recorders/players

JH-3

The J-H3 as a cost effective compact player represents solution for HDCAM tape viewing, logging, and off-line editing applications. The unit offers computer display output for viewing at XGA resolution, optional i.LINK interface, and multi field/frame rate operation. It is equipped with HD and SD serial digital interfaces and a downconverter is included as standard. It works at 24PsF, 25PsF or 29.97PsF. 24PsF recorded tapes can also be played back at 25P with time code conversion.

HDW-S280

Half-Rack Recorder for mobile and field applications. HDCAM recording and playback - 1080/59.94i, 50i, 23.98PsF, 24PsF, 25PsF and 29.97PsF switchable. Legacy playback for Betacam, Betacam SP and Betacam SX. Built in downconversion and upconversion. LCD monitor on front panel. Runs on AC, DC 12V and battery power. Easy setup using Memory Stick.

HDW-1800

The most affordable HDCam recorder, HDW-1800 offers HDCAM recording and playback at 1080/50i, 1080/59.94i, 1080/25P, 1080/29.97P, 1080/23.98P and 1080/24P. It also has a built in HD to SD downconverter whose image can be squeezed or cropped within the VTR for display on a 4:3 monitor. In addition, with an optional board 1080/59.94i material can be converted to 720/59.94P and 3:2 pull-down conversion from 1080/23.98P to 1080/59.94i or 720/59.94P is also provided. Finally, a simplified control panel includes a built-in LCD display for on-the-spot picture confirmation and access to operational set-up menus

HDW-M2000/20

HDCAM Studio Editing Recorder. Plays Digital Betacam, Betacam/SP, Betacam SX, MPEG IMX. Records and plays HDCAM at frame rates: 1080/23.98, 1080/24, 1080/59.94i, 50i, 29.97PsF, and 25 PsF. CineAlta compatible. Built-in up-conversion of playback-compatible Standard Definition tapes to 1080i and down-conversion of HDCAM tapes to 480i is a standard feature. Metadata handling, UMID (Unique Material Identifier Data) record capability, and simplified menu setups and firmware upgrades via Memory Stick media. Capable of handling Dolby-E and AC-3 audio.

HDW-M2100/20

Plays Digital Betacam, Betacam/SP, Betacam SX, MPEG IMX. Plays HDCAM tapes at frame rates: 1080/59.94i, 50i, 29.97PsF, 25 PsF, 23.98PsF and 24PsF. Built-in up-conversion of playback-compatible Standard Definition tapes to 1080i and down-conversion of HDCAM tapes to 480i, metadata handling, and UMID (Unique Material Identifier Data) metadata recording capability, Capable of handling Dolby-E and AC-3 audio.

HDCAM SR

HDCAM SR is "HDCAM made properly" some said, but with respect. Today, it is the highest standard of high definition recording, specially in the domain of tape based and field recording. As for now, there is no HDCAM SR camcorder, but portable recorder **SRW-1** is today a *de facto* standard of tape based, digital film acquisition.

It was introduced in 2003, uses a higher particle density tape and is capable of recording in 4:4:4 RGB with a bitrate of 440 Mbit/s. The increased bitrate (over HDCAM) allows HDCAM SR to capture much more of the full bandwidth of the HDSDI signal (1920x1080). Some HDCAM SR VTRs can also use a 2x mode with an even higher bitrate of 880 Mbit/s, allowing for a single 4:4:4 stream at a lower compression or two 4:2:2 video streams simultaneously. HDCAM SR uses the new MPEG-4 Studio Profile for mild compression, and expands the number of audio channels up to 12.

HDCAM SR EQUIPMENT

SRW-1/ SRPC-1

The SRW-1 HD Portable Digital Video Recorder and SRPC-1 HD Video Processor form the first Sony full-bandwidth 4:4:4 (RGB) portable VTR system adopting the HDCAM-SR format. The SRW-1/SRPC-1 offers virtually lossless 1080-line high-definition recordings at multiple frame rates on the HDCAM-SR tape media. The SRW-1/SRPC-1 connects to the camera via HD-SDI dual link or optional optical fiber cable to create a convenient, portable full-bandwidth 4:4:4 (RGB) image capturing system. The SRPC-1 processor unit provides a variety of video-processing functions and houses an array of input and output connectors, including HD/SD signals, 12 channels of digital audio, and 4 channels of analog audio. The processing functions include 2-3 pull-down insertions for 525 down conversion, and RGB 4:4:4 to Y/Pb/Pr 4:2:2 color space conversion. The system is capable of operating in three recording modes. SQ (standard Quality) providing 440 Mbps video payload to tape in both 4:4:4 or 4:2:2, HQ (High Quality) mode allowing for 2x speed recording yielding 880 Mbps to tape with a 2:1 compression ratio in full band RGB 4:4:4, and 3D mode where two separate 4:2:2 HD SDI inputs can be recorded simultaneously to the same tape, providing an efficient means of recording stereo full bandwidth 4:2:2 images for 3D productions. Each stereo channel is recorded at 440 Mbps with the benefits of full error correction to both channels.

SRW-5000 & SRW-5500

The SRW-5000 is a high-end HD digital videocassette recorder that employs the HDCAM-SR format. Key features include high quality 1080i, 1080P or 720P recording and playback, a wide array of internal format conversions, including 4:4:4 to 4:2:2 legacy playback of HDCAM and Digital BETACAM tape formats.

The SRW-5500 employs the HDCAM-SR format but is also capable of recording and playback of the HDCAM format. Key features include high-quality 1080i, 1080PsF, or 720P recording and playback, a wide array of internal format conversions, including 4:4:4 to 4:2:2, legacy playback of Digital Betacam tape formats. Capable of recording 23.98/24/25/29.97/ 30PsF, 1080/50i/59.94/60i, and 720/59.94P, . The optional HKSR-5001 Format Converter provides 3/2 pull down sequence for conversion of 23.98 or 24 fps recordings to 59.94 interlaced output. It also provides conversion of 1080 to 720/59.94P, and 720P to 1080. With the optional HKSR-5002 Digital Betacam decoder board, Digital Betacam tapes can be played back and up converted to either 1080i or 720/59.94P formats.

POV _ SONY HDCAM VS. PANASONIC VARICAM DISCUSSION

by Michael Brennan

Comparing these cameras (Sony F900 and Panasonic Varicam) is an *apples and oranges* exercise. I hope this article helps you can make a decision based on fact not marketing hype or biased comment. Note that as a f900 owner I am more familiar with the f900 than the Varicam.

COMPRESSION

Ask to see a split screen comparison recording of uncompressed HD and HDCAM from a f900 i.e. record HDSDI output from camera direct to NLE and at the same time record to tape. Split screen the two.

If a test is not available then simply switch between playback and live camera output on a 24 inch monitor.

Does it look like 2/3rds of the color information is "thrown away"?

Another test, ask your favorite post house to record a uncompressed image to HDCAM. Do a split screen with the original image. You'll be surprised at the result. Do the same with Varicam.

Someone may show you a multiple generation test of how blocky HDCAM can get. Such tests are usually technically correct but ignore "work arounds" in common practice. Who is stupid enough to make multiple generation dubs on HDCAM when SDTI cloning is an option? (The post house that does not want to buy a SDTI card for its HDCAM decks!) Same applies to Varicam where there is an SDTI option and now option to play into FCPHD via firewire.

12 Bit v 10 Bit

In respect of comparing camera heads bear in mind that the Panasonic and Sony HDW750 has a 10 bit A-to-D and the Sony f900 a 12bit. So the f900 theoretically has greater dynamic range, more tones and colors at the camera head.

What is the difference between a 10bit and 12bit head?

The words vibrant and rich has been used to describe the Panasonic. When Sony introduced the 700 (10bit) DigiBeta camcorder, vibrant and rich were also used to describe the picture. But on a large screen vibrant can look plastic when the eye seeks out more tonal variation. The new Sony HDW 750 also has a 10bit head and looks "vibrant" in comparison to the f900 which has amore subtle range of tones in my view.

When viewing HD pictures for analysis avoid Plasma displays which only work at 8 or 10bit. They do not display subtle tones. A shot taken with a 10bit camera, of a tropical beach, with blue sky, bright green foliage and emerald sea looks like a postcard on a plasma screen.

Will your viewers notice the difference?

CINEGAMMA

Both cameras have cine gamma curves which exaggerate the knee and is meant to help film dps who have difficulty lighting for CCDs :)

However, it does not alter the fact that the imager is a CCD and needs a different lighting approach to lighting film. Cinegamma curves divide the pie differently, they do not make the size of the pie any bigger. CCDs have a fixed dynamic range, altering the gamma curve redistributes the camera processing so minor gains are made in processing of the highlights.

TIMELAPSE

In respect to ramping neither cameras are capable of "recording" under 23.97 frames per second. The VariCam cannot "record" less than 59.97 frames per second.

With the Varicam you can decide on location the precise frame rate you need from 1 to 60. With f900 all 24 frames are recorded per second, delaying the decision to post. This takes control away from the DP.

You can use a portion of the shot in real time should something interesting happen. The VariCam will exhaust a 30 minute tape in 30 minutes of location recording even thought you may only be committing one frame per second to tape. (A shooting ratio of 60 to 1)

If buying multiple cameras is an option then the cheaper HDW750 has a time lapse option that records 200 frames to RAM then downloads to tape. It replays the time-lapse effect straight from the camera. The Varicam replays all 60 frames per second including buffer frames so replay of the time-lapse effect on location from the camcorder is not possible.

The Varicam and the HDW750 benefit from less than 1/24th second exposure in time lapse mode which gives the characteristic blur of motion. The f900 cannot do this.

SLOW MOTION

Both Varicam and HDCAM, up to 60fps require a post process to extract slow motion sequence from the original recording.

At 60p frame rate the Varicam is native and requires no post process. Frame rates up to 60 are possible with HDCAM. Half vertical resolution but full horizontal resolution image is derived from the original HDCAM recording.

So HDCAM at 60 is made up of a 1440x 540 image which is interpolated to 1920x1080, Varicam at 60fps is 960x720 interpolated to 1920x1080. Technically then the HDCAM has more pixels, but in reality the Varicam seems a little sharper at 60p at least on smaller screens, possibly due to our eyes greater sensitivity to vertical resolution than horizontal.

SAMPLING

Our film friends describe conversion of 4k to 2k as super sampling, and state that it is a good thing, yet the same guys describe the process as compression when referring to sampling of HD cameras!

Panasonic Varicam has a 1 million pixel imager. Sony has 2.1 million pixel imager (both cameras do not use all of the pixels) Varicam records 960x720 pixels of luminance detail Sony 1440x1080 pixels of luminance. On playback VTRs convert the image up to 1920x1080 pixels. HDCAM samples the original 1920x1080 to 1440x1080 whereas the Varicam samples 1220x720 to 960x720. So comparing the two is a apple and oranges comparison.

The often quoted compression figures of 3:1:1 and 4:2:2 when used as a direct comparison are misleading.

Both manufacturers can be blamed for this.

As the f900 starts out with more pixels, it is fair to say that a HDCAM recording has greater color and luminance detail of that scene than the Varicam (when both are uprezzed back to 1920x1080) The 4:2:2 recording is easier to pull a key from but the picture is lower resolution.

Sure a key is going to be easier from a low res 4:2:2 image than a higher res 3:1:1 image. But what happens to the picture when it is bumped up to 1920x1080? Color detail in the original image of the scene is 480 x1080 on HDCAM and 480x720 on Varicam, luminance 1440x1080 on HDCAM and 960x720 on Varicam.

So when both cameras are pointed at a scene the HDCAM records more actual detail in luminance and color than Varicam.

COST

The cheaper Sony 7 series cameras and the Varicam reduces the total cost of a typical drama kit by around 30% compared to f900.

TAPELESS BROADCAST HD SOLUTIONS

Ikegami EditcamHD

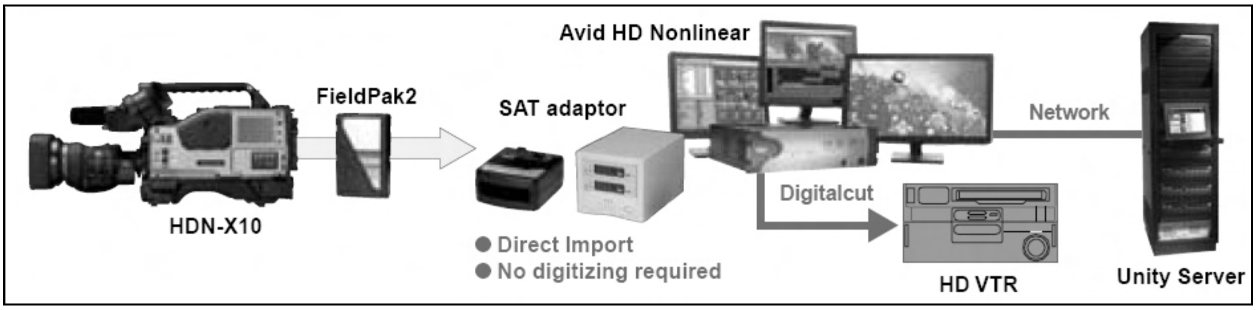
HDN-X10DNG Camera is rather different from the rest of the HiDef cameras in the fact that is recording HD data onto a Field Pack hard disk module which is compatible with the Avid codec.

EditcamHD is using three 2/3 inch 2.1 megapixel CMOS sensors which are the first of the completely remappable sensors. The native resolution on chip is 1080x1920 (interlaced or progressive) but it can subsample for PAL or NTSC.

Video processing is mostly done by Chip C4 ASIC (Application Specific Integrated Circuit) which processes digital output, video from the CMOS sensors including knee, gamma, color and DTL correction.

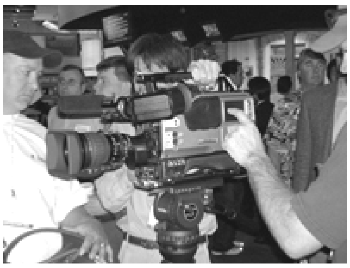
Avid developed DNxHD encoding that is specifically designed for nonlinear editing and multi-generation compositing. Though uncompressed high-definition (HD) data rates require 1.2Gbps, Avid DNxHD encoding offers mastering quality HD media at reduced file sizes. The Avid DNxHD codec offers selectable bit depths and data rates. Users can choose 8 or 10-bit sampling at 145M and 220M bit rates. Initially, the HDN-X10 will support 145M bit rate Avid DNxHD while 220 Mbps would be supported in the future.

Audio and video data recorded on a FieldPak2 can be directly accessed and edited from an Avid nonlinear editing system, without digitizing or moving files.



The standard FieldPak2 employs a hard disk drive, however, other nonlinear media can be readily used. FieldPak2 has the capability to use solid-state memory, such as Flash Memory, or any other new technology. The HDN-X10 can record high definition video onto a FieldPak2 and simultaneously record proxy video to an attached USB flash memory device.

The RetroLoop function ensures that cameraperson will capture a critical shot, since the recorder is always ready for the decisive moment. Audio and video are temporarily stored in a buffer on the disk drive. Though the cameraman presses the REC trigger after event has occurred, the HDN-X10 has been storing images from the selected period of time before the trigger was pressed. Even when the HDN-X10 is in playback mode, pressing the record button will automatically record the video clip to a free space on the disk. The operator can start recording at anytime.



Grass Valley "Infinity "

"Infinity" is a rather new and daring system that is quite different from other market approaches. While other manufacturer relay on the evolutionary development of their products (Beta, Beta SP, Digital Beta, HDCam; DV, DCVPro, DVCpro 50, DVCPro HD) Grass Valley decided to design a completely new system from the scratch.

The basics of the system is flexible architecture that uses different compression algorithms for different purposes - DV 25 Mb/s 4:1:1 or 4:2:0 (DVCAM and DVCPRO), JPEG 2000 high-efficiency, scalable compression for SD (4:2:2, 10 bit) and HD (4:2:2, 10 bit) and MPEG-2 for SD (4:2:0 and 4:2:2) and HD (4:2:0). In such a way, the system is capable to record and play back 1080i50/60, 720p50/60, 625i50 and 525i60.

The quickly emerging JPEG2000 compression scheme is designed to be scalable and allows users to encode a file once and decode multiple resolutions for different distribution platforms. Unlike other tapeless systems, which record both a low-res and high-res HD image onto a disk or solid-state memory card, the Infinity camcorder records a single HD file and then, using JPEG2000 compression, decodes at least three lower resolution versions in real time. This conserves space on the storage media. Another advantage of JPEG2000 is its ability to support the full raster 1920×1080 image, versus the common technique of subsampling horizontal resolution, resulting in 1440×1080-size images being used prior to compression. In addition, because JPEG2000 is wavelet-based — as opposed to the DCT scheme for MPEG-2 — there are no blocking artifacts. Artifacts from JPEG2000 appear as a blurring of the image, which Grass Valley says is more acceptable to the human eye. JPEG2000 also offers true random access to every frame with synchronized digital audio.

The "Infinity" camcorder features the ability to record content directly to an internal Iomega REV PRO disk or compact flash cards. The camera can also be connected to external hard drives and computers via their on-board USB 2.0 and FireWire ports. It includes 14-bit digital HD camera head with advanced video processing, a color LCD monitor as well as SD audio and HD/SDI video connectors for real-time output. Also provided are Gigabit Ethernet and FireWire connectors. Built-in PDA-type user interface is used for video monitoring and clip management, audio setup and metering, detailed camera setup and configuration and metadata insertion and editing. Camcorder weighs only 4.5 kg without lens.

The disk cartridges come with 35GB of storage capacity. This provides about 45 minutes of 1080i HD at 75Mb/s and more than two hours of 25Mb/s HDV. REV PRO uses standard laptop hard drive components but is engineered to provide the added benefits of removability, portability and archivability. REV PRO offers many advantages over standard REV, including enhanced bandwidth capacity (110 Mb/s real time record/playback for throughput for HD video up to 100 MB/s) along with the needed overhead support for audio, timecode, and metadata tracks. It also offers simultaneous record/playback capability and faster rendering speeds for non-linear editing systems. The disks are also attractive for archival applications.

There are two versions of compact flash memory cards that can be used for the Infinity camcorder, all made by SanDisk. They include the Extreme-III, which comes in sizes up to 4GB for high bit rate HD, and the Ultra-II in sizes up to 8GB for SD and 25Mb/s to 50Mb/s for HD. This form of recording is ideal in harsh weather conditions or in applications where extreme vibration might affect image acquisition.

USB memory sticks are also compatible with the Grass Valley Infinity camcorder and DMR. USB sticks offer less storage capacity than CompactFlash, thus less video record time.

In addition to serving as a playback and storage device, the Infinity digital media recorder (DMR) provides editing, file management and multichannel file distribution features. The player uses the same media as the camcorder and also provides full baseband video and IT connectivity. DMR is facilitates recording/playback on Iomega REV or CompactFlash removable media, true nonlinear, random access and simultaneous read and write from the media.

Record time comparison of common SD/HD data rates on REV and REV PRO media

COMPRESSION FORMAT	VIDEO DATA RATE	RECORDING TIME	MAX FILE TRANSFER SPEED
DV (SD)	25 Mb/s	>120 Minutes	Up to 8X
MPEG-2 (SD)	25 Mb/s	>120 Minutes	Up to 8X
MPEG-2 (SD/HD)	50 Mb/s	>60 Minutes	Up to 4X
JPEG 2000 (SD)	25 Mb/s	>120 Minutes	Up to 8X
JPEG 2000 (SD/HD)	50 Mb/s	>60 Minutes	Up to 4X
JPEG 2000 (HD)	75 Mb/s	>45 Minutes	Up to 2.5X

SONY XDCAM-HD

A new entry in the world of HD video production is based on it's SD predecessor which, according to Sony, was sold altogether in more than 10.000 pieces.

XDCAM HD is clearly positioned between HDV and HDCam in terms of picture quality, features and price and shows Sony's determination to go on with disk based solution that are using MPEG compression. It is also obvious that (at least for now) XDCAM HD is primarily targeted towards broadcasting market as a simple, reliable and affordable HD solution.

XDCAM HD camcorders and decks record and playback AV signals and metadata utilizing Professional Disc media, using blue-laser technology to record up to 120 minutes of HD content (at 18 Mbps). Alternatively, in Standard Definition mode it can record up to 85 minutes of SD DVCAM signals at 25 Mps.

XDCAM HD products use a nonlinear optical disc, the PFD23. Recordings are made on a file basis, allowing easy integration into other IT-based equipment such as PCs and nonlinear editors. The recorded files on the disc can be directly accessed by a compatible PC connected via the i.LINK (File Access Mode) interface, and furthermore can even be sent through a standard Ethernet network -feature that has never been available for HD-based production. The XDCAM HD system also features the Scene Selection function that allows simple cuts-only editing to be instantly performed within the camcorder or decks. Being disc based, the XDCAM HD products offer a range of tremendous benefits, especially instant random access to footage. Also, new footage is always recorded onto an empty area of the disc, eliminating the worry of accidentally overwriting valuable existing footage.

XDCAM HD offers a choice of non-linear DVCAM capture and 1080-line High Definition recordings at a higher bit-rate than HDV. In High Definition mode, XDCAM HD captures true 1080-line pictures using MPEG-2 Long GOP coding at a selectable bit-rate of 35, 25 or 18 Mbps, giving XDCAM HD users greater creative and operational freedom.

More precisely, content is recorder in MPEG-2 MP@HL1440 4:2:0 35 Mb/s (60 minutes of recording), 25 Mb/s (90 minutes), 18 Mb/s (120 minutes), or DVCAM 4:1:1 525/59.94, 4:2:0 625/50 (85 minutes). Frame rates are 1080/59.94i, 50i, 29.97P, 25P and native 23.98P, qualifying the format to become a member of the CineAlta family. In all cases other than proxy audio (which is compressed A-law 4ch/2ch 8-bit 8kHz), production audio is 2 or 4 channel selectable and uncompressed (Linear PCM).

The XDCAM HD products record low-resolution AV data concurrently with its high-resolution data on the same disc. This low-resolution data version – called “Proxy Data” – is much smaller in size than high-resolution data (1.5 Mb/s for video and 0.5 Mb/s for audio), and its format is identical to that of the current XDCAM products. The data can be conveniently used for a variety of applications, such as immediate logging on location, off-line editing, daily rushes of shooting on location, client approvals and more. Proxy Data can be browsed and edited on a standard PC using the PDZ-1 Proxy Browsing software supplied with all XDCAM HD products or editing software offered by industry-leading manufacturers.

XDCAM HD Equipment

CAMCORDERS

PDW-F350/PDW-F330

Both XDCAM HD Camcorders incorporate three HD-native, 16:9/4:3 switchable, HD Power HAD CCDs, each with a high density of approximately 1.56 megapixels (1440 x 1080) and also a high integrity 12-bit A/D conversion circuit. The ADSP (Advanced Digital Signal Processing) of the XDCAM HD camcorders uses more than 30 bits in nonlinear processes, minimizing round-off errors to maintain the high quality of the Power HAD CCDs. The XDCAM HD camcorders allow operators to choose from five types of gamma curves (Standard, CINE 1, 2, 3 and 4). They also offer two additional features – Slow Shutter function and Turbo Gain function – for shooting in low-light conditions, which can be used alone or together depending on the situation or the operator's preferences.

Also, both camcorders incorporate a down-conversion capability that allows material recorded in the MPEG HD format to be converted to DV signals and output via the i.LINK port, even when recording. They also use 16:9 3.5-inch color LCD to display a highly advanced interface giving access to detailed metadata or key scenes (selected automatically and/or manually) for quickly reviewing content on site. One can even perform simple cuts-only editing on the camera itself. Camcorders can record two or four-channel, 16-bit, 48-kHz uncompressed (Linear PCM) audio. Assignable buttons enable operators to assign frequently used functions and interval recording intermittently records signals at pre-determined intervals. Both camcorders allow metadata recording: UMID, Extended UMID, Essence Marks.

There are two major differences between the PDW-F350 and DW-F330. First is that F350 offers Slow & Quick Motion Function that enables users to create fast- and slow-motion footage at frame rates selectable from 4 fps (frame per second) to 60 fps in increments of 1 fps. Another benefit about this feature is that users can see the results right in the camcorder's LCD screen, on the spot. Other feature that differentiate F350 is that it has built in HD-SDI output.

RECORDERS

PDW-F70 Recording Deck/PDW-F30 Viewing Deck

The XDCAM HD decks records (PDW-F70) and plays Professional Disc HD material at 1080/59.94i, 50i, 29.97P, 25P and native 23.98P using the "MPEG HD" codec that uses the industry standard MPEG-2 MP@HL compression. And for high quality sound, four channel, 16 bit, 48 kHz uncompressed audio is used. The deck also can down-convert MPEG HD material to DV signals and output via the i.LINK interface. In addition, it can also up-convert DVCAM material to HD signals and output via the HD-SDI or HD analog component connection. An optional board also allows input and output of 25 Mb/s MPEG-2 TS (Transport Stream) for easy integration with HDV equipment and nonlinear editors.

XDCAM HD
Professional Disc System

XDCAM HD Q&A

Q: What recording media does the XDCAM HD system use?

A: The same PFD-23 Professional Disc media as in XDCAM standard definition recording. Only now the media delivers more maximum recording time: 120 minutes at 18 Mbps.

Q: Why do XDCAM HD camcorders have 1/2-inch type CCDs instead of 2/3-inch?

A: The XDCAM HD system was designed to meet the urgent requests from customers for affordable, professional HD production with interchangeable lenses. The choice of 1/2-inch type image sensors enables Sony to deliver three distinct classes of professional HD production: Sony HDV 1080i camcorders use 1/3-inch, XDCAM HD camcorders use 1/2-inch and HDCAM camcorders use 2/3-inch type sensors.

Q: Why did Sony choose bitrates of 18, 25 and 35 Mbps?

A: Because MPEG2 includes both interframe and intraframe compression technology, it can offer higher quality at lower bitrates than intraframe compression alone. The XDCAM HD system uses 18 Mbps and 35 Mbps variable bitrates, plus a 25 Mbps constant bitrate. These rates offer decisive advantages in cost, recording time and compatibility. For example, the XDCAM HD system offers the longest recording time currently available in an HD camcorder: over 120 minutes at 18 Mbps. And thanks to the low bitrates, XDCAM HD recording is compatible with just about any NLE that works with 25 Mbps.

Q: Does 25 Mbps XDCAM HD recording use the same compression as HDV 1080i recording?

A: Yes. While XDCAM HD recording at 18 and 35 Mbps uses variable bitrate technology, the 25 Mbps alternative uses a fixed bitrate for compatibility with HDV 1080i editors and recorders. Basically the only difference is that HDV editors use Transport Stream (TS) and XDCAM HD uses Elementary Stream (ES). When the PDW-F70 recorder and the PDW-F30 player are fitted with the optional PDBK-102 MPEG Transport Stream (TS) card, these decks can be connected directly to HDV 1080i recorders, camcorders and compatible NLEs, via the i.LINK HDV interface.

Q: What is the recording time?

A: Extended recording time is another big advantage of the XDCAM HD system bitrates. Recording time is over 60 minutes at 35 Mbps, 90 minutes at 25 Mbps and over 120 minutes at 18 Mbps. This represents the longest recording time of any HD camcorder currently available.

Q: Can I upconvert XDCAM standard definition content to HD?

A: Yes. The PDW-F70 recorder and PDW-F30 player can both upconvert XDCAM standard definition content recorded in the DVCAM format at 25 Mbps to 1080i high definition at the output.

Q: Can I downconvert XDCAM high definition content to SD?

A: Yes. All XDCAM HD camcorders and decks can downconvert to standard definition.

Q: Can I record HD and SD on the same disc?

A: No. The XDCAM HD file system requires a disc to be all HD or all SD. However you can freely select HD bitrates of 18, 25 or 35 Mbps for each clip you record on the same disc and 60i, 30P, 50i and 25P can be mixed as well. However a dedicated disc needs to be used when recording 24P material.

Q: How do I edit XDCAM HD assets?

A: You have plenty of options. First, all 29 companies that currently support XDCAM standard definition are also committed to supporting XDCAM HD production. So depending on your system, you can choose from various workflows. Second, when equipped with the optional PDBK-102 MPEG TS card, the PDW-F70 and PDW-F30 work with the full range of NLEs that are compatible with HDV 1080i. And third, you can use the HD-SDI output of the PDW-F70 and edit as with a traditional VTR.

Q: Can I use my current HDV editing software to edit XDCAM HD 25 Mbps material?

A: XDCAM HD system is compatible with HDV 1080i editing. The PDW-F70 recorder and PDW-F30 player accept the optional PDBK-102 MPEG TS card. This outputs a 25 Mbps signal over the i.LINK interface for the large pool of NLEs that are compatible with HDV 1080i recording.

Q: Does the XDCAM HD system use Proxy A/V?

A: Yes. The system combines the beauty of high definition with all the workflow innovation of the XDCAM system, including the durability of optical discs, the simplicity of file-based operations and the power of Proxy A/V.

Q: Will Sony offer PAL versions?

A: You're reading about them now. All XDCAM HD camcorders and decks support both PAL and NTSC standard definition. One world, one camcorder.

Q: What frame rates are supported in the XDCAM HD system?

A: The base PDW-F330 camcorder shoots high definition at 1080/59.94i, 50i, 29.97P, 25P and 23.98P. The camcorder also captures standard definition at 480/59.94i, 480/29.97P and 480/23.98P or 576/50i and 576/25P. The advanced PDW-F350 adds variable frame rate capture from 4 fps to 60 fps in 1 fps increments. The PDW-F70 recorder and PDW-F30 player support all the frame rates of both the PDW-F330 and PDW-F350 camcorders.

Q: What is MPEG long GOP?

A: Like HDV recording before it, the XDCAM HD system uses the international standard MPEG 2 Main Profile at High Level encoding with a long Group of Pictures (GOP). Because the system combines interframe and intraframe compression technology, it enables us to achieve a higher picture quality at lower bitrates than systems that use intraframe compression alone. As we've just stated, XDCAM HD production is compatible with NLEs that accept HDV signals. MPEG long GOP is the reason why.

Q: Do you plan to discontinue the HDCAM line?

A: Absolutely not. With 2/3-inch type image sensors and 140 Mbps recording, HDCAM products offer compelling advantages for high-end sports, episodic television and feature films. It's a whole different class.

Q: Why is the CineAlta trademark (brand) on XDCAM HD products?

A: Sony uses the CineAlta name to identify a high level of cinema production. With gorgeous performance at true 24 frames progressive, the XDCAM HD system fully meets that description.

Q: Why is Sony offering the Professional Disc media?

A: Sony believes that the Professional Disc media is a means by which our customers can achieve benefits in production workflows, where flexibility, speed, and cost effectiveness are key requirements. The Professional Disc media has been engineered specifically for professional content creation; its data rate, data capacity, transfer speed, robustness, and instant random access provide professional-quality performance.

Q: Is the XDCAM system's Professional Disc media the same as the consumer Blu-ray Disc media?

A: No. While there are some similarities, the Professional Disc media uses a unique phase-change recording material to support higher read/write speeds. In addition, the Professional Disc cartridge shutter supports access by two simultaneous pickups, while the earliest Japan-market Blu-ray Disc media had a shutter that accommodated only one pickup. Current Blu-ray Disc media uses a bare disc without cartridge. There is no cross-compatibility between XDCAM products and Blu-ray Disc products.

Q: What is the difference between the recording material used for consumer Blu-ray Disc media and that used for the XDCAM system's Professional Disc media?

A: The higher transfer rates of the XDCAM system require a more sensitive phase-change recording layer. The Professional Disc recording layer must change from crystalline (high reflectivity) phase to amorphous (low reflectivity) phase fast enough to enable transfer speeds of up to 72 Mbps. In comparison, the writing speed of consumer media is 36 Mbps. Aside from the different phase-change material, the track pitch, recording density and production processes are the same.

Q: How does the read/write/erase life cycle of the XDCAM system's Professional Disc media compare to the Blu-ray Disc media?

A: They're identical in the minimum spec. Both are rated at a minimum of 1,000 read/write/erase cycles under normal operating conditions. The Professional Disc media has a maximum read/write/erase life cycle of 10,000 under ideal operating conditions (73 degrees F, 50% RH). All of this information is based on Sony's own testing.

SPECIALIZED HD SOLUTIONS

Cine SpeedCam

Cine SpeedCam is the premiere true high-speed digital camera system designed for HD cinematography. Whether shooting green screen, tabletop, action sports, documentary, music videos, or narrative, Cine SpeedCam captures slow-motion widescreen jump-off-the screen images.

Featuring a prismless 1536 x 1024 CMOS imager, Cine SpeedCam captures up to 1000 fps at full resolution or 10,000 fps at lower resolutions. Images are rendered as uncompressed TIFF sequences or AVI formats. Output is simply imported into HD editing and computer graphic systems.

The Cine SpeedCam includes a compact Weinberger progressive-scan HD camera that accepts PL mount 35mm or Nikon B-mount lenses. The film-style camera is fully compatible with a Chrosziel Mattebox, Follow-Focus, Preston Zoom control, and top-mounted monitor/finder. The system includes a separate capture station that runs under Windows 2000.

The **System Control Host** is an all-in-one workstation, consisting of a 19“ rack, integrated PC, flat-screen monitor, keyboard and mouse. The system is completely connected up and ready-to-run. It only needs to be placed in the desired position, and connected to an external power supply. After the transport lids have been removed, the monitor and the keyboard can be folded out with simple hand movements. Start up the computer, and you can begin already.

All components can be secured appropriately for transportation. When closed, the 19“ rack is very well suited to swift transportation by car or truck. The rack is not, however, to be used as a flight case. For dispatching by airplane, the system must be secured separately.

The computer always corresponds to the respective state of the art and is optimally designed for the operation and guidance of up to 4 Cine SpeedCam high speed cameras.

Iconix HD RH-1

Iconix HD RH-1 1/3" is a progressive 3CCD High Definition remote head point of view camera system providing a high-performance, multi-format solution in a small package. It features 14-Bit quantization, electronic shutter, programmable gamma function, SDI, DVI-D and analog outputs, genlock and remote control. It is capable of shooting in 720p @ 24, 25, 30, 50 and 60 Hz, 1080i @ 50 & 60 Hz, 10800p @ 24, 25, 30, 50 and 60 Hz, 700 Lines (720p), 900 Lines (1080i/p)

HDV

THE VERY BASIC

HDV is a "consumer high-definition video format" proposed by a consortium of manufacturers. These companies proposed the basic format specifications in July of 2003, and the formal announcement of the format came in a press release from the HDV consortium on 30 September 2003.

Affordable HD system

The HDV standard enables everybody to record superb, High Definition imagery onto DV tape. In this way, HDV camcorders leverage the broad availability of DV recording media—and the considerable development costs already devoted to DV recording mechanisms. This makes HDV a practical, affordable alternative for real-world high quality video.

Digital picture quality

While analog video recording exposes the picture to noise and distortion, digital video recording maintains low noise, high accuracy and rich, vivid color. In addition, component digital recording with separate channels for Y (luminance), B-Y (blue color difference) and R-Y (red color difference) makes for a wider range of recorded colors.

16:9 widescreen recording

HDV captures images in the same 16:9 widescreen format that is used for High Definition television. Because this widescreen image is a better match for the human field of vision, it results in a more lifelike, more immersive experience—closer to the feeling of "being there."

Digital sound quality

The HDV format sound tracks use MPEG-1 Audio Layer II digital encoding. In this way, it approaches the sound quality of Compact Disc, at far lower bitrates.

Affordable DV tapes

HDV uses exactly the same cassette tapes that are already popular for DV recording. Even the recording time is the same. In addition, the tape transport and head drum are identical to those used in current DV recording systems.

MPEG-2 compression

HDV uses the same MPEG-2 compression that is already used for digital broadcasts and DVDs. The MPEG-2 system is so widely used because it employs "interframe" compression in addition to the "intra-frame" compression employed in DV recording. Using both compression technologies enables HDV to achieve High Definition picture at the same bitrates as Standard Definition DV. While MPEG decoding appears in a wide range of consumer products, including all DVD players, MPEG encoding had been too complex for affordable products until recently. Advances in large-scale integrated circuits (LSIs) and signal processing technology have now made High Definition MPEG encoding available for affordable products like HDV camcorders.

Powerful error correction

Compared to DV, HDV uses higher compression ratios. This makes HDV more susceptible to visual impairment when recorded data is missing during playback. For this reason, the HDV format incorporates greater error correction redundancy and more robust error correction methods. While the DV correction method operates only within recorded tracks, the HDV method operates among multiple tracks. The result is a powerful improvement in error correction. Even when data is lost, the HDV picture can continue to look amazing.

Both 720p and 1080i recording

For added flexibility, the HDV standard embraces two types of High Definition recording. The 1080-line interlace scan (1080i) recording takes advantage of 1440 horizontal pixels per line (1440 x 1080). The 720-line progressive scan (720p) recording incorporates 1280 horizontal pixels per scanning line (1280 x 720).

HDV FORMAT - for the more inquisitive

We are rapidly transitioning into a high definition world. Driven by this trend, the demand for HD content creation is increasing. Although there had been a plethora of high-end HD creation tools, until the advent of the HDV format, no cost-effective production tools existed.

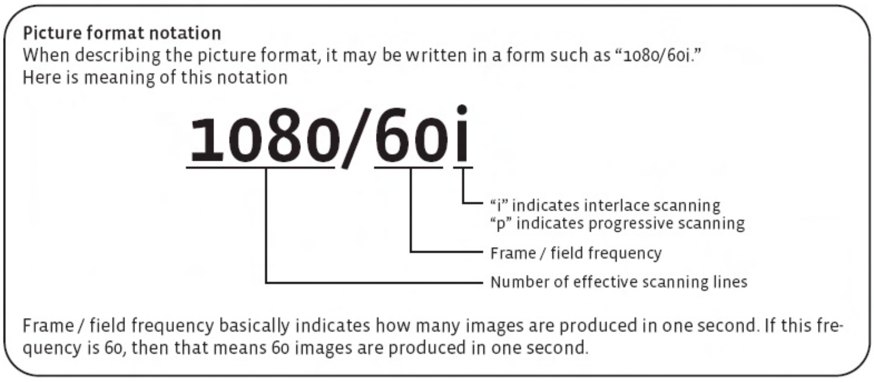
The concept of the HDV format was to develop a high definition standard capable of inexpensively recording high quality HD video using conventional DV recording media. By using the mechanisms of a DV camcorder, mitigation of development costs and development efficiency would be realized.

Efficient bit-rate reduction while retaining the high quality of HD images is made possible by means of the MPEG-2 compression scheme. In order to use MPEG-2 encoding to compress the large quantity of HD image data, complex signal processing and small silicon area for portable recorders are required. Advancements in semiconductors and signal processing technology have now made possible the use of the HDV format as a standard for low cost content creation. HDV camcorders represent the conversion of personal content to High Definition.

HDV™ Specifications

	DV	HDV (720p)	HDV (1080i)
Media	DV tape		
Video Signal	576/50i (PAL) 480/60i (NTSC)	720/25p, 720/50p, 720/30p, 720/60p	1080/50i, 1080/60i
Number of Pixels	720 x 576 (PAL) 720 x 480 (NTSC)	1280 x 720	1440 x 1080
Aspect Ratio	4:3 (16:9)	16:9	
Video Compression	DV	MPEG-2 Main Profile at High-14 Level	
Luminance Sampling Frequency	13.5 MHz	74.25 MHz	55.6875 MHz
Video sampling Format	4:2:0 (PAL) 4:1:1 (NTSC)	4:2:0	
Video quantization	8 bit		
Video bitrate after compression	25 Mbps	19 Mbps	25 Mbps
Audio compression	n/a	MPEG-1 Audio Layer II	
Audio sampling frequency	48 kHz/44.1 kHz (2-ch. mode) 32 kHz (4-ch. mode)	48 kHz	
Audio quantization	16 bit (2-ch. mode) 12 bit non-linear (4-ch. mode)	16 bit	
Audio bitrate after compression	1.5 Mbps	384 Mbps	
Audio Mode	Stereo (2-ch.) Stereo x2 (4-ch.)	Stereo (2-ch.)	
Data format	n/a	MPEG-2 system	
Stream type	n/a	Transport Stream	Packetized elementary stream
Stream Interface	IEEE 1394 (DV)	IEEE 1394 (MPEG-2-TS)	

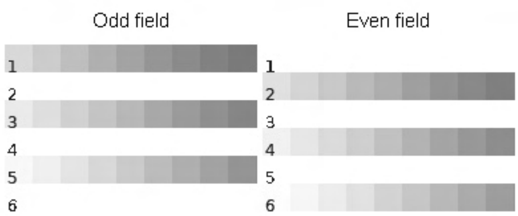
Aspect Ratio: Ratio of picture width to picture height.
Sampling Frequency: The number of digital samples per second.
Sampling Format: In digital video systems, the frequency ratios of the Y/B-Y/R-Y channels.
Quantization: The number of bits used to express a digital sample. 16-bit quantization yields 216 or 65,536 possible levels.
Bitrate: The number of bits per second. 1 Mbps equals 1 million bits per second.
Data format: The standard used for audio and video data.
Stream type: The system for combining audio and video data in the MPEG-2 system.
Stream interface: The data transmission standard.



CHARACTERISTICS OF THE FORMAT

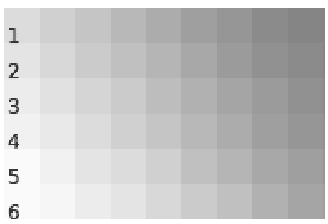
Progressive and interlace scanning

Interlace is the scanning method adopted for television broadcast systems such as NTSC and PAL. In brief, interlace scanning refers to the scanning of every other line of an image as the first field, and then scanning the lines in between as the second field. The benefit of interlace scanning is that it displays motion pictures on a video monitor with negligible flicker. After thoroughly investigating the human eye characteristics, tests have demonstrated that at least 60 images must be displayed within one second to avoid flicker. The result was to use a 1/60-second rate for each scan, but in the first scan, from the top to bottom of the image, only the odd-numbered lines (1, 3, 5...1079) are scanned, and for the next scan, only the even-numbered lines (2, 4, 6...1080) are scanned.

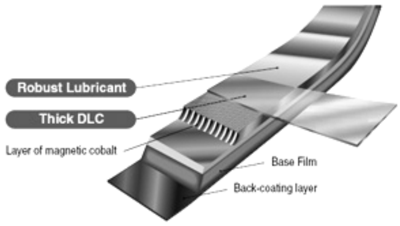


Progressive scanning

The DTV broadcast transmission infrastructures give the broadcaster the option of using an interlaced system or a non-interlaced system - the latter known as progressive scanning. The progressive scanning system was adopted initially in computer displays, which do not require considerable transmission bandwidth. In progressive scanning, each line is scanned in sequential order from the top to bottom of the picture. The entire 720 lines (or 1080 lines for 1080p) are displayed in one scanning operation.



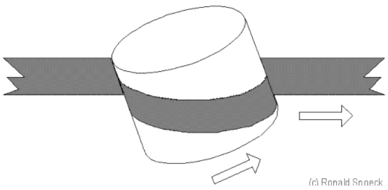
Recording HD images on DV tapes



The HDV tape transport mechanisms are based on the DV helical scan format. Therefore, videotapes used for DV recording can also be used for HD recording, and the recording time is equivalent. Because the DV tape specification does not spell out the exact chemical formulations or manufacturing methods, but only the physical characteristics, there are many possible formulations that arrive at the target specifications.

Helical scan

When videotape recording was being developed in the late 70s, engineers faced a serious problem. Slow tape speed was desirable for longer recording time, but the venerable stationary head tape recording scheme could not yield the high writing speeds required for high-quality video recording. A means of achieving high writing speeds and long record time needed to be invented. The breakthrough solution, “helical scanning,” became the basis for all analog and digital videotape recoding to date. In the helical scan process, the tape is pulled at slow speed, and the high writing speed is achieved by helically wrapping the tape around a rapidly rotating drum with four (in the case of DV and HDV) small embedded record heads. This recording scheme produces recorded tracks that run diagonally across the tape from one edge to the other. In other words, the recorded tracks are parallel to each other but are at an angle to the edge of the tape. Analog formats stored one video field or frame every drum revolution. Digital recording schemes continuously quantify and store the instantaneous signal level as a numerical value, producing considerable amounts of data. To handle the greater data-rates generated by digital recording formats, a segmented recording scheme is utilized where multiple tracks are used to record a single video frame (for example, ten tracks for DV and HDV 720p). For DV and HDV recording, the tracks are subdivided into sectors that carry specific types of payload or operation data, such as ITI (Insert Track Information), which carries tracking information.



DV tape recording

HDV1080i and HDV 720p devices are downward compatible with DV from which both HDV tape transports mechanisms were derived. The DV format records the digital signal following a segmented recording scheme with ten tracks per frame for NTSC, (480/60i) and twelve tracks per frame for PAL, (576/50i). The video, audio, and subcode payloads are recorded into individual sectors within each track.

HDV 720p

The HDV 720p specification simplified and mitigated product design and manufacturing cost by adopting the same track and sector structure as DV. The sector’s ITI (tracking signal), subcode and overwrite areas are also used for HDV recording. HDV 720p devices store the entire HDV payload, which encompasses MPEG video (18.3 Mbps), audio (384Kbps), error correction and visual search signal into the sector used exclusively for video by the DV format. Ten TS tracks combined contain one error correction unit. This format is also called **HDV1**. GOP is 6 frames.

Future HDV camcorders may offer 720p60 (or 50). Doubling the frames-per-second (720p30 to 720p60) will put a much greater load on an MPEG-2 encoder. Because 720p HDV encoding has a limit of 19Mbps: either a longer (e.g., 25 or 30 frames) GOP will need to be used or the encoding will have to be twice as efficient—else there are likely to be more MPEG-2 artifacts.

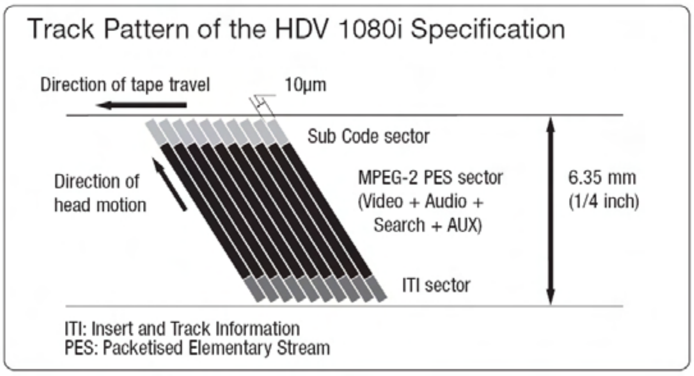
HDV 1080i

The HDV 1080i specification does not follow the DV tape footprint as HDV 720p does. In order to accommodate a higher bit-rate, the HDV 1080i specification adopted a unique track and sector structure that maximizes the length of the track for MPEG-2 payload recording. The video payload bit-rate is 25.4Mbps, which is 28% higher than what is possible by strictly adhering to the DV track and sector structure. The remaining area contains audio at 384Kbps, error correction data and two visual search signals. This format is also called **HDV2**. In 1080i/50 regions GOP is 12 frames and in 1080i/60 regions GOP is 15 frames.

Does the 1080i signal recorded by the obtainable HDV camcorders meet the ATSC requirements for HDTV? The ATSC standard defines the number of horizontal pixels to be 1920 while actual 1080i camcorders records only 1440 pixels. The ATSC standard employs square pixels. During the time for each scan line, 1920 pixels should be transferred.

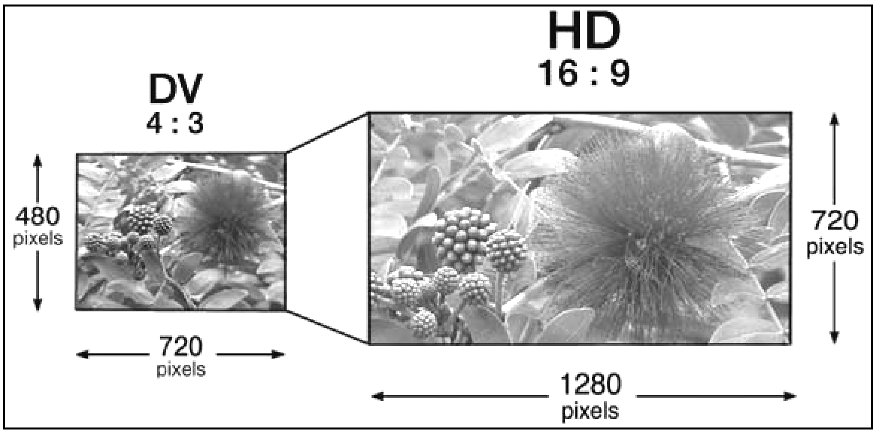
So how are 1440 pixels mapped to 1920 pixels? The answer is that each pixel is rectangular—not square. In the case of 1440, each pixel needs to have a 1.33:1 pixel aspect ratio.

A Closed 12-frame GOP is employed (IBBPBBPBBPBB) for Region 50 video (1080i50) while a Closed 15-frame GOP is employed (IBBPBBPBBPBBPBB) for Region 60 video (1080i60).



Powerful error correction capability

With the MPEG-2 format, which uses inter-frame compression, the impact of missing data is much greater than for the DV format where intra-frame compression is used. For this reason, the amount of data for error correction coding used by the HDV format was greatly increased relative to the DV format. Moreover, by abandoning the DV error correction method that operates within a single track, for a correction method spanning multiple tracks (10 for HDV 720p and 16 for HDV 1080i), error correction capability was drastically enhanced. The benefit of the HDV 1080i sixteen-track error correction scheme has empirically demonstrated an excellent performance record.

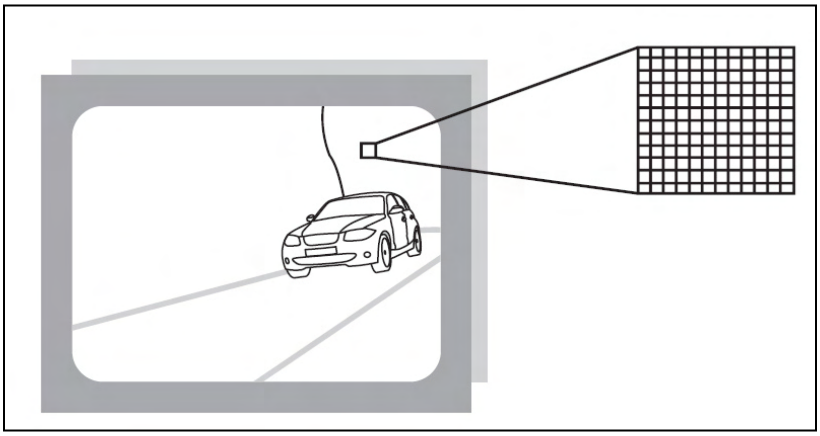


MPEG-1 Audio

Standard HDV audio is 16-bit / 48 kHz 2-channel stereo in lossy compressed 384 kbps (kilo bits per second) MPEG-1 Layer II format (.mp2). This contrasts with uncompressed PCM (Pulse Code Modulation) DV Audio at 12/32 (non-linear), 16/44.1 (linear), or 16/48 (linear). HDV audio, compared to 16/48 LPCM (Linear Pulse Code Modulation) audio, is compressed at a ratio of exactly 4:1 (4 to 1). Note that the 384 kbps figure quoted above is the total audio payload data rate. The actual audio data rate, in its 4:1 lossy compressed form, is 192 kbps per channel. Given the rule of thumb of 6 dB of dynamic range per bit of word length (also variously called resolution, sample size, word size, or quantization), the 16-bit word length used in HDV audio offers 96 dB of dynamic range and the 48 kHz sampling rate (Fs) used in HDV audio, as per Nyquist-Shannon, offers an AF (audio frequency) upper limit response of 24 kHz. Both of these figures are theoretical maximums, of course, and will be less in actual practice.

HDV Compression

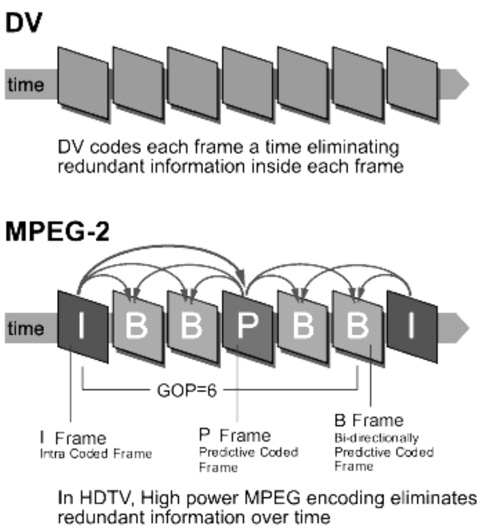
To appreciate the MPEG-2 compression system used for HDV technology, it helps to first consider the simpler, "intraframe" compression system used for DV. The system works because one pixel of blue sky is almost exactly the same as the next. By encoding only the differences between pixels—in fact, only the differences you can see—DV compression can cut the data rate by 80%. That's a 5:1 compression ratio, which reduces an initial bitrate of roughly 124 Mbps to a recorded bitrate of 25 Mbps after compression.



Intraframe compression works because each pixel of blue sky is almost exactly the same as the one next to it. The system needs to record only the differences.

Because it records a High Definition signal, HDV must handle far higher initial bitrates. For example, the 1080/60i HDV signal (1440 x 1080) has 4.5 times as much data as the 480/60i DV signal used in NTSC countries (720 x 480 pixels).

For this reason, HDV must use a more powerful compression engine: MPEG-2. MPEG-2 starts with intra-frame compression, similar to the DV compression system. But MPEG-2 goes on to add "interframe" compression. This system works because, in the typical sequence of pictures, one frame of video is almost exactly the same as the next. By encoding only the differences between frames, MPEG-2 can achieve another major round of bitrate reduction!



MPEG-2 is a temporal or *inter-frame* compression technology that compresses segments of video into GOPs, or Groups Of Pictures. There are three different picture types in a GOP; “I” or intra-frames, “P” or predictive frames, and “B” or bi-directional frames.

I-frames contain all of the data needed for reconstruction and are similar to each frame of DV. P-frames need the preceding frame for reconstruction, and B-frames need both the preceding and following frames to be reconstructed. As you might imagine, there is quite a bit of processor overhead necessary just to playback MPEG-2, not to mention actually editing it.

By using the redundant data in adjacent frames, MPEG-2 is able to achieve high compression rates (over 20:1) while maintaining very high video quality. Let’s use a very simple example to demonstrate how MPEG-2 compression works. Imagine you are videotaping a car driving from left to right across the view screen. If the camera is on a tripod the only thing changing from one frame to the next is the car moving across the monitor. Instead of saving all of the data for each frame, MPEG- 2 need only record the new position of the car from frame to frame.

Frame 1 - Fully encoded. Frame 1 - The car is encoded as data. Frame 2 - Uses data from frame 1 to display the car in a new location.

In the picture above, frame 1 would be encoded as an I-frame since all of the data in the frame would need to be encoded. Next, the MPEG encoder would analyze the next frame and “realize” that the only difference between frame 1 and frame 2 is that the car changed position. The car would then be encoded as data, or what is called a motion vector. Frame 2 may then be generated by using the background image from frame 1 and the data image of the car in the new position.

Since there is street and grass in frame 2 where the car was in frame 1, this relatively small portion of frame 2 would have to be encoded. The data requirements of frame 2 are much less than frame 1 because only a small part of frame 2, and the data representing the car and its position, need be recorded. In reality, the car would be used in many frames as it moves across the screen, thus decreasing storage requirements even further.

By combining the power of both intraframe and interframe compression, the MPEG-2 system of HDV is far more efficient than DV compression. In this way, even though HDV encodes a signal with up to 4.5 times the data of DV, it can achieve comparable quality at the same bitrates as DV.

HDV & MPEG-2 - in depth explanation

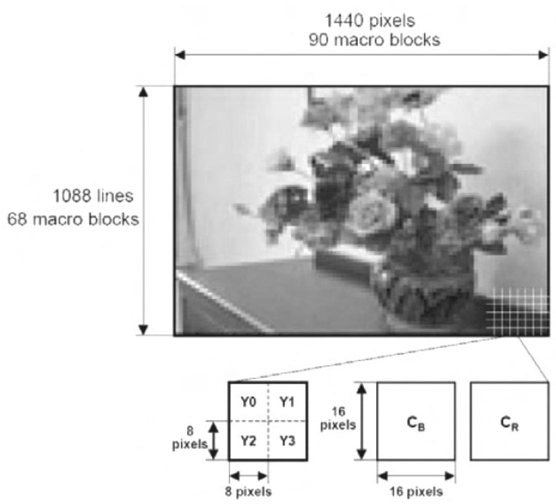
MPEG-2 is used as the compression format

Until the HDV format was launched, no cost-effective HD production tools existed. The HDV consortium's goal was to develop a high definition format that could inexpensively record high quality HD video using conventional DV tape as the recording medium. MPEG-2 was chosen due to its ability to provide high video quality at lower bit-rates when compared to using an intra frame compression codec such as DV. The MPEG-2 standard is not a single rigid specification. It is a flexible toolkit providing four levels and six profiles to choose from, for selecting the most suitable compression scheme for any application.

WHY MPEG?

The MPEG (Moving Picture Experts Group) created the MPEG-2 standard as a "compression toolkit" that could accommodate a wide range of picture sizes, from standard definition to high definition, at a higher picture quality for a given bit-rate. MPEG-2 was approved in 1994 as a standard intended for delivery of high quality digital video. It is the compression scheme used for DVD disks, direct digital broadcast satellites, terrestrial and cable high-definition TV (HDTV), digital standard definition broadcast (SDTV), and cable TV (CATV).

The Moving Pictures Expert Group showed its wisdom by not rigidly specifying the compression algorithms. Instead, they merely specified the syntax for storing and transmitting the compressed data, as well as the decoder. This approach freed the encoder manufacturers to continue to refine the encoding algorithm. The only constraint is that it must produce valid MPEG-2 streams that can be decompressed by any MPEG-2 compliant decoder.



MPEG-2 realizes very high compression efficiencies while maintaining high video quality by taking advantage of temporal redundancies within a sequence of images. The MPEG-2 codec works on two stages. In the first step, all the video frame images are divided into 8-pixel luminance blocks and 16 pixel color blocks. One macro block contains four luminance blocks and two chrominance blocks. The blocks are compressed using DCT- based intra-frame compression techniques similar to that used by DV. Then, using the first compressed image as a reference frame, (called an I-frame), the second stage eliminates redundant information, keeping only those parts of the following images (B- and P-frames) that differ from the reference image. During playback, the decoder will then reconstruct all images based on the reference image and the "difference data" contained in the B- and P-frames. This combination of I, B and P frames is known as a Group of Pictures (GOP).

Elementary Streams (ES)

The output from the MPEG-2 video and audio encoders are elementary streams. Elementary streams are continuous and do not stop until the source ends. Each ES contains only one type of data (audio or video) from a single audio or video encoder.

Video ES

The raw output of an MPEG-2 encoder is called a video elementary stream or video ES. The data rate of the HDV 1080i video elementary stream is 25Mbps.

Audio ES

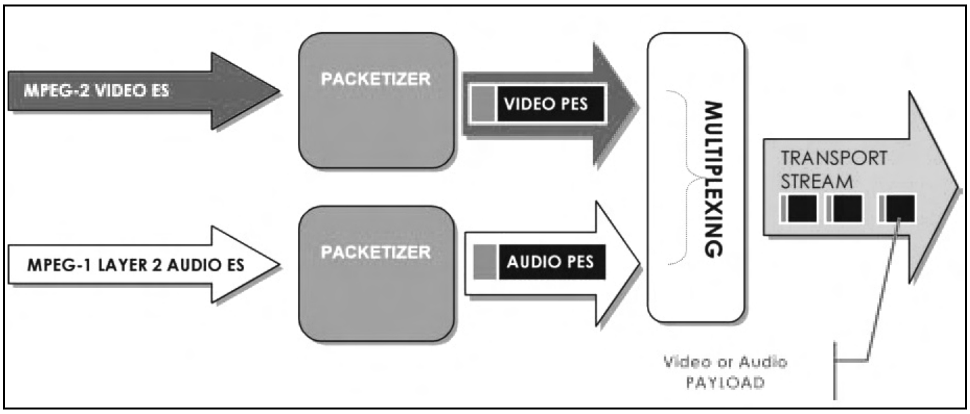
The HDV audio is also compressed using the MPEG-2 compatible MPEG-1 Audio Layer II audio codec. The data rate of the compressed audio elementary stream is 384Kbps, the highest data rate permissible, providing good compression efficiencies while maintaining high audio quality.

Packetized Elementary Stream (PES)

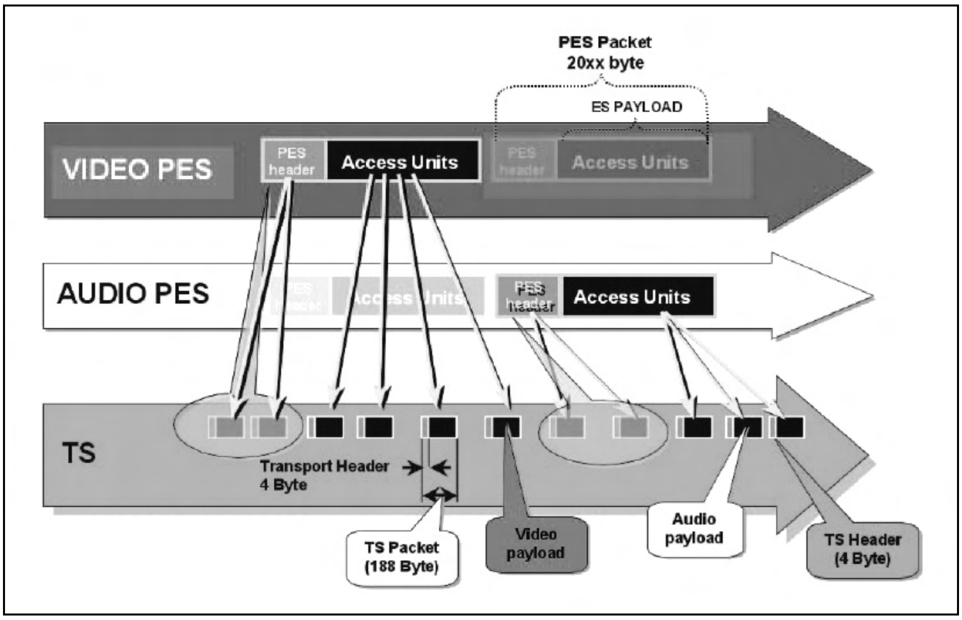
The continuous elementary bit-stream is then fed into a packetizer, which divides the ES streams into parts of a fixed size in bytes. These packets are known as Packetized Elementary Stream (PES) packets. A PES contains only one type of payload data, video or audio, from a single encoder. Each PES packet begins with a packet header that includes a unique packet ID. The header data also identifies the source of the payload (video or audio) as well as ordering and timing information needed by the decoder to recreate the audio and video and reproduce them in sync.

Transport Stream (TS)

The next stage multiplexes the video and audio PES into a single stream for storage or transmission. The MPEG standard defines two methods for multiplexing video and audio elementary stream data: Program and Transport. The Transport Stream method was selected for HDV recording because it simplifies detection of the start and end of frames as well as facilitating recovery from packet loss or corruption.



Thus, the video-PES and audio-PES streams are multiplexed to form a single Transport Stream. The transport stream packets have a fixed 188 Byte packet size. The PES packet size is variable e.g. 2048 Byte; much longer than a transport packet. Thus, each PES packet is subdivided into multiple TS packets as described below.



As shown in the graphic above, the PES header is placed at the beginning of a transport packet payload, following the transport packet header. The remaining PES packet content fills the payloads of consecutive transport packets until all the PES packet data is used up. The final transport packet may be padded with blank information (digital ones) to make it conform to the specified 188 Byte packet size. The transport stream containing the video and audio packetized elementary streams is transmitted via the i.Link interface to another compatible HDV device for dubbing or for storage and editing on a PC hard drive.

MPEG-2 LEVEL/ PROFILE TABLE

MPEG-2 LEVEL/ PROFILE TABLE

	Profile					
Frame types	Simple	Main	SNR-Scalable	Spatially-Scalable	High	Studio
PICTURES	I&P	I,P & B	I,P & B	I,P & B	I,P & B	I,P & B
CHROMA SAMPLING	4:2:0	4:2:0	4:2:0	4:2:0	4:2:2~ 4:2:0	4:2:2~ 4:2:0
HIGH						
Samples per Line		1920			1920	1920
Lines per Frame		1152			1152	1080
Frames per Second		60			60	60
Max. Bit-Rate (Mbps)		80			100	300
HIGH 1440			HDV			
Samples per Line		1440		1440	1440	
Lines per Frame		1152		1152	1152	
Frames per Second		60		60	60	
Max. Bit-Rate (Mbps)		60		60	80	
MAIN						
Samples per Line	720	720	720	720	720	720
Lines per Frame	576	576	576	576	576	576
Frames per Second	30	30	30	30	30	30
Max. Bit-Rate (Mbps)	15	15	15	15	20	50
LOW						
Samples per Line		352				
Lines per Frame		288				
Frames per Second		30				
Max. Bit-Rate (Mbps)		4				

Level

In the case of the HDV format, efficient bit-rate reduction while retaining the high quality of HD images is possible by means of the MPEG-2 MP@HL-1440 (main profile at high level) compression scheme highlighted above.

CHALLENGES OF MPEG 2

Searching and Editing Capabilities

The use of helical scan and MPEG-2 long-GOP encoding makes tasks requiring individual frame access, such as frame accurate cuing, editing, and fast-forward or fast-reverse visual search, extremely challenging. The MPEG-2 inter-frame coding algorithm compresses several frames into one GOP sequence, making it necessary to decode all the pictures in the GOP in order to access any individual picture.

Native MPEG-2 Editing

You can't modify compressed video without decompressing it. You can't view it in its compressed form. In fact, no-one has ever 'seen' MPEG-2 or any other type of compressed video, because you can't 'see' the digits that make up the staggeringly complex body of mathematical data that MEPG- 2 is in reality. All you can ever see is the decompressed results of the compressed video.

Video compression is not lossless - it's lossy. This isn't quite as bad as it sounds. Whilst it's true that when you compress video by twenty to one you are throwing away ninety-five percent of the data, what you're actually disposing of is data that you probably wouldn't miss anyway. So even after throwing away ninety-five percent of the picture, it still looks nearly a hundred percent as good. This is the miracle of modern compression technology.

As a result, editing long-GOP MPEG-2 files is not without challenges. Unlike uncompressed video, or intra-frame compressed video formats such as HDCAM or DV, the MPEG-2 compression employed in HDV reduces bit-rate and file size by inter-frame compression, where all frames forming an HDV 1080i GOP are compressed together. The GOP contains one "I" reference frame followed by a sequence of B & P partial frames that contain only the fractions of the image that differ from the reference frame. It would be possible to edit at each "I" frame, but this solution does not provide acceptable accuracy. In order to achieve frame accurate "native" MPEG-2 editing, it was necessary to create new tools that allow cutting in the middle of GOPs, removing the unused frames and splicing the partial GOPs together, without visually degrading the image. It is also necessary to repair the bit-rate and GOP sequence for the all the frames contained within the edit transition. In other words, the MPEG-2 compression and PES and TS structure must be restored to the original HDV coding parameters for the duration of the entire edit or effect, so that a standard decoder can seamlessly play it back.

The native MPEG editing process described above is computationally intensive, and initially made "native" long-GOP editing impractical. Thanks to the advent of powerful new microprocessors, cost-effective memory and sophisticated software algorithms, efficient MPEG-2 long-GOP editing is now a reality.

POV _ Which HDV format is better to shoot in - 720p or 1080i?

by Kerr Cook

720p refers to a frame comprising a 1280x720 pixel grid, with the full frame "progressively" filled in each frame. There is no interlacing or half-frames used. The frame rate can vary and this must be taken into account, but common 720p frame rates are 24fps, 30fps, and 60fps. A true 24fps is like "film" (provided the resolution is high enough). However, 30fps and 60fps can be "converted" to "24fps film" fairly easily by data reduction (dropping frames). Since each frame is "full" (and not interlaced), motion artifacts are minimized and can be dealt with. Also, because each frame is a full frame, Pausing or freezing the video or even taking a snapshot/still will look very good.

1080i indicates a frame composed of 1920x1080 pixels, usually at 60 interlaced frames per second. This means that there are actually 30 full complete 1920x1080 frames per second made up of two half-frames each 1/60th of a second. The half frames alternate between the even numbered horizontal lines and the odd lines. Upon viewing, the two half-frames are seen as a whole entire frame, although they differ in time by 1/60th of a second.

Which is better? At first glance, the 1080i has a higher resolution and should be capable of showing more picture detail. The "interlaced" trick has been used to good success from the legacy NTSC and PAL video "SD" (Standard Definition) systems. Today, bandwidth isn't as limited as it was in the 1950s, but interlacing does allow the available bandwidth to be used for more video data (finer details and more resolution).

However, because the interlaced half-frames differ in time by 1/60sec, subjects moving rapidly will appear doubled or blurry if one "froze" the video as when hitting Pause (or taking a screen snapshot). When viewed normally, high speed motion will still appear to be very smooth and rest of the scene will be with high detail due to the high resolution.

Making a screen shot/still will be better with progressive. But how many times do we do that? After all we WANT "moving recordings" and these are video cameras, not still cameras!

Note that conversion between 1080i and 720p is possible, but not exact and often introduces artifacts, particularly when high speed motion of the subject is involved. Also, since the overall resolution of 1080i is higher, one will either lose some "real video information" or have to interpolate and "create more information without more video detail".

For this very reason different "TV" stations broadcast in different formats of HDTV (where available). Sports oriented stations will tend to use 720p (1280x720/60p) while other stations use 1080i (1920x1080/60i) which conveys more information and is better suited when the original source was from film or made for film.

Common HD viewing devices can limit you as well - for example, a display with a native WXGA 1280x768 will not display a 1080i video in full resolution but downconvert (and possibly create more artifacts) to reduce the 1080i's 1920x1080 to 1280x768.

Therefore, it is important to remember that you often are only judging the results of your choice based upon what you see (and the limits of the output display device you are using). A recording made in 1080i may not display in full resolution on all of the HDTV displays today, but will still have the higher resolution and can play back even better on the currently very top-end and tomorrow's 1920x1080 display devices.

In summary, 720p recording may hold the edge if you are recording sporting events or where there is a lot of high-speed motion and you want to later Pause and examine, step through frames, extract still snapshots, or do slow motion analysis. This is particularly true if a full 60p frames per second can be done, and less so if only 30p is available. A recording done at 1280x720/60p with 60 full frames per second recorded will allow very nice frame-by-frame examination of the video. 720p (30p or 60p) can also be converted easily to 24fps "film look".

For the highest resolution, 1080i can't be beat today and that high 1920x1080 resolution of the video is superior for "vistas" and general recording (with movement and motion) where critical examination of each frame via slow motion or stills will not be a priority. Overall, for "regular viewing", the 1080i video will look better. A film source can be displayed quite nicely in 1080i, but conversion of a recording in 1080i to "film look" is a little more difficult.

No matter which HDV format one uses though, the results are far superior to DV of today and the legacy NTSC and PAL video systems of yesterday!

JVC ProHD

JVC (Victor Company of Japan) was the first in the industry to develop and market a consumer digital Hi-Vision camcorder, the GR-HD1, in 2003. Subsequently they released a professional application model, the JY-HD10. Based on this development in September 2003, four companies - Canon, Sharp, Sony, and JVC - unified their HDV format standards, and proposed it as the HDV format for the industry.

However, although first to push a new format, JVC decided to call it's line of products ProHD. The HDV format includes three sub-formats: _a) 720 horizontal pixels by 480 scanning lines SD progressive at 25p, 50p, and 60p; _b) 1280×720 HD progressive at 24p, 25p, 30p, 50p, and 60p; and _ c) 1440×1080 HD interlace format (50i and 60i). While Canon and Sony opted for the third version - 1080i, JVC went for the second - 720p.

So, ProHD uses a variation of the HDV format to deliver 720p @ 24 fps video. Unlike HDV, ProHD does not record 1080i to tape. It uses built-in converter to upconvert 720p to 1080i, or downconvert to SD.

While HDV (1080i) system is using 25 Mbps data rate, Pro HD has a 19.4Mbps data rate that is composed of three types of data: MPEG-2 video (17.8Mbps), MPEG-1 Layer 2 audio (0.384Mbps), and supporting data (1.2Mbps). This means that in the future, additional two channels of (PCM) audio will be added to existing two (MPEG compressed).

Also, a closed six-frame GOP (IBBPBB) is employed which means that its 50% shorter than in 1080i format. That makes it more rugged and less sensitive to tape defects that could produce visually disturbing artifacts.

In addition, ProHD allows for SMPTE/EBU timecode reading/ writing, and also supports user bits. This is achieved by the time code information been recorded in the GOP header area of MPEG data, and interpolated frame by frame using the frame update information.

F1	F2	F3	F4	F5	F6	F7	F8	F9	F10	F11	F12
F1		F2		F3		F4		F5		F6	
I		B		B		P		B		B	

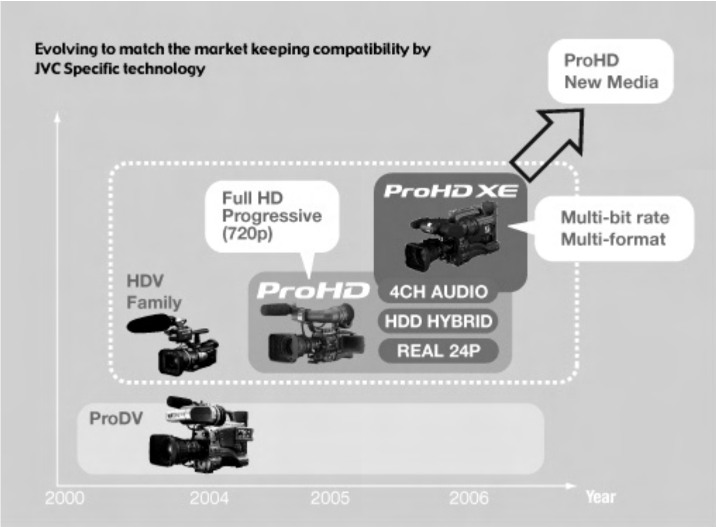
720p24 HD Video

When a ProHD camcorder records 720p24 (720p23.976), the camera captures 47.952 progressive frames per second from the 1280x720 CCDs. As each frame is captured, it is sent to the encoder. Therefore, the encoder inputs two frames for every frame that will be written to tape.

The table on the left shows how six frames are processed. For 24p, this pattern is repeated four times. First row denotes the incoming frames from the CCD. Second row indicates the frames that are generated from the incoming frames by the "Motion Smoothing Filter." Third row describes the MPEG-2 frames—making up one GOP—recorded to tape. After each six-frame GOP has been encoded, it is written to tape over 60 tracks. Unlike other methods of recording 24p, ProHD is the first format to record to tape at a rate of 24fps. **This means that 24p ProHD cannot be played on current HDV products.**

Key differences between HDV and ProHD		
	ProHD (tape)	HDV
Video Signal:	720/24p	720/60p, 720/50p, 720/30p,720/25p 1080/60i, 1080/50i
Number of Pixels:	1280 x 720 (ONLY)	1280 x 720 + 1440 x 1080
Compression:	MPEG2 Video: MP@HL-1440 (Main Profile@HighLevel 1440)	
Timecode:	SMPTE/EBU	NONE
Audio:	4 channels TOTAL: (2-channel PCM audio, 2-channel MPEG-1 Layer 2 audio: 16-bits, 44kHz, 384 Kbps)	2 channels TOTAL: (2-channel MPEG-1 Layer 2 audio: 16-bits, 48kHz, 384kbps)

JVC PROHD XE - Another HDV format?



According to some of the sources from JVC (see picture below) JVC ProHD XE will be the "professional" version of HDV. A comparison would be DV25 to DVCPRO50 - where the DV25 formats are a compromise on SD quality, DVCPRO50 is not. Likewise, with a higher bit rate (expected to be double HDV standard) PRO HD will not suffer the quality compromises of its lower bitrate cousin.

No doubt this format will carry a higher price tag, with the first camera coming with 3 x 2/3" CCD that support full 1920 x 1080 resolution at 60P (even though MEPG-2 itself, used for the recording format does not support 60P HD bitrates). The camera will support 720 (1280 x 720) at 24P, 30P and 60P and 1080 (1920 x 1080) at 30i (60 fields). This XE format supports four audio channels (but it is not known if there is compression or not).

Like the HD100U this camera will support dual hard drive and DV Tape media. However, 1080 resolution will be recorded on HDD only.

ProHD Equipment

CAMCORDERS

GY-HD110/111

GY-HD110 is a successor of the well-known HD100, the major building block of the whole ProHd product line. It is a compact camcorder, offering both DV and HDV recording, designed to be used on the shoulder, yet light enough and small enough for easy handheld shooting. Professional camcorder with interchangeable lenses, mechanical stops on the zoom, focus & iris controls, and twin XLRs. GY-HD110 has DV and HDV output (HD111 has also inputs).

Main Features:

- 3-CCD compact shoulder camcorder
- 1/3", 1280 x 720 pixel, progressive scan CCDs
- Interchangeable lenses via bayonet mount
- Magnesium die-cast body
- Switchable between standard definition and high definition
- DV and HDV output via IEEE1394 port
- HD live output signal is uncompressed 720p/50 or /60
- HD recording in 720p/25, /24 or /30 to either or both Mini DV tape and optional hard disk drive
- HD output 1080i/50 or /60 signal off recorded video
- SD 576i/50/60 recording in 16:9 and 4:3 modes
- Color viewfinding via 0.44" eyepiece and 3.5" LCD panel, both switchable to B&W
- Patented Focus Assist for speed and accuracy of focus
- Twin XLR audio outputs
- Different set-ups are memorized on transferable SD memory card

GY-HD200

Due to the implementation of JVC's new "Super Encoder," developed for the latest line of ProHD products, GY-HD200 is capable of HDV720/50P/60P true progressive image acquisition. Additionally, the GY-HD200 has Enhanced Cinema Gamma capability, which allows the photographer to enhance the captured image. The camcorder also records in both SD - including 24P and 24PA - and HD, and has JVC's focus assist function, which enables the user to focus precisely on each scene by highlighting details in the viewfinder. Finally, the HD200U features 2 XLR connectors for each audio channel.

To further enhance the HD200U's ability to utilize multiple types of lenses, JVC created an exclusive optional lens adapter - HZ-CA13U - specifically designed for the 1/3" bayonet mount of JVC ProHD camcorders, which enables the use of 16mm film prime lenses with a PL mount.

GY-HD250

In addition to the above, GY-HD250 has built-in gen lock capability and component and HD-SDI output, with professional connectors mounted on a magnesium die cast chassis. The GY-HD250 also features several interchangeable lenses, enhanced cinema gamma, external time code synchronization, BNC connectors, built-in mount for a 14.4V professional battery, and a patented focus assist feature.

In the tradition of the popular GY-DV550U professional DV camera, the GY-HD250U can easily be converted to a cost effective studio camera. The camera's optional CCU provides connection to industry standard 26-pin multi core cabling for power, gen lock, R/B gain, black level, and intercom up to 330 feet.

GY-HD7000

Somewhere on the way to implement its ProHD XE project, JVC developed HD7000 camcorder, shown only as a prototype. It should utilize three 2/3-inch CMOS imagers which produce higher image quality with far lower power consumption than conventional CCDs. The camera includes a built-in highly efficient MPEG-2 encoder capable of providing extremely high-quality, bandwidth-efficient recordings of the HD images. It records 720p continuously up to 276 minutes on full size DV cassette, or up to 60 minutes on mini-DV media. In addition, it records 720p or 1080i directly to an optional Direct To Edit HDD module. To give the whole list, it is easily adaptable to following scanning rates: **HDV** - 720/24p/25p/60p/50p, 480/60p, 576/50p; **MPEG2** - 1080/60i/50i (HDD Only); **DV**: 480/60i/24psf, 576/50i/25psf .

Consumer HD developments.

At the time of writing of this Report, it is rather unclear what will be next consumer camcorder developed by JVC and, even, which format will JVC embrace. Early specs indicate that the HD Everio camcorder will capture video and stills to an internal hard drive in full 1080i, 1920 x 1080 at 50i (PAL) and/or 60i (NTSC), with a 3-CCD configuration. Camcorder will have manual focus control. If the rumors prove true, it will mark JVC’s long-awaited re-entrance into the consumer HD market after the critically derided GR-HD1 was released in June 2003.

RECORDERS

JVC CU-VH1U

The first of JVC HDV recorders is still sold in USA and other 60Hz countries. It features a built-in 240,000 pixel high-resolution 3.5-inch LCD monitor, a digital iLink interface for non-linear editing and dubbing, S-Video, composite and audio connectors function as both inputs and outputs, component outputs for multi-format playback, and an SD memory card slot for capturing stills from tape.

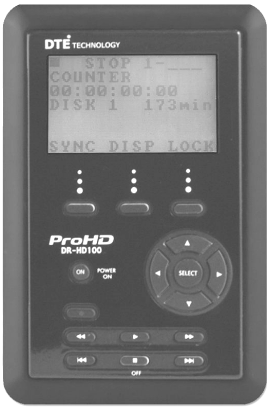
It will play back signals recorded in 720/30p (MPEG-2), 480/60p (MPEG-2) and 480/60i (DV) It can also capture progressive HD, SD and DV 1280 x 720 JPEG stills and save them to a memory card. In addition, tape time code or day and date subcode can be displayed on screen.

JVC BR-HD50U

The BR-HD50U includes a full size/miniDV compatible mechanism that has the capacity to record up to 276 minutes of video in either standard or high definition. The unit supports signals that are recorded in 720 24p, 25p, 30p and 480/60p HDV, and 480/60i and 24p DV. A front panel 8-digit LED provides display of time code, user bits and VTR status. With its built-in HDV decoder, it has the ability to convert 720p MPEG2 recordings to 1080/60i or 480/60i for monitoring purposes. The BR-HD50U provides an HDMI output for direct digital connection to the HDTV display monitors

With switchable HDV and DV recording mode functionality along with DVCAM playback it allows users to transfer both HD and DV recordings to and from non-linear editing systems. The BR-HD50U features digital input and output via an IEEE 1394 standard 6-pin connector for lossless dubbing and recording of both HD and SD programming. In addition, it includes versatile input and output connections including analog component (BNC), Y/C and Composite (BNC) as well as RS-422 control.

DR-HD100



Designed especially for the JVC GY-HD100/200/250 ProHD camcorders and compatible with most third party editing software, DR-HD100 is connected with the camcorder by a single FireWire cable that passes audio, video, timecode, and control information, allowing simultaneous recording to disk and tape in HDV or DV mode. It features Direct To Edit (DTE) video recording technology that converts the output from the camcorder or VTR to a nonlinear editing (NLE) format and records it on the internal disk drive. It combines DTE Technology with advanced caching and redundant tape and disk recording. Internal Disk Type: 40GB or 80GB, 5400 RPM, 8MB cache enabling up to 8 hours of recording. One can also extend recording time by linking multiple JVC DR-HD100 units together.

CANON 1080i EQUIPMENT

SEMI PROFESSIONAL CAMCORDER CANON XL H1

Probably the most professional HDV (1080) camcorder on the market at the moment of the writing of this Report, Canon camcorder is combining:

a) proven technology of the XL 1 and XL 2

b) adding HDV features

c) adding SDI, genlock and real time code capabilities

d) developing proprietary interchangeable lenses to conform with HD requirements.

The XL H1 camcorder has three **1/3 inch 16:9 interlaced CCDs** that capture images at 1080i resolution. The camcorder features selectable frame rates of /50/60i, 30 Frame and 24 Frame to allow the user to adjust to the assignment at hand and can switch back to SD resolution if needed.

The XL H1 HD camcorder is including **DIGIC DV II** - an image processor that can process both HD and SD video signals as well as still photos, while maintaining the correct color space for each mode.

The XL H1 camcorder's **professional jack-pack terminals** consist of three key features designed to streamline in-studio television production : HD-SDI output (High Definition Serial Digital Interface), Genlock and SMPTE Time Code input and output.

Canon's XL H1 camcorder **TOTAL CINE CONTROL** is able to customize video recordings using a number of variables, including: three color matrixes for a wide range of color correction and two cine gammas for intricate adjustment of dynamic range, customizable: knee, black stretch, horizontal detail, coring, sharpness, noise reduction, color gain, hue and master color adjustments. Each one of these settings can be modified independently.

In addition to video capabilities, Canon's XL H1 HD camcorder can capture **still images** plus metadata at full HD resolution (1920 x 1080 dpi or 2.1 megapixels) onto a standard Secure Digital (SD) Memory Card and MMC media.

Canon's camcorder has a new multi functional color electronic **viewfinder** (EVF) and 2.4" 16:9 LCD monitor with Safe Area Marking built-in; black and white mode; Zebra Pattern (70-100 IRE); Horizontal and Vertical flip and a Distance Readout (using 20X HD Video lens).

As a menu option, users can chose to view Aspect Ratio Guides in the viewfinder. Canon provides a choice of 4x3, 13x9, 14x9, 1.66:1, 1.75:1 1.85:1, 235:1 guides. The XL H1 HD camcorder viewfinder also includes a feature called **Focus Help**. The first setting - Peaking - creates an exaggerated line in the viewfinder that disappears when the image is focused. The second setting - Magnifying - enlarges the viewfinder image, helping the camera operator better see if the image is properly focused.

The 20x **HD Video lens** offers a fast f/1.6 to f/3.5 aperture and a close focusing distance from only 20mm away (when at wide angle). At an aspect ratio of 16:9, the 20x zoom range is 38.9mm to 778mm (35mm equivalent), and at the 4:3 aspect ratio, it is 47.4mm to 954mm (35mm equivalent).

Canon's Super-Range **Optical Image Stabilization** (OIS) system corrects camera shake instantly so even hand held shots, at full telephoto, and shots taken from a moving car, are smooth and steady.

Canon is also offering a **wide angle lens** with 6x optical zoom and a focal length of 3.4mm – 20.4mm (35mm equivalent approximately 24.5mm – 147mm). It will also feature an independent aperture ring.

The Canon Console

"Canon Console" is a PC-based software package which will allows control over a variety of camera features and recording operations. The software package is designed for integration into professional production studios.

Canon Console will provide control over four primary functions: image control, camera operation, video recording, and playback. The extent of manual operation that the software allows appears to be quite extensive: Gamma, Master Pedestal, Color Phase, Custom Presets and AE Metering. The frame rate of the XL HD1, which shifts between 1080i, 60i, 30F and 24F, can also be controlled remotely, along with zoom, focus, shooting mode, and frame rate. The whole communication is done via the "Fire Wire" connection.

POV _ AND WHAT, ON EARTH, IS 24F?

By Steve Mullen

... Canon does not claim it captures “24p” because its three 1.67 Megapixel CCDs do not capture a "progressively scanned" image. In this way, the XL H1 is like the Sony Z1 and FX1, which also use interlace CCDs.

At its website, Canon calls its “24fps mode” by the marketing name 24F. Canon claims 24F “gives the look and motion of film.” Clearly, the “look and motion of film” requires 24fps with a *constant interval between frames*.

The obvious process that could accomplish true 24fps is to clock the 1440x1080 CCDs at 48Hz. By clocking the CCDs at 48Hz, a constant stream of video frames is captured. This eliminates the non-equal time between frames of Sony's CineFrame 24. It also inherently supports a 1/48th second shutter, something not provided by CineFrame 24.

While Canon has a perfect right to withhold information on the process by which 24F is obtained, given the claim of film motion, the company should disclose whether 24F has a constant timebase. When I asked if the camera captured with a “constant timebase,” Canon representatives declined to answer.

Employing the Kell factor of .85 with a 1.33:1 (1440x1080) aspect-ratio image, the H1’s effective horizontal resolution should be about 920 lines. (The use of non-square pixels indicate effective vertical resolution should be about 700 lines.)

Interlace-scanning CCDs employ row-pair summation to reduce interlace line flicker and twitter. Row-pair summation reduces effective vertical resolution to almost 800 lines in 1080i60 mode.

In 24F mode, Canon could use its “DV Frame Mode” technique to read out the CCDs. This “vertical green-shift” mode employs *every other field* and creates the luma signal by adding Red+Blue pixels from rows 1 and 3 together with the sum of Green pixels in rows 2 and 4. This solution would yield about 600 lines of effective vertical resolution.

Another option would be to use Smart Deinterlacing to create each frame from *both fields*. While static resolution will be that of an interlaced frame (approximately 800 lines), resolution for moving objects (not the entire field) will be as low as that of a field (about 400 lines).

One possible marketing advantage of Smart Deinterlacing is that because resolution tests are inherently static, they indicate about 800 lines of effective vertical resolution. This would allow Canon to claim there is no loss in resolution between 60i and 24F. (Some Internet reports do indicate a test resolution of 800 lines.) Hopefully, anyone purchasing a $10,000 camcorder will realize that since video almost always has motion, de-interlacing cannot provide resolution equal to interlace scanning.

The Canon XL H1's DIGIC DV II chip outputs video with or without pulldown. The 24F data has 2:3 pulldown added to the odd and even lines of each de-interlaced frame to yield 1080i60. The 30F de-interlaced video is already 1080/60PsF (Progressive segmented Frames), while 60i is, of course, already 1080i60. Thus, 1080/60PsF and 1080i60 are output as 4:2:2 uncompressed video from the XL H1's HD-SDI port and from the analog port.

The 1080/60PsF and 1080i60 are also MPEG-2 encoded. Canon has supplied all major NLE vendors with XL H1 units so they can implement a capture process that enables 24F and 30F to be stored to disk as 24fps or 30fps video that is free of interlace artifacts.

POV _ More on CANON XL H1

by Chris Hurd

The CCD block in the XL H1 utilizes three one-third inch 1.67 megapixel CCD image sensors which provide an effective target area of 1440 x 1080 pixels. Each CCD has a native 16:9 shape. The 1440 x 1080 dimension is the same matrix used in Sony HDCAM camcorders. Like the preponderance of most all 3CCD blocks these days, Pixel Shift technology is employed in the horizontal axis. The advantage of Pixel Shift offset is that it provides more sampling points when converting the analog voltage output from the CCD block into a digital video signal.

The individual photosites on a typical 1440x1080 sensor are not square pixels, but anamorphic in shape. Commonly referred to as non-square pixels, they each have a PAR (pixel aspect ratio) of 1:1.333, which allows an HDTV monitor to display this HD signal properly as 1920x1080 (all HDTV displays use square pixels, or a PAR of 1:1). Basically, the CCD target area pixel matrix is anamorphic in nature due to the PAR value of 1.333 of each pixel. The width of the matrix and its non-square pixels is displayed through the square pixels of an HDTV monitor. In mathematical terms, this can be expressed as (1440 x 1.333) x 1080 = 1920 x 1080. While any HDTV monitor will properly scale this signal automatically to 1920x1080, it is important while editing HD video from the XL H1 to set the Pixel Aspect Ratio of your video editing software to 1:1.333. In other words, an HDTV knows what to do with non-square pixels, but your editing software might not.

The XL H1's DSP (the digital signal processor, which is the brain of the camcorder, much like the CPU in a computer) is Canon's own proprietary technology referred to as Digic DV II. With the introduction of the second-generation Digic DV II for the XL H1, the latest iteration of Digic technology is now engineered for HD video processing. Digic DV II also allows for parallel image processing for simultaneous still photo recording plus HD video output. In addition to its normal 60i (sixty interlaced fields) for HD video output, it also provides the optional HD frame rates of 30F and 24F (thirty full frames per second and 24 full frames per second, respectively).

PROSUMER CAMCORDERS CANON XH A1 & XH G1

In addition to its flagship H1, Canon also introduced two new camcorders, the XH G1 and the XH A1. Both include exactly the same imaging system as Canon's XL H1, including three 1/3-inch 16:9 CCDs and the ability to record 1080i video in both 60 interlaced and 24 frame rate modes. The new Xl G1 and X H1 are identical to each other in every regard, save for a professionally equipped “jack pack” of I/O ports that accounts for the $3000 price difference.

These new camcorders retain all the same core imaging specs and manual controls as found in H1. The key difference is in the body. The XL H1 offers interchangeable lenses, and can accommodate the entire XL lens series. The XH G1 and XH A1 follow in the tradition of the Canon GL series, which have smaller bodies and do not offer interchangeable lenses.

The XH G1 and XH A1 feature three 1/3-inch CCD sensors, each a native 16:9 with a resolution of 1440 x 1080. While the camcorders do not offer a true 24p frame rate, they feature the same 24 fields per second shooting mode found on the XL H1.

The XH G1 and XH A1 feature the same DIGIC DV II processor found on the XL H1. The camcorders offer a 20x optical HD lens, featuring Fluorite glass and Ultra-Low Dispersion glass. The lens has a focal range of 32.5mm – 650mm (35mm equivalent). Encircling the lens are three separate rings, controlling focus, zoom, and iris. All of these controls have a secondary interface elsewhere on the body or in the menu. The camcorders also feature Super Range optical image stabilization

Perhaps the most notable new feature for professionals is an improved SD/HD-SDI, which is available only on the XH G1 as part of the jack pack. The new design embeds not only the video signal and time-code, but now the audio as well.

The camcorders will store up to 9 custom pre-sets in the camcorder’s internal memory, including a custom LCD display that shows only the information that the user defines. These settings – up to 20 variables – can also be saved as a special file to SD card and imported to other XH G1s and XH A1s.

Images can be viewed on a 2.8-inch widescreen LCD (207K resolution) or a 0.57-inch color electronic viewfinder (269K resolution).

The manual control suite is largely similar to the XL H1. There is an auto mode, full manual mode, and aperture and shutter priority modes. The gain can be manually adjusted up to +36dB. There are also two built-in ND filters, at 1/6 and 1/32.

Another one of the upgraded features of the XH G1 and XH A1 is Instant AF, a new focusing system that decreases focal time and increases focal effectiveness. The method works by implementing an entirely separate, external sensor that measures camera-to-subject distance first using contrast, to get the focus “in the ballpark.” It then needs to drive the focus lens only a small degree to fine tune it.

The XH G1 and XH A1 offer a number of audio controls, as well. Both camcorders offer two XLR terminals that provide phantom power. Each channel has audio level adjustment via external dials.

CONSUMER CAMCORDER - CANON HV10

Recently, canon introduced its first consumer-oriented high definition camcorder - HV10. Among the key features: optical image stabilization, a 10x optical zoom, a 1/2.7-inch CMOS sensor, and Instant AF, a new focusing system borrowed from Canon's prosumer line.

The HV10 features a 1/2.7" CMOS chip (2.96 gross MP, 2.07 effective MP). This is the first Canon camcorder to utilize a CMOS chip, though the company has manufactured them for some time for use in their still cameras. The camcorder shoots full 1080i HD video, and offers noise reduction built into the chip (historically, noise has been a problem with many CMOS camcorders). The CMOS sensor is designed with a Bayer pattern, which defines the arrangement in which color filters are laid out, boosting the number of green pixels to increase color production for the human eye. The HV10 also features a DIGIC DV II processor, the same processor found on Canon's prosumer HDV line, including the XL H1. The HV10 also features Super Range optical image stabilization. Another benefit of the CMOS is the ability to capture stills up to 2MP while simultaneously shooting video. Stills save to a MiniSD card, the same card media found in Canon's DVD lineup.

The HV10 includes manual exposure and manual shutter speed (1/8th – 1/2000th video mode, 1/2 – 1/500th still mode), an array of Program AE modes, zoom, white balance, and focus. This last control, focus, is among the most important when shooting HD video, as focal errors are exaggerated with the corresponding increase in resolution. The HV10 does not offer a focus ring, instead, it employs an external button to activate manual focus and a small dial to make adjustments.

The Canon HV10 employs the Instant AF system, which uses an external sensor to speed up and increase the accuracy of focusing. The sensor judges camera-to-subject distance first to get a rough estimate of the proper focus. The focus lens then needs only to make fine adjustments.

Monitoring the video is done through a 2.7-inch widescreen LCD with a 210K resolution. The Canon HV10 also comes equipped with a 0.27-inch view finder, which has a 123K resolution.

Additional features on the HV10 include a video light, histogram dsplay, zebra patterns, and grid markers. It uses a Canon HD video lens, F1.8 – F3.0, with a 37mm filter diameter. The zoom range extends to 10x optical and 200x digital. The focal distance ranges (in 35mm equiv.) from 43.6mm – 436mm.

SONY HDV 1080I EQUIPMENT

CAMCORDERS

SONY HVR-Z1 (and HDR-FX1)

Although it wasn't the first (JVC came much earlier, but with ambiguous success) Sony X1 is *de facto* a kind of a standard in HDV camcorders. From the engineering, esthetic and also marketing point of view Sony put a lot of efforts to present this camcorder as a beginning of an era of affordable High Definition devices.

And, in a way it was, since JVC's camcorder worked in HDV1 (720p) and Sony's in HDV2 (1080i) sub-format.

X1 and Z1 are in fact the same camera, but Sony is following it's praxis to develop "professional" and "consumer" versions of some of its camcorders. In the past that was the case with DV/DVCam devices, now with HDV ones. There are a number of subtle differences between these camcorders, but the basic ones are that Z1 employs professional XLR audio connectors and, when recording in SD, uses DVCam and X1 DV format.

Here are some of the features of the camcorder:

3CCD Camera System with 1080i HD CCDs The HVR-Z1 incorporates three 1/3-inch type 1080i HD CCDs, each with a 16:9 aspect ratio, a total pixel number of 1.12 M (1,012 x 1,111) and an effective pixel number of 1.07 M (972 x 1,100). The combined 3CCD system achieves a resolution of 1,440 x 1,080 by adopting the precise spatial offset technology and interlace scanning system.

Camcorder incorporates a high-integrity 14-bit HD DXP (Digital eXtended Processor), which features a 14-bit A/D converter and advanced camera processing. This higher bit resolution allows the contrast to be reproduced more faithfully in mid-tone areas of the picture.

The HVR-Z1 is equipped with a new Carl Zeiss Vario-Sonnar T High-Definition lens with a 12x zoom function. This lens is designed with a wide viewing angle and a focal length ranging from 32.5 mm to 390 mm in 16:9 mode and from 40 mm to 480 mm in 4:3 mode and has a filter diameter of 72 mm.

It also employs the Super SteadyShot system, whereby horizontal and vertical movements can be detected independently by the sensors. The prism system located behind the lens adjusts and optically compensates for unsteady camera handling

The HVR-Z1 can switch between HDV 1080i, DVCAM and DV recording, providing full flexibility to record in either standard or high-definition. In addition, it can be switched between 50i and 60i modes (PAL and NTSC). It is capable of native 16:9 widescreen image capturing, with a high-resolution of 720 x 576 pixels (PAL) and 720 x 480 pixels (NTSC) in DVCAM and DV formats and providing true 16:9 images in SD format

The HVR-Z1 can convert material from 1080i down to 576i and 480i and output these video signals through its i.LINK interface or analogue component, composite, or S-video connectors. It can also down- convert to 576p and 480p and output these signals through its analogue component video connectors. When down-converting these signals, the aspect ratio displayed can be converted from 16:9 to 4:3. Display modes can be selected from Squeeze, Letterbox or Edge crop.

The HVR-Z1 provides two XLR audio input connectors for connecting professional microphones or feeding an external-line audio source. Phantom power of approx. 40 V8 can be supplied for the external condenser microphone.

The 0.44-inch type color LCD viewfinder displays high-resolution color pictures of approx. 250,000 pixels in a widescreen aspect ratio of 16:9. Operators can also select to display pictures in black and white.

The HVR-Z1 includes a 3.5-inch type color LCD monitor with a high-resolution of approx. 250,000 pixels, which allows for viewing of the input source during recording, or checking the playback picture on location in a widescreen aspect ratio of 16:9. Simultaneous Operation of LCD Monitor and Viewfinder are also possible.

The Auto Exposure Override function allows operators to manually change exposure settings during the AE mode via an iris dial. This allows operators to set the desired exposure settings with no need to set all exposure settings modes to manual. This function can easily be recalled at the touch of an Assign Button

The Hyper Gain function can automatically boost the gain level up to approx. +36 dB at the touch of an Assign Button. This makes it possible to shoot in extremely low-light conditions.

The All Scan Mode, similar to the Under Scan Mode of other camcorders, displaying all effective scanning lines in the screen.

Functions frequently used in the field can be assigned to six Assign Buttons (push buttons), allowing operators to make rapid changes under field conditions.

The AF (Auto Focus) Assist function allows operators to focus on desired subjects when using the AF mode. Operators can manually change focus positions using a focus ring during AF mode, allowing AF reference focus positions to be shifted to manually changed positions. At the touch of a button, the centre of the screen on the LCD monitor and viewfinder can be magnified to about twice the size, making it easier to confirm focus settings during manual focusing.

The time code can be preset using any number in H/M/S/F (hours/minutes/seconds/frames) to record desired tape-position information. The time-code mode can be selected between “REC RUN” and “FREE RUN”. In addition to the time code, user bits can also be set.

The HVR-Z1 provides a special gamma feature – the Cinematone Gamma – which allows operators to quickly set up and load a gamma curve with similar contrast characteristics to a film gamma curve.

The Cineframe allows picture movement to be reproduced like a film. Combined with the use of Cinematone Gamma, this allows a cinematic and film-like look to be achieved. Three types of Cineframe modes can be selected. Cineframe 25 is used in 50i mode and can reproduce the picture movement like films of 25 frames/second in HDV, DVCAM and DV formats. Cineframe 24 and Cineframe 30 are used in 60i mode and can reproduce the picture movement like films of 24 or 30 frames/second in HDV, DVCAM and DV formats.

Here is the overview of the interlaced modes of Z1 in both 50i and 60i variants :

50i mode

Recording Format	Playback/ Down-conversion Format	i.LINK	Input		Output		
			Analogue Composite	S-Video	Analogue Component	Analogue Composite	S-Video
1080/50i	1080/50i	○	–	–	○	–	–
	576/50p (16:9/4:3)	–	–	–	○	–	–
	576/50i (16:9/4:3)	○	–	–	■[1]	■[2]	
576/50i (16:9	576/50i (16:9/4:3)	○	■[2]	■[2]	■[1]	■[2]	
576/50i (4:3)	576/50i (4:3)	○	■[2]	■[2]	■[1]	■[2]	

60i mode

Recording Format	Playback/ Down-conversion Format	i.LINK	Input		Output		
			Analogue Composite	S-Video	Analogue Component	Analogue Composite	S-Video
1080/60i	1080/60i	○	–	–	○	–	–
	480/60p (16:9/4:3)	–	–	–	○	–	–
	480/60i (16:9/4:3)	○	–	–	■[1]	■[2]	
480/60i (16:9	480/60i (16:9/4:3)	○	■[2]	■[2]	■[1]	■[2]	
480/60i (4:3)	480/60i (4:3)	○	■[2]	■[2]	■[1]	■[2]	

POV _ POINTS TO CONSIDER REGARDING X1 & Z1

Frank, author of a very good and popular blog http://www.humanvalues.net/hdv/ put together this text in order to open the discussion about the camera.

Yet, one should know that, according to the numbers, HDCAM with its 4:1:1 and compression rate of 7:1 is a rather poor format. In reality, however, a number of Hollywood films were shoot with it.

Numbers are not everything. Still, here is this interesting text:

These camcorders shoot only *interlaced video. They are* not *capable of producing progressive (NI or non-interlaced) video. This is true even in the so-called (24F/25F/30F) "Cineframe modes". The Cineframe modes are* ***effects modes*** *and not true progressive scan modes of operation. Also note that on all models of the HVR-Z1, the field order (dominance) is upper (top) field first, which is the exact opposite of the DV format where the sequence is lower (bottom) field first.*

The 1080i shooting modes have a frame size of 1440 x 1080 (width by height), not *the 1920 x 1080 (width by height) frame size which is usually associated with the term "1080". That's a reduction of 518,400 pixels per frame, or exactly 25 percent fewer pixels per frame than one might expect from a 1080 format. Additionally, a frame size of 1440 x 1080 equates to an aspect ratio of 4:3,* not *16:9. 1920 x 1080, on the other hand,* is *a 16:9 aspect ratio frame size. Needless to say, digital video files produced by these camcorders use non-square pixels, while the camcorders themselves utilize a pixel offset technology to help compensate for the fact that the imaging CCDs (Charge Coupled Devices) have but 960 active pixels per scan line, exactly half of the 1920 pixels required for true ATSC-compliant 1080i HDTV.*

Adam Wilt, author of the famous http://www.adamwilt.com/HDV website, writes more on the Cineframe modes:

Cineframe 30 and Cineframe 25

Cineframe 30 on the 60i FX1 (or on the Z1) works just like the slow shutter on Sony's SDTV DV cameras: it throws away one field and doubles the other. The resulting image has half the motion resolution of the normal interlaced mode and appears like a progressive frame, but it only has a single field's worth of information, so its vertical resolution is somewhat degraded, and diagonal lines may look "steppy" or "jaggy". Because the field-tossing happens in HD, the downconverted SDTV output looks considerably better than field-doubled standard definition. Instead of being half as good as normal interlaced mod. How about in HD? If you have a true 1080-line display, Cineframe looks just like field-doubling (as you might expect), with half the vertical resolution of normal interlace shooting.

Cineframe 24

Cineframe 24 (CF24) is the really interesting one: it implies the look of 24fps motion picture film. For casual uses, it works very well: the images appear to have 3:2 pulldown, with two "interlaced" frames and three "progressive" frames in every five, and the motion is pleasingly stuttery. However, the camera itself is still running at 60i, so there's definitely some funny business 'twixt the chip and the clip. Still, However, the motion is worse (more uneven, more syncopated) than true 24p imagery, and it cannot be reverse-telecined to get smooth 24fps imagery. CF24 is fine as a special effect if you're staying on video at 60i, but it's not suitable for a true 24fps feel, nor will it work for film-outs: the motion is too unsmooth, and the vertical resolution of the image is damaged. For film-outs, shoot at 60i and use a program like DVFilm's Maker or your film-out facility's own in-house process to convert 60i to 24p.

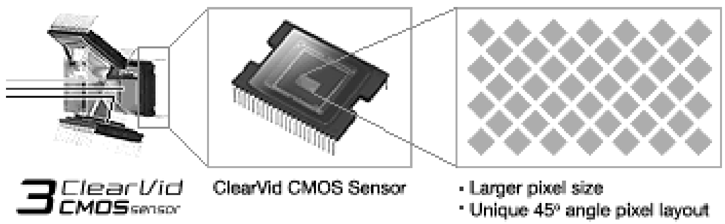
Sony HVR-V1 (and HDR-FX7)

Sony invented 24p six years ago when it developed the HDW-F900 HDCAM camcorder at the behest of George Lucas, who wanted to shoot *Star Wars* Episodes I, II, and III in a digital medium. But Panasonic and JVC have more fully exploited 24p capabilities across their professional camcorder lines. Panasonic introduced 24p to standard-definition MiniDV with its AG-DVX100 and followed up with the compact AG-HVX200, a DVCPRO HD system that initiated the era of flash-memory P2 recording. JVC based all of its ProHd line on progressive technologies.

Now at long last, Sony has extended 24p to a Handycam-style camcorder that requires neither shoulder nor tripod.

HVR-V1 is a new, 3 chip, progressive HDV camcorder delivered, contrary to Z1, in two versions - PAL (25p) and NTSC (24p). But this goes only for V1, not FX7 which is the consumer version.

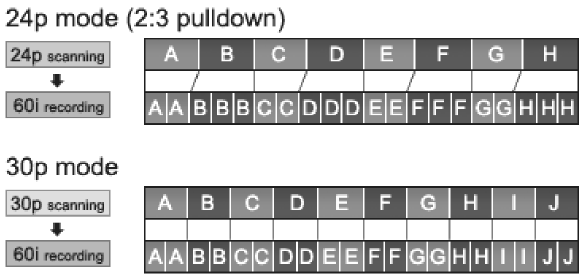
There is a impressive list of features hidden in a smaller body that one of Z1: a three-CMOS imaging block — the first ever in a camcorder brought to market — with optical image stabilization, an active histogram in the viewfinder (like in Sony's A1), an optional hard disk recording system, and adjustable shutter angle in degrees as with a motion picture film camera (instead of fractions of a second like with a still camera).



In this camera Sony employs 1/4in. chips with 1.2 million gross pixels (1.03 million effective pixels in HDV). These 960x1080 ClearVid CMOS chips deserve special note, because they introduce a pixel grid that's tilted 45 degrees, such that square pixels become diamond-shaped. Not a pixel-shifting technique, the configuration effectively multiplies the resolution of these 1/4in. chips. Further, because of Sony's CMOS design, the photosensitive sites of these 1/4in. CMOS chips are identical in size to those of the 1/3in. CCDs used in the Z1.

ClearVid technology is tightly integrated with Sony's Enhanced Imaging Processor (EIP). The reality is that the HVR-V1's "image" is being formed in and by the EIP. The CMOS chips are only "collectors" of information the EIP needs to both create and manipulate an image. Image creation is the EIP's most fundamental task because, according to Sony, the EIP works at "1920x1080/60p at 4:2:2." This specification implies both that the created image is 1920x1080 and that it is created from 60p scanning of the ClearVid chips. Thus, the EIP has a 2 million-pixel buffer for each of the three primary colors.

Although there's no way to capture this much information via HDV — which is reduced in pixel count, chrominance sampling, and field output to 1080x1440, 4:1:0, and 60i before heavy compression — the V1 presents an intriguing new possibility: an HDMI connector for uncompressed HD output (1080x1440). HDMI (High Definition Multimedia Interface) is basically an upgrading of DVI with embedded digital rights management. Ostensibly it's there for digital monitoring, but think of HDMI as a poor man's HD-SDI.



Speaking of 24p, the V1 adds 2:3 pulldown and records the resulting segmented 24p frames to tape as 60i HDV. In restoring 24p for editing, are there compatibility issues with popular NLEs? Not as long as the 2:3 cadence is understood by the NLE, but it appears that Sony flags its 24p-to-60i cadence differently from Panasonic's, which in turn is incompatible with JVC's solution. Like the Z1, the V1 internally downconverts and makes a terrific DV and DVCAM camcorder.

How then, is 60i obtained? The CMOS chips always progressively scan 1080-line frames into the EIP. And the EIP outputs 540 fields at 60Hz to the encoder. To remove *interlace flicker* and *interline twitter* artifacts, Row-Pair Summation is performed at the point where 1080 lines are converted to 540 lines. Because Row-Pair Summation acts as a low-pass filter, it results in a 25-percent loss of effective vertical resolution.

A side dial can be defined to control iris from F1.6-F11 (24 steps) or exposure. Video gain can be set from 0, 3, 6, 9, 12, 15, to 18dB. Shutter speed can be set as follows: 30P/60i (1/4, 1/8, 1/15, 1/30, 1/60, 1/90, 1/100, 1/125, 1/180, 1/250, 1/350, 1/500, 1/725, 1/1000, 1/1500, 1/2000, 1/3000, 1/4000, 1/6000, 1/10000) and 24P (1/3, 1/6, 1/12, 1/24, 1/40, 1/48, 1/50, 1/60, 1/96, 1/100, 1/120, 1/144, 1/192, 1/200, 1/288, 1/400, 1/576, 1/1200, 1/2400, 1/2800, 1/10000).

A feature called TC Link enables you to synchronize timecodes between cameras using i.LINK. This makes possible multiple camera shoots with tapes carrying identical timecode because all camcorders can be set with identical timecode prior to shooting. The V1's i.LINK port can be connected to Sony's new HVR-DR60 (60GB) hard disk recorder to record an HDV/DVCAM/DV stream.

The V1's zoom is a new optical 20X Zeiss Vario-Sonnar design — longer than the Z1's 12X – with the addition of 1.5X digital extension based on image processing of CMOS scans. This delivers the equivalent of a 30X zoom. Like Panasonic's DVX100 and HVX200, the focus ring while electronic nonetheless achieves repeat focus marks, meaning it can be used with follow-focusing knobs. Sony will also provide an optional zoom-through 0.8X wide-angle adapter with a unique locking bayonet mount and extra-wide matte box .

SONY HVR-A1 (and HDR-HC1)

While Z1 (and the new V-1) are, specially because of the 3-chip configuration, professional audio inputs and numerous manual overrides considered as a professional "prosumer" model, single chip HDR-HC1 and A1 derived from it, can't hide their consumer heritage. Still, they are not high quality machines, specially since most of the technology used is coming from X1 & Z1.

The biggest difference is that A1 and HC1 are using single, CMOS chip contrary to 3 imagers of their bigger "brothers". Again, the major difference between A1 and HC1 is in the use of XLR audio connectors (because of the small body, here it was done as a separate module) and DVCAM/DV options.

Features include: The HVR-A1E incorporates one 1/3-inch type primary color CMOS (Complementary Metal Oxide Semiconductor) sensor with 2.97 million total pixels and a 4:3 aspect ratio, this has been developed based on Sony's many years of experience in imaging devices. This CMOS sensor can produce high-quality images with high sensitivity and low noise levels due to advantages such as its unique pixel design and advanced noise reduction technique.

The EIP is Sony's newly developed image processing IC intended for high-speed processing of large amounts of data captured by the CMOS sensor. In addition, the EIP employs the unique algorithm that first separates image data into texture patterns and brightness components and then processes these two elements independently. This makes it possible to have high details in the dark as well as in brightly illuminated areas of the picture, delivering a clear image with a wide dynamic range even under backlight conditions. Also borrowed from bigger model, these camcorders have Time Code capability and Cinematone Gamma Cineframe feature.

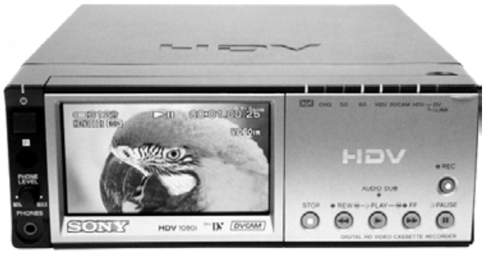
SONY HDR-HC3

The smallest of Sony HDV camcorders (only 600 grams with tape and battery) HC3 is a real consumer device, but because of the high picture quality can be used as a second or backup camera.

It features 1/3" ClearVid CMOS Sensor, 2.7" Wide (16:9) LCD & 211K pixel LCD screen as well as Super NightShot Infrared System for shooting in the dark. By increasing the record rate from 60 fps to 240 fps for 3 seconds camcorder is enabling impressive slow motion effect. Also, it facilitates parallel video and still pictures recording - up to the resolution of 2.3 Megapixels. Built into the lens body of the camera, the assignable dial can be used for customizing a number of functions. Finally, it also borrows a kind of Cinematic mode to record " 4 frame film-like" effect.

RECORDERS

SONY HVR-M10



HVR-M10E runs on AC or DC. It can switch between HDV 1080i, DVCAM and DV recording. and between 50i and 60i modes (PAL and NTSC). It can convert material from 1080i down to 576i and 480i and output these signals either through its i.LINK interface or analogue component, composite, or S-video connectors. It can also down-convert to 576p and 480p with the aspect ratio converted from 16:9 to 4:3. The HVR-M10E includes a 3.5-inch type color LCD monitor with approx. 250,000 pixels, in a widescreen aspect ratio of 16:9. The time code can be preset using any number in H/M/S/F (hours/minutes/seconds/frames) to record desired tape-position information. The time code mode can be selected between “REC RUN” and “FREE RUN”. In addition to the time code, user bits can also be set.

SONY HVR-M15

The HVR-M15U is a new, 50/59.94Hz selectable lightweight, compact HDV 1080i VTR capable of standard or mini-cassette record and playback of HDV-2 1080i, DVCAM and DV (SP). <in a way it is a successor of the famous DSR-11, DVCam recorder used a lot in editing suites. It is possible to record up to 276 minutes of HDV material. HDV-2 1080i recorded tapes can also be downconverted with time code to an appropriate DVCAM VTR using the standard definition DV output mode via an i.LINK connection. Additionally, the i.LINK HDV Mode, and the DV/DVCAM Modes allow for time code input. The HVR-M15U will also playback select HDV-1 720p pre-recorded tapes but only with analog output, not over i.LINK.

SONY HVR-M25

The HVR-M25U is a new, 50/59.94Hz selectable lightweight, compact HDV 1080i VTR capable of standard or mini-cassette record and playback of HDV-2 1080i, DVCAM, and DV (SP). It is equipped with a 2,7" LCD monitor and audio recording level controls. 1080i recorded tapes can also be downconverted with time code to an appropriate DVCAM VTR using the standard definition DV output mode via an i.LINK connection. Additionally, the i.LINK HDV Mode and the DV/DVCAM Modes allow for time code input. The HVR-M25U will also playback select HDV-1 720p pre-recorded tapes but only with analog output, not over i.LINK HDV as a native transport stream.

SONY HVR-1500

This professional half rack size deck offers a number of features sharing many characteristics with the popular Master series DVCAM range. It features a 2.7” LCD monitor with integrated display panel for status check, video and picture monitoring Sony HVR-1500 supports HDV1080i, DVCAM and DV recording and playback as well as additional benefits using either standard or mini sized DV cassettes and supporting both 50i and 60i recording and playback. It features a number of optional modules for increased workflow flexibility like H-SDI in/out and RS-422 control.

SONY HVR-DR60

HVR-DR60 is a portable hard disk (HDD) compact recorder and an ideal companion for Sony's professional HDV camcorder range. It offers 4.5 hours of continuous recording via i.LINK and is capable of recording video images in either Standard Definition (SD) or High Definition (HD) depending on the camcorder and user requirements. The HVR-DR60 offers the flexibility of recording to both the camcorder and the disk simultaneously. In addition as the product is file-based, workflow options are enhanced providing high-speed access to NLE systems and random access to video files. Utilizing the FAT32 file system the HVR-DR60 adopts the .m2t file format for HD recording and AVI Type 1 file format for SD recording.

POV_ Four Affordable HD Camcorders Compared

by Adam Wilt

On January 11th 2006, filmmaker Barry Green organized a side-by-side comparison of four low-cost HD camcorders: the Canon XL H1, JVC GY-HD100U, Panasonic AG-HVX200, and the Sony HVR-Z1U. For reference, he added two "real" HD camcorders to the mix: the Panasonic HDC27F Varicam and the Sony HDW-F900/3 CineAlta.

I had the privilege of crashing his party, and this is my report on how the tests were conducted and what we saw. I'm basing this both on impressions I had and notes I took on location, and on examining captured clips from all the cameras.

First, however, I need to provide some context and caveats. Camera comparisons are incredibly difficult to perform, to judge objectively, and to quantify. By their nature, they are open to errors of omission and commission, and to accusations of bias. At their best, they illuminate aspects of performance, but they can never completely encapsulate the entire scope of how a camera behaves and how it renders a scene, because there are simply too many variables to control. There's also the danger of perceived bias. Much of the time when equipment is compared, it's in terms of a "shootout", with the goal of picking winners.

Equipment

We tested four low-cost HD camcorders, all of them using three 1/3" CCDs:

Canon XL H1, a 1080i-native HDV camcorder with interchangeable lenses, 1440x1080-pixel CCDs, and 24f and 30f modes in addition to 60i.

JVC GY-HD100U, a 720p-native HDV camcorder with interchangeable lenses, 1280x720-pixel CCDs, and 24p as well as 30p recording.

Panasonic AG-HVX200, a fixed-lens DVCPROHD machine recording on P2 cards in either 720p or 1080i/p modes. It is said to use 1080p chips with an unspecified horizontal pixel count.

Sony HVR-Z1U, a fixed-lens 1080i-native HDV camcorder using 960x1080-pixel chips.

We put this Gang of Four up against the 2/3" 3-CCD **Panasonic HDC27F Varicam** and the **Sony HDW-F900/3 CineAlta**. The Varicam has 1280x720p CCDs, while the CineAlta's chips are 1920x1080p-native. Both cameras had ENG-style HD zooms, but I didn't record model numbers.

Some material was recorded to the native recording format of the cameras under test: 720p or 1080i HDV, or DVCPROHD on a P2 card for the Panasonic. We also captured clips of every test in uncompressed 10-bit format to hard disk using a PowerMac G5 with AJA Kona LHe card, using Final Cut Pro as the capture application.

The Tests

Once we had all the equipment set up and had resolved various technical glitches, we had five hours left in which to play. Obviously we were not going to be able to perform exhaustive tests, so we settled on some basics: sensitivity, resolution, and dynamic range. Along the way we'd look at white balance, color response, and image tweaking, but we simply didn't have time to explore these in detail.

Since most of the folks involved were interested in film-style production, whether for film transfer or for "the film look" on video, the cameras were for the most part run in their 24fps modes, although we switched the Canon between 24f and 60i modes to ensure that we were getting the highest possible resolution from it ("24f" is not a true progressive mode, and I wanted to see if there was a difference in image quality between 24f and 60i). We also ran the Z1 in 60i mode, as its Cineframe24 (CF24) mode produces compromised results, and we also know that CF25 and CF30 modes result in a field-doubled image with half the normal vertical resolution.

All the cameras white balanced cleanly, but we saw some interesting differences on the vectorscope. The Varicam's vector display was much tighter than the CineAlta's, but both cameras showed even "pools of light" on the vectorscope: bright near the origin, with a smooth fade-out at the edges.

The Canon's display, by contrast, showed an obvious quantization, with a central square of intense data and a gridded penumbra on the 5x magnified display.

The Z1 and HVX showed looser patterns, with regular horizontal and vertical bars of intensity.

At first, we attributed the quantization to the AJA A/D converter, but when we hooked it up to the Canon's analog outputs, the Canon's display was essentially unchanged, just very slightly fuzzier. Clearly, there's some sort of processing in the cameras that's causing the Cr and Cb signals to be coarsely quantized, but there was nothing detectably posterized on the picture display that we could detect as a result of this.

Sensitivity

The white card was swapped for a gray card, and the lights were adjusted to provide 120 foot-candles of illumination. Jay metered the card with his Spectra-Pro spotmeter set for ISO 320, 24fps, 180 degree shutter - hence 1/48 sec for the exposure - and got an aperture of f5.6.

All the cameras were set to their 24fps mode and 1/48 shutter save for the Z1, which we left at 60i, 1/60, because it lacks a true 24p setting. We selected "normal" or "standard" video gamma on all the cameras as it's the only gamma setting shared by all of them, so it was the only way to consistently compare exposures. We then adjusted each camera's iris until the gray card was reproduced at 50% brightness on the waveform monitor. We then read off the f-stop, and were able to determine the effective sensitivities of the cameras:

Camera	f-stop	Effective ISO rating
HDW-F900/3 CineAlta	Just under 5.6	Just under 320
HDC27F Varicam	Just under 4	Just under 160
Canon XL H1	4 + 1/3 stop	200
JVC GY-HD100	Just under 5.6	Just under 320
Pana AG-HVX200	5.6	320
Sony HVR-Z1	4	160

Notes

- It's worth noting that the Sony was at 1/60 sec shutter, while the others were at 1/48 sec. If the Sony had been capable of shooting at 1/48, it would have gained almost 1/3 stop.

- Surprisingly, the 1/3" cameras were very close to the 2/3" cameras. If all else were equal, the smaller chips should yield lower sensitivity. But the 1/3" cameras were all visually noisier than the 2/3" cameras; they've picked up sensitivity at the expense of noise. The Z1, the slowest of the bunch, had the cleanest, lowest-noise picture.

- In shooting exteriors with the Z1 and HD100 side by side (actually, with the HD100 strapped on top of the Z1, but that's a different story), I found that when both cameras were run at 1/60 sec shutters on auto-exposure, their f-stops tracked exactly, and the resulting exposures matched. The 2/3-stop difference between them seen on this test may simply be due to the different color balances between sunlit daylight and the fluorescent Caselights and a corresponding difference in spectral sensitivities between the two cameras.

- The HVX200's strong showing - it was the most sensitive of the group - is interesting in that the camera is said to use a 1080p-native chip. With vertically smaller pixels than the 720p-native JVC, and without the benefit of sensitivity-doubling dual-line readout used in the interlaced Z1 and H1, one might expect it to be between half a stop and a full stop slower than the other 1/3" cameras. Not only was it faster, it was no noisier than the JVC or the Canon. The reason behind the HVX200's strong showing is unknown.

- Even with the differences, all the 1/3" cameras were within 2/3 stop of each other (crediting the Z1 with 1/3 stop for its higher shutter speed). Sensitivity isn't a strong differentiator between these cameras.

Resolution

We next shot the DSC ChromaDuMonde chart. It has an 11-step grayscale, white and black patches, resolution trumpets, and a sequence of precision color chips designed to map out a regular hexagon on the vectorscope. We didn't spend a lot of time on the color patches (ironically, since they are the main claim to fame for the ChromaDuMonde) since we could easily have spent the rest of the day just tweaking each camera for perfect color reproduction. Instead, we focused on the resolution trumpets to determine the native sharpness of the chips, and see what happens to detail too fine to be properly rendered.

The following test used the Combi-2.3 resolution chart. In addition to resolution trumpets, it has a frequency sweep consisting of a wide band of vertical lines of varying spacing, becoming more tightly bunched towards the right; large blocks of lines at fixed frequencies in both horizontal and diagonal directions; and "bullseye" patterns similar to a Putora sharpness indicator. The greater variety of resolution targets offered more chances to determine limiting resolutions, as well as chances to see what out-of-band detail looked like, and the bullseyes graphically illustrate H/V detail balance.

So, how did the cameras look?

The **1920x1080p CineAlta** sets the sharpness standard: at the 1000-line limits of the charts, both horizontally and vertically, the resolution trumpets are trembling, but all five black lines are still present and fixed in place. On the Combi chart the frequency sweep decays into undifferentiated gray from just past 1000 all the way to 1200 lines, with only the slightest bit of aliasing visible. The fine detail in CineAlta images looks like images from a high-resolution still camera sized to 1920x1080; there's almost no moire or aliasing to be seen. Likewise, on real-world images like the dynamic range setup we did later, the pictures are crisp and natural with as much detail as a frame this size can hold.

The **1280x720p Varicam** likewise has a clean and balanced 700+ line image in both H and V directions. It shows a little bit more aliasing and moire past its detail limits than the CineAlta does, but it's not objectionably worse.

Of the 1/3" cameras, the 1440-pixel, **1080i Canon XL H1** was the clear winner in horizontal resolution, and it was second only to the 1920-pixel CineAlta. I see almost 800 TVL/ph from it, with minimal aliasing above that: an astonishingly good performance.

In 60i, vertical resolution was a solid 700+ lines; in 24f mode, we thought it looked like half-resolution material on the monitors, consistent with what you'd get with field-doubling. Looking at the captured clips, especially the Combi-2.3's bullseyes, I'd have to say that it certainly looks like field-doubled vertical sampling, with about 540 TV lines usable, although certain aspects of the image "feel" sharper. I'm not sure how to describe it, but perhaps Canon's secret sauce for creating 24f results in a perceptually sharper picture than plain field-doubling, even if the clues I can glean from the interference patterns on the bullseyes would indicate otherwise.

The XL H1's minimum sharpness value still showed some enhancement overshoot on the waveform monitor, so we weren't able to completely defeat its detail setting, but the detailing was minimal and mostly unobjectionable. Dialing sharpness up and down did little to the perceived limiting resolution, although it clearly affected the "crispness" of the image. At -7, the image was naturalistic; at +7 it was as edgy as a Sunday-morning talk show.

The **1280x720p JVC HD100** closely followed the Canon and the Varicam with almost 700 TVl/ph and 700 lines vertically. Everyone was very impressed (and some were more than a little surprised) at the JVC's strong showing (the JVC's recorded HDV resolution of 1280x720 exceeds that of the Varicam's 960x720 DVCPROHD; if recorded resolution were the only factor of interest, you'd probably buy the JVC!). The JVC, furthermore, showed the most pleasing rolloff in high frequencies of any of the 1/3" cameras; it had less visibly distracting aliasing than its stable mates, and less than the Varicam; more aggressive optical low-pass filtering may explain the lower aliasing along with lower perceived sharpness.

The JVC has a considerable range of detail settings, including "off". "Off" was truly off, while "min" was a bit edgy for the film folks among us; we agreed that we'd prefer a setting between "off" and "min". Even so, both were equally sharp at the limit, though we felt that the edginess of the images at JVC's default setting and higher were clearly in the electric-video realm.

The **Sony Z1**and **Panasonic HVX200** brought up the rear; as I look at the images I see them being equally coarse. Both cameras showed noticeable aliasing above the limiting resolution; to my eye they were equal in this respect. On the charts, I saw both cameras at 550 TVl/ph.

Changing "sharpness" settings on the Sony makes a large difference in perceived sharpness, with lower settings making the image very blurry and higher ones making it edgy, if no higher in resolution. The HVX200's corresponding control had a subtler effect; the machine holds its fundamental sharpness better with detail turned down, and it doesn't go quite as electric in its edginess when it's cranked up all the way. Sharpness on the Sony was at 5 and on the HVX we used -3 or -4, both to give the same apparent sharpness (as judged from edging artifacts) as the Canon did on its minimum setting.

Vertically, the 1080i Sony Z1 showed better than 720 lines, as expected, but the HVX in both 720p and 1080i showed 540 lines, as if its 1080p CCDs images were being field-doubled like the Z1's CF or the Canon's 24f modes. As far as we know, there's no setting on the HVX that causes such field-doubling (slow shutters aside), so this result is puzzling to say the least.

1080-line camera limiting resolutions:

Camera	Chip details	H limit, TVl/ph	V limit, TVl
HDW-F900/3 CineAlta	2/3" 1920x1080p	1000+	1000+
Canon XLH1	1/3" 1440x1080i	800-	700+ (540)
Sony HVR-Z1U	1/3" 960x1080i	550	700+ (540)
Panasonic AG-HVX200	1/3" ???x1080p	550?	540?

Notes:

- Numbers in parentheses are for non-native recording rates, i.e., CF25 or 24f modes. Note also that the CineAlta will show 700+ lines vertically in interlaced modes.

- Numbers are for 10-bit uncompressed recordings at 1920x1080 resolution. Video recorded to the camera's native recording format may show lower horizontal resolution numbers due to subsampling: HDCAM, HDV, and 50i DVCPROHD top out around 810 TVL/ph; 60i DVCPROHD goes to 720 TVl/ph.

- The HVX's horizontal pixel count is not published.

- The HVX's resolution numbers are suspect and should not be trusted until further testing is done.

720-line camera limiting resolutions:

Camera	Chip details	H limit, TVl/ph	V limit, TVl
AJ-HDC27F Varicam	2/3" 1280x720p	700+	700+
JVC GY- HD100U	1/3" 1280x720p	700	700
Panasonic AG-HVX200	1/3"???x1080p	550?	540?

Notes:

- Numbers are for 10-bit uncompressed recordings at 1280x720 resolution. Video recorded to the camera's native recording format may show lower horizontal resolution numbers due to subsampling: HDV can capture up to 720 TVl/ph; 720p DVCPROHD goes to 540 TVl/ph.

- The HVX's horizontal pixel count is not published.

- The HVX's resolution numbers are suspect and should not be trusted until further testing is done.

Image Rendering, Dynamic Range, and Exposure Characteristics

We next set up a scene with 12 stops of dynamic range, from a black-draped box in the shadows to a white shipping case blasted with light. The gray card, the ChromaDuMonde, and actress Kacy Bult's skin tones were all illuminated to the same level, and the cameras were set to expose these subjects at 50%. The shadowed depths of the studio and Kacy's dark dress gave us more low-key information while shiny objects gave us specular highlights.

We tried to optimize each camera for the best subjective image quality and the broadest latitude. I'll mention specific departures from the default setup (normal gamma, black stretch, knee, matrix, no gain boost, etc.) as I recall them.

Both Panasonics, as I recall, were set to Cine-Like_D gamma. On the HVX200 the knee is not separately settable in this mode, and I don't know what was set on the Varicam.

The Z1 was left at normal gamma; both its cinegamma settings depressed midtones too much for our tastes, although I turned on black stretch to reveal more shadow detail.

The JVC was kept in normal gamma, while its knee was set to manual at 80% for the strongest highlight compression (I don't recall if we used any black stretch on the JVC).

Here's where we missed an opportunity: the Canon XL H1 has a variety of menu settings we failed to exploit. Its knee was set to "middle" whereas "low" might have bought us a smidgen more highlight detail. The Canon also has two noise reduction options (NR1, which appears to perform recursive or "3D" noise reduction, and NR2, which is said to be like "applying the skin detail function over the entire picture") as well as coring (which reduces enhancement noise in the shadows), all of which we neglected to engage, so the Canon's image was a tad noisier than it otherwise might have been. The Canon was used with normal gamma and no black stretch.

As far as I know we used the normal color matrices on the Canon, JVC, and Z1. I'm not sure what was used on either Panasonic or on the CineAlta, nor do I know how any parameters were set on the CineAlta; I didn't have time to look at it in detail.

In general we tried to stay with the "equalized" sharpness settings across all the cameras we had agreed on for the resolution tests, and we tried to set the gray card at 50% exposure, but aside from that the cameras were individually optimized for this one scene. Even so, the Varicam wound up darker in the midtones. Take any qualitative comparisons with a grain of salt; what we saw in Burbank may not correspond with what you see on your set.

All the cameras did a very good job of rendering the scene. Everyone present was surprised at how little difference there was between the cameras when it came to putting a clean, pleasing picture on the screen. There were differences in resolution, colorimetry, noise, and dynamic range, but these differences were minor compared to the overall high quality and similarity of the images.

The CineAlta and Varicam took top honors overall; they had better resolution, lower noise, wider latitude, and more subtle highlight handling than all the 1/3" contenders - but their lead over the "toy cameras" was much less pronounced than anyone expected. The Varicam in particular yielded gorgeous images, and those who expressed a preference agreed that if they could take home one camera from the test, based on that one scene, it would be the Varicam.

Amongst the 1/3" cameras, all aside from the Sony Z1 had noticeably noisier images than the 2/3" cameras. The Z1 looked almost as clean as the 2/3" cameras. The Z1 lagged in sharpness and aliasing, tying (as I saw it) with the HVX200, and its highlight handling was a bit less accomplished than the others.

The Canon XL H1 was the resolution champ amongst the 1/3" cameras, with a crisper, visibly more detailed image than its compatriots. To my eye it showed slightly more noise than the HVX200, with the noise being a fine-grained luma noise compared to the HVX200's slightly softer, more chroma-oriented noise. I preferred the Canon's noise signature as being less video-like, but Barry preferred the HVX's noise for exactly the same reason - you'll want to judge for yourself. In any case, there was potential to reduce the visible noise in the Canon's image that we didn't explore; we'll have to do that in a later test.

The Canon clipped highlights a bit more harshly than the HVX did; it was comparable to the Sony as best I remember. Again, had we set the Canon's knee to "low", we might have eked out a small increment in usable highlight detail; how much so I can't say. Something else to test on another day...

The HVX200 was not the resolution winner, but it did a very good job on skin tones, handling highlights cleanly. It showed less noise than the Canon by a slight amount, and the noise was more colorful: more film-like according to Barry, more like color-under analog to my eye. This is one of those subjective things where taste is as important as numbers.

In post-test comparisons I found the HVX's skin tones to be slightly on the greenish side. I used my Channel Balance filter, in Final Cut Pro to reduce Cb by 10-15%, and the resulting images were much more pleasing and a better match for the other cameras.

The real surprise of the test was the JVC HD100. It had the noisiest picture of the bunch, but in every other aspect we were all stunned at how good its images were. While the Canon was slightly crisper, the JVC rendered a more naturalistic, more alias-free image while yielding only a little ground in terms of raw resolution (and remember that the other cameras are 1080-line cams while the JVC is 720p-native). Its image detail clearly topped that of the Z1 and HVX200. The JVC also seemed to handle highlights more gently than the other cameras, and may (if I recall correctly, but this is disputable) have held onto detail for half a stop more overexposure than the other cameras did.

And the skin tones! After shooting the normally exposed images, we increased each camera's exposure by two stops to drive Kacy's skin up into the knee-affected area. While I don't recall specifics for the other cameras, I do recall that everyone was agog at how well the JVC handled skin tones. There was little of the hue shift that characterizes overexposed skin on so many cameras; the HD100 "looked more like film" in this test than the other 1/3" cameras did.

If a winner were to be picked on how well a camera did on the tests as compared to its expected showing, the HD100 would be that winner.

No, I don't have numbers for this test. All cameras shot the same scene from different angles, so it's difficult to adequately judge whether a visible highlight detail on one camera is blown out on another because of the angle of reflection or because of a difference in highlight handling. Also, the captures from the +2 stops test don't show consistency in midtone exposure; I know there were some issues involved in getting some of the cameras to match, and different gamma curves were used, so after the fact it's impossible for me to say what exactly is going on. I've simply provided frame grabs (below, in a .zip file) from the normal exposure test, and you can download it and make your own judgments.

Note that FCP applies a gamma correction to exported stills to compensate for the default Mac screen gamma of 1.8 (PCs and video use 2.2). If you're viewing the stills on a PC or on a Mac calibrated to 2.2 gamma, try adding a gamma correction around 1.22 to see the tonal balance more the way we saw it on-set (in Photoshop's Levels control, slide the middle slider leftwards until its readout is 1.22).

Conclusions?

All the 1/3" cameras clustered together more tightly than we expected. Each camera excelled at some aspect of image rendering, but all of them were more alike than different; none stood out as being clearly superior all around.

Furthermore, they all came a lot closer to the 2/3" cameras than we thought they would: while we could clearly see that the big cameras made superior images, the contrast between the 1/3" and 2/3" cameras was nowhere near what we expected to see.

DP and CineAlta operator Art Adams once characterized my Z1 pix as "half HD" for their horizontal softness, and that perception holds as I look at the 10-bit uncompressed clips: The 1/3" 1080i camera pictures are only about half as crisp as the CineAlta's. In 720p, the JVC comes close to the Varicam in raw detail, although its noise is quite a bit higher.

When you consider that none of these 1/3" cameras comes anywhere close to half the price of their 2/3" brethren, you'll see that "half HD" isn't bad for the money.

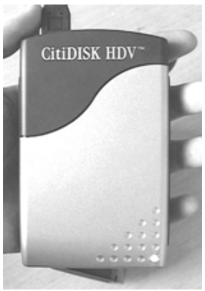
We came away convinced that any of the cameras would do a creditable job in the hands of a skilled user, and that the choice of camera should be made more on features and ergonomics than on image quality. This is not to say that people didn't pick favorites; people did. It's just that no one, not even the most partisan among us, would have claimed that any one of the cameras was unacceptable for doing serious work.

We also understood how sketchy and rudimentary our explorations were. We didn't look at motion rendering, or how the camera's different codecs and recording formats affected image quality. Do the cameras behave differently in daylight-lit exteriors than in tungsten-balanced interiors? How does each one handle handheld? What kind of work is each camera most suited for?

We didn't have time to answer these questions, so they remain subjects for future tests.

HDV EXTERNAL STORAGE SOLUTIONS

In addition to good, old DV cassettes that are the storage medium for HDV recordings, there are a number of manufacturers who are supplying additional, mostly HDD solutions:



Shining Technology CitiDisk for HDV - Palm-sized disk recorder eliminates the time-consuming step of recapturing video footage in post. Internal shock-absorbing system increases reliability. Up to 420 minutes of recording with 100 GB drive. Records HDV/DV/DV50 streams from camcorder controlled by camera's REC button with tape, or by CitiDISK HDV's REC button without tape. CitiDISK HDV stores the MPEG2 transport stream as a M2T file, as well as DV (DV25) and DVCPro50 (DV50) into the unit for immediate editing capability. "QPLAY" last captured HDV/DV/DV50 streams on viewfinder when setting camera to VCR mode. Navigating history clips is also possible by "Press-n-Hold" "QPLAY" button for over three seconds.

FOCUS *FireStore FS-4* interfaces with the camcorder via FireWire cable that passes audio, video, timecode and control information, allowing the user to simultaneously record to disk and tape. It also provides a comprehensive backlit display, menu system and buttons allowing easy control and management. The FS-4 comes standard with a 40GB hard drive and is available with up to 80GB of capacity. One can also extend recording time by linking multiple FS-4 units together. A 10 second electronic shock cache ensures you never lose footage, even in the roughest of conditions. There is a special version for JVC HDV camera.

Bella Corporation *Catapult* is a paperback-sized digital encoder that allows capture of video footage from DV or HDV video cameras directly to iPods or virtually any USB drive. It plugs into any standard or HD camcorder with a FireWire port and processes the video as recorded, eliminating the need to convert the footage later on. Besides saving time and offering access to higher storage capacities, the Catapult also enhances the camcorder with a number of features not available out of the box, such as time-lapse recording, remote trigger capabilities, and both pre- and post-recording ability. Pre-recording is an especially attractive option, as it seems to buffer whatever the CCD is capturing for a preset timeframe, allowing essentially to "turn back the clock" and preserve events that already happened once the record button is hit.

MacroSystem *HDV Recorder* is a standalone HDV hard drive recorder/converter that includes a removable 250 gigabyte hard drive, providing up to 30 project partitions to store up to 23 hours of HDV material. The HDV Recorder is compatible with all HDV formats: 720p, 1080i, NTSC and PAL and a single hard drive can contain any combination of these formats. It also converts the HDV material in real time to DVI and VGA, with output resolution. HDV Recorder is provided with the front and back inputs for FireWire, DVI and VGA outputs, S/P DIF coaxial digital audio output, analogue stereo output and mini-keypad with one-touch functions for record, playback pause, Fast Forward and Rewind and more. It allows the setup of a "playlist" from multiple HDV films, loop mode for playback (individual films and play list) via an easy to use GUI.

HDV & AUDIO

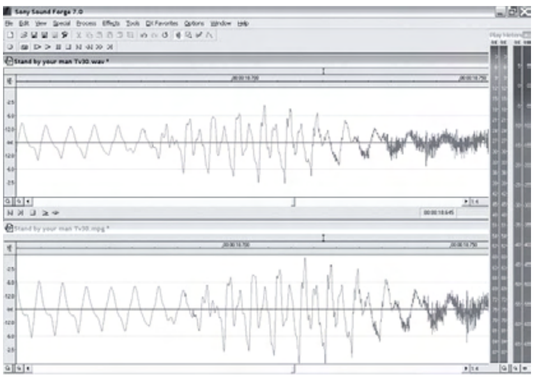
While DV audio is uncompressed, in order to further reduce storage requirements HDV audio uses MPEG-1 Layer II compression. The HDV spec has recently been modified to include MPEG 1/Layer 1 and MPEG 1/Layer II compression, thus providing four channels of audio to the HDV camcorder spec.

PCM, or Pulse Code Modulation, is an uncompressed audio format that virtually anything can read. It's the audio version of the .txt file, if it were to be put in those terms. CDs, DAT machines, and DV video cameras use PCM audio, as do higher grade video cameras.

To put things in perspective, MP3 files are MPEG 1/Layer III audio files. Layer III is the most efficient of MPEG audio formats, but is more designed for low bitrates, such as those that MP3 players use. Layer I is the least efficient, and requires a very intelligent decoder. MPEG 1/Layer II is the best compromise, allowing for a high quality decoder, while being very efficient. In simple terms, the way MPEG compression works is by playing on the psychoacoustic principles in masking areas that are inaudible to the human ear, much like how high compression video cameras play on the perception of light and color to the human eye.

MPEG 1/Layer II audio is a compressed audio format, but that shouldn't suggest it is a compromised audio format. The video world lives wonderfully with compression, and there is no reason to suggest audio can't do the same. Uncompressed audio has a relatively high bitrate of 1.6Kpbs, and compression pulls this down to less than 400Kpbs. In fact, MPEG 1/Layer II HDV audio is at the top end of the specification for MPEG bitrates. As MPEG is a lossy compression format, extreme dynamics in volume and frequency can unmask issues with encoded/compressed audio. As compression rates go up, there will always be some loss of fidelity. The goal becomes recording audio that is aurally indistinguishable from the original, or marginally audible, but not bothersome or detrimental to the program.

Generally MPEG 1/Layer II audio is well-suited for dialog and general audio. Recording a symphony with long tails or reverbs in the room, or recording highly dynamic performances with intimate detail such as a solo singer with a guitar may also reveal issues during the fade outs of the music, but bear in mind that this format was not designed to act as a master recording system for highly dynamic audio content. Just as with DV, the critical audio should be recorded to a separate device that has DACs (Digital Audio Converters) that are of a high quality. No video camera in the HDV or DV world has DACs suited for critical recordings. In the digital realm, resolution is critical. To achieve maximum resolution in audio, audio should be properly recorded.



Notice that the .wav file on top contains greater resolution overall from the MPEG 1 Layer II, 384Kpbs file shown below.

It's all about numbers. You may already know the challenges involved with chromakeying green screen footage in the DV 4:1:1 world; trying to process MPEG 1 Layer II audio isn't much different. Audio sampling can be considered much in the same way as video records. The higher the number of frames, the smoother and more accurate the recording of the motion will be. The higher the frequency in audio sampling, the more faithful the sound recording is to the original. If the camcorder's framerate is too low, the recording will miss portions of movement and any action recorded will be jerky and irritating. Sampling/frequency rate is similar to how many pixels/resolution the camcorder records. The number of bits is relevant to the framerate. While a bit depth of 12 bits provides for acceptable audio, 16 bits are the standard of the video industry, with 24 bits being the next level, or what is referred to as "high definition" audio (when the sampling rate is higher than 96k).

The HDV audio standard has recently been added to, allowing for up to four channels of audio, but two of these reference channels are 12bit, 32k audio channels, and not suited for anything other than dialog in the way of high quality audio. For most video recording purposes, 24 bit isn't practical, as it predominantly offers only a greater dynamic range in a format that once prepped for broadcast, can't take advantage of the extra data. While it may be beneficial to have the extra bits at acquisition, the cost would be a diminished video signal due to the limited bandwidth. Hence, the camcorder standard of 48K/16bit in lower cost equipment and at broadcast.

What all this points to is that recording digital audio is a numbers game, and if you don't record at maximum levels without hitting 0dB, then you are leaving a lot of numbers on the table that you can never recover. It's somewhat similar to filming a few stops down and then trying to compensate for under exposure in post. You can process the frames, but the noise becomes more apparent in the image. You're much better off having the correct exposure to begin with.

Catching the Wave!

Microphone placement and gain are critical with MPEG 1 Layer II audio. The already-compressed format will only serve to cause the audio to sound weak if not properly recorded. Whereas the PCM format of audio in the DV realm and analog recording of the Beta SP format allowed for some latitude in pushing audio levels up while simultaneously dealing with existing noise, MPEG 1 Layer II audio will not be as forgiving. You need to make every bit count. The lower the audio level coming into the encoder, the fewer bits are used, and therefore, the audio suffers a loss in quality in the editing stages. For example, the audio might have noise, and if noise reduction is applied to a low-resolution audio file, it's entirely possible that it will be difficult for the noise reduction software to separate the noise from the actual audio. You may already know the challenges involved with chromakeying greenscreen footage in the DV/4:1:1 world. Trying to process MPEG 1 Layer II audio isn't much different.

POV _ HDV AUDIO

by Douglas Spotted Eagle

... HDV audio is far from perfect. Frankly, so is linear, PCM based audio if you're using a DV camcorder to capture the audio. However, for dialog purposes, HDV audio is not only perfectly acceptable, it's preferable when considering the need for carrying double audio recording gear. If you were recording a John Prine concert, or a symphony, I'd definitely carry a DAT machine or other high end recording equipment such as the Edirol R4 device. And I'd suggest the same if you were recording these sorts of events on a DV camcorder too. Double record if audio range is critical. However, do not be concerned about the quality of HDV audio based on anti-HDV commentary found on various websites. These charts, and your own ears, bear out the quality of HDV audio and where it is quite useful and amenable to audio production.

Ironically, while listener acumen isn't a test of "what's good enough," most people are very happy with their 128Kpbs MP3 files on their personal music devices, and virtually no one ever negatively comments on AC3 audio, which is generally somewhat poor. Granted, these are delivery codecs, not acquisition codecs, but the quality of the HDV audio format is substantially higher than either of these delivery formats.

Keep in mind that the analog to digital conversion process is substantially more critical than the medium on which it is recorded. HDV camcorders, particularly the Sony Z1 and A1 camcorders, have outstanding converters. To get a better conversion, you'd need to step to an external box such as an EchoFire box from Echo, an Apogee Rosetta (if you've got serious cash) or one of the many M-Audio devices available.

Avoid recording to MD; you can clearly see that even the frequency range of spoken word is dramatically impacted. Using an iRiver device is another great option provided you're recording in PCM mode vs MP3 format.

Although converting the MPEG 1, Layer II stream into PCM audio at point of capture doesn't reconstitute the frequencies that were compressed, immediate conversion allows the file to maintain integrity throughout the editing process. Reverbs, delays, etc will be smooth and clean, once converted. Compressed audio formats shouldn't be filtered, as the recompression for final output may have issues. Most NLE's will convert the compressed audio to uncompressed when the audio is brought to the timeline, or converted to PCM when an intermediary format is introduced to the HDV video.

Record your HDV audio at appropriate levels; this will make the biggest difference of all when shooting with HDV audio. Use good microphones, just like you'd do with any other recording device, and get it close to the source. Make sure all gain stages are proper, so that you're recording clean, with robust levels, and you'll have no issues with compressed audio at all. This holds true for any audio that is to be compressed at any level, and for audio that isn't to be compressed. Good audio techniques are important regardless of the recording format.

Test your HDV camcorder to know how it will handle audio in a variety of shooting situations. You don't want to find yourself being quite knowledgeable about the visual aspects of the camera and ignorant of the audio aspects, do you? Sound is 70% of picture; it should encompass a substantial bit of your camera knowledge as well. Good sound is the absence of bad sound; great sound is pre-planned good sound.

Make your audio great.

POV _ Portable (and affordable) Audio Recorders for HDV Producers

By Anthony Burokas

Given that most prosumer HDV camcorders have evolved from existing prosumer camcorders, we can expect their internal audio components to retain the lackluster performance of their forbears. By lackluster, I mean that they fail to meet their own specifications. Published testing results have shown that the mic preamps in these camcorders do not have the frequency response or signal-to-noise ratio that "16-bit 48KHz" specifications would indicate.

Those are just numeric specifications of the amount of bits allocated to record audio. The quality of the audio that is recorded is a completely different story. From bad microphones and poor wireless systems to camcorder microphone preamps that hamper audio quality, the time has come for those striving for high-definition in their video to capture high definition audio as well. And it almost goes without saying, at this point, that you won't achieve that goal by relying on the onboard audio of the camera alone.

Now as we move to HD acquisition, most of us are doing so via HDV. It uses 4:1 compression using MPEG-1 Layer-II—and this is just for two channels of audio. Canon touts its XL H1 as being able to shoot and record four channels of audio (previous XL models offered the same feature). This means a unique audio data stream that uses 8:1 compression. If you are going to compress the audio, why not use a more universal standard like MP3 (MPEG-2 Layer-III), where perceptual encoding and high bit rates can satisfy even the pickiest audiophiles in today's ubiquitous portable MP3 players?

Portable Audio Recorders

Portable audio recording devices are designed from the ground up to do one task, and do it well: record clean, high-quality audio. Recently, several manufacturers brought to market small, portable, solid-state digital audio recorders that offer high-quality audio in convenient packages. In fact, they can go well beyond 16-bit 48KHz, all the way to professional audio-level 24-bit 48KHz WAV files. Just as with oversampling on a CCD, 24-bit audio recording enables you to capture, edit, and deliver some of the most pristine audio you have ever recorded.

The one challenge here is that these recorders require the user to go back to the "film-style" double system for recording audio. That is, using a clap slate and syncing up the audio in post. But in reality, this is far easier than it ever was now that we have visible waveforms in our nonlinear editing software. Even though HDV tape will still be digitized in real time, we can download hours of HD audio in just a couple of minutes. It is worth the effort to step up both ends of your production when the consumers of your product will be enjoying it on digital screens and high-quality surround-sound systems that reveal the effort you put into the production.

To survey the current crop of HD-capable audio devices that are most likely to fit both the workflow and budget of event videographers, we gathered three recorders with comparable price points - round **$ 400** : the Edirol R1, the M-Audio Microtrack 24/96, and the Marantz PMD660. Each of these are two-channel recorders capable of recording uncompressed audio in WAV files, as well as compressed audio in MP3 format.

Edirol/Roland R1

The Edirol/Roland R1 a compact flash-based audio recorder that uses two AA batteries. The R1 is about the size of a small Betacam cassette. It features both line- and mic-in, as well as built-in stereo microphones. It has an input-level adjustment dial that is always active. The screen can display an audio meter, but indicates the average of both channels. It has a limiter you can turn on or off.

The R1 can record WAV files in 24-bit and 16-bit at a sampling rate of 44.1KHz. It can also record 16-bit MP3 files at 64, 96, 128, 160, 192, 256, and 320Kbps. You can use cards as large as 4GB, but the largest single file you can record is 2GB. After that the recorder will stop. With a 24-bit WAV file, that's 125 minutes. With 320Kbps MP3, that's 831 minutes (13 hours). This should be enough time for any continuous sound recording.

The clear and easy-to-use buttons had us going through the menus very quickly without the manual. However, because the display has only two lines of text, we had to crack open the manual to find out what some of the abbreviations meant.

Testing revealed that the R1 requires more gain than other recorders. Even with the input level all the way up, we often found our audio levels to be average. Though it has an internal limiter, we did not find ourselves having to turn down the input levels because there was too much gain. Contrast this to a DAT machine, which never required us to turn up the same stereo

All in all, if used as a clean, basic audio recorder with an external microphone, the R1 will provide you with audio clips that deliver. We don't recommend it for the built-in effects or for the kind of work where the audio you want to record tends to be very quiet.

Marantz PMD660

The Marantz PMD660 is a little thicker, wider, and longer than the R1. It uses this additional size to provide true balanced XLR connectors and space for four internal AA batteries. The XLRs are for microphone-level input only and can provide phantom power. Line-level I/O is only available through a 1/8" stereo jack. There is a headphone jack on the front and a full-size USB jack for data.

The compact flash card fits into a door on the front of the unit. The door is a bit tricky but is designed so that it can be screwed shut over the media. The eight segment meters are right above this door.

The 660 simplifies recording options compared to the other recorders tested here, as well as the rest of the Marantz product line. You can record audio as MP3-44.1KHz, MP3-44.8KHz, PCM-44.1KHz, or PCM-48KHz. That's it. Other options include automatic level control (useful for reporting), a limiter, and an internal attenuator. The 660 also features two built-in microphones and adds a single internal speaker. It would be fairly impossible to critically assess the audio on the 1" speaker in the 660. As with the R1, there are also no wind screens for the 660's mics.

In testing the 660, we found it very easy to get around. The ability to see and adjust the recording levels of different channels proved to be very handy. In one case, one performer was much louder than the other. We had placed a stereo microphone between them, and easily turned down the one channel.

M-Audio Microtrack 24/96

The M-Audio Microtrack is an astoundingly small and light recorder. You turn the thing over in your hand and find yourself looking at what appears to be a slightly thicker, rounded iPod Mini, but is actually a full-featured audio recorder. From the 1/8" stereo mic to the balanced TRS 1/4" L&R mic/line inputs, all the way to separate RCA lines-out and even coax digital-out, this little unit makes use of every inch of available space.

The right side of the unit is the simplest, with just the compact flash slot and a little rocker switch you use to navigate the menus. This is also the only unit to support MicroDrives, which is good for versatility, though they will use more power than compact flash cards and shorten total record time when powered by a battery.

In the menus, you can set the input-level adjustments to be linked or separate. Linking them means that using either the left or right adjuster will affect both channels. You can unlink them in the menu, and then the left or right adjuster adjusts only that channel. You can also turn linking on and off while recording. It's convenient and capable and offers operation similar to the Marantz with the two record-level adjusters linked by friction, but easily adjustable separately.

Also, space on the M-Audio is at a premium so some things have multiple functions. It is not intuitive to use the menu navigator button/rocker to pause recording or playback, but that's what it does. Also, there's no dedicated button to stop a recording; you just hit the record button a second time. While it may start to seem fairly intuitive after some time, things like this can befuddle a new user.

Conclusion

With all three units tested here, the included or built-in microphones are not high-end elements. Also, the built-in/attached microphones are very susceptible to noise from handling the recorders. Even resting on a table or floor they pick up surface noise very easily. Using an external microphone separated from the recorder by a cable is essential. It is the only way you can touch and adjust settings on the recorders without recording handling noise.

Each of these units also has certain strengths. They all produced very good audio. While there are certainly more capable, and more expensive, portable recorders, these three seem to be vying for the same place in our camera bag.

The Marantz offers ease of use, good run time, fast response, and balanced XLRs. When the mic preamps get overloaded, the 660 has an internal pad you can add to salvage your audio. It restricts flexibility in recording settings—probably to encourage producers with bigger budgets or higher-end requirements to step up to Marantz' bigger flash recorders. The 660 takes more power to give the same or less run time and it's also considerably bigger than the other two recorders tested.

The R1 offers a small form factor, many recording settings, as well as numerous features and capabilities including optical out. It gets a decent record time on just two AA batteries. It lacks balanced inputs and input pads, and you can't monitor or adjust individual channels. The display is the weakest of the bunch.

The Microtrack is a truly diminutive recorder with many recording settings, coax digital out, and RCA line out. It offers amazing run time from an internal battery. It lacks the ability to change batteries; in the field this can really become an issue. It also lacks an internal limiter or pad so if something is too loud, it's distorted and there's nothing you can do about it. Lastly, it seems that M-Audio still has a few tweaks left to implement in their firmware to make the record-level adjustment work properly.

Each recorder takes several seconds to start up and get ready—no different from most any camcorder. The Marantz is the only one that can cut a track on the fly. The others have to stop recording, save, and then can start recording again. For some people, this will be the key factor in their purchase. The R1 is second fastest, and the M-Audio slowest.

When it comes to which one worked best for me, personally, I have to go with the R1. While not the snazziest or fastest, it works. It functions simply, and it offers great flexibility and run time with batteries I can change in the field. I can deal with the file date and naming issues. Now, add to this that Roland has just announced the R-09, a smaller, lighter and simplified version of the R1. Unfortunately, they also removed the limiter, which is critical for the work I do. But if you liked the R1, and don't need a limiter, this new recorder may make your choice even easier.

EDITING HDV

HDV at a glance

HDV is a specification for recording 16:9 HDTV on DV cassettes. The format's main specifications call for both 720p and 1080i recording, with a 4:2:0 sampling structure: Chroma has half the resolution horizontally and vertically as luma does, just as it does in DVD, digital television transmission, and 625/50 DV and DVCAM. Long-GOP MPEG-2 is used to squash HD down to a bitrate suitable for DV tape recording.

In 720p (720 line, progressive scan), 25, 30, 50, and 60 frames per second can be recorded. The luma information is sampled at 1280 pixels across by 720 down-which gives it a higher raw sampling resolution than 720p DVCPRO HD-and the video is recorded to tape as an MPEG-2 transport stream (TS) at around 19 Mbps.

In 1080i (1080 line, interlaced), 50 and 60 field-per-second video is supported, sampled at 1440 x 1080-the same luma subsampling used in HDCAM. It's recorded as a 25 Mbps MPEG-2 packetized elementary stream (PES).

Audio in either case is two channels of 16-bit 48 kHz sound, compressed to 384 Kbps, using the MPEG-1 Layer 2 specification so that it takes up one-quarter of the space of uncompressed audio.

More pixels, more problems

HDV's transportability over FireWire and the fact that it records to MiniDV tape make it easy for folks to think of HDV as simply "high-definition DV." There are, however, three significant differences between HDV editing and DV editing. *First*, HDV uses inter-frame compression, while DV does not. *Second*, HDV audio is MPEG-2, not PCM. And *third*, the number of pixels per HDV frame is either 2.7X (1280x720) or 4.5X (1440x1080) the number of pixels employed by DV.

	Horizontal Pixels	Vertical Pixels	Pixel Count	Multiplier (vs. 480i)
480i	720	480	345,600	
720p	1280	720	921,600	2.7
1080i	1440	1080	1,555,200	4.5

All these differences create the need for a huge amount of computation to accomplish editing. This need can be satisfied in several ways. The four techniques for editing HDV could be called *draft*, *proxy*, *native*, and *intermediate*. Let's work our way through all these options.

As a general note, native HDV performs all the computations while you are working with the timeline. As you might expect, to obtain good timeline performance with a native HDV editor, a very powerful computer is required. Alternatively, HDV editing can break the task into less computationally intensive steps, which is the approach used by the draft, proxy, and intermediate solutions.

HDV - how many formats?

When talking about HDV editing, we have to bare in mind that there is not just one or maybe two sub-formats - HDV1 and HDV2. In reality, most of the manufacturers added some "flavor" to these formats, so the situation at the moment of writing of this Report is something like this table from Adobe, where this experienced and respected manufacturer is explaining different approaches to the editing of different sub-sub-formats:

HD Format/Camera	Frame Rates	Interface	Capture Hardware/Software	Codec Options/Notes
HDV	1080 60i, 50i; 720 30p	IEEE 1394	Adobe Premiere Pro 2 Built-In Support	HDV native
Canon XL H1	1080 60i, 50i, 30F, 24F	IEEE 1394	Adobe Premiere Pro 2 w/ Canon presets update	HDV native No 24F export to tape
	1080 60i, 50i, 24F	IEEE 1394	CineForm Aspect HD, Prospect HD	CineForm CFHD, Intermediate
	1080 60i, 50i	IEEE 1394	Matrox Axio SD, Axio LE, Axio HD; RT.X2	HDV native (Summer 2006)
JVC GY-HD100U	720 30p, 25p, 24p	IEEE 1394	Adobe Premiere Pro 2 w/ JVC presets update	HDV native No 24P export to tape
	720 30p, 25p, 24p	IEEE 1394	CineForm Aspect HD, Prospect HD	CineForm CFHD, Intermediate
Sony HVR-Z1, HDR-FX1, etc.	1080 60i, 50i	IEEE 1394	Adobe Premiere Pro 2 Built-In Support	HDV native
	1080 60i, 50i; CineFrame 30, 25, 24	IEEE 1394	CineForm Aspect HD, Prospect HD	CineForm CFHD, Intermediate
	1080 60i, 50i		Matrox Axio SD, Axio LE, Axio HD; RT.X2	HDV native
HDV -> Uncompressed	60i, 50i; 30, 25, 24 p/F/ CineFrame	HD-SDI	[See Uncompressed HD]	uncompressed

Streams?

Transport stream? Packetized elementary stream? To make a long story less long, a transport stream (TS) is analogous to a QuickTime or AVI wrapper containing video and audio data.

A packetized elementary stream (PES) is a "raw" stream of compressed video or audio data (actually, a TS is more like an MXF wrapper than QuickTime or AVI, though it isn't that much like any of 'em, but let's split one hair at a time). There's also the program stream (PS), which is much like a TS, but designed for comparatively error-free environments instead of the hurly-burly of long-distance transmission, and better optimized for editing purposes; however, HDV doesn't use program streams. Confused yet? No worries-regardless of the stream type, the data is the same: long-GOP MPEG-2 video.

The native HDV (HDV-1, ProHD, and HDV-2) file extensions look like this:
.M2A = Audio (the native MPEG file format of the audio elementary stream)
.M2V = Video (the native MPEG file format of the video elementary stream)
.M2T = Transport Stream (transport layer, which is usually removed by NLE software)

Draft editing

We are all likely familiar with using draft editing techniques. We batch-capture a tape using a codec different from the one used by our camcorder. Naturally, this codec is chosen because it decodes faster than our tape's codec. Apple's PhotoJPEG can be decoded faster than DV, so it has long been used as non-NTSC/PAL draft codec for DV.

Of course, our draft codec should require less storage space and disk bandwidth. One way to accomplish this is to simply lower compression quality. Alternately, we can degrade image resolution. It is also popular to drop every other field, or every other column, or both. The latter option cuts storage by a factor of four.

Because computers can now process DV so efficiently, it is possible for DV25 itself to be used as an NTSC/PAL draft codec for HDV. Now all the effects that support DV can be used on our draft HD material. All that is needed is a computer that's fast enough to transcode HDV to anamorphic DV. The advantage of working with DV is that the timeline is ready for playback on an NTSC/PAL display when connected via IEEE 1394 to the monitor. In fact, you can directly export a DV production.

After the production has been edited, the timecode of the draft clips is used to generate a batch-recapture of the HDV material. Of course, this requires HDV equipment with frame-accurate capture ability.

Proxy editing

Adobe Premiere 4.2 supplied the first implementation of proxy editing. We would capture all our taped material to motion-JPEG and save the file on our $10,000 4GB disks. Next we initiated a batch conversion of all these clips to a draft codec. This often was an all-night job — and in those days it was rare that a computer could run more than a few hours without crashing. Nevertheless, if we were lucky, it worked. The proxy codec typically supported 15fps playback with a resolution of 240×180 pixels.

So, you can also edit HDV by proxy. In proxy editing, you capture HDV, then convert the material into proxy clips using a codec more suitable for editing, such as SD DV, or SD or HD OfflineRT (Photo-JPEG based). You edit your show with the lower-resolution proxy clips, taking advantage of NLE's realtime capabilities with the more friendly format, then conform or online your finished program from the original material.

Proxy editing tools include Pro Indie HD Toolkit, Lumiere HD, and HDpartner Pro. They use separate programs running outside of the NLE to capture HDV material, demultiplex the MPEG-2 transport streams into separate audio and video files, convert the compressed audio into uncompressed AIFF, and transcode the MPEG-2 video to the proxy format.

After you edit your show, you relink your clips to the original media and render, typically to an uncompressed file. You then feed that fat file into a separate compression utility to squeeze it back down to a long-GOP MPEG-2 transport stream ready for export to HDV or D-VHS, or export to a variety of formats using Apple Compressor, Discreet Cleaner, Sorenson Squeeze, or other compression utilities.

Of course, you can also render an SD timeline, taking advantage of high-resolution HDV acquisition to give you a richly detailed picture thanks to the benefits of supersampling. Many HDV users today are making SD DV and DVD masters; in such workflows, simply choosing DV or uncompressed SD as your proxy format lets you benefit from HD imaging while keeping the rest of your editing workflow and final delivery in the same SD formats you're already used to.

An embarrassment of riches? Perhaps, and there's more in the works. Most HDV applications don't have batch-recapture capability yet, for example. But the breadth of choices hints at the tsunami to come. Poke around the Web sites; maybe edit an exploratory project or two. That way, when the wave hits, you'll be ready to ride it.

Going native

Native DV editing means that with a cuts-only production, exactly the same bits are output to a tape as were input from a tape. No quality is lost. For manufacturers of HDV editing systems, however, “native” means any NLE in which MPEG-2 clips are placed into a timeline.

This blurring of the definition of native has come about because legacy MPEG-2 NLEs were rapidly modified to handle HDV, but not in the same way as second-generation NLEs expressly designed to edit HDV (i.e., Final Cut Pro 5). So in fact “native” HDV editing can be accomplished three ways, based on the ways that manufacturers use the term. For the sake of discussion, I've dubbed these approaches ***quasi-native***, ***pseudo-native***, ***and true-native***.

A *quasi-native* HDV editing system repacks the transport stream to a program stream in realtime during capture. (Audio may also be decoded to PCM to facilitate audio editing.) The program stream is edited in the timeline.

A timeline can be recorded to an HDV camcorder only after the program stream — along with any encoded audio — is repacked to a transport stream. Although some time is wasted during export repacking a program stream to a transport stream, no MPEG-2 frames are decoded and encoded — except for a few GOPs at each cut point and where effects have been applied. The ability to handle cut points by encoding only a few new GOPs is often called Smart GOP Encoding.

However, some NLEs, like MPEG Edit Studio Pro, force a complete decode of the program stream followed by an encode back to a transport stream.

A *pseudo-native* NLE places transport stream clips into the timeline. (Audio may, during capture, be decoded to PCM to facilitate audio editing.) The transport stream is edited in the timeline. A timeline can be recorded to an HDV camcorder only after every MPEG-2 frame is decoded and encoded. The new video elementary stream — along with any encoded audio — is packed into a new transport stream.

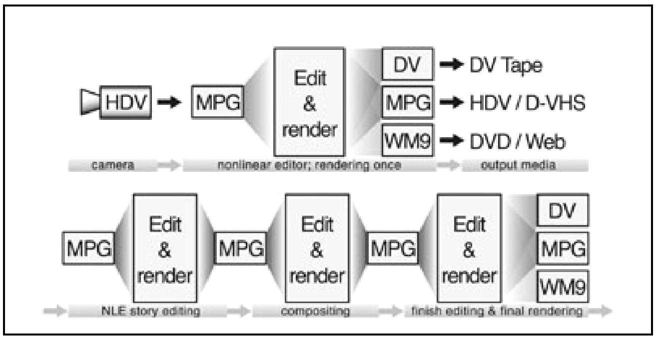
Under this system, hours may be wasted to export even a cuts-only timeline. Moreover, quality is obviously lost.

A *true-native* HDV editor also works directly with transport streams. (Again, audio may be decoded to PCM to facilitate audio editing.) And, again, the transport stream is edited in the timeline. During export, however, no MPEG-2 frames are decoded and encoded, except at cut points and during effects. This type of technology essentially eliminates export delays. It is a perfect analog of native DV editing.

Bottom line, when you read marketing claims about “native” editing, you've got to ask serious questions about exactly what type of technology is employed. Likewise, when you read about the virtues of employing an intermediate codec, do not simply buy into all the negative claims made about native editing.

Native HDV editing workflow

With FireWire transfer and HDV-native editing, your workflow is almost identical to working with DV over FireWire. The data rate is low enough to make capture on single disks, including laptop drives, feasible. Plug in the camera, capture material from it, edit, and print back to tape. With most NLEs, the material is decompressed once (actually, each time a frame is displayed or processed) and recompressed once (after all of the effects on the timeline have been applied), so your finished program is only one generation removed from the camera original, as shown on the upper half of the diagram below.



Single- and multigeneration HDV-native editing is almost the same as working with DV.

This workflow has been proven with DV25. At 19 or 25 Mbps, HDV is as meek and tractable as DV for desktop-or laptop-editing.

Some NLEs allow "prerenders" or "precomputes" of portions of the timeline, speeding up future operations. Instead of rendering a complex effect from scratch every time, these NLEs keep intermediate render files around and simply composite new information atop them.

Similarly, some projects require video to be bounced between an editing program and a compositing app like Adobe After Effects or Discreet Combustion. In both cases, any given frame may pass through several generations of decompression and recompression. Keeping your material in HDV's highly compressed MPEG-2 can lead to a nasty buildup of compression artifacts and generational losses (Figure above, lower half).

Native or not Native, that is the question!

One of the big buzz words has lately been 'native', especially with respect to HDV editing and keeping the video in it's native format. In the case of HDV, this generally means the capture process maintains the integrity of the original MPEG-2 transport stream which was originally digitally recorded and compressed on the tape. This MPEG-2 compression uses a long GOP (group of pictures) consisting of 6, 12 or even 15 frames, which means it is using interframe compression, so not every picture is a complete frame; it relies on other surrounding frames to help define the video you see playing back. Even if you capture the video using an MPEG-2 TS codec, if you do anything to alter this video, including in this case a cut, you are no longer editing 'native' HDV as you have almost surely cut into one of the GOP's (groups of pictures) which requires two new GOP's be created and reassembled, thus compromising the integrity of the original 'native' transport stream.

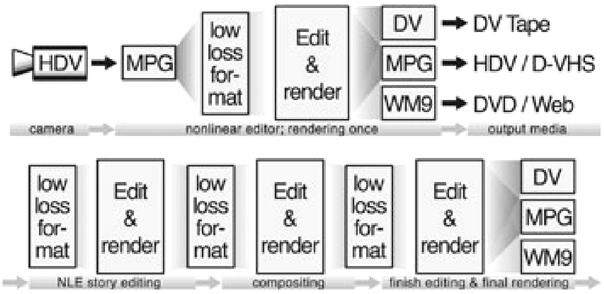
So while on the surface it would seem that keeping the video in it's native format would be the best scenario for maintaining the highest level of quality, the reality is a bit more complex. Not only is it processor intensive to break this group of pictures apart; it is equally intensive to rebuild a new group of pictures which is what must take place in order for the video to playback. This not only sacrifices speed, but it compromises quality as well as video compression is never lossless. It's usually not so bad the first time around, but each time compression takes place, you start with less and less data, and the quality will degrade. Depending on the codec, sometimes this happens quickly, and sometimes slowly.

Also, in order to play MPEG-2, either in a source window or timeline, the MPEG-2 video stream must be decoded on the fly to a video stream so it can be displayed on your computer’s monitor. Moreover, if HD video is to be monitored on an HD display device, the MPEG-2 video stream must be decoded on the fly to a YUV video stream and output via HD-SDI or component analog.

When more than one video stream is required, during a transition, for example, multiple MPEG-2 streams must be decoded on the fly. During a dissolve, each of the two streams must be decoded at greater than 2X faster than realtime to allow surplus CPU cycles to compute the FX. There is another factor that impacts realtime HDV editing. Engineers have developed ways to compute a realtime “preview” image of a special effect that is less than full quality. Techniques include skipping fields and/or discarding every other pixel within a line. Doing so can reduce the amount of compute power needed to render FX by up to a factor of four.

Intermediate editing

In such cases, it makes more sense to move video around in a less-compressed state. Although you can go out today and buy NLEs that capture and store HD in its full, uncompressed state, the high data rate and the stack of RAIDed hard disks required to record it make such NLEs both costly and intimidating.



Using a low-loss editing format instead of editing native HDV reduces multigeneration compression losses.

So, by splitting the pre-editing process into two phases, the amount of required computing power is significantly reduced — to the point that a fast computer can handle the task.

The key to splitting the computational tasks is first to capture and convert HDV to an intermediate codec, and then to edit this more efficient intermediate codec.

An intermediary codec is like a translator, or "in-between" codec, that assists the editing software. Connect HD, Aspect HD, and Lumiere (for Final Cut Pro) are all intermediary codecs. You capture in either native MPEG from the HDV camera, and the video is converted to the intermediary either in real time after capture, or during capture.

Once your editing and effects are finished, you can recompress to HDV's MPEG-2 or to WM9, H.264, etc., just as in the HDV-native case, but the codec allows you to bounce among applications without incurring the compression losses that native HDV would (see above)

When you render to print to tape, if you wish to print to your HDV camera, the intermediary will re-convert the intermediate stream to the MPEG format once again.

with texts by Adam Wilt & Steve Mullen

HDV NLE solutions

Since the situation is changing on the, literally, daily basis, it is practically impossible to give any really accurate and updated list of the editing systems that is supporting HDV format. Not only that the versions of the software are changing, but also some of the features that could be decisive in choosing one system over the other.

However, here is a list of software solutions that support HDV editing, based on the list produced by Sony:

Adobe Premiere Pro
Real-time editing for professional video production offering precise control over virtually every aspect of a production. Integration into the Adobe Production Studio together with After Effects, Photoshop, Audition, Encore & Illustrator. Although it supports native HDV editing, for some of the sub-formats it still needs Cineform plug-ins. Also, together with HP, Intel, Microsoft, and Dell, Adobe has assembled and certified a line of open, scalable, desktop HDV and HD solutions called Adobe ***OpenHD*** Certified Solutions.

Apple Final Cut Pro
A high-performance, comprehensive non-linear editing application aimed at filmmakers, broadcasters and professional videographers. Version 5 offers native long GOP MPEG-2 editing for HDV, while the previous version supported HDV via the Heuris Pro Indie HD Toolkit or Lumiere HD. Integrated in the Final Cut Studio comprising of FCP, Motion, Soundtrack Pro, DVD Studio Pro & Compressor.

Apple Final Cut Express HD
An advanced video editing application aimed at video enthusiasts, students and aspiring filmmakers, the new HD version offers support for HDV so users can capture professional-quality HDV over a single FireWire cable, without requiring any additional software or hardware. Uses Apple Intermediate Codec to process HDV.

Apple iMovie HD
A consumer-oriented editing package included in the iLife digital media suite. Uses Apple Intermediate Codec to process HDV. Affordable.

Avid Liquid
Originally designed by German Fast, bought by Pinnacle and finally by Avid, Liquid Pro was the first of the NLE solutions that supported native HDV editing. A powerful SD and HD video editor for PC offering integrated DVD authoring, surround sound audio processing, and thousands of real-time effects. Offers native transfers and frame-accurate editing of 720p and 1080i HDV content.

Avid Liquid Pro
Liquid software enhanced by a breakout box that enables analog and digital I/O for formats from VHS to HDV, including 1:1 component video. It also enables display on broadcast monitor and HD downconversion for HD preview on SD monitors . With surround-sound audio mixing.

Avid Liquid Chrome HD
Top of the line of Liquid systems. Includes HD and SD SDI I/O supporting any video format, from DV to uncompressed HD, simultaneous HD and SD output & AES-EBU audio.

Avid Media Composer
Professional film and media editing solution that also supports native HDV editing. Comes either as pure software or with hardware support - Mojo, Adrenaline or DNxce. (Grand)father of all NLEs.

Avid Xpress Pro
Based on the well known Avid GUI, as a standalone solution or portable offline editor, Avid Xpress Pro delivers end-to-end, concept-to-conform creative flexibility. Native HDV support is now available with no intermediate formats and no transcoding. Features include automatic color correction, real-time mixing of formats and resolutions, advanced 24p tools, multicam editing, etc.

Avid Xpress Pro + Mojo
With the addition of Mojo hardware, AXP enables 1:1 digital and analog I/O and embedded and AES/EBU audio, bi-directional signal flow that facilitates record while monitoring and also ? genlock and word clock for sync to external devices.

Avid Xpress Studio
The complete studio solution that comprises of software - AXP, Avid 3D, Avid FX, Avid DVD, Avid Pro Tools, and hardware solutions - Mojo and Digi 002. In such a configuration, the package enables drag-and-drop 3D animation, titling, effects, compositing & DVD authoring

Canopus (Grass Valley) EDIUS Pro
The most powerful version yet of Canopus 's acclaimed non-linear video editing software application. A seamless realtime workflow offers multi-track, mixed format HD / SD editing, compositing, chroma keying, titling and timeline output capabilities. Supports HDV.

Canopus (Grass Valley) EDIUS NX
Combination of software and hardware, EDIUS NX offers seamless realtime workflow using any mix of HD and SD video formats, editors can work with unlimited video, audio and effects layers, while always previewing projects in high-quality, full resolution HD and SD video. HDV is offered as standard with the above product and an EDIUS NX for HDV Expansion kit is also available separately.

Leitch VelocityHD
A real-time, format-flexible non-linear editing system. VelocityHD supports direct IEEE 1394 I/O of both 1080i and 720p material from HDV devices. HDV content can also be mixed seamlessly with other HD formats on the timeline. Enables HD-SDI I/O and IEEE-1394 HDV Support, multi-Stream Real-Time SD Editing, real-Time HD/SD Color Correction and Panasonic VariCam Variable Frame Rate Processing.

MEDIA 100 HD
A 10-bit uncompressed hardware and software based editing system for video professionals capable of handling SD and HD, 4:3 and 16:9 content in the same timeline. HDV support is provided by an intermediate codec.

MPEG Edit Studio
While most of the editing software are modified to edit MPEG footage, this one was designed from the scratch to do just that - edit MPEG files. It supports HDV and AVC files.

NewTek Speed Edit
Speed Edit is a resolution-independent video editor designed to work quickly and efficiently on any video project, from web streams to High-Definition. SpeedEdit supports editing in HDV, MPEG-2, AVI, QuickTime, Flash , etc.

Sony Media Software Vegas
An integrated professional solution for scalable DV production, sound editing, mixing, surround sound production, and more. Version 6 has comprehensive support for HDV, and is available as a standalone package or as a complete production suite bundled with DVD Architect, Dolby Digital AC-3 encoding software and more.

Ulead MediaStudio Pro
A complete Digital Video Suite, offering Non-linear Video Editing, Real-time MPEG capture, Real-time preview, as well as Real-time output. Version 8 includes native HDV support, including batch capture and Smart Proxy.

OTHER SOLUTIONS

HDV - HSDI converters

There are several products that convert HDV into HSDI signal to support high end editing systems. Among them are:

Convergent Design HDV-Connect **-** decompresses the HDV video and audio on the fly as well as up-scaling to standard HD-SDI (1080i or 720p).

Miranda's HD-Bridge DEC - high quality HDV decoder interface with multiple output formats that provides HD/SD SDI with embedded audio and Time Code.

HDMI board

Blackmagic Design Intensity is affordable HDV editing card that uses HDMI connection which is also called "poor people's HD-SDI". Some of the consumer HDV and even AVCHD camcorders and recorders (like Sony V1, Sony HDR-UX1, HDR-SR1, JVC BR-HD50, etc) are using this connector to connect directly to HD televisions and displays. It can also be used for higher quality capture from HDV cameras by capturing direct and bypassing the HDV compression chip, for high quality video, captured direct from the CCD. Because edit software cannot play back to HDV cameras for monitoring, Intensity is ideal to use for monitoring uncompressed HD or HDV and even DV edits on the latest big screen televisions and video projectors by connecting to the built in HDMI-out.

HD boards

A number of manufacturers are producing boards that enhance and speed up the HDV and other HD tasks.

Matrox RT.X2 - Designed primarily for realtime native HDV and DV editing, it also provides a high-quality MPEG-2 4:2:2 I-frame codec so you can capture other HD and SD formats using RT.X2's analog inputs and mix all types of footage on the timeline in real time. Works with Premiere Pro.

Matrox Axio is a professional solution that features no-render HD and SD finishing in a wide range of compressed and uncompressed formats, superior realtime color correction tools, advanced realtime effects, and a full complement of analog and digital audio and video inputs and outputs. Works with Premiere Pro.

Aja Kona line of boards for Mac computers add real time hardware support to FCP editing software.

Aja Xena does the same for the Windows based solutions - Premiere Pro, After Effects, PhotoShop, Combustion or Digital Fusion.

HDV TO FILM - SWISS EFFECTS TUTORIAL

HDV is a heavily compressed format. Audio and image are packed into one single data stream (.m2t) which is recorded on tape (“multiplexing”). This data needs to be demultiplexed (“demux”) for further use (editing etc.).

HDV File extensions:

.m2a = Audio

.m2v = Video
.m2t = Transport Stream (Multiplexed)

Compatibility

There are two different codec types for HDV. Therefore HDV formats are not necessarily compatible. JVC and Sony use different codecs. Canon uses the same codec as Sony BUT only recordings in 1080i are compatible! The frame modes differ and so Canons frame mode cannot be read by Sony equipment and vice versa. Panasonic does not use a HDV codec.

Workflow for film out of Sony's HDV footage:

• The use of iMovie for capturing HDV footage is not recommended by Sony. The results are not bad, but native editing is to be preferred.

• Final Cut Pro 5 is capable of handling Sony's HDV. The demux process can also be done separately from “.m2t” to “.m2v” with “Lumiere HD” (sound separated as AIFF) or with “MPEG Streamclip” to .mov.

• Native editing is possible with: Apple (FCP5), Adobe (Premiere), Avid, Pinnacle (Liquid 6), Sony (Vegas) and others

• At the moment it is not possible to make a clone (native copy) of a HDV tape to a HDV tape including the timecode information. Otherwise earlier timecode issues are solved in the new available software.

• The standard Sony HDV deck has got a firewire out and a RGB connection for RGB monitors.

• There are some hardware additions making a HDV – SDI conversion (both ways).

• Cineform: “Aspect HD” offers handling of the new HD formats (JVC HD1/HD10 & HDV, JVC D-VHS, Sony HDV) connected to the Adobe Premiere platform.

I’m sure there are other post tools available which do a good job. We are not associated with any of these companies.

Two important differences between the FX1 and Z1 which matter for transfer to 35mm are:

• With the Z1 model you can switch between 50i and 60i in HD resolution or between PAL and NTSC in standard definition.

• The black stretch option in Z1 model

Recommendations for transfer of HDV to film:

For residents in NTSC countries (Japan, USA, some in Central/South America) we strongly recommend to use 50i HD. With the Sony Z1 for example you still have the option to shoot in NTSC or 60i HD for projects which are not for transfer to film and require 60i.

Important: Never record in 30p for transfer to 35mm!

If available shoot in true progressive mode 24p or 25p.

Do not use Cine Frame Modes. These modes are not a truly progressive. The Frame Mode setting works with interpolation and this leads to a worse image quality than using interlaced mode. Transferring from interlaced source material to film is no problem.

Deinterlacing will reduce detail but can improve motion reproduction. It can be done in post production. The quality depends on the calculation.

Film Look gamma settings: Generally gamma settings which are supposed to give a "film look" are made to give the footage on video a filmish look. For a transfer to film it is not very helpful and depending on the camera it should even be avoided. To my knowledge the only camera which has a useful setting for tape to film transfer is Panasonics Varicam.

Settings for Sony HDV cameras:

Sharpness: There is a range of values 1 to 15 for detail enhancement. The camera should be set to a value between 8 and 12. You can go to the higher end for wide shots and lower for close ups.

Black Stretch: On

Skintone Detail: Off

The *Sony HDV* cameras are not as strong under low light conditions as other video cameras are. Using the gain might be no problem for TV purposes, but the increased video noise is much better visible after blowup to 35mm. So using gain should be avoided whenever possible.

In our first tests there were some glitches in the clips meaning that either a frame was missing or there was a doubling of a frame. This was either introduced during recording, while import or in the demux process.

Further work done with FCP5 did not show any problems.

The *desqueeze* from 1440x1080 to 1920x1080 should be done at the end of the whole process just before film out or during the transfer.

Image quality: The image looks good. It is an interesting combination of good resolution on one hand and some rather strong compression artifacts. It has more videoish characteristics than the professional HD formats. It can't compete with HDCam or Varicam quality but it will generally outdo DV or DVCam. When used correctly the results of HDV can be very good.

Motion reproduction: Motion can be a problem with HDV. The compression type that is used by the HDV format works in a way that not every image is recorded entirely but only once for the parts which are not moving for a group of 12 images (Sony HDV). If the whole image content changes (in pans or with a shaky hand camera) the compression must be stronger to keep the data flow within the given limits. As a consequence the image quality decreases more or less visibly in pans and motion artifacts can occur.

Color reproduction: The colors didn’t blow us away. This is also one of the consequences of the strong compression (less sampling on colors).

With slightly underexposed footage which was brightened up in post in part of the images noise was visible in uniform surfaces.

Some general conclusions:

To my opinion well done footage in DigiBeta, IMX or DVCPro50 could look better than an average HDV image. Equally HD or HD downconversions to SD or an HD or SD telecine of film footage. But these are all far more expensive cameras/techniques.

After all please keep in mind that shooting in HD demands more care and experience than shooting in SD specially in what concerns lighting.

Some post production workflows for these new systems are not settled yet. This can make post production more cumbersome than with established formats. As the software for HDV post production improves the processes get easier and faster.

Progressive DV or interlaced HDV?

There is no absolute answer to this question. HDV is better than DV in resolution, but what concerns motion reproduction progressive DV has its advantages. DV has slightly better colors. What is preferable must be evaluated for each project separately.

Please also keep in mind that post production in HD is generally more expensive than in SD.

Combining Formats: Combining video of different sources is often difficult. They just don’t look the same. Shooting with different systems should be avoided unless a difference in look is wanted.

Special Effects: Special Effects work is generally more difficult to do with HDV footage. The compression (color sampling and resolution) makes the borders of objects less clear.

Using mini35 or similar “depth-of-field” units

As these devices work with rotating ground glass surfaces the structure of this surface is introduced to the image as a grain type effect. Even if this is wanted it is a problem for HDV as the changing structures are identified as motion. The “group of pictures” compression causes the quality to drop. I have talked to a representative of mini35 about this and he told me that in their system the glass structure is smaller than the resolution of the HDV cameras. Therefore it is possible to use the mini35. Still it is absolutely mandatory to set the system up properly.

Audio quality:

HDV audio is recorded to tape and multiplexed together with the image. The quality is worse than sound recorded with a DV camera. External sound recording is recommended.

Delivery formats for transfer to 35mm:

Never play out any footage back onto a HDV tape! Repeated compression will further damage the image quality. Delivery formats for a finished project or a test for transfer to 35mm are:

- HDCam Tape
- Series of image files (TIFF, TGA, DPX, BMP)
- DVCPro HD can be used with footage of the JVC HD-100U as it uses the resolution of 1280x720 pixel.

Transfer system:

There are basically two transfer techniques CRT and Arri Laser. For HDV footage we generally recommend CRT in 2k as the artifacts tend to come out stronger when transferred on the Arri Laser. Still this is a decision which must be made for each project separately.

Testing is recommended!

With every new camera model or format some time and experience is required to become aware of all advantages, disadvantages and possible pitfalls. Only a test transfer to 35mm can give you full insight in what you can expect.

Many film out systems have very different properties. Our recommendations for settings are limited to our systems.

POV _ HDV to Film: A Real-World Test

by John Jackman

In the world of professional video production, the HDV format has gone from novelty to viability in record time. The rapid changes began over a year ago when Sony introduced the HVR-FX1, and *DV* Contributing Editor Adam Wilt pronounced its compressed, MPEG-2 picture to be "better than it has any right to be." The release of the Sony HVR-Z1U upped the professional-quality ante, and HDV cameras from Canon, JVC, and Panasonic have streamed into the market. With slick editing solutions available from all of the major players-Apple, Avid, Canopus, CineForm, Lumiere HD, and others-the HDV format has arrived in a big way.

Despite the sales success and broad acceptance of HDV, there is still an information gap in terms of how well it really performs. Although a lot of HDV units have been sold, a large number of *DV* readers are still on the fence about whether to buy into the format or not.

So I decided to put the latest HDV techniques and technology to the test. I produced a low-budget short from beginning to end in HDV, with the intent of creating the best possible product in standard definition for DVD distribution, HD for digital broadcast, and, because the promise of low-budget filmmaking is driving the intense interest in HDV, I decided to take the piece all the way to a 35 mm film blowup.

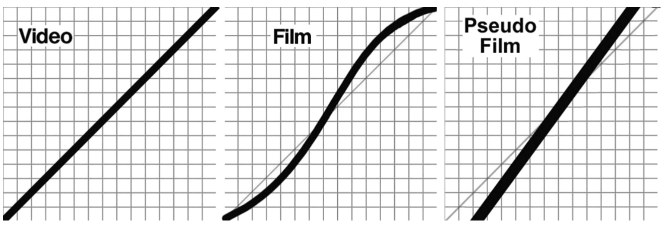
The end result is here: An overview of the decisions and discoveries I made while producing a real-world project in HDV, along with the reactions of some seasoned DPs to the final film result. I found out a lot during the process-more than can fit in the pages of the magazine.

Early decisions: Camera, frame rate, and gamma

Armed with the script for *Windsor Knot* (a historical period drama about the abdication of England's King Edward VIII that I've been wanting to shoot for some time), I set out to choose a camera. At the time I was shooting (May 2005), I felt that there was only one viable camera for the project-the Sony HVR-Z1U. The Z1 has several appealing features, the most important of which are the abilities to use pro audio connections and shoot in 1080i-50. Even though creating a 24 fps version for the film blowup was critical, I found that creating true 24p was easier and more effective in my tests starting with 50i than with 60i (more about this reasoning can be found online at DV.com).

I didn't consider Sony's CineFrame mode, which, though it creates a 24 fps video file, has unacceptable motion artifacts and image degradation (for more about CineFrame, see Adam Wilt's analysis at www.adamwilt.com/ HDV/cineframe.html).

I experimented with the Z1U's CineGamma settings in an effort to achieve a film-style gamma curve. The Z1U has two CineGamma settings, with CineGamma 2 being more pronounced. I liked the look of CineGamma 2 and decided to use that mode in shooting. On inexpensive cameras, these film-like gamma settings are accomplished not with the true S-curve that I would apply in post, but rather by tilting the straight gamma curve to a more extreme position Although this accomplishes almost the same thing as the gentle S-curve, it's not quite the same. It doesn't supply the more gentle roll-off of highlights and tends to crush dark grays to black sooner.



Video has a straight gamma curve. Film stocks often have a gamma curve shaped like a shallow S. (right) Inexpensive cameras with "cine" gamma adjustments usually simulate this by tipping the straight video gamma.

After testing color tweaks in the camera menus, I left most of the settings on factory defaults. I turned the sharpness control down considerably, though not to its lowest setting, which is a tweak I recommend for nearly all cameras if you want a film-like finish. Reducing the artificial sharpening (technically known as aperture correction) tones down harsh edges and avoids compression artifacts.

On location: Decisions and discoveries

I was dealing with a microbudget for this project (well under $3,000 for all expenses and salaries), so I scheduled a single day of shooting on location.

The day came, we showed up with a truckload of equipment and people, and *Windsor Knot* was in production.

The decision to shoot in 50i necessitated a PAL-compatible monitoring solution. I brought the JVC BYH13Y production monitor from my edit suite.

We monitored composition, exposure, and color on SD via the down-converted Y/C output of the camera. But we discovered that neither an SD monitor nor the camera's viewfinder, nor its LCD screen were up to the job of representing HDV's details-we ended up with slightly soft focus no matter what we used. To deal with this issue, Sony provides a zoom function on the viewfinder, as well as a peaking function, which flags high frequencies (such as in-focus sharp edges) with an accent color (red, yellow, or white). This works well to visually cue the camera operator when focus is right on. Unfortunately, peaking can't be used at the same time as zebra display, so the cameraman had to keep switching between the modes.

The HVR-Z1U also has a basic zebra display that defaults to 100 IRE. We set the zebra at 90 IRE to avoid the "video look" of overexposure and clipped whites. I think clipping in HDV is really nasty, even worse than in DV. So an essential rule for shooting in HDV is *don't overexpose!* It's much better to be a stop under rather than a stop over while shooting. If necessary, you can stretch the contrast back out in post.

Postproduction: Quality control

Editing was done in Premiere Pro 1.5.1 in 1080-50i using CineForm Aspect HD Codec.

Editing native in HDV with no quality loss is now touted by some NLE vendors, but it was not an option for *Windsor Knot*.

I used the Sony HVR-M10U as my VTR for capture and recording. The editing system was built around a Windows XP CPU with a 3.2 GHz Intel Prescott HT processor, 2 GB of memory, and dual-200 GB SATA drives set up in a RAID-0 configuration for video storage.

Once capturing and transcoding was completed, managing files and editing the HDV material worked just like in any other format. Editing with the Aspect HD codec was a satisfying experience. The response was snappy, and CineForm's real-time engine really worked and allowed me to play back more layers and effects from the timeline than some higher-end hardware-based systems.

Just one thing was missing-live playback to a real monitor. This can't be done in real time via 1394 with Aspect HD because the software must transcode back to an MPEG transport stream for display.

The color-correction tools in Aspect HD, while not high end, are comprehensive enough to allow pretty decent manipulation of the color in shadows, midtones, and highlights. I tried to stick with the Aspect HD real-time plug-ins to give them a thorough test, and found that the combination of the two (Color Balance and Color Corrector) generally allowed me to do what was necessary.

Fix it in post

I ran into two problems from the initial shoot that normally would have prompted a reshoot, but since that wasn't an option, I decided to fix them in post and test the limits of special effects in the HDV format. Remember when I said an essential rule for shooting in HDV was, "Don't overexpose"? Well, the first shot we did was a rack focus with a brightly sunlit window that was completely blown out. The second problem was a shot where the camera crossed the line, meaning that the character in the shot seemed to be facing the wrong direction when intercut with the other camera angles used in the scene. I decided to use After Effects to fix both these issues. I planned to motion-track a fix for the blown-out window and use a greenscreen shot of one character facing the correct direction to replace the other shot.

The Aspect HD footage imported correctly into After Effects, though it was necessary to manually create a 1.33 anamorphic aspect ratio preset for the footage to display properly. To correct the overexposed window, I prepared and blurred a graphic of exterior foliage to seem out of focus. I placed it behind the video footage (below it on the composition line). I applied the luminance keyer with the matte choker to make the offending window transparent, and the new exterior was motion tracked to match the foreground. Because the shot wasn't designed to be tracked, it required some extensive hand-tweaking to get the motion just right, along with the look of the rack focus. The end result works well, however, and doesn't call attention to itself.

The greenscreen shot was an interesting test of how far you can push this highly compressed 4:2:0 format in the special-effects realm. We had high-res still photos of every corner of the opulent living room set, and I simply used a portion of one of those as the background plate. We shot the character (Stanley Baldwin) delivering his line in front of a green fabric backdrop with similar lighting to the live shoot.

I created a greenscreen composite using the Color Range keyer in After Effects. I used the matte Choker filter to smooth the jagged edges of the matte and choke (contract) it to eliminate green edges.

In post, I tested several keyers, including Ultimatte AdvantEdge and Zmatte, but got the best results on our footage with the Color Range Keyer and Matte Choker in After Effects. The After Effects matte choker has improved in the last few upgrades, and now can smooth out the jagged edges of low color sampling schemes (such as DV 4:1:1 or HDV 4:2:0) effectively. Considerable choking was necessary to achieve a clean edge. This worked nicely with Stanley Baldwin, whose 1936-era slicked-back hair provided a fairly defined edge to work with. On a subject with wisps of escaping hair or similar fine lines, those details would have been lost.

I also needed to blur the edge of the matte considerably to match the other hard edges in the natural picture. The initial matte had a crisp, well-defined edge that looked artificial-too sharp-when composited into the HDV picture. This is true to a lesser degree in less-compressed HD formats as well, but mainly showed the limits of the Z1U lens. The HDV format can hold edges that are much sharper than the standard lens can transmit.

Deinterlacing and conversion

Shooting in 50i was a decision I made in the beginning to preserve video quality through to the end. Prepping the final sequence for DVD and film output required a two-step process: First, I had to deinterlace the footage (from 50i to 25p), and then change the frame rate from 25p to 24p. (After I wrapped up postproduction on *Windsor Knot*, a new version of Aspect HD was released that would have made it a one-step process; see the "An Even Better Workflow" sidebar.)

There are numerous techniques for deinterlacing footage, some of which are terrible (field duplication), others of which are a little better (field blending methods), but the goal is to get good results without sacrificing vertical resolution. After all, what's the point of shooting in a high-definition format if you just go and toss away half the vertical detail in post?

The approach I used for *Windsor Knot* was a "smart" deinterlace in After Effects, which involves identifying those areas of a picture that have motion between the fields and those that don't, and selectively applying field blending only to the areas that have interfield motion. Another good option for smart deinterlacing is DV Filmmaker from DV Film.

Once the material was deinterlaced into a 25p AVI movie, conversion to 24p was done on a frame-to-frame basis by interpreting it as 24 fps in After Effects. To stay in sync, the audio was slowed down 4 percent in Sound Forge separately. The resulting 1440 x 1080 24p AVI file was ready for output to film. For DVD output, the file was scaled in After Effects down to 720 x 480 with 3:2 pulldown applied. The end result-viewed on a 720p projector- looked very film like. Surround-sound encoding was provided by the SurCode for Dolby Digital 5.1 Encoder plug-in.

Film blowup discoveries

The most intriguing test of the HDV format was the final stage-the output to 35 mm film. I sent identical 2-minute 24p CineForm HD codec files to DV Film in Texas and Heavy Light Digital in New York. The file included a test shot with high color and detail, and the greenscreen composite shot from the finished short, as well as interior and exterior shots from the piece. Both labs printed the file to Fuji 8522 negative stock and printed to Fuji print stock.

Because HDV-to-35 mm is still fairly new territory, I used two different labs to discover what, if any, differences would show up in the final print. The results point out the importance of running a test before choosing a lab.

We screened the test prints at the School of Filmmaking, North Carolina School of the Arts, in a full-size theater. A panel of experienced film DPs was in attendance, including Arledge Armenaki (*Dennis the Menace, The Howling V*), Richard Clabaugh (*Children of the Corn IV, Plato's Run, The Prophecy II*), and D. A. Oldis (*Non-Abductees Anonymous*). Armenaki and Clabaugh had both taken part in a similar screening of DV-originated footage blown up to 35 mm a couple of years ago.

The first print from DV Film was a bit disappointing. The DPs complained about low black density (blacks looked dark gray instead of black), graininess, pixelization, color blocking, and low saturation. The resolution of fine detail in the test shot was lacking.

The print from Heavy Light Digital was much better. The print had good black density, yet still had visible detail in dark areas. The color was better, and the resolution was much sharper. Wide shots of the manor house exterior showed detail in individual stones.

DV Film asked for another shot at the footage. The second print was better and had higher overall detail. The blacks were denser-too dense, in fact, with a subsequent loss of detail, and the color was artificially intense.

We watched the samples twice, pausing in between to talk about them. Afterward, I asked the group to sum up their reactions to the best example, and to HDV as a low-budget filmmaking format. Overall, they agreed that the HDV blowup was substantially better than DV-originated blow-ups we had seen previously, though the sample HDV clearly remains a step below true HD in effective resolution. They thought it was likely that the inexpensive lenses used on the lower-priced prosumer units contributed to the softer image when compared with footage from a Panasonic VariCam or Sony FDW-900H; those cameras are used with lenses that cost many times more than the total price of the Z1U.

After some discussion, Armenaki and Clabaugh agreed that the blowup from Heavy Light looked very much like a blowup from 16 mm. They felt that origination on Super 16 would look somewhat sharper, but the parallel to 16 mm was strong. Armenaki went so far as to say that if he had been told it was a blowup from 16 mm before screening the footage, he might not have noticed the subtle cues that the footage had originated as video. All agreed that the result was watchable, and that an average audience wouldn't notice the differences if the other aspects of story and filmmaking craft were right.

It was interesting that none of the DPs noticed the greenscreen composite shot until I pointed it out. D. A. Oldis was impressed that the composite was so clean when originating from a 4:2:0 format.

Budget considerations

Then came the difficult question: At what budget level should a filmmaker consider HDV? This produced several answers and discussion about local low-budget projects being shot on film. Armenaki and Clabaugh finally suggested a feature project under $200,000. Both felt if they had higher budgets, they would opt for renting a higher-end HD camera or shooting on Super 16.

To answer this question, of course, requires a judgment call. There are many other factors that would enter into a producer's decision to use HDV for a film with potential for theatrical release. Many types of documentaries would be better if they were acquired on video because it's more economical, allowing for many hours of lengthy subject interviews. While a DP might want the higher resolution and exposure latitude of a VariCam or CineAlta on a $500,000 project, the producer and director might opt to pay for higher quality talent in front of the lens-or hire a larger number of high-quality actors. The producer might even prefer to actually pay actors who otherwise would be working on deferral (fat chance!).

Conclusions

My overall reaction to this trial project was real excitement about the potential of the HDV format. I'll be even more excited when the manufacturers stop squabbling and get HD DVD or Blu-Ray players shipping, so there is a viable HD distribution and playback method. Editing was a far better experience than I expected, and the end result was more filmic than I expected.

As people who have attended one of my workshops know, I pay a lot of attention to compression artifacting. One of the very interesting discoveries I made was that the MPEG-2 artifacting in most scenes seemed very similar to film grain- very different from the obvious mosquito noise artifacting of DCT compression in DV footage. Although the pseudofilm grain was more pronounced than I prefer, it wasn't unpleasant or intrusive, and wasn't more noticeable than the grain on some film stocks.

In retrospect, I would probably opt to use the less-aggressive CineGamma 1 setting on the Z1U or to change the gamma in post.

The format wasn't as delicate as I predicted, contrary to early fears about dropouts. I ran initial tests using ordinary pro DV tape rather than Sony's more expensive HDV tape, and saw no noticeable dropouts. Of course, for a more extensive project, I'd probably want to use the HDV tape just to have the extra bit of insurance against dropouts.

I'll probably buy one of the HDV cameras soon, but before I make my decision, I want to undertake a similar test all the way to 35 mm film blowup. And I plan on reporting the discoveries I make along the way, so stay tuned.

POV _ BBC PREDICTS BRIGHT FUTURE FOR HDV

I honestly can't believe what I'm seeing. A full resolution HD camera at this price is just unbelievable. It could take on everything that's currently being shot with DSR-PD170P — it's that concept, but better. - ANDY BENJAMIN, BBC

The new HDV camera is causing quite a buzz in the broadcast production world. At the BBC, it's at the beginning of a round of tests, but there's already a sense that this format could make a big impact. "It gives us the chance to produce affordable HD programmes at all levels of programming," says Andy Quested, at the BBC's HD department. "It's as important as DV is to the current standard definition format."

Indeed, the camera has already won over the BBC's classical music department, where it has shot behind-the-scenes documentary footage for a triple bill celebrating the life of Sir Frederick Ashton, renowned choreographer for the Royal Ballet.

Andy King-Dabbs is the producer and documentary director of this 140-minute special for BBC4, called Ashton at 100, Fred's Steps. He says, "It's very exciting. It cost me no more to use than a DV camera, but the results I've got look spectacularly good. I'm hoping the results of this test will mean that very early in 2005 we'll be able to rely on the HDV for broadcast television."

Meanwhile, the Corporation's internal hire operation DV Solutions has been sounding it out for all-round usefulness and independent consultants are assessing its technical advantages.

Fiona Macbeth is the BBC's Self-Op Development Manager for People Development. She sees great promise if the HDV platform is all it seems to be, most importantly because it's a wide-screen format. "The goalposts might be changed with this new camera: It's the idea of a small camera at a lower cost with true widescreen, enhanced picture quality and a number of other advantages," she says.

Macbeth argues that the camera could lead to editorial and cost benefits in other programme genres than those currently benefiting most from DV. "It's not just the technology, it's the way of working that it offers. It allows for greater access and filming in real situations." As well as areas such as news and current affairs, HDV could be used for drama or entertainment.

First, the camera needs to get the thumbs up from seasoned operators. At DV Solutions, mentor Andy Benjamin has given the camera a good going over and — even with just a short trial — he's very positive. "I honestly can't believe what I'm seeing," he says. "A full resolution HD camera at this price is just unbelievable. Who could have thought four years ago that it was possible for L4,000?"

The BBC has already publicly declared that it is committed to phasing in HD gradually over the next few years, so that all productions will be produced in HD by the year 2010.

"We've been asking the manufacturers for years for a true 16:9 camera and now they've done that and they've done it in HD as well, which is a bonus," says Benjamin. It isn't going to replace the more serious professional cameras, but he does see it doing an important job. "It's definitely a lightweight solution that one person could take on. It could take on everything that's currently being shot with DSR-PD170P — it's that concept, but better." He suspects that it could even, in some cases, take on the bigger, higher-end cameras.

Although Benjamin has one or two niggles with the consumer camera – in particular with the audio – hopes are high that the professional version of the camera will tackle this.

The BBC has also involved outside consultants in the initial stages of assessing the format. Alan Roberts is an expert in color science and has specialised in HDTV and color cameras. "I think it's a nice camera," he says, talking about its picture output. "It will be a second camera and while it's not as good as the HDW-750P or HDW-F900, nevertheless it's a startlingly good camera for its price."

The BBC is happy to see that the camera uses 1080-lines HD, given the Corporation's goal to see all HD production in the highest quality as soon as possible. "It makes a very acceptable 1080-line pattern," says Roberts. "It's interlaced, but quite a significant proportion of lower-end programmes are going to be interlaced because that's the sort of look we're used to, so this sort of camera will drop into things perfectly." Of the camera's six potential profiles, he feels that two are right for professional use and he notes that there's a "very nice flip-out LCD" at the front of the camera.

One man who is taking a technical overview of the trials is Chris Price. It's his job as mentor in the BBC's Production Modernisation division to direct technological decisions. "I'm very interested in HDV cameras because they have the potential to replace everything we do with DSR-PD170P — our workhorse cameras in terms of self-op," he says, "but they offer much better picture quality."

The interest is primarily in the wide-screen capability, although he sees that "as HD scales up, on probably quite a steep curve, in terms of future use it offers the potential for a reliable high definition picture."

There are more tests in the pipeline and the most crucial of those will be in early 2005, with the arrival of the HVR-Z1E professional version of the camera. The BBC would also have to discuss use of the format with co-production partners, who are involved in many of the HD productions. But Price is looking ahead: "There's potential for this camera to affect all areas currently self-op DV and that's something like ten per cent of the BBC's total output."

Quested is also looking into the future, specifically the BBC's future working with HD. His main issue with the camera is ensuring that the HDV pictures can be easily downloaded for an HD edit, but he expects the HVR-Z1E professional camera to sort this out. And he shares his colleagues' excitement at what this type of camera could do for broadcast production.

The HDV camera's switchability from standard definition to high definition means that it could become a natural replacement camera, with broadcasters gradually phasing it in to take over from current alternatives. It would be used more and more for HD as that becomes the norm.

For the next few months, HDV will continue to be tested, but the camera has clearly already impressed." We need to see how and where it sits in the hierarchy of cameras," says Quested. "But it's already looking quite high up that hierarchy."

POV _ HD DREAMS - HDV OFTEN LOOKS GREAT, BUT NOT ALWAYS

By *Jim Feeley*

I'm in a dealer's showroom, stuffed with equipment used by Hollywood DPs - ARRI cameras, DigiPrime lenses, etc. The owner shows me a prototype HD camera so new it's still in an unopened box. He hands me a cassette that looks like a shrunken 3/4-inch cartridge or maybe an 8-track tape. The camera looks like a small ENG camera without a VTR and doesn't seem special in any way. But Michael, the proprietor, excitedly explains that the camera records a 4:2 image.

I figure he means 4:3 or 4:2:2 and I didn't hear him correctly. I ask. He repeats. 4:2. I mull this statement, then a gloomy light bulb appears above my head (metaphorically...but then, everything here is a metaphor). There is no third number because all the color is crammed into a single channel, as with S-VHS. This new camera is HD Y/C. I wake up in a sweat.

I made up that last line, but regrettably the rest is what I actually dreamed. Let me make two points here: one, most of my dreams aren't nearly this pathetic and two, the low-cost HD formats and cameras we already have are much better than they could be, and much better than many currently consider them.

General wisdom of every new technology progresses through four phases: Disbelief (there's no way it could be any good), Hype (it's the most amazing thing ever), Backlash (it's over-hyped junk) and finally Acceptance or Rejection (it's another tool with advantages and disadvantages that will/won't work for me). HDV has entered the backlash stage. The first-blush of new love has faded from our cheeks and loins, now we have to decide if we want to commit or move on.

HDV Image Quality

There's no denying that HDV images can look great. Thanks to luma sampling that equals HDCAM and exceeds DVCPRO HD, interviews, scenics and many other shots have a level of detail that's stunning. But motion, especially fast-moving and detailed motion as in sports footage, presents quite a challenge for the real-time MPEG encoders in standard HDV cameras. It's a challenge HDV can often meet, but not always. This is the downside of HDV's impressive MPEG compression efficiency. A brief review: Unlike DV, JPEG and similar intraframe compression schemes, HDV's MPEG compression searches for both spatial redundancies within single frames and temporal redundancies across multiple frames. An HDV camcorder will record a complete image of one frame (an I-frame), but several subsequent frames hold just information that differs from that complete image. The MPEG compression engine will predict where to place the pixels in these subsequent frames.

Most HDV cameras record one I-frame followed by 14 predicted (B or P) frames. This forms the 15-frame group of pictures (GOP) that makes HDV compression so efficient. However, with high-motion footage, the further a predicted frame is from an I-frame, the worse the prediction. You can choose one of two paths to address this shortcoming. Shoot carefully. Or use a shorter GOP.

Shooting carefully is always a good idea. For HDV, minimize abrupt changes in camera motion with a tripod, dolly or Steadicam-style camera stabilizer and keep light levels higher than you would with DV. The pixels on those high-definition CCDs are really small and need plenty of light to expose a good image, and changes in color challenge MPEG compressors as much as changes in position (i.e., motion).

Once the camera is set and you have controlled camera movement and light levels, you may still encounter content with motion that produces images you don't like. At that point, you can decide that you, the client, and the audience can live with those images or that they won't notice a problem (and in my experience, most clients and audiences won't), that you like the long-GOP, high-motion aesthetic (some do) or that you want a shorter GOP.

Even though this frame was shot handheld from a car and the bike cranks are spinning around 100rpm, the image looks nice, with just expected motion artifacts. This is probably an MPEG I-frame

Several frames later, the MPEG compressor is trying to guess where all those pixels from the previous I-frame should be placed. It isn't doing a great job in this predicted (B or P) frame.

Camera manufacturers have developed two responses to the challenge motion presents a 15-frame GOP. JVC says use a shorter HDV GOP. Panasonic says use a much shorter GOP, and don't use HDV. And on a related note, Canon decided to keep the 15-frame GOP, but maximize CCD resolution and camera image control. While I don't yet have a lot of hands-on experience with all the low-cost HD cameras—at this writing they aren't all shipping—the different approaches are intriguing.

JVC's GY-HD100U camcorder records images to a 6-frame GOP, minimizing motion estimation needs. But according to the JVC Web site, a feature of the camera's CCDs, High Speed Twin Readout, can cause "a small difference in the shading or color...between the left and right portions of the screen." I've heard a couple of scary stories about strong split black levels, but have only seen very minor differences when I've looked for it myself; differences that are basically unnoticeable.

The Panasonic AG-HVX200 records HD images as DVCPRO HD, a format with a 1-frame GOP. That takes care of predicted frames. But for HD, the camera's P2 solid-state media is limited to relatively short record times, doesn't record HD to tape (just to P2 cards or third-party hard disk recorders) and has lower luma sampling than HDV. For 720p, DVCPRO HD samples at 960 x 720 pixels versus the 1280 x 720 for 720p HDV; for 1080i, DVCPRO HD samples at 1280 x 1080 pixels compared to HDV's 1440 x 1080. However, the HVX200 records at a variety of frame rates, offers some 1080p recording and uses a 100 Mbps HD signal (and also supports 50 Mbps SD recording to DVCPRO50—a great format). Overall, Panasonic says the HVX200 offers 81 different image-format and frame-rate options. And the P2 cards' recording time, about 20 minutes of 720/24p on an 8 GB card, won't be an issue for many users.

Canon's XL H1 takes a different tack - it offers CCDs with much higher resolution than some other HDV cameras, time code in/out, an HD-SDI port and a completely adjustable color matrix. But the camera is front heavy, and Canon's not yet clear about how its 24f and 30f modes work. However, the flexibility in image rendering is unprecedented at this price level.

The perfect low-cost HD camera has yet to be announced. And, of course, there's more to a camera and a format than the size of its GOP. But compare this to the pre-DV days when those on a budget debated the virtues of Hi8 and S-VHS. With HD we can already choose from several absolutely useful cameras. In fact, all of these HD cameras are better than my dream camera.

POV _ WHAT'S WRONG WITH HDV?

By Mark Schubin

The history of videography is filled with miracles. Is HDV another? What is usually considered the first patent for television scanning was issued in 1885 but the first video image of a recognizable human face didn't appear for another 40 years. In between, one researcher even tried using a freshly extracted human eyeball to get a system to work.

The 1925 video picture could well be considered a miracle. It was soon followed by a working video recorder, because early television was so crude that it required no more bandwidth than an audio signal, which could already be recorded on phonograph records. But in the 1930s there was a shift from crude "mechanical" (moving-scanner-based) video to what was called at the time high-definition television. The HDTV of the 1930s required bandwidth comparable to today's standard-definition television, and there was no way that could be captured by an audio recorder.

The first videotape recorder sold (in 1956) was another miracle. In fact, one of its breakthroughs, narrow-band FM, was previously declared impossible. Now we're in the era of modern HDTV. As recently as a decade ago, a single high-end HDTV camera, lens and recorder could cost a million dollars. It could also cost less. About a third of the million was represented by a digital open-reel one-inch-tape recorder, about as tall as its operator (and much heavier).

At a time when standard-definition video recording had already moved to cassettes, the HDTV behemoth required not only threading but also (in its early days) "burnishing" of tapes before use. But videographers could also opt to use analog cassette formats—UniHi and WVHS— costing much less but offering less quality. Modern high-end HDTV recorders, such as Panasonic's DVCPRO HD and Sony's HDCAM, are a small fraction of the size, weight and cost of the old open-reel units, and they're easier to use. Maybe they were another miracle.

And now there's also HDV. HDV camcorders are a small fraction of the size, weight and cost of even DVCPRO HD and HDCAM camcorders. Are they the latest miracle of videography? Or should they treated as lower-grade equipment, like UniHi and W-VHS systems?

Consider the three elements of the milliondollar system: the recorder, the camera and the lens. The recorder can be further subdivided into the tape transport and the encoder. HDV uses a DV tape transport. It's a mature technology that's found in millions of consumer camcorders. But it doesn't have the wider track pitch and other features that distinguish Panasonic's DVCPRO and Sony's DVCAM from the consumer camcorder recording format.

At least in part because of the use of a DV tape transport, HDV's video encoder is restricted to DV's data rate. Reports on HDV often note that, in its 1080-line mode, its recorder captures only 1440 samples per line instead of the 1920 that the old open-reel recorders captured. That's certainly true, but it's just as true of the higher-end HDCAM recording format. DVCPRO HD, in 1080-line mode, captures an even-fewer 1280 samples per line (though it captures more color samples per line than does HDCAM—640 instead of 480).

Sony was able to introduce the drop in the number of samples per line in HDCAM because, although the missing samples contribute a quarter of the detail-fineness resolution, they contribute much less to the perceived sharpness of the image. Sharpness is a psycho-visual sensation proportional to the square of the area under a curve plotting contrast ratio against detail fineness. There's so little contrast ratio in the finest detail that losing it sacrifices very little area under the curve. Still, there are times when it's important to capture all 1920 samples per line, and for those Sony offers HDCAM SR and Panasonic offers HD D5. There's also the D6 format for those who want to avoid bit-rate reduction ("compression") altogether.

Although 1080-line HDV's 1440 samples per line are the same as HDCAM's, HDV uses a much higher compression ratio. The use of inter-frame coding helps improve quality at low bit rates, but it also makes the system susceptible to motion artifacts and makes compressed domain editing difficult. Nevertheless, in theory, the quality of HDV compression should be no worse than that of broadcast HDTV. A U.S. digital television broadcast channel has a video payload of about 18 million bits per second (18Mb/s), and HDV uses an even higher 25Mb/s. But a broadcaster will usually spend a lot more on just a video encoder than the cost of a complete HDV camcorder. So, although the format should allow for future quality-increasing improvements, for the moment it's not clear that 1080-line HDV camcorder encoders can compete even with those of HDTV broadcasters.

Then there's the camera portion of an HDV camcorder and, within the camera, the imaging chips. There is nothing about the HDV recording format that determines their size, but a tiny camcorder demands tiny chips. Both JVC and Sony have been using 1/3-inch-format chips, with roughly half the diagonal dimension of larger 2/3-inch-format chips.

The size of an imaging chip affects a camera's sensitivity, depth of field, diffraction-limited resolution and lens acceptance angles. All else being equal, a camera's sensitivity is proportional to the area of the sensors on its chip. Being half the diagonal of a 2/3-inch chip, a 1/3-inch chip has roughly a quarter of the area. It is, thus, two f-stops less sensitive if it carries the same number of photo sensors. Sony mitigates the sensitivity difference by using chips with half the horizontal-detail resolution and offsetting the green from the red and blue to recover some of the detail. That makes the individual photo sensors on the chip have roughly half the area of those on a 2/3- inch HDTV camera instead of a quarter and restores half the lost sensitivity. JVC's 1280 x 720 grid also has about half the number of sensors of a 1920 x 1080 HDTV camera, so its sensitivity should, in theory, be comparable. It can be said that more sensitivity is always a good thing.

The value of more depth of field is less obvious. All else being equal (including shot framing and distance), depth of field is nominally inversely proportional to imager size, so 1/3-inch imagers have twice as much as 2/3-inch ones. Videographers using larger-format cameras may be able to reduce their apertures to get sufficient depth of field when they want the extra range. But those using small-format cameras may find it difficult to open the aperture sufficiently for the limited depth of field they desire.

Then there's diffraction. Diffraction is an optical characteristic that limits the size of the smallest detail that can be perceived at a particular aperture. It is a characteristic of the aperture and the color of light (red is worst; violet is best). But a diffraction-limited point of light that just fills one picture-element's photo sensor (one pixel) on a 2/3-inch camera chip will fill roughly four pixels on a 1/3-inch chip. Put another way, if HDTV resolution is diffraction limited on a 2/3-inch camera at F8, it will be diffraction limited on a 1/3-inch camera of the same video standard at F4. Much less of the iris range will deliver full HDTV resolution.

Then there are lens acceptance angles. Acceptance angles may be more easily understood by a simple equation. Object size is to image size as distance to the scene is to focal length. If a close-up of a face requires a 50mm focal length on a 2/3-inch camera, then, at the same distance, it will require a 25mm focal length on a 1/3-inch camera.

If a 1/2-inch format lens could be mounted on a 1/3-inch format camera, only light from the inner region of the lens—normally the best region—would make it onto the imaging chip. The lens/camera combination would have an outstanding telephoto range, but it would have a poor wide angle. JVC's new GY-HD100 camcorder is designed for interchangeable lenses. It has 1/3- inch imaging chips, but, because they are designed for a 720-line rather than a 1080-line format, they have less of a diffraction-limit problem. Most stunning, the camcorder's suggested retail price is $6,295, *including* a Fujinon Th16x5.5 lens. A 5.5mm focal length on a 1/2-inch camera is equivalent to 7.6mm on a 1/3- inch camera, but a 5.5mm focal length on a 1/3-inch camera is close to double that on a 2/3-inch camera—in other words, not very wide. Furthermore, the *5.5* figure suggests that the lens might be a half-inch model, in which case the wide angle would be narrower still. Perhaps that's why JVC offers a wide angle adapter as an accessory, for a suggested price of $600. Another accessory listed on JVC's web site is an actual wide-angle lens, the Th13x3.5. Its suggested price is about twice as much as the whole camcorder/ normal-lens package.

In the old million-dollar HDTV package, roughly a third was devoted to the lens. Many old-time HDTV experts believe that those ultra-expensive lenses for one-inch-format cameras were the best HDTV lenses ever made. Unfortunately, few could afford them. Lens technology has improved dramatically over the last decade, but there's still a limit to how much clarity can be squeezed into a small package. A typical 2/3-inch HDTV field production lens of a sort like Fujinon's HA18x7.6 or Canon's HJ17x7.7 has a list price in the $20,000 range, several times the cost of HDV camcorders.

So how can JVC include a 16:1 Fujinon HDTV zoom lens with its GY-HD100 HDV camcorder for so much less than the apparent cost of the lens alone, and how can Sony sell its HDR-HC1 HDV camcorder for under $2,000, including a built-in 10:1 HDTV zoom lens? Among possible answers are that the companies are losing thousands of dollars on each sale, that a miracle has occurred in HDTV lens manufacturing, or that perhaps the term *HDTV* is being rather loosely applied. Still, HDV camcorders are being bought by the tens of thousands. Clearly, manufacturers have come up with *something* that lens itself to the need.

POV _ So is HDV 'real' HD? What constitutes 'real' HD anyway?

by Mike Curtis

That's pretty much a religious question, with no One True Answer I'd say.

It all boils down to one's definition of what makes for "real" HD.

Is "real" HD 1920x1080 or 1280x720? Since the Varicam's DVCPRO HD format records 960x720, does that make it not real, since it is less than 1280x720? Is anything higher than 720x540 HD? Opinions vary.

As a FORMAT, HDV records 1440x1080 pixels to tape. Even though it is heavily compressed MPEG-2, I think one could make a reasonable argument that this should qualify as "real" HD in terms of resolution.

It also only records in the 4:2:0 color space, which isn't the same as the nominal/purportedly 4:2:2 of broadcast acquisition standards. But it can be quite reasonably argued that HDCAM only records 3:1:1 color space to tape, so 4:2:0 is at least a tie if not superior depending on how you argue. Obviously, HDCAM's 22ish MB/sec is vastly more data to work with than HDV's 3.2 MB/sec, but then the whole argument of codec efficiency gets into play, and by the end of it, all you've got is two engineering Ph.D's getting into a slappy fight, and who wants that? (Other than for entertainment value.)

As a CAMERA, all the currently shipping HDV cameras are best described as prosumer gear, not fully professional gear. Again, what is one's definition of professional? If you make your living with it, does that make it and you a professional level thing? The current HDV cameras are generating images that are not of the quality of the Sony 750 & 900 series cameras, not by a long shot. You see them side by side and say "Wow, that's totally different."

Would you consider an XL1 to be a professional SD camera? I think some would argue yes, others no. Do you consider it broadcast quality? Do you consider it good enough for network TV? Network TV reality shows? What are the bits and pieces that make up the definition of "true" or "real" HD? Is it HD-SDI outputs, a certain sensor resolution, type or number of sensors? XLR inputs and 24 hour timecode? Pixel res, color space, 24p support?

See? All the potential definitions are fuzzy...depending on where you are coming from, and how high you want to set the bar.

My opinion: HDV as a format should "count" as HD, but at the low end of the spectrum. The HDV *cameras* presently on the market are of low to middling quality compared to the Golden Standards of a few years ago (Sony F900 or 750), and those could be argued to not be "true" HD cameras, but again, it all depends on one's definitions, needs, and expectations. And of course, budget.

Especially with JVC's $30K HDV camcorder coming out in the not too distant future, definitions are fuzzy.

I'd say it is time to distinguish high end HD cameras from low end HD cameras, the same as is done with standard def cameras. Somebody's one chip Optura DV camcorder? Definitely not pro. A $25-$30K Panasonic (not Panavision as I mistakenly typed earlier) SDX-900, that is still shooting a DV variant (DVCRPO50) and does 16:9, 24p, XLR inputs, SDI outputs (I think..right?), interchangeable lenses, and 4:2:2 colorspace I would definitely call a pro piece of gear, but it still records on those little bitty tapes. (Yeah I'm cheating with DV vs DVCPRO50, but you get the idea.)

I'd imagine similar arguments came along when DV hit the market, and all the BetaSP and Digibeta camera owners called DV not a "real" format, either calling it not professional or not broadcast quality. I'd argue that there are now broadcast quality professional DV cameras on the market (even if there weren't 10 years ago).

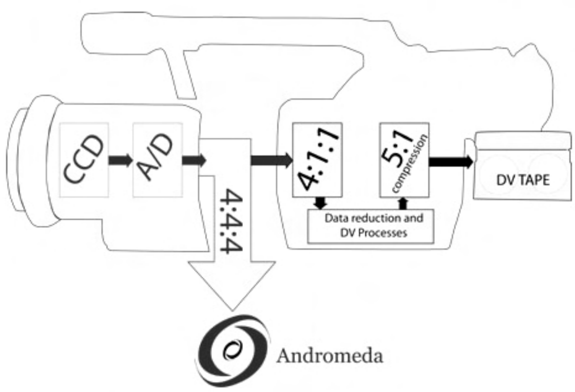
Or, perhaps, there will be different definitions for different groups of people. Professional broadcast folks working on primetime TV will have one set of standards as to what constitutes "real" HD, those working on reality TV will have another set of standards which will probably be similar to low end indie filmmaker standards.

HD, DIFFERENT WAY

Reel Stream Andromeda System

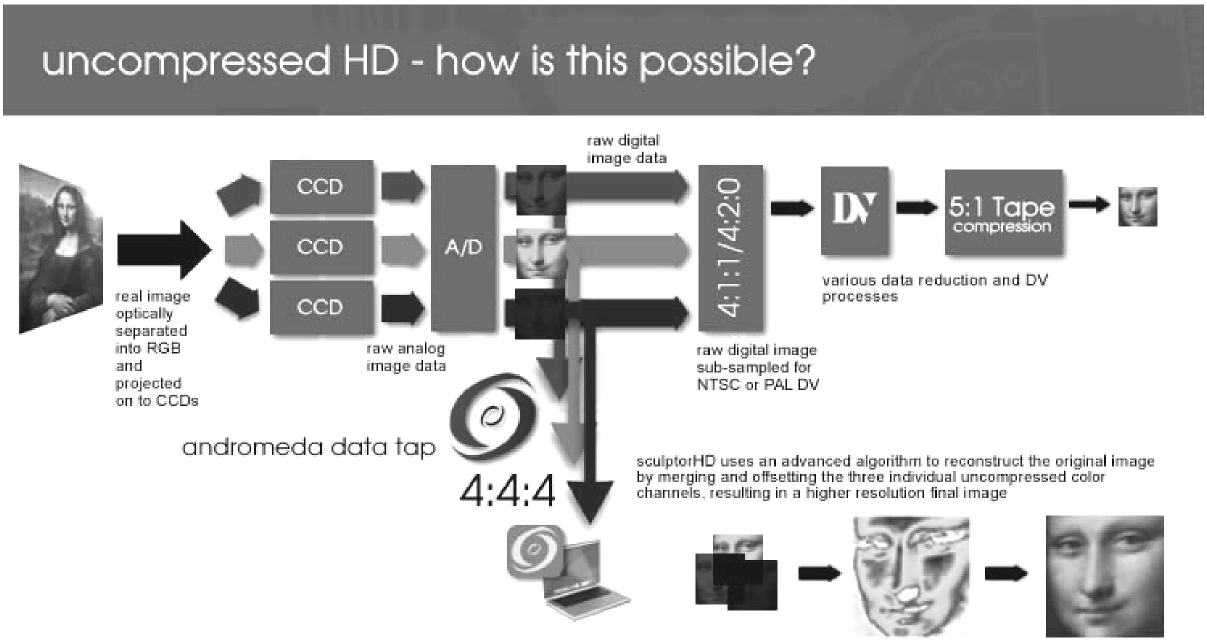
Two Purdue University (US, Indiana) graduates, Juan P. Pertierra and Jeremy Jacobs, had devised a way of modifying the Panasonic AG-DVX100 to bypass the camera's tape mechanism and output a 4:4:4 10-bit uncompressed RGB signal. Like any digital-video camera, the DVX100 discards a great deal of information when it records to tape. By intercepting the camera's signal before that data was jettisoned, Pertierra and Jacobs offered the tantalizing possibility that a MiniDV camera could output an image with more color depth than most hi-def cameras. Moreover, by offsetting the camera's green layer by half a pixel, the system could output an image with an effective resolution of 1540x990 pixels.

Pertierra and Jacobs' system, now known as the Reel Stream Andromeda Data Acquisition System, retails for $2,500. What you get for that money is a warranty-voiding modification to your DVX100, of which the most visible result is a new USB 2.0 port in the side. This can feed into a Mac running the company's proprietary software, SculptorHD, which is used to capture footage and transcode it into a variety of formats. Jacobs, Reel Stream's chief operating officer, says he and Pertierra based their system on the DVX100 because they wanted to provide high-quality footage to as many people as possible, and they felt a very popular camera would be the best vehicle to do that. "It's also a phenomenally engineered camera," he adds.



FEATURES

- Resides entirely inside the host DVX-100(P/AP) camera, only adds less than 4 grams of weight.
- The only externally visible change is the addition of the standard USB connector.
- Does not affect the normal functionality of the camera. All original functions can be used whether Andromeda is being used or not.
- Does not affect battery life, as power is taken from the USB bus.
- Records UNCOMPRESSED FULL BANDWIDTH RGB (4:4:4) direct from the Analog-to-Digital converters of the camera, before any processing is done.
- User-definable 3-channel viewer lookup tables (LUTs) make monitoring easy, regardless of what the recording LUT is
- Supports color precision greater than 8-bits.
- Yields wider dynamic range than footage normally captured with the camera.
- Allows for output up to 1540x990 from the DVX100 by utilizing the pixel shift between the CCD's.
- Supports user definable, realtime, 3-channel(R,G,B) lookup tables (LUTs) on the device itself. This allows the mapping of the original 36-bits to a lower precision with arbitrary curves. For example, 12- bit RGB linear to 10-bit logarithmic.

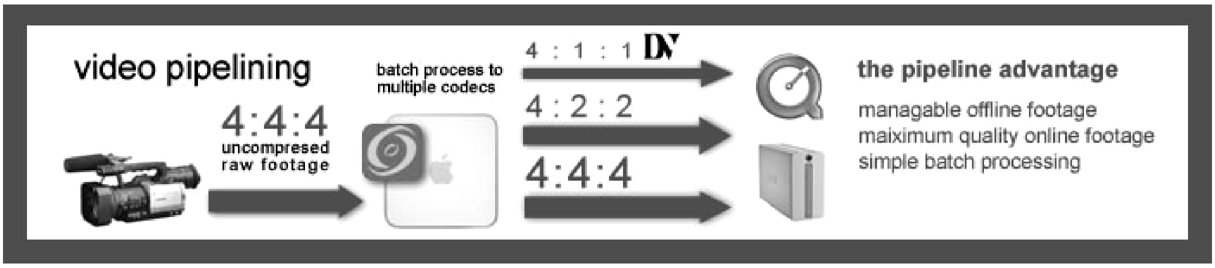


TECHNICAL SPECIFICATIONS

- **WEIGHT:** < 4 grams
- **INTERFACE:** USB 2.0 High Speed
- **RECORDING MODE:** Uncompressed, Full Bandwidth RGB (4:4:4)
- **RECORD LUT:**
  - CHANNELS: 3 (independent curves for each CCD)
  - INPUT PRECISION: 12-bit (for DVX100)
  - OUTPUT PRECISION: 10-bit or 8-bit

application solution that provides a front-end for recording uncompressed footage with **andromeda**, and allows for video pipelining, the process of batch transcoding captured raw footage into multiple formats. SculptorHD is bundled with every andromeda installation.

Let's face it, working with 10-bit uncompressed high definition footage in a non-linear post environment is extremely difficult for even the most powerful systems. But should quality suffer just because of manageability?



FEATURES

- Provides the recording front-end to andromeda, as well as **video piplelineing**, the transcoding of raw uncompressed footage into multiple formats.

MONITORING & RECORDING

- Uncompressed monitor displays all image data captured by the CCDs
- Supports windowed and full-screen modes
- Supports external reference monitors such as calibrated NTSC displays
- Color bar output to all monitors
- Multiple widescreen reticules with silk screen
- User-definable 3-channel viewer lookup tables (LUTs) make monitoring easy, regardless of what the recording LUT is
- Clipping highlight "zebra"-like function clearly shows pixels that are over-exposed at the CCD
- Vertical and horizontal flipping of monitor to support 35mm adapters such as the RedRockMicro micro35
- Selectable viewing of the R,G, and B layers to reveal what each of the 3 CCDs capture
- Realtime RGB histogram
- Records to any drive connected to the computer that can handle the required bandwidth
- User-selectable sounds provide feedback when the computer screen is not visible to the operator

POST-PROCESSING & EXPORTING:

- Exports either individual frames or Quicktime movie clips from the original raw uncompressed recorded data
- Batch processing
- IN/OUT render markers allow efficient exporting of only the required footage
- Supports exporting movie clips in any Quicktime encoder format installed on the system
- Individual frames can be exported in formats such as TIFF, BMP, CIN, DPX, JPG, etc.
- Supports 3-channel rendering lookup tables (LUTs), and gamma curves
- User-selectable SD and HD frame sizes up to 1540x990 (NTSC pixels) for the DVX100(a)
- Supports Video Pipelining

Sanyo Xacti HD1

The SANYO Xacti HD1 is the world's first high-definition compact digital media camera offering advanced video performance. The palm-sized HD1 records both 720p high-definition video and 5.1-megapixel digital still images to a standard Secure Digital flash memory card. This camera features a 2.2-inch OLED color display and a 10x optical zoom lens with image stabilization. Like all the Xacti media cameras the HD1 can record high definition video and simultaneously capture still images with a simple press of the shutter button.

SANYO's proprietary high-definition imaging engine enables advanced image processing functions such as real-time MPEG-4 compression, noise reduction and high-definition processing. Recording in the global multimedia standard MPEG-4 delivers exceptional video clarity and detail in an unbelievably portable configuration. What's more, because MPEG-4 is exceptionally efficient in the way it records digital information, higher quality videos and stills can be saved in smaller files.

No camera is better than its lens and the HD1 features a 10x optical zoom lens with a 38-380mm focal range (35mm equivalent). The all-glass lens has a maximum aperture of f/3.5 from wide to telephoto focal lengths. The HD1 incorporates a digital image stabilizer It is said to distinguish between unintentional camera shake and deliberate camera movement.

The HD1 employs a 2.2-inch SANYO-developed OLED (Organic Light-Emitting Diode) display with 210,000 total pixels. Trademark features of OLED displays are wider viewing angles, brighter picture without need for a backlight, greater contrast with richer colors, faster response speed for smooth playback of rapid movements and lower power consumption than LCD displays. When not in use, the display folds back into the side of the camera to protect the screen.

The HD1 can record over 21 minutes of 720p HD video on a 1GB SD card or over 42 minutes on a 2GB card and is compatible with the newer 4GB size cards for even longer recording. One can record in Standard Definition mode (640 x 480 pixels at 30fps progressive) for up to two hours on a 2GB SD card. It's easy to switch between high-definition and standard-definition recording modes by simply pressing the "HD/Norm" button on the side of the camera.

The HD1 is equipped with a docking station that provides an instant connection to a TV or PC. A wireless remote control further enhances both the playback and recording functions. The camera battery is automatically charged whenever it's placed in the docking station.

Sanyo HD1 Specs

- 10x Optical Zoom Lens / 10x Digital Zoom Lens
- 16:9 widescreen format (HD-SHQ / HD-HQ modes)
- 2.2 Inch OLED (Organic Light-Emitting Diode) Display
- 22 Adjustable Manual Focus Settings
- 5.1 Megapixel Digital Still Photos
- 60 fps Fluid Motion Recording (640 x 480 TV-HR Mode)
- 720p HD Video Scanning (1280 x 760 Progressive)
- Advanced MPEG-4 Compression Technology
- Anti-shake digital image stabilizer
- Built-in 4-mode Flash
- Built-in Digital Image Stabilization
- Capture Still and Video Images Simultaneously
- Ergonomically Designed for One Hand Operation
- High Quality Stereo Recording (AAC-LC)
- High-capacity SANYO rechargeable Lithium-ion battery
- Multifunction docking station
- PC/MAC Compatible
- PictBridge Compatible
- Pop-up flash with double the brightness of conventional models
- Rapid Continuous still shooting
- Record Over 41 Minutes of High-Definition Video on a 2 Gigabyte SD Card (Sold Separately)
- Red-eye reduction mode
- Remote control included- Exif Print and Print Image Matching III
- SANYO High Capacity Rechargeable Lithium-ion Battery
- SD Memory Card Compatibility (Cards Sold Separately)
- Self timer (2 seconds / 10 seconds)
- Super Fast Start-Up
- Super Macro shooting down to 1 cm (W) / 1 m (T)
- Super-fast 9Mbs Frame Rate
- USB 2.0 & S-Video Output
- Voice recorder function: over 33 hours recording time with optional 2 GB SD Memory Card
- Wind Noise Reduction
-

FUTURE SOLUTIONS

AVCHD

AVCHD (Advanced Video Codec High Definition) is a new high definition recording format introduced by Sony and Panasonic. It can use various storage media, including 8 cm recordable DVD discs, as well as hard disk, and SD and Memory Stick Pro memory cards, and is being positioned to compete with hand-held video camera recording formats like HDV and MiniDV.

As its name implies, MPEG-4 AVC (H.264) video compression is used. This is touted as a more efficient compression scheme when compared to the MPEG-2 compression used in HDV camcorders, potentially offering both reduced storage requirements and better video quality. Audio can be encoded in 5.1 AC-3 or 7.1 linear PCM.

It is interesting to notice that these are the same compression methods used for movies on Blu-ray Disc and HD DVD; it's obvious that the designers have decided to share technologies.

Among the touted advantages of AVCHD over MiniDV tapes is true random-access, since time-based seeking on AVCHD does not involve a fast-forward/rewind operation as it would on tape-based formats such as miniDV. AVCHD is expected to be playable in settop Blu-ray Disc players and possibly the Play-station 3.

Specifications for the “AVCHD” format Version 1.0

Recording Media		8cm DVD media/ SD Memory Card/“Memory Stick”/ Hard Disk Drive			
Video	Video Signal	1080/60i 1080/50i 1080/24p	720/60p 720/50p 720/24p	480/60i	576/50i
	Pixels (horizontal x vertical)	1920×1080 1440×1080	1280×720	720×480	720×576
	Aspect ratio	16:9	16:9	4:3, 16:9	4:3, 16:9
	Compression technology	MPEG-4 AVC/H.264			
	Luminance sampling frequency	74.25MHz 55.7MHz	74.25MHz	13.5MHz	13.5MHz
	Sampling structure	4:2:0			
	Quantifying bit number	8 bit (luminance/color contrast)			
Audio	Compression technology	Dolby Digital (AC-3)		Linear PCM	
	Bit rate after compression	64 ~ 640kbps		1.5Mbps (2 channels)	
	Audio channels	1-5.1 channels		1-7.1 channels	
System		MPEG-2 Transport Stream			
System bit rate		~ 24Mbps			

SONY's approach

1) DVD version - HDR-UX1

The HDR-UX1 is the first camcorder to record high definition to a standard DVD disc under the AVCHD format. The HDR-UX1 is clearly aimed at both high-end consumers and prosumers as it includes features that set it apart from most previous DVD camcorders.

The high definition HDR-UX1 works according to the same principles of conventional standard definition DVD camcorders, but records both to conventional single layer 8cm DVDs and new Dual Layer Discs. These Dual Layer Disks were will capture up to 1 hour of HD footage. Previously, DVD camcorders were limited to single layer discs with a max recording time of 30 minutes of standard definition video.

The HDR-UX1 wields a 1/3" ClearVID CMOD sensor, the same imager found on the DCR-DVD505. This chip packs 2.1 gross megapixels (1.43 effective MP in 16:9 and 1.08 effective MP in 4:3). The camcorder features adjustments usually found only on Sony's prosumer models, including a multi-function ring (controlling focus, exposure, AE shift, and white balance shift). The HDR-UX1 also has a headphone jack and microphone jack, and zebra stripes which can be set to 70 or 100. The Carl Zeiss Vario-Sonnar lens has a maximum aperture of 1.8, and a focal range of 5.1 - 51 mm. While the AVCHD standard has a ceiling of 24 Mbps, the HDR-UX1 will be limited to a maximum 12 Mbps bit rate.

In an indication that Sony hopes the HDR-UX1 will also appeal to high-end consumers with home theatre systems, it supports Dolby Digital 5.1 Surround Sound, and an HDMI port. The widescreen LCD display measures 3.5" and functions as the camcorder's touch screen interface for menu navigation and manual control adjustments.

The HDR-UX1 includes a built in flash for taking stills of up to 4.0 Megapixels, and the camcorder can take stills while recording video at an impressive 2.3 Megapixels. Stills are recorded to Sony's MemoryStick Duo or PRO Duo cards, which are not expected to be included. Stills cannot be saved to DVD.

2) HDD version - HDR-SR1

The HDR-SR1 is the world's first consumer high definition camcorder that can record video to a hard drive disk. It uses the new AVCHD format: a versatile encoding format that uses MPEG2 and H.264 encoding chips to create high definition video. Though the AVCHD standard allows for up to 24 Mbps, the HDR-SR1 will have a maximum bit rate of 15Mbps.

The camcorder is clearly geared to the prosumer market. The HDR-SR1 brings back a multi-function ring which will control focus, exposure, AE shift, and white balance shift. In addition, some of the biggest news about the HDR-SR1 is that Sony has brought back a dedicated microphone jack and a dedicated headphone jack, two features that can't be found on any Sony consumer camcorder under $3,000. The camcorder also features an HDMI-out jack and a Control-L jack.

The HDR-SR1 uses a 1/3" ClearVID CMOSm which offers 2.1 gross MP (1.43 effective MP in 16:9 and 1.08 effective MP in 4:3). Sony is including their dual record function, which allows users to record stills at a resolution up to 2.3 Megapixels while recording video. The camcorder records stills to the hard disk drive, MemoryStick Duo, and MemoryStick PRO Duo cards and includes a flash.

The Sony HDR-SR1 captures video to a 30GB internal, non-removable hard disk drive. It has four high definition quality settings and .The are as follows: XP (15 Mbps), HQ (9 Mbps), SP (7 Mbps), and LP (5 Mbps). All bit rates are variable rather than fixed. In HD mode, the HDR-SR1 shoots 1080i (or 1080 lines of vertical resolution at an interlaced rate of approximately 60 fields per second). In SD mode, it shoots 480/60i (or 480 lines of vertical resolution at an interlaced frame rate of approximately 60 fields per second).

Panasonic Solution

Panasonic, is developing technology to record HD video onto Secure Digital (SD) cards using the AVCHD format.

“Panasonic's efforts to develop the technology to record HD images onto SD Memory Cards and construct a new playback and editing environment, in addition to its establishing the AVCHD standard for 8 cm DVDs, will serve to further stimulate development of products that take advantage of the characteristics of both media,” said Mr. Akihiro Nakatani, Director of Video Camera Business Unit, Panasonic AVC Networks Company.

Panasonic did not specify any specific models, either DVD or SD-based, that will utilize the AVCHD format. Burt Desmond, Vice President of the Optical Group in Charge Product and Marketing, was able to confirm, however, that the public could expect to see products delivered “in late 2006 or early 2007, depending on the market.” The manufacturer has already put one SD-based camcorder on the market, the standard definition SDR-S100 (pictured on the left)

HD video will be able to fit onto SD cards because the AVCHD format uses MPEG4 compression, a more efficient codec that the MPEG2 currently found on most SD and DVD. The format will also support video at 1080i and 720p, as well as Dolby Digital AC3 and Linear PCM codecs for audio. Data transfer rates will also increase. Currently, SD and DVD are limited to maximum of 8.5Mbps. AVCHD allows for speeds up to 18Mbps.

POV _ AVCHD - What's the Catch?

by ***Richard Baguley***

This all sounds good so far: We've got high-def video and high-quality sound in a format that doesn't take up much space. But it does take more space than standard-definition video. According to Sony, the maximum amount of sound and video you'll be able to fit on a single-layer DVD using the DCR-UX1 at the maximum quality setting is a meager 15 minutes. Standard-def DVD camcorders can hold around 20 minutes at their maximum quality. You'll be able to increase that to an hour on the Sony HDR-UX1 by lowering the quality and using the recently announced double-layer 8cm DVD discs, but how well the quality holds up at the lower-quality settings remains to be seen.

Another wrinkle comes when you want to do something with the video: The new format is incompatible with existing high-definition camcorders and editing systems. At the moment, most software will be unable to read the discs or files that the new camcorders produce.

That limitation will ease, though: A number of video software companies have signed up to support the AVCHD format, including Adobe, Sonic, and Ulead. They will offer programs that support the new format (and will perhaps update their existing products to do the same), though none have released details about when this will happen. Sony Japan will include a basic video editing program with the new camcorders. So for the first generation of products, the video editing choices are going to be limited; however, options will appear down the line.

Sony also claims that you'll be able to watch footage recorded on an AVCHD camcorder to DVD on both Blu-ray Disc players and the forthcoming PlayStation 3. The discs won't be compatible with older DVD players, though - most won't have the processing power to decompress the MPEG-4 video. Both Panasonic and Sony are planning to license the technology, however; so we will probably see AVCHD-compatible DVD players from them and other manufacturers shortly.

One major advantage of the new format is that you won't need an expensive Blu-ray Disc or HD DVD burner to use it: Because you can store the video on the same standard DVDs you already use, you can use the same DVD burner. All you'll need is the new software to write the video out in the correct format and an AVCHD-compatible player.

DELIVERY OF THE HD CONTENT

True mass distribution of HD content is awaiting the emergence of technologies that have all the qualities necessary to make it succeed in the marketplace; there are many different medias and formats to choose from, depending on workflow needs.

High-definition DVD delivery

The great promise for HD delivery is the DVD. The DVD has many advantages over tape and other methods. DVDs are inexpensive to manufacture, their small size makes them easy to distribute, they are durable, and the audio and video quality is high and does not deteriorate with use. DVD players are small and inexpensive, and the average consumer can use them easily. It would seem that the DVD is also the perfect answer for HD delivery. The only problem is that HD requires over twice as much storage space than is available on a standard DVD, and a much higher data rate than standard DVD hardware can handle.

A number of technologies have been developed to squeeze more data onto a DVD and currently two are vying for supremacy in the marketplace: HD-DVD (supported by the DVD Forum) and Blu-ray. The HD-DVD expands on the current DVD format. The Blu-ray format takes a different approach with a blue laser. A two-layer HD-DVD formatted disc can hold up to 30 GB. Blu-ray offers up to four layers, which can hold a total of 100 GB. With the new HD formats, producers are not locked into one compression method, as they are with SD DVDs. Both competing formats offer the choice of three video codecs: MPEG-2, Microsoft's VC1, and H.264/MPEG-4 AVC.

SD DVD-video distribution

If you can't wait for an HD standard for DVDs, you can distribute your HD content as SD on a standard DVD. The output will be SD, but because the original content was HD, it's possible to achieve very high-quality SD results.

DVD-ROM delivery

A mid-range PC and monitor provide a platform for playback of HD content. Because the installed base of computers is far higher than that of dedicated HD players and displays, there is a ready-made audience for HD content. A number of titles have been distributed commercially using DVD-ROM delivery. Users can also burn their own HD content onto DVD-Rs.

MPEG-2 and Windows Media are the most popular formats for HD DVD-ROMs in use today, and both can work well. The Windows Media HD format was the first to be used in commercial products. It can compress a 2.5-hour HD title on a dual-layer DVD. MPEG-2 requires much higher bit rates for equivalent quality.

One drawback to Windows Media is that it doesn't work at HD frame sizes on Macintosh computers. If you want playback on anything other than a computer that runs Windows, another format, such as MPEG-2, is appropriate. Note that there are issues with the availability of MPEG-2 playback software.

Because you can play back the files on a computer, you can build various levels of complexity into the user interface. However, it's a good idea to allow users to pick their own player for the raw files because users commonly have their own preferences for players.

Hard drive delivery

For kiosk and laptop presentations, playback from the hard disk is the simplest and most reliable way to go. Space is plentiful, and a hard drive is more durable for continual use than a DVD-ROM drive. Additionally, because peak data rates are so fast from a hard drive, the only real limitation is the system's decode performance. For delivery of compressed content, any modern hard drive is more than good enough.

Progressive download delivery

Progressive download is the original form of web video delivery. Unlike real-time streaming, progressive download transfers the file using the same protocols as web pages. There are no buffering errors or image glitches due to dropped packets, but there is also no guarantee of real-time performance and users with slow connection speeds will have to wait. With progressive download, you can encode the content at higher data rates than the viewer's connection speed. Only the portion of the file that has been transferred plays, but the viewer can watch that portion and decide whether or not to continue the download.

Real-time streaming delivery

While it is technically possible to stream HD in real time, bandwidth remains a barrier. A visually pleasing 720 24p video requires at least 4 Mbps, even in high-end formats. This data rate is not available in homes today and is more than most intranets can sustain. However, high-bandwidth streaming is currently being used in a number of scenarios using dedicated networks, such as hotel pay-per-view and IPTV (Internet Protocol Television) systems. An IPTV system, which is typically operated by a telecommunications provider, delivers a cable TV-like experience to customers over a DSL connection.

There have also been impressive demonstrations of HD streaming over the academic Internet2 network. The fastest consumer Internet connections are only around 8 Mbps at best today, but the combination of improved codecs and increased bandwidth should make HD streaming to users a feasible market later this decade.

Broadcast delivery

You can broadcast HD as ATSC. In most cases, you provide broadcasters with master tapes of the programs, and then they handle the encoding themselves. However, local broadcasters may be able to accept programming as MPEG-2 transport streams.

Most HD broadcasting that occurs during the day is often in the form of loops of compressed MPEG-2 content. Enterprising HD producers might be able to get some airtime by providing free, high-quality HD MPEG-2 content for local broadcasters to include as part of their loop.

APPENDIXES

BBC HD PRODUCTION TIPS

HD – Production

- Think of HD as being higher quality than SD, which is exactly what it is. So much of the production process is exactly the same.
- Using HD won't make a bad script/story any better.
- Dependant on genre there may well be a lift in production costs. If you use a great deal of CGI then the lift may be significant.
- Acquisition in HD for a SD deliverable will increase the shelf life of the programme significantly. The HD deliverable is only a conform away.
- A programme shot in HD will look wonderful in SD and even better in HD.
- 5.1 sound is an option on certain programmes on HD. This makes the pictures significantly better!
- Progressive or Interlace? How you want motion to be portrayed will determine the best capture format - sports/fast motion- use interlace, film look -use progressive.

HD – Production Management

- What are the delivery requirements? Be clear from the outset what these are and work backwards for an effective schedule.
- Negotiate and agree delivery requirements and frame rates up front with Co-Producers.
- What acquisition format will they accept?
- How much/what percentage of the programme will they accept as upconverted archive or non HD material?
- Expect your costs to be higher than SD in the areas of design, costume, make-up and post production (including CGI).
- Don't forget that your graphics must also be HD!
- For US co-productions a frame rate conversion will lead to a change in programme duration.
- Allow time and budget in pre-production for key tests on camera, lenses, make-up and design. Also test the camera's performance in extreme lighting and temperature conditions.
- Look for HD experience in the key HOD areas of camera, sound, costume and make-up.
- Color viewfinders on cameras are recommended and HD monitors on location should be 14 inches plus for effective critical focusing.

HD – Standards

- There are two HD line standards, two HD scanning options and various frame rates. But for the moment, just remember these:
- 720 line, 50 Frames, Progressive (labeled as - 720p50)
- 1080 line, 25 Frames, Interlaced (labeled as - 1080i25)
- As time progresses we would ideally master on:
- 1080 line, 50 Frames, Progressive (labeled as - 1080p50)

HD – Formats

A 'format' is the way in which we store our content. E.g. DigiBeta is an SD 'format'. These are the major HD tape formats, like in SD they range in quality dependent on price, the more money you pay the higher the quality.

- HDCam – Good workhorse – not the best for chroma key
- DVCProHD (Varicam on tape, P2 on solid state card) – Good workhorse – not the best for chroma key.
- HDCam SR – Expensive but high quality.
- HDV – Cheap, but not acceptable for full HD production.
- D5 HD – Expensive but high quality

Just like in SD beware of the concatenation of errors when using any compressed recording format. The above formats are all labeled 'HD' but record different incompatible data.

HD – Set/Production Design

- HD brings out fine detail and texture, enriching the picture rather than detracting from it. HD gives a richer picture quality.
- Feedback was positive from designers who've experienced HD. They welcome seeing fine detail so long as budgets allow for them to maintain design standards and using HD is planned from the outset.
- Most textures and finishes are better tolerated on HD than SD.
- Color: Most colors are true to the eye. White was well tolerated; red didn't bleed but is quite dominant; black filled in less with more nuance and depth.
- Using HD will highlight scenery defects such as repeat taping and painting over scenery flattage joins, knocks and damage, dirt and scuff marks.
- Any patching needs very careful paint / color matching and more effort to look good to make it an acceptable standard.
- Knocks, scratches, general wear and tear are distinctly noticeable and need additional time and effort to rectify.
- The cost of repairs and re vamping scenery / furniture will need to be built into production budgets.
- Floor paint / cover: care needs to be taken as footmarks, scuffs and dirt are clearly visible.
- HD requires design teams to take additional care with set dressing detail. E.g. set dressing that has text and labels.
- Traditional methods to age / break down / distress surfaces will need a finer approach and expertise e.g. where we might give a general 'splatter' that fills in on SD are seen as 'spots and splatter' on HD.
- On set maintenance and closer scrutiny for dressing continuity will need to be vigilant to make sure surfaces are kept clean and free from marks. These will show more using HD.

HD – Costume

- HD brings out fine costume detail and texture, enriching the picture rather than detracting from it. HD gives a richer picture quality. All fabrics including sequin, glitter, fur, and feather are well tolerated.
- Color: White was well tolerated; red didn't bleed but is quite dominant; paramedic green and fluorescent is true to the eye with less reflection: black filled in less with more nuance and depth.
- Checks, stripes and close weaves that would strobe or flicker on standard definition are more tolerated on HD. However care should still be taken as many productions may be shot on HD but viewed on SD receivers.
- Wear and tear to costume items would be seen on HD. Care would need to be taken with costume artifacts in close up shots e.g. hat brims, necklines and jewellery. Any minute defects are seen and can distract.
- Where costumes need to be 'worn realism'' and not smart there may be more tolerance than expected, but sweat, fraying and dirt are easily seen and could distract from the performance.
- Dressing crowd will need more consideration as any worn defects or less well fitting clothes are more likely to seen.
- Traditional methods to age / break down / distress costumes will need a finer approach and expertise e.g.: where we might give a general 'spray' that fills in to the eye and SD camera, they are clearly seen as 'spots and splatter' on HD.
- On set maintenance will need to be vigilant to counteract sweat, grease and continuity. These will show more using HD.

HD –Make-up

- Most skin and hair tones are well tolerated and similar to standard definition and film.
- Artists and make-up practitioners may be concerned that every blemish is accentuated by HD and need re-assurance and longer time in the chair to make sure standards are maintained on camera.
- Men have generally needed less make-up and therefore less time to complete a general corrective make-up and hair tidy. Using HD will require a more complete make-up application to mask beard shadow and shine.
- To give a seamless finish many make-up specialists may prefer to use airbrush techniques which has implications for additional costs to purchase kit.
- HD will pick up on all edges and highlight any imperfections. Applying prosthetic pieces or effects make-up will need skill and additional time to be accurate.
- Wig and facial hair lace will also be more difficult to hide, needing finer quality hair pieces and experienced make-up practitioners to apply them. Additional time will be needed to make sure edges are well concealed. Some glues responded better than others with less
- glisten.
- Blood and special effects can tend to look over accentuated with high glisten. Red is dominant.

- On set make-up maintenance will need to be vigilant to counteract shine and maintain the make-up throughout. These will show more using HD.

HD – Cameras

- Progressive or Interlace? How you want motion to be portrayed will determine the best capture format - sports/fast motion- use interlace, film look -use progressive.
- If you want 'film motion' select 25P as your frame rate. (Check your deliverable first!).
- The Contrast handling of HD cameras can be extended by at least two stops by selective modification to the menu options in the camera. Suggested settings are available from the BBC.
- Shutter Speeds: Electronic cameras have electronic shutters. These are default at 1/25th. A shutter is used to shorten the time the camera has to capture the frame without changing the frame rate.
- Camera test: it's well worth shooting tests for camera, make-up, wardrobe, and set design, before committing to particular settings.
- If you're shooting in HD you will need an HD lens as most SD lenses are not capable of resolving the image to the high level necessary for a HD camera.
- Focus is very precise in HD and Back Focus is very critical. Check the Back Focus on a regular basis and especially if the camera has been transported any distance as the lens mounts tend to fret and loosen.
- Exposure: Control your 'high lights' as overexposure is just as disastrous in HD as SD. Don't be afraid to under-expose, it will work.
- Filters can be used as with all other camera systems.
- Be aware that additional detail correction, as usually applied to an SD shoot, may not be appropriate in HD, since the HD acquisition can cope with the resolution of the scene in a natural way without the need for additional "sharpening". This may not be apparent if viewing on set on a small monitor, but over-sharpened pictures will not look good on a large HD-capable screen, or once coded for transmission. If the programme is subsequently down-converted to SD, detail correction may be applied at that stage, for the SD version only.

HD – Graphics

- HD is widescreen only but beware the SD deliverable will have standard 'graphics safe areas' (either 14x9 or centre cut out safe).
- Fonts are scaleable so will work fine in HD – assuming your platform will work HD.
- Render times will be significantly longer – so keep a close eye on the cost of CGI! (It may also impact on your design process as the delay in rendering of large projects can disrupt the creative workflow).
- Good design will look good in any resolution.
- Archive content will usually be in SD – but with careful use (not full frame or polished) will work well in a composite.
- In HD 'pixels' are square unlike the rectangular ones in SD.
- Uncompressed HD images will be much larger than the equivalent SD image. (8.3 Mbytes for a 4:4:4:4 image). This will mean very large 'scratch files' when layering graphics.
- Beware single line wide shape on interlaced output (twitter).
- Check the resource workflow of any new project and identify areas than are unfamiliar. Tests may be required to ensure consistent results. E.g. Captioning in an NLE compared to a dedicated caption device.
- It's hard to deliver a HD deliverable in an SD timescale. (Render times).
- Ensure you are familiar with the meaning of the new HD jargon. E.g. Progressive, HDCam, Varicam etc.

HD – Post

- HD has 5 times the resolution of SD therefore there is far more data to move around in the edit suite. This means you either wait longer for each render or upgrade to faster hardware. Either way, it may impact on post budgets.
- A 'good edit' is a 'good edit', the resolution of the image won't change the edit point. But remember that we use 'close ups' so much in TV because of the lack of SD resolution, so in HD we may opt to hold shots for longer. So it may influence the style of editing.
- HD is widescreen only, but beware of the SD deliverable with its SD shoot & protect policy.
- Be clear on the individual characteristics of the various HD tape formats. E.g. some are not ideally suited to chroma key work.
- Familiarise yourself with the viewing characteristics of a HD glass monitor, 'HD ready' LCD and HD Plasma screen. Remember that most domestic HD displays are 'HD Ready' LCD's not Glass TV's like they are in the SD world!

- Dubbing a 5.1 sound mix will be required on certain HD content.
- Consider a SD offline post process, this should reduce post costs.(A conform will be needed before delivery).
- HDV is not currently considered to be HD, only limited amounts of HDV footage can be used in HD programmes.
- Avoid dubbing more than 2 generations of HDCAM to preserve quality.
- When shooting DVCpro HD keep on-speed (25fps) and off-speed (4fps to 60fps) on separate tapes. You'll avoid extra costs in post.
- Up-converting SD to HD does not make bad pictures any better, 'rubbish in = rubbish out'.
- Standards conversion between 30 frames and 25 frames HD is not perfect, is not widely available, is expensive and can produce artefacts. (i.e. make all your crews shoot the same frame rate! - hopefully related to your deliverable format).

HD Sound

- Surround sound (5.1) – More like a cinema experience with a total of six speakers, front left, centre and right. Rear left and right and a LFE (Low Frequency Effects), for the loud bangs and crashes.
- Many resource/craft providers are familiar with 5.1 working.
- Is the surround sound (5.1) to be produced live or as a post operation? If live, pay special attention to the monitoring setup and capabilities of the mixing desk. If post, what is the workflow route?
- What is the delivery tape format as this has track implications. (for the BBC technical trial – delivery will be on HDCam).
- Planning - what you need to establish depends on the context, style, and the individual details of the proposed programme. Talk to your craft experts for advice and guidance.
- It is possible to achieve very good surround sound quite simply.

HDV FAQ

Why was the HDV format developed?

While the original DV format included a HD specification, it was for 1024 lines of vertical resolution rather than 1080 lines – which is increasingly popular with HD devices such as consumer plasma and LCD displays. By compressing 1080 scanning lines with MPEG2 format, the HDV format is able to support the demand for 1080 resolution while still retaining a high degree of compatibility with the DV format. In fact, the HDV format can record and play back this higher picture quality on exactly the same cassette using the same tape speed and track pitch as DV.

What kind of media is used for HDV?

Conventional DV tapes are used for recording in HDV.

How long is the HDV recording time?

It is the same as DV recording time. Also, with the HDV 1080i specification, there is no long- playing mode.

How is it possible that the large HD video data quantity of HDV can be recorded in the same running time as the DV standard on DV tape?

Recording is possible in the same running time because MPEG-2 is used. MPEG-2 is a compression system that can realize high resolution even at a low bit rate by using information on differences between frames.

What is the difference between HDV and DV? Which has better picture quality?

HDV and DV have different image compression and tape recording methods. Since HDV was developed in order to record and play back high resolution HDTV video, HDV has higher resolution from the standpoint of the number of pixels.

What is the HDV video compression method?

HDV uses MPEG-2 compression -Main Profile at High-14 Level. The bit rate after compression for the 1080i specification is 25 Mbps.

Isn't picture quality deterioration such as block noise and errors usually a concern with MPEG-2?

A MPEG-2 compression can deliver very good performance as long as appropriate bitrates are used. Since HDV uses a bitrate of up to 25 Mbps after compression, the format achieves excellent picture quality.

What is the audio compression method for HDV?

The audio compression format is MPEG-1 Audio Layer II. This format can compress and record a signal with a sampling frequency of 48 kHz and quantization of 16 bits, at a bit rate of 384 Kbps.

Which has better sound quality, HDV or DV?

With DV's 16-bit 2-ch mode sound and HDV's audio recording, DV has better quality sound for the parts where compression is not carried out. However, since HDV uses a very high bit rate (384 Kbps) for sound compression, the sound quality is almost on par with uncompressed audio.

Is the HDV sound quality comparable to a music CD?

Since HDV audio is compressed, theoretically it is inferior to CD sound quality. However, as mentioned above, by securing a high bit rate after compression, the sound quality is almost on par with that of a CD.

In the future, will the DV standard disappear and the HDV standard become mainstream?

Along with the widespread adoption of HD broadcasting and HDTVs, it is expected that the HDV standard will soon become the norm. However, DV is currently the mainstream as far as price and the popularity of DV displays are concerned. Nevertheless, there will soon be more models of HDV camcorders on the market, and when the prices come down, HDV will likely replace DV as the main standard.

Can you record standard definition (SD) video in addition to high definition (HD) video? Can you mix SD and HD video on one tape?

The HDV format only specifies high definition video, however most of the HDV camcorders and VTRs support DV and some also DVCam.

*I**s HDV's recorded track pitch different for professional and consumer versions?***

HDV format adopts the same track pitch (10 micro meters) on both professional and consumer products.

How is the picture quality when downconverted to SD?

It will be almost equivalent to DVCAM native recording, although it varies depending on each picture

What is the difference between the Sony and JVC HDV cameras?

The JVC cameras are 720p. This means they have 720 lines of horizontal resolution, displayed/shot in progressive frames. The Sony cameras have 1080 lines of horizontal resolution, shot in interlaced frames. The resolution of the JVC camera is 1440 x 720p, and the resolution of the Sony cameras is 1440 x 1080i. (when viewed at aspect ratio, the Sony actually displays 1920 x 1080i. A 1440 anamorphic image yields a 1920 display)

What is the difference between 1080i and 720p?

The 720p format employs progressive scanning with 720 effective scanning lines and 1280 samples per line. The 1080i format uses interlace scanning with 1080 effective scanning lnes and 1440 samples per line.

Why are there two formats, 1080i and 720p, for the HDV standard?

The two formats meet the needs of different HD infrastructures around the world.

Which has better picture quality: HDV 1080i or HDV 720p?

A The picture quality will depend on the performance of individual products. Select the for mat that best meets your needs.

How does HDV error correction differ between 1080i and 720p?

A The two differ in correction coding ratio and the method for error correction across multiple tracks.

Can tapes recorded with the 1080i specification be played back on a 720p-specification camcorder? Or vice versa?

It may not always be possible for a 720p camcorder to play back a tape recorded in the 1080i specification, and vice versa. Compatibility depends on the actual specifications of the product.

Can I upload HDV data to my computer and edit it? Is it possible to edit both the video and audio just like with DV data?

This is possible if you have an HDV application software on your computer. The type of editing will depend on your software.

Can I upload HDV data to my computer and then save it on a DVD disc?

If your HDV application software allows you to convert the data to SD, you can save it as a DVD video. Also, you can save it on a DVD data disk, which is the same concept as data backup. However, in this case it will not be compatible for use on a DVD player.

After uploading HDV data to my PC and editing it, can I then write the data to a DV tape using the HDV or DV standard?

Either is possible if your HDV application software permits it.

What are the necessary PC specs to allow for uploading and editing of HDV data?

The basic should be Pentium 4 3.06 GHz or higher RAM: 256 MB or higher (1 GB or more is recommended) HDD: UltraATA100 i.LINK terminal as standard equipment Display: XGA or higher Video memory: 32 MB or higher Software: Windows XP SP2 or higher

How big is a HDV file when it is uploaded to a computer?

If the data is uploaded in MPEG-2 format without conversion, the file wil be about the same size as a DV file of the same running time. A ten-minute video is about 2 GB.

What is a transport stream? (A ts file?)

A Transport/ts stream is the multiplexed packeted data that makes up the MPEG file. It is a muxed/blend of audio and video. It has a fixed length for structure. Demultiplexing is achieved by unique packet IDs (PIDs).

Is the Audio format of HDV any good?

The audio format of HDV is MPEG 1 Audio layer II. It has a bitrate of 384 Kbps, and can be very good. However, it's not suitable for heavy editing, so audio like video, is best sent to the intermediary. (and is automatically done so by the intermediary tools) Keep in mind that while this format is not quite up to CD standards, it is quite good. DV camcorders record audio in PCM format, so it's the same as a .wav file.

The HDV audio spec is similar to very high bitrate MP3 audio. If you need high quality audio in a PCM format, we suggest you use a DAT or other uncompressed source that can do a true 16 bit/24 bit recording at 48k/96khz sample rate. Remember, when you use the Cineform intermediary audio is converted to a 48K/16 bit format, so you'll not need to worry about the audio quality in editing.

How do I capture HDV?

HDV is captured in exactly the same method as you capture DV. Using a capture application like the ones offered by Cineform, you'll capture media, and either conform it to the intermediary on the fly, or conform it to the intermediary later. Because HDV also has timecode embedded in the file, Batch Capturing and previewing scenes for capture should stay the same.

I heard that HDV has .5 second dropouts. Is this true?

It is true that if you experience a dropout in HDV that it will last for one-half second. This is due to the MPEG format of HDV, and how GOP I frames determine the rest of the image and frame content.

Do I need a new monitor to preview HDV files?

Maybe. You can monitor HDV one of two ways. You can view it on a computer monitor that is at least 1900 x 1200, or you can use an external HD television monitor. If you want to use an external monitor, you'll need to use an HD card similar to the My HD card from MIT systems, or something similar. Since HD will be viewed on plasma and LCD screens in the future, you'll want to view on a monitor similar to what the footage will be viewed on so that color correction, etc are accurate. You can view HDV in your NLE application on a lower resolution computer monitor, and likely be reasonably accurate, but for critical video, "reasonably accurate" just isn't good enough.

How does the camera connect to my computer?

The HDV camera connects to your computer via the same Firewire connection that you currently use to capture DV, connect hard drives, scanners, etc. Some proprietary hardware cards will also soon accept HDV information over Firewire.

Isn't HDV just too huge a data rate/stream to edit with?

HDV in 1080i format is the same bitrate (25Mbps) as DV is. However, depending on the system, you may experience slowdown on the system. A reasonably fast computer can manage the bitstream without any trouble.

How do I deliver HDV files to a broadcaster or client?

Eventually, HDV will be delivered via Blu-Ray discs in most scenarios. Blu-Ray is still just around the corner. Currently, your options are:

- Deliver on WMV-HD
- Downconvert to SD/Standard Definition, and deliver on DV, Beta, or DVD
- Upconvert to HDCam with an application like Sony Vegas. You will suffer some loss, but in seeing some footage upconverted to this format, it was pretty impressive.
- Deliver using NERO's Recode H264 format, playable on settop DVD players.

Is HDV interlaced the same way as DV? Is it upper or lower field first?

HDV, unlike DV, is upper field first when working with interlaced modes.

I read that HDV has bad motion artifacts. What's the scoop?

If you attempt to do very fast pans with HDV, due to the way the frames are generated with MPEG and GOP, you may see motion artifacts. However, this is not nearly the issue as it's often painted to be. It's a good idea to rent, borrow, or download images from a website to see for yourself, how HDV works with fast motion.

HDV Glossary

1080i_ High Definition system with 1080 scanning lines of interlaced information.

4:3_ Aspect ratio of conventional, Standard Definition television.

16:9_ Aspect ratio of High Definition television.

720p_ High Definition system with 720 effective scanning lines and progressive scanning.

ACM_ Audio Compression Manager, developed by Microsoft as the standard interface for signal processing of audio data in the Windows environment, particularly geared towards the wav file format. Some tools allow custom ACM processes.

ADC_ Another name for Analog to Digital Converter.

Anti-aliasing_ The manipulation of edges (e.g., those between areas with contrasting colors) in an image, graphic, or text to make the edges appear smoother. Anti-aliased edges appear blurred up close but smooth at average viewing distance. Anti-aliasing is critical when working with high-quality graphics for television display use. Opposite of aliasing.

Aspect ratio_ Width and height ratio of the picture

ATSC_ Advanced Television Systems Committee determines voluntary technical standards of acquiring, authoring, distribution and reception of high definition television.

ATV _Advanced Television, now referred to as DTV. (Digital Television)

AVI_ Audio Video Interleave. AVI is a video file format.

Blu-ray Disc_ optical disk developed by Sony, Panasonic, and Phillips. On a disk the size of a regular DVD, 27 GB of data or six times the data of a DVD can be stored. Using this technology for recording, it is possible to maintain the quality of HDTV content.

B-frame_ In inter-frame compression schemes (e.g., MPEG), a highly compressed, bidirectional frame that records the change that occurred between the i-frame before and after it. B frames enable MPEG-compressed video to be played in reverse. Contrast with i frame and p frame.

Bit rate _ The amount of data used in one second (1 Mbps means 1 megabit of data is used in one second)

Channel(video)_ Each component color that defines a computer graphic image—red, green, and blue—is carried in a separate channel, so each may be adjusted independently. Channels may also be added to a computer graphic file to define masks.

Codec _ Compression/decompression module

Component Video_ The connection of a video device I/O consisting of 3 primary color signals: red, green, and blue that together convey all necessary picture information. In consumer video products the 3 component signals have been translated into luminance (Y) and two color difference signals (PP, PR), each on a separate wire.

Compress_ (File size) Resampling, reducing a file size for streaming or sharing over the internet or intranet. Usually a lossy process, causing some loss of audio quality. REAL Media, MPEG, MJPEG, Microsoft wmv/wma are all examples of compressed media. HDV uses the MPEG compression format of 4:2:0, while NTSC DV uses 4:1:1.

Data format _ The standard used when recording video and audio as digital data.

Deinterlace_ The process of removing artifacts that result from the nature of two-fields-per-frame (interlaced) video. There are various methods of deinterlacing, and may be done in the camera or in the editing application.

Downconvert_ converting HDV to SD, or converting any higher resolution image to a lower resolution. Sony cameras can accomplish this internally, but any NLE can accomplish this task.

D terminal_ A connector that can transmit the three signals that make up component video: Y (luminance), B-Y (blue color difference) and R-Y (red color difference). The connector is shaped like the letter "D." The terminals include D1 for 480i; D2 for 480p and 480i; D3 for 1080i, 480p and 480i; and D4 for 720p, 1080i, 480p and 480i. For High Definition, the D terminals on both sending and receiving devices must be D3 or D4.

DV _ Digital Video. Related to DVC Pro and DVCam. Also known as DV25, for their 25 Mbps rate.

DVI_ Digital Visual Interface. The DVI port provides a pure digital video signal to a digital flat-panel display or projector. Using a digital signal for the entire path maintains the image quality at the highest level, because the signal is not degraded as a result of a digital-to-analog conversion.

Error correction_ Methods that detect and correct missing or garbled digital information. Behind the scenes, modern digital recording and transmission systems employ powerful error correction.

Field frequency_ The number of fields per second.

Frame_ One picture in a sequence of moving pictures. In interlace scanning, each frame contains two fields.

Frame frequency_ The number of frames per second.

Field-One complete vertical scan of a picture that has 262.5 lines. A complete television frame comprises two fields; the lines of field 1 are vertically interlaced with those of field 2 for 525 lines of resolution according to the NTSC standard.

GOP _ Group of Pictures. A GOP contains several different types of compressed frames: I, P and B frames.

HDMI _ High Definition Multimedia Interface. Can handle uncompressed digital HD, as well as several channels of sound.

HD-SDI _ HD version of SDI, which is the professional standard for moving uncompressed SD video around a studio.

HDV _ High Definition Video. HDV is a video format that uses the HD line resolution (1080i or 720p) in a highly compressed format: MPEG-2 Transport Stream. This creates a stream that is small enough (roughly 25 Mbps @1080i, 19Mbps @ 720p) to fit on a standard DV tape. In addition to the data compression of the MPEG-2 format, HDV does not store all of the full-resolution HD video data.

HQ Codec _ A codec developed by Canopus to compress HDV into an editable format. HQ reduces the overhead required to decode the file for playback and editing while still maintaining the true HDV quality.

HVD _ High-clarity Video Disk. HVD is a Chinese technology that comes in the form of a very low cost player capable of playing back high-definition material recorded onto a DVD-R disk. The compression used is MPEG-2, just like HDV. A viable short-term alternative for displaying HD video.

I-frame_ In inter-frame compression schemes (e.g., MPEG), the key frame or reference video frame that acts as a point of comparison to p- and b-frames, and is not rebuilt from another frame. Opposite B frame and P frame.

Inter-frame compression_ A compression algorithm, such as MPEG that reduces the amount of video information by storing only the differences between a frame and those before it.

Interlaced_ Interlace scanning is a method that can produce two images in a single scan, by scanning every other line. For example, if there are 480 scanning lines, only the odd numbered lines are scanned for the first image (1, 3, 5, ... 479), and all the even-numbered lines are then scanned for the next image (2, 4, 6, ... 480). Interlace scanning has the advantage of displaying smooth movement.

Intra-frame compression_ Compression that reduces the amount of video information in each frame on a frame-by-frame basis. Compare to Inter-frame compression.

Mbps _ Megabits per second. Usually refers to a transfer rate.

MPEG _ MPEG (pronounced M-peg), which stands for Moving Picture Experts Group, is the name of a family of standards used for coding audio-visual information (e.g., movies, video, music) in a digital compressed format.

MPEG-2- an extension of the MPEG-1 compression standard designed to meet the requirements of television broadcast studios. MPEG-2 is the broadcast quality video found on DVDs and requires a hardware decoder (e.g., a DVD-ROM player) for playback.

MPEG-2 Long-GOP Compression _ The standard used to compress footage shot in HDV into a storable format.

OHCI _ Open Host Controller Interface. Refers to the standardized interface through which OHCI-compliant devices can talk to each other, regardless of brand or device type.

P frame _ In interframe compression schemes such as MPEG, the predictive video frame that exhibits the change that occurred compared to the i frame before it. See I-frame and B-frame.

Pixel_ Picture Element. The more pixels in a frame, the greater the resolution of the frame.

Progressive Scan Video _ Progressive scan video is scanned from right to left, top to bottom, up to the end of the frame.

Quantization_ This indicates what level value to express the data sample with (16 bit is expressed with 216 = 65,536 level)

Render_ To blend all multimedia files together in one master file format. Akin to baking a cake from all it's individual ingredients.

Resolution_ A measurement of information in a frame. The higher the number of pixels, the higher the resolution. HD may be either 1280 x 720 or 1920 x 1080i

RGB-Abbreviation for Red, Green, Blue. Colorspace used for graphics, and most NLE applications.

SD _ Standard Definition. Refers to non-HD video.

Stream interface _ Data transmission standard

Stream type _ This is the system for combining video and audio data into a single set of data in the MPEG-2 system.

Temporal compression_ A compression method that reduces the data contained within a single video frame by identifying similar areas between individual frames and eliminating the redundancy. See also codec..

Transfer rate_ How fast a disk drive or CD drive can transfer information to the CPU. May be a burst rate or sustained rate. High cache levels (8 meg) or larger assist in providing information to the CPU at fast rates, important when building large composites in any NLE.

VGA _ Video Graphics Array. A computer standard for connecting computers to analog display devices. A decent way to get HD video from a computer to the screen. The connection is video-only.

Video File_ In most applications, this is relevant to Quicktime, .mpg, .wmv, avi, m2t, or m2v files; data files that contain video information.

Wavelet_ Wavelet compression works by analyzing an image and converting it into a set of mathematical expressions that can then be decoded by the receiver. Wavelet compression is scalable, depending on the features of the encoding application.

WMV _ Windows Media Video. WMV is a video file format with a relatively high compression rate.

Y, U, V _ Luminance - Bandwidth - Chrominance. Sometimes referred to as Y, Cr, Cb. The video signal is separated into components of brightness and color, potentially to a degree more advanced than S-video.