

Fourth Year Technology Manual



Camera Manual

Camera functions:

Red slider – Menu

- Zebra – shows lighting detail. For use with aperture and shutter detail
- Movie mode – Frame: slow moving but sharper
 - Normal: better for movement
 - Digital Photo: for capturing photos
- Sensor: infra-red for remote (one in front and one in the back)
- Tally Lamp: light that goes on when you start recording
- Audio mode: 16 bit gives 2 channels = better sound
 - 14 bit gives 4 channels

Note: Impedance electromagnetism and resistance. Diff between line and mic inputs.

- Audio in 2: only working when set to 12 bit
- Record mode: Short play or Long play (SP or LP)

Focus – either manual or auto-focus

Has auto focus option, but can become tricky when different things move into picture and tries to adjust, as well as at times when lighting changes.

* Manual option good for creating different effects, such as depth of field

Stabiliser always on

ND filter: changes how much light is filtered into lens

Ratio: 3:4 ratio best for our usage; 16:9 better for widescreen.

Lenses:

Can interchange lenses, BUT have to be very careful not to allow dust onto the lens as this will damage it. (Note: same goes for changing tapes!!!).

How the Lens works:

- Prism within lens breaks up light into three ‘channels’: Red, Green and Blue
- These then refracted off a mirror and onto another lens to form the picture. This process enhances the colour of the final product and gives a sharper picture.

Also (from manual) Potential focal range, from extreme wide to super telephoto (in 35mm equivalent), is 24mm to 17,280mm. 16:1 Optical Zoom: The longest optical zoom of any DV camcorder, the 16:1 zoom has a focal length range of 5.5mm to 88mm (35mm focal length equivalent of 39mm to 633mm). It has high speed motors for auto-focus and zooming, a six-blade Iris and a 1.5x ND filter. Externally, the lens provides a variable speed zoom, manual zoom, manual focus control options and a one-push auto-focus button.

Shooting Modes: (from manual)

Three recording options for virtually any imaging need include capture of high resolution Full Motion Video (Normal Movie Mode), high resolution Stop Action Images of Moving Subjects (Frame Movie Mode) and Picture Perfect Single Images (Digital Photo Mode).

Frame Movie Mode lets you continuously record an incredible 30 frame images a second, while effectively eliminating motion flicker by capturing a full image with every scan. The Frame Movie mode allows you to record high speed action for the purpose of extracting high

resolution frame Video images, which can then be displayed, printed or digitized.

For SLR-style flash photography, the Digital Photo mode will accommodate the Canon Speedlite 380EX E-TTL flash, using an optional FA-100 Flash Adapter.

Five Program AE Modes: The XL-1 offers five AE Program Recording modes for convenience, plus full manual control. By simply rotating a large back dial, you can choose settings to suit your shooting preferences:

Easy (Green) - All functions are automatic

Auto (A) - All settings are automatically set. Functions such as Focus, Exposure, and White Balance can be set manually.

Spotlight Mode - Another Auto mode, this is for when you are shooting bright subjects on a dark background.

TV (Shutter Priority) - Manually select your own shutter speed from 1/60, 1/100, 1/250, 1/500, 1/1000, 1/2000, 1/4000, 1/8000, 1/15,000, and the camera automatically sets the correct aperture.

AV (Aperture Priority) - Manually select your own aperture from 8 F-stop settings (f/1.6 to f/16), and the camera will automatically set the correct shutter speed.

Manual Mode - Full control over 27 shutter speed and 27 aperture settings, as well as manual control of Focus, White Balance, Gain (five preset levels from -3 to +12 dB) and Exposure Lock. A gauge in the viewfinder indicates when a proper shutter/aperture has been selected.

Three Digital Audio Modes: The XL-1 offers three Digital Audio modes (16-bit and two 12-bit modes) and is the first camcorder to offer simultaneous recording on four channels, enabling recording of four separate tracks. You can also output each signal independently.

*The Canon XL-1 can generate full-field color bars. Just follow these steps: A. Turn on the camera in the full auto mode (Green Box mode). B. Press and hold the two shutter buttons for about 5 to 7 seconds. You now have color bars in your viewfinder. To turn off the color bars, simply press and hold the two shutter buttons until the color bars disappear from the viewfinder. To turn off the color bars, press the two shutter buttons again



Sure Mixer:

Buttons on Mixer:

- Gain
- Bass cut Filter – takes away wind /echo
- Balance – mixes input ratio to a particular output

Mic and line inputs: relates to impedance; if plug line into mic or vice versa, there is no sound because the resistance is too high.

Note: switch off rifle mic batteries and mixer when not in use!!!

How to set mixer to camera for use:

- Tone: must be at -4 (optimum record level)
- Switch off 1khz button
- Set camera to manual, on side panel, and adjust audio to 12 DB (black box around it).
- Camera / mixer now set for optimum sound☺

Different Mics: Use different mics for different areas to achieve optimum sound quality.

Stereo Mic – attaches to camera. Good for getting ambient sound and interview at same time. Good for vox-pops type interviews.

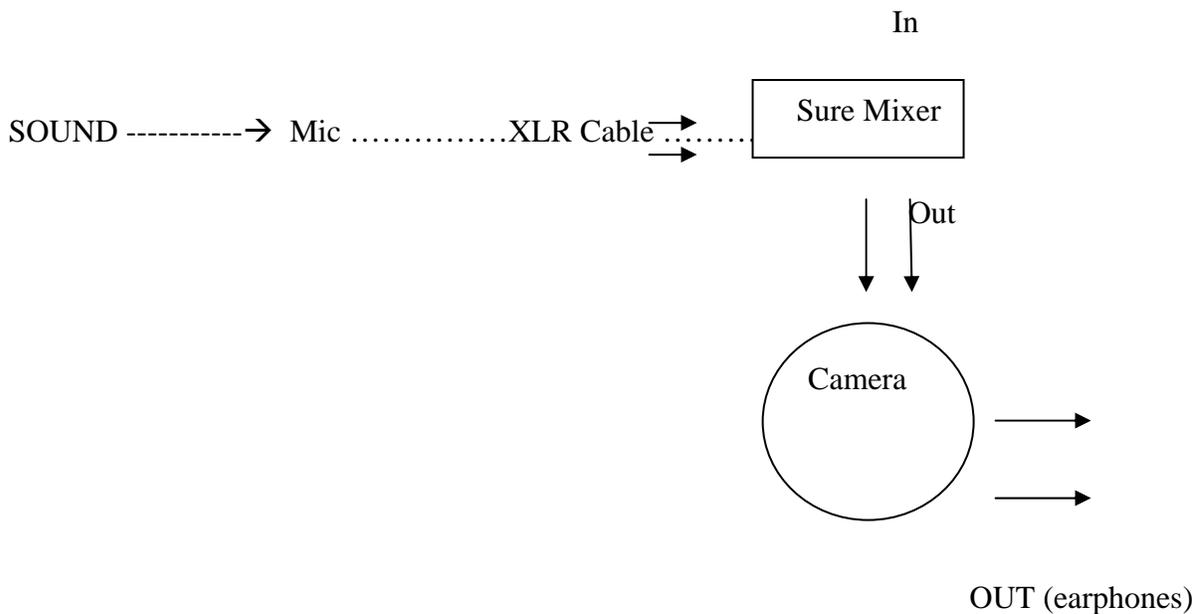
Rifle Mic – best for situations when need direct sound with little background noise. Best to direct towards throat from 1.5 metres, below sound source. Can also use cover to decrease wind noise and echo. Must not be in shot. Attaches with yellow cord.

Lapel Mic: good for interview sound. Must not be in shot.

Radio Mics: uses wireless transmitter. Must both be set to same frequency to receive sound signal. Attach transmitter to mixer pack for easy use. Must be within line-of-site for use from a distance. Don't put mics in shot, especially for stand-uppers.

Audio-pathways:

Follow from Left to Right :



Lighting Workshop (4 April)

1. Pack shot }
2. Standard 3 point I/V } 3 Red Heads
3. Night/moonlight }
4. Ambient lighting exercise

- Pack shot has no shadows, can see all features of face. A 'real' shot/ is pleasing, doesn't call attention to itself. Nb: reflected light; soft box/white umbrella – diffuses the light rays.
- Standard 3 point – will use most this year for interviews, etc. Is not highly dramatic or cinematic.

- Moonlight – different colour balance. Is very moody and dramatic. Use a blue gel for effect.
- Ambient lighting: Use key light from one side to achieve depth.
- Tungsten Lighting – a bit yellow. Use wax paper (scrim).

3rd term Tech week

Focus on:

- Camera cables
- Depth of field
- Camera menu functions
- Signal processing
- Sound mixing – sure; multi-mikes; audio sweetening; final mixing
- Script writing
- Camera movements
- Difficult lighting situations
- Formats/compressions
- Iris and shutter
- Colour correction
- Sequences

Camera Cables

Kettle plug – also comes in mini

3 prong 15amp (2 prong = 13amp)

(all our lights must take 15amp)

BNC, co-axle cable:

Round ended plug, metal prong in centre, has plastic sheath around cable.

Is expensive \$\$\$

For monitors, VHS, anything that carries high quality video signals.

Female plugs carry the signal (plug into male piece).

*if have very long cable, distribution amplifier (DA) will push up the signal to compensate for loss of signal strength.

RCA cable, co-axle (not professional)

Has greater resistance than BNC

Carries both video and audio

Yellow for video, White and Red are for different audio channels

Firewire:

Used by most cameras. Comes in 4 to 4, 4 to 6 and 6 to 6 variations.

Also known as 1394 protocol, developed by Apple.

Carries video and audio signals simultaneously.

Composite Cable: analogue. Has highest signal to noise ratio. Subject to interference. Takes video signal. Is not so good.

Component: has different components within it. Splits signal into R (red), G (green), and B (blue), and white/grey. Gives less noise, therefore is better.

SVideo cable: better than composite, but not as good as component. Much cleaner, less chroma noise, less interference. Can use for monitoring or dubbing. Video Only.

9 pin remote cable (RSS control cable protocol):

Only carries control information.

Can carry digital or analogue

XLR cable/ Canon XLR cable

Can take stereo

Common, left and right channels

For audio only

(isn't so good).

Jack (also in mini, or mini-mini)

Black ring indicates stereo, mono doesn't have any ring.

Network Cable – has phone connection a end. Used for phone and internet connections.

DEPTH OF FIELD

(get definition)

3 ways to manipulate DOF:

1. Iris
2. Focal Length (zooming)
3. Camera to object distance

Iris (aperture)

- mechanical
- controls amount of light coming in
- usual optimal shooting value between 4 and 8 fstop value
- smaller the fstop opening, the wider the iris is open.
- Wide iris = shallow depth of field
- Small iris = great depth of field

Focal Length

- changing focal length ie; ZOOMING
- long focal length = shallow DOF (more creative)
- short focal length = great DOF

Camera to object distance

- changing the distance between the object and the camera with change the amount of space between the two, therefore changing the depth of field.

CAMERA MOVEMENT

Composition problems: need consistency of approach. Need to synchronise our movement with our focussing

Extreme Close-up: must have more space between bottom and mouth than between top and eye – fills negative space with the subjects personality.

Medium Shot: must have minimal headspace. Have more lower frame space than head space.

When panning – always leave 5 seconds of still shot before starting; start slow and then speed up. PRACTISE!!!!

*use beanbags to absorb shocks when filming in bumpy situations!!!

XL1 and Audio

Pulse Code modulation:

- digital audio recording
- sound recorded as 0 and 1 (like computer code), after it is converted in pulse codes
- ie: series of on/off signals
- sound track is optional

2 basic properties of sound waves:

- Frequency (low = bas, high = treble)
- amplitude (soft – loud)

Frequency and Amplitude together make up the Sine wave

- More cycles per second = higher frequency
- human ear can hear from 20 cycles per second
- distance between peaks of waves = wavelength

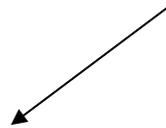
XL1 and sound recording:

SOUND -----> camera picks up sound -----> outputs analogue signal



Signal converted to digital

In playback, sampling points are recreated
and audio is processed by a digital
to analogue converter



Amount of detail in audio recording depends on the number of samples per second, and the number of "bits" per sample (which control noise and distortion)

Therefore good quality sound = high sample rate + high bit per sample

Sound waves are made up of a complex combination of sine waves

Only need to record 2 points per cycle of such a wave's highest frequency to be able to reconstruct the wave in playback

*sample frequency = number of times the signal is measured per second

- because digital systems use finite means to record infinite signal variations, some mismatch is inevitable, therefore this mismatch adds noise and distortion

can gauge a digital system's dynamic range by multiplying its bits by 6

when you copy a signal, you degrade it, therefore because XL1 records digital, there is no degradation

As samples are read off the recording, they're fed into a buffer circuit which smooths out speed variations and therefore reduces wow and fluttering

The A/D Converter

- measures/samples strength of changing voltage @ regular intervals, therefore generating a steady stream of numbers
- the higher the sample rate, the more accurate the resulting data is. Higher sample rates make for increased treble response, and 'hi-fi' sound
- bit depth refers to how many bits the converter uses for each measurement of the signal. More bits = better signal

16bit stereo sound (48kHz, 2 channel) = highest quality

12bit stereo (32kHz, 2 channel) = records on 2 of 4 channels, (stereo 1 and stereo 2), divides audio track into layers, so can add other sound later.

12bit stereo (32kHz, 4channels) = simultaneous recording on stereo 1 and stereo 2; sound quality is lower; can use up to 3 mics at same time on different channels.

Balanced XLR microphones contain a noise-cancelling cable that reduces unwanted interference

XLR records sound in unlocked audio – allows for some variation in number of samples per frame.

Using the audio monitor is only useful when recording in 12 bit stereo sound (stereo 1 and 2)
If recording in 16 bit, then sound is fixed in stereo 1 only.

Audio Mixing with 3 mics and sure mixer.

NB!!!! Check all mics and sure mixer batteries before starting shooting!!!!

Using: Hand held radio mic – for primary sound (Track 1, left side)

Rifle mic – for ambient sound (Track 2, right side)

Lapel mic – for secondary sound (Track 3, right side)

4 different settings to practice in:

1. Bathroom (toilet sound)
 2. Outside (bird sound)
 3. Busy place (people sound)
 4. Quiet place
- Also, turn off base cut (on sure mixer).

Check levels on sure mixer to make sure it's not distorting (head phones can be deceiving!!!)

Problems we encountered:

- dying batteries half way through shoot (therefore sound died)
- rifle mic plugged into left side, not right as originally thought, therefore rifle mic was primary sound and not hand held radio mic.

NB:

- You can view and play only one channel at a time in the Source Monitor when editing.
- The XL1 has built-in VU meters and you can select which audio inputs are displayed on the VU meters. However, VU meters alone don't cut it. It's always advisable to monitor your audio with headphones, so you can listen for any audio noise problems. The XL1 will allow you to monitor Stereo 1, Stereo 2, or all four channels together with headphones.

Getting to grips with Codecs:

for preparation of high quality compressed videos. Uncompressed video files are too large and the data rates are too high to transport effectively over a local area network or the Internet, so you need to compress them.

Bitstream type

**Data rate (KiloBits Per
seConD)**

**Time on one 700mB
CD-rom**

Uncompressed high definition (1920 x 1080 29.97 fps)	745750	7.5 seconds
Uncompressed standard definition (720 x 486 29.97 fps)	167794	33 seconds
DV25 (miniDV, DVCAM, DVCPRO)	25000	3 min, 44 seconds
Typical DVD	5000	18 min, 40 seconds
VideoCD	1167	80 minutes
Broadband web video	100-2000	3 hours, 8 minutes at 500 Kbps
Modem web video	18-48	48 hours, 37 minutes at 32 Kbps

Data rates and storage requirements for different DV media types

Type of video (format) and compression type are two different things: one video format may support multiple compression types and ratios, and a type of compression may be used in multiple formats. However, most standard video formats include requirements that specify compression types and data rates.

Different Video formats: DVD-Video

CD-Video

CD-Rom

Internet Format

Mobile Devices (relatively new)

Compression tools and formats hide the mathematical complexity of compression from the user, but to achieve the best results, you need to understand the fundamentals of why and how compression tools and formats operate. Compression technologies take advantage of the strengths and weaknesses of human senses by reducing data that isn't likely to be perceived.

How compression works

Fundamentally, compression works by summarizing a sequence of images and sounds as efficiently as possible. Video that has been compressed doesn't provide an identical representation of the source file back to the user—the data rates would be far too high. Instead, the encoded files describe the important details of the content as tersely as possible while still providing a reproduction that, to the human sensory system, provides the experience of the original as accurately

A codec = a matched pair of compressor and decompressor; this performs the compression. A compressor is part of the encoding process, reducing the amount of data required to store the video. A decompressor works on the receiving end, decoding the compressed data so that it can be presented to the viewer. It's important that the pair be matched because the decoder (decompressor) needs to understand the encoder's (compressor's) summary of the data.

Types of compression

Video codecs can use spatial compression, temporal compression, or a combination of both.

Spatial compression

Spatial compression, also called intraframe compression, affects only a single frame at a time. Most compressors only use spatial compression, so there aren't any interdependencies among frames. This type of compression makes random access to any point in the video and editing easy.

These codecs deal very well with smooth gradations in an image, but they may not be as successful at encoding random details or sharp edges at lower bit rates. Any compression technique that encodes images at too low a data rate, can cause visible degradation of the image. This degradation results in visible flaws called artifacts. Two of the most common kinds of artifacts are ringing (in which a sharply defined edge may have a halo or smudge) and blocking (in which a smooth edge can become blocky in appearance). One common area of trouble is small text with sharp edges. Some codecs use very different base technologies, like wavelet, and therefore deal better with sharp edges.

Temporal compression

Temporal compression, also called interframe compression, adds the ability to use other frames as a reference for the current frame. In video, each frame tends to be similar to the

frame preceding it. Temporal compression encodes only the changes from one frame to another (with the exception of key frames, as described below, which contain a complete representation of the data in a frame, without reference to previous frames).

Frame types and compression

A keyframe, or I-frame, is a complete image that is compressed using intraframe compression. An I-frame isn't based on any other frames in the film. The first frame of a movie is always an I-frame.

A delta frame is compressed using interframe compression and contains only those portions of the adjacent frames that are different. If two frames are mathematically identical, and the second one is a delta frame, it will require only a few bits to encode.

There are two main types of delta frames: P-frames and B-frames. The content of a P-frame (predictive frame) is based on the previous frame; the content of a B-frame (bi-directional frame) is based on the previous and subsequent frames.

Audio compression

While audio may use only a small fraction of the bits in a compressed file, it is responsible for half of the experience.

Sampling rate

The most fundamental factor in audio is sampling rate, which is measured in Hertz (Hz), or cycles per second. Audio CDs use 44100 Hz, or 44.1 kilohertz (KHz), which provides excellent reproduction.

sample	Used	sufficient For
8 KHz	Phone system	Speech

11 KHz	Old multimedia standard	Better speech
22.050 KHz	Also old multimedia standard	Recognizable music
32 KHz	Common in broadband video	Minimum for decent music
44.1 KHz	Audio CD	Music
48 KHz	DVD, DAT	Music
96 KHz	High-end audio recording	Music mastering

Perceptual audio compression

Reducing the sample rate and number of channels can reduce the data rate; however, good compression must go well beyond that. Most modern codecs use perceptual encoding techniques: that is, an internal model of the human auditory system determines the important parts of an audio source and spends the available bits on those parts. At low data rates, the audio can still sound quite altered from the source. The number of bits required for “good enough” quality has been dropping precipitously in recent years.

During production, there are techniques you can use to produce video that compresses well:

Interlaced versus progressive scan

Camera motion

Shutter speed

Backgrounds

Depth of field

Capturing video: choosing formats and connections

Capturing video is how content gets from an external source like a VTR or camcorder into the computer. The type of video, or format, and to a lesser extent the connection type you select to capture content, can dramatically affect the quality of the video on the computer. It’s always desirable to start with the highest possible quality video and audio signal. In almost every case, compression doesn’t make video look better than the original source. The higher the quality of the source material used, the higher the quality of the final compression results. The

inverse is also true, so it is helpful to build a basic understanding of the video and audio formats available and how they compare in quality.

To understand the video formats, you must understand the video signal components. In the beginning of video, we dealt only with brightness, or luminance (luma) signals. The variations from very low brightness all the way to complete brightness gave us black-and-white television. Color was added by generating two channels of color, or chrominance (chroma) values for the signal. To accommodate the millions of black-and-white television sets still in use, a method for adding color was invented that allowed a black-and-white set to ignore the colors and still show the luminance, or black-and-white, picture. Since broadcast television is transmitted over antennas, the luminance and two color channels are sent together as a single signal. The various video formats used today were created using this technology.

Choosing the right capture codec

When you capture content, you must choose an appropriate codec. The choice depends on the capture hardware you're using, the format from which you're capturing, and your storage requirements. There are three basic types of codecs to choose from: DV, Motion JPEG, and uncompressed.

DV codecs

The DV25 format is ideal when capturing from a DV25 deck. Over a FireWire connector, you can use DV25 to copy the native bits from the tape onto a hard disk, making a perfect copy. If you use a different format at a higher data rate, the resulting video will be slightly glossy..

motion Jpeg codecs

Motion JPEG has been the leading format for high-end video-editing systems for some time. Motion JPEG is 4:2:2, and most implementations allow you to specify a data rate or quality level. Some implementations can even create a mathematically lossless Motion JPEG. Typically, data rates of 50 Mbps or greater are considered broadcast quality.

Uncompressed codecs

More and more cards support true 4:2:2 uncompressed video. The data rates are large, and the quality is no better than a lossless compression. One significant advantage of some uncompressed codecs is support for 10-bit-per-channel captures, which can perform better for analog and especially SDI sources. High-end video editing applications, such as After Effects Profes-

sional, are able to process video in more than 8 bits per channel, improving the quality. Some hardware vendors also include support for 10-bpc rendering in Adobe Premiere Pro. Because uncompressed codecs have such high data rates, you should use a fast drive system, such as a RAID (redundant array of independent disks) system.

Note: Don't confuse uncompressed 4:2:2 with uncompressed RGB codecs, often called None.

Understanding preprocessing

Preprocessing is the middle step of video compression and involves transforming the decoded frame of the source video into the optimized frame given to the codec. The goal of preprocessing is to transform the video into the final format.

Deinterlacing video

The most basic and critical form of preprocessing for the web is deinterlacing. Most video is produced and edited as interlaced (although, an increasing amount is done as progressive scan). But almost all web video is encoded as progressive scan. If the source frame of video is left with interlaced lines intact, the output shows the stacked lines. The lines look bad, but worse, those lines have sharp edges and are difficult to encode. So, at the same bit rate, deinterlaced video shows fewer artifacts than interlaced video.

Encoding

If preprocessing is the art of compression, encoding is its science. Encoding means defining the correct parameters, such as data rate, frame size, and frame rate, to get optimum results for the project. Balancing these parameters can be difficult because there are many trade-offs. As always, it's most important to understand the goals that the compressed video is meant to achieve.

Choosing a data rate mode

Different codecs and formats can provide different data rate modes. Some codecs support only one data rate mode, others provide a number of options. In most cases, there is a single optimal mode for a particular use.

Data rate modes include:

- **Average limited** is the most common type of data rate limitation. In this mode, you specify the average data rate, and the codec tries to make sure that the file ends up at the

requested average. The codec varies the rate up or down to match the changing difficulty of the video.

- **Peak limited** encoding is generally meant for hardware devices or high-data-rate content where the speed of the decoder (CPU, memory, or disk) is the limiting factor. Specifying a particular peak-limited data rate doesn't mean the peak of the file will actually be at the requested bit rate. Instead, the peak-limited data rate is the maximum rate supported by the decoder, but the encoder is free to use a lower rate if appropriate for the content.
- **Buffer limited** encoding is the method of choice for real-time streaming. In buffer-limited encoding, the average data rate isn't applied to the overall file, but it is applied to any given section of video. So, when video is encoded with a three-second buffer, any arbitrary three-second chunk of the file has a data rate at or below the target data rate. Most streaming encoded files use both average-limited and buffer-limited encoding. Buffer-limited encoding is often called constant bit rate or CBR.
- **Quality limited** encoding is different from the other methods because it doesn't specify a data rate. Instead, it specifies a quality target, and each frame uses as many or as few bits needed to reach that quality target. This mode isn't compatible with real-time streaming. However, it can work very well for archiving content or for downloading mission-critical video where quality is more important than the file size or download time. For example, a stock video company may use quality-limited encoded files for short web samples to make sure that the content looks as good as possible and does not waste bits on unnecessarily high data rates that would make the content easy to encode.

Choosing between encoding speed and quality

Many codecs offer a control that specifies a trade-off between encoding time and quality. The faster modes typically perform much less exhaustive motion estimation. Generally, big speed changes cause much smaller quality gains—an eight-times slower encoding process might only have 20% better compression efficiency. The correct trade-off between speed and quality varies

depending on the project. For DVD projects, titles under an hour won't gain much by slower, higher-quality encoding because the data rate is so high. Web-distributed content almost always benefits from the slower, high-quality encoded files, because bandwidth is so often the limiting factor for web video.

Setting frame size

Frame size (also called resolution) is the height and width of the final video frame, measured in pixels. The data rate changes in proportion to the area of the frame (height times width). Thus, converting from 320 x 240 to 640 x 480 would require about four times the data rate, but converting to 192 x 144, you could reduce the data rate down to one-third. The effect isn't quite as strong as the math would suggest; because there are fewer pixels, pixel quality becomes more important.

Most codecs and formats require the height and width of a video to be divisible by two and give best compression efficiency when height and width are divisible by 16.

It's important to figure out the target aspect ratio first, and then make sure that the frame size you choose gives the correct aspect ratio given the picture shape in which the content is delivered.

4:3	16:9
160 x 112	208 x 120
192 x 144	256 x 144
256 x 192	336 x 192
320 x 240	432 x 240
384 x 288	512 x 288
512 x 384	688 x 384
640 x 480	848 x 480

Suggested frame sizes for 4:3 and 16:9 aspect ratios when working with square pixels.

Adjusting the frame rate

Frame rate is the number of frames per second at which the video runs. Higher frame rates appear smoother, and lower frame rates appear choppy. Anything below 20 fps doesn't appear smooth, and below 10 fps, the video looks more like a filmstrip than moving video. You should try to use the source frame rate if possible, and no less than half the source frame rate, unless you target real-time streaming to dial-up modem users. Raising frame rates generally pays off more than raising frame sizes in improving the user experience.

The output number of frames per second must be an integer divisor of the number of source frames per second. Therefore, the output can be one-half or one-third the source but not three-fifths. Good frame rates for each type of source appear in the table below.

Film	PAL	NTSC
59.94	23.976/24	50
29.97	12	25
15	8	12.5
10	6	8.67
7.5	N/A	6.25
6	N/A	5
5	N/A	N/A

It's important to use frame rates that are evenly divisible by the source frame rate.

Negotiating frame dropping

Some codecs optionally or automatically reduce frame rate in order to maintain the quality of difficult frames and keep within the target average data rate. This process generally takes the form of a control that sets the minimum image quality per frame. If the bits that the codec would normally allocate to a given frame aren't sufficient to hit the target quality, it raises the data rate for the frame to the minimum required for quality; then drops one or more frames that follow to keep the average data rate on target.

Whether this process is appropriate depends on the content. For entertainment content, such as movies and especially music videos, having the video smoothly in sync with the audio is important, so frame dropping is not recommended. Conversely, presentation video, especially with a whiteboard in the background, might be better with many frames dropped in order for on-screen text to remain legible.

How keyframes use 1-pass and 2-pass algorithms

Historically, most codecs worked in a single pass—they read the source file and wrote the compressed data frame-by-frame. The process worked, but required the data rate mechanism to anticipate the makeup of the future content. In a 2-pass algorithm, the codec first analyzes the video and builds a table of the relative encoding difficulty in each frame. It then calculates the actual bits per frame needed to achieve the highest possible average quality and applies these bits in the second pass. The net effect is the same as a quality-limited encode in which the correct quality value reaches the target data rate.

A benefit of 2-pass encoded files is consistent quality—the parts that are easier and the parts that are more difficult to encode match more closely. This consistency creates a better user experience than a video in which some scenes look great and others look terrible.

Delivery methods for video

The method you use to compress content depends greatly on how you plan to deliver it. It's useful to understand the different environments in which people use video and the trade-offs each environment entails.

Disc-based delivery works well, and the available data rates are radically higher than those for web video. Even an 8x IDE CD-ROM can provide a sustained data rate of 8000 Kbps! The largest CD-ROM discs today are 800MB. DVD provides vastly more room: DVD-5 discs hold 4.7GB and DVD-9 discs hold up to 8.4GB.

Downloadable files

The most basic type of video on the web is a simple, downloadable file. The file is downloaded to the user's hard disk like any other file.

Progressive download files

During progressive download, a file is transmitted through standard web protocols such as FTP (File Transfer Protocol) or HTTP (HyperText Transfer Protocol), but users can view the part that has already been transmitted while the remainder is still downloading. This format allows the clip to finish downloading while it is playing. However, in some cases, the video playback catches up with the downloaded data, causing the playback to pause momentarily...ie like YouTube(?).

Real-time streaming

The next level of web video is real-time streaming. This type of transmission offers the traditional experience of seeing the video after only a few seconds of buffering, but it risks image glitches, poor quality, and limiting the data rate to the bandwidth available to the client at the time of viewing.

A common question is when to use real-time streaming and when to use progressive download. There are cases where the choice is obvious, and other cases where the choice is not

so obvious. A good rule to consider is duration—clips under three minutes are often better as progressive, and clips over three minutes are often better as streaming.

Choosing a compression format

- **Features** Often the biggest determining factor of a platform is the features that users need.

If a format can't meet the project requirements, it's obviously not an option. In every project, different features vary in their degree of importance. Compression efficiency is almost always critical. Real-time streaming scalability is another major feature.

User base Depending on the project and audience, user base may be very important. With most advertising content, users are unlikely to download a new player or codec just to watch a marketing clip. But for compelling content, users may consider making sacrifices. For example, Apple logged several million downloads of QuickTime in the 72 hours after a very popular movie trailer was released.

Platforms

Some formats are only available on a single platform or have different features depending on the type, or the version, of the operating system. Most of the modern media players are available for at least Mac OS® and Windows; some are available on Linux® and other operating systems. If you require very broad compatibility, an older standards-based format, like MPEG-1, might be appropriate.

See Manual for detailed descriptions of the various types of video and audio codecs that we will come across.

