

Camera

The Canon XL1 3CCD Digital Video Camcorder

The Canon XL1 camera was the most advanced camera when it was released in the early 1990s. Since then it has been overtaken by other cameras but still performs well because of its various modes. The beauty of this camera is the ease with which variables can be manipulated. Cameras before the XL1 did not allow this level of manipulation of functionality and as such this camera is extremely useful for the television journalist.

How it works

- *Basically the Canon camcorder records in a string of alternating lines. This refers to its resolutions which is 530 horizontal lines*

Features

The beauty of the Canon is its interchangeable lens system: this means that you can change from a normal lens, to a wide angle lens, or even to a lens from a normal camera. By so doing you can choose the lens which best suits your situation. The wide angle lens is best used for establishing shots while the normal lens will be used most of the time.

- *The Canon XL1 has a Super Range Optical Image Stabiliser which is an advancement on previous stabilisers. This can be done by sliding the small switch on the left of the camera and is useful for shots where there may be vibration. It is however useful to turn off the stabiliser when you specifically want a shaky shot (such as in our sequence).*
- *The view-finder is advanced in that you can use either your left or right eye and it is quite open to repositioning. The viewfinder consists just of an eye-piece however, and does not have the handy pull-out screen of the Panasonic. This takes some getting used to but the picture in the eye-piece can be adjusted.*
- *The Canon XL1 has an optical 16X zoom lens which is highly sensitive*

The Canon XL1 has 3 shooting modes:

1. *NORMAL → this is the most commonly used mode and is good for movement*
2. *DIGITAL → this allows you to take still images*

3. *FRAME MOVIE* → this is useful for high-resolution stuff. In this mode the picture is non-interlaced but is very sharp. (This setting is good for big scenes, e.g. a sunset; or if you printing to 35mil)

There are basically five modes, Auto, Manual, VCR Tv and Av of which Tv and Av are new modifications. All of these (barring VCR which is for playback), offer various degrees of manipulation for the user. Depending on the mode you can change certain things on the camera. These settings are all changed by turning the round black dial on the camera

- In the Tv/Av mode certain things are automated, but: in Tv you can select the shutter speed and the camera will automatically set a matching aperture (the aperture has to do with the amount of light coming into the camera; with the Av mode you can select your aperture and the camera will automatically set a matching shutter speed.
- In the Auto mode most things are automated, but you can still control the white balance and your focus
- In the manual mode you are able to manipulate everything

Cool stuff to play with and use:

- *Slow shutter:* There are settings you can use to slow down your shutter speed: this is good for when you have varying degrees of light (such as low-light situations) as it allows you to have better control over the colour and light
- *Flash photography:* you can attach a separate flash for flash photography (but I don't think we have these?)
- *Zebra Pattern:* This highlights contrasts, allowing you to see where there's any over-exposure or bad reflections so you can change them. It is displayed literally with a zebra-stripe pattern.
- *Four-Channel Digital Audio System*
- *There are three digital audio modes and this camcorder can record on all four channels, at the same time! This is a very complicated thing because there are many channels and many things to plug in and is elaborated on in the section on sound*
- *The channels do affect the sound quality though: When it's on two channels, you get 16bit sound which is of a better quality and what you would normally use. When it's on four channels, you get 12 bit sound which is of a lesser quality. It all depends on how many microphones you want to use.*
- *Time Code:* The cool thing about the time code here is that it identifies each individual frame, not just the whole long recording, so it is super useful when it gets down to editing. The XLR uses a drop-frame system which means it's very accurate.
- *Data Code:* But, you can also hide the cool date and time thing and rather display other features such as the shutter speed or exposure settings
- *Wide Screen mode:* here you can switch to the 16:9 ratio for a big-screen effect

- *Sensor: This is for use with the remote control and allows you to control the camera remotely...very useful if you are shooting on your own*
- *Tally lamp: this is a tricky little button which allows you to turn off the red button at the front of the camera that shows its recording so that whoever you're filming cannot see it. This can be used to your advantage*
- *The Mic attenuator (Mic Att on the camera) is used to either pump up or down certain sounds depending on what you want to come out. This is called 'pumping'. It's very good for doing a standupper or reporting from loud areas, such as warzones*
- *In record mode there's also long play and short play options. Basically what this does is allow you to lengthen your tape. This decision must always be made at the beginning of a shoot though because if you switch halfway through your tape will be useless. Short play is the normal mode and gives you the best quality. It isn't advisable to use long play but in situations where you may only have one tape the long play setting can increase your tape capacity by one-third. This does however lower the resolution.*
- *A/F = Auto Focus: if you're in manual this will auto focus for you.*
- *N/D Filter = Neutral Density Filter: this automatically chops down how much light the iris accepts through the lens; it decides itself when it needs to be used (the sun light will flash to tell you).*
- *Spotlight: This is useful for shooting in situations where you are shooting a spotlight. By using this you can shoot whatever is under the spotlight and this will smooth out the potential over-contrast.*
- *Picture Search: This is a useful little tool to check out your last shots*
- *Audio Monitor Switch: This allows a readout on the VU reader which tells you if you're over-modulating, etc.*
- *W/B is supposed to override the Auto setting*
- *White balance: this allows you to set the whites in your recording. There are three settings which can be changed with a round dial which you push in to select.*
- *On the left is the lightbulb switchy which is really useful for indoor light*
- *Then there's the sunlight switch which is useful outdoors*
- *The last switch is negotiable*

Tips & Terminology

- *The line-in has a high resistance and a high impedance*

Rifles

- *A good distance to hold the rifle mic from one's subject is no more than 1.5m*

Shure Mixer

- *The round dials on the mixer are called pots, which is an abbreviation of potentiometers*

General

- *CCD = Charge Couple Device: this is temporary info storage in the camera*
- *The higher the shutter speed, the less light that comes through*
- *The greater the shutter speed, the more distinct the frames are for playback. Manipulating the shutter is useful for manipulating the depth of field. (Depth of field used properly marks the difference between amateur videomakers and professionals).*
- *dB = the ratio of units of noise, which is measured in Dbs.*
 - *By using this you can make your scene lighter/darker than the limit; this is useful at night, like pumping it up to 12dB to lighten the scene (but it's noisy because it's manufactured).*
 - *Useful tip: use stockings behind the lens to help lighten (stretch them out across it). Use varying colours for varying effects.*

DEPTH OF FIELD

Manipulating depth of field can lend complexity to a shot and can often change the mood or connotation of the shot. It is therefore a useful tool to use but can be difficult to get right. When you do get it right however, it lends the piece a certain edge.

Basically a great Depth of Field (DOF) means a greater area of focal possibilities.

There are three ways to manipulate DOF:

1. Iris

This manipulates the amount of light coming in and there is a direct relationship between how much light is let in and the depth of field achieved.

Essentially the lower the f-stop number on the iris control, the more open the iris and the higher the f-stop number, the less open the iris is.

→ a lower number then lets in more light while a higher number lets in less light.

→ In terms of DOF:

As you go higher, you maintain DOF.

- Smaller numbers allow more things to be in focus

- Higher numbers allow greater DOF, meaning the main object is in focus and the others aren't.

Summary:

→ Wide Iris = Shallow DOF

→ Small Iris = Greater DOF

Tip: Be careful of playing with the iris in daylight; you can't push up the iris too much when there's natural light otherwise you'll just get burnout.

2. Focal Length (Zoom)

This refers to how far you are zoomed in relation to the optical centre of the camera.

More zoom makes for increased focal length. Less zoom makes for decreased focal length.

→ In terms of DOF:

- Long Focal Length = Shallow DOF

(this generally allows you to give a more creative effect visually and can be used to obtain certain dramatic effects)

- Short Focal Length = Great DOF

(Here everything is in the same focal plain so everything's clear)

During a shoot you'd make decisions according to what's important in the shot. In other words, your choice in depth of field would be determined by your outcomes for the shot. The cinematographer/director needs to ask what the shot is being composed for; what purpose it is to serve; what message it is to get across. Various connotations can be achieved by manipulating depth of field in this way.

3. Camera to Object Distance

In terms of DOF:

- *The closer the camera is to the object, the more shallow the DOF.*
- *The further away the camera is from the object, the greater the DOF.*

ASIDE

SHUTTER

Be careful when using the shutter to manipulate your picture!

What it's for:

- *To get the maximum amount of light coming through in difficult lighting situations. Essentially playing with the shutter is a manipulation of the frame rate.*

How it works:

- *The higher the shutter speed, the choppier the image, and the lower the shutter speed the smoother the image.*

→ in both of these scenarios having the shutter speed too high or too low can result in a strange picture.

For example, too high a shutter speed can give a jumpy picture, while too low a shutter speed can create a smear effect (not unlike the feathered edge effect in post).

FOCUS

Tips:

- *Auto-focus setting → this takes the mid-point as the point of focus.*

So if you want to focus on a specific thing, make sure it's dead centre, push AF, and that'll be your focus. This focus should stay once you've moved the camera.

- *Manual Focus* → Turn the ring anti-clockwise for closer objects and clockwise for objects that are further away.

COMPOSITION

FRAMING

It is very important to adhere to framings in a piece. Consistency between framings is crucial. In other words, keep your close-ups, mediums and wides, etc. the same throughout your piece.

1. Extreme Close-Up

- *In this shot the subject fills the frame*

- *Convention holds that the distance between the mouth and the bottom of the frame be greater than the distance between the eyes and the top of the frame (i.e. more chin than brow should show).*

- *This type of look creates connotations of a large personality, and lends an intensity to the picture.*

- *Overall an atmosphere of power is created.*

- *If this shot were to be reversed with the forehead being more prominent, the opposite effect would be achieved.*

2. Medium

- *In this shot there's more space at the bottom than at the top of the frame*

- *This type of shot generally validates the subject more*

- *If this shot was reversed with less space at the bottom and more at the top, then the opposite effect would be achieved: the subject would look weaker and more subservient.*

- *Be careful to make sure there is some headroom in these shots though*

MOVEMENT

- *When moving within a shot it's a good idea to start slow, speed up, and end slow*

→ *this allows you to accommodate for any changes that may occur. It is also important to speed up your shot over any boring bits and rather keep it slower during interesting bits. Make sure you go slow enough to keep the interesting bits in so as to cover the boring bits, then zip past the boring bits and go slow on the interesting bits.*

- *This applies to all movements, such as pans*

- In every camera movement the shot should be broken up into three shots

→ this provides your editor with shots to work with (still-move-still).

Tip:

Cover up any zooms you may need to do with pans. A good cameraman will practice until the zoom is virtually imperceptible underneath the pan.

Hardware

CABLES

There are oodles of different types of cables which we'll utilise in the industry. They can be loosely divided into three main categories: video, audio, and control according to what type of information they carry. Essentially cables carry signals via a medium from one point to another and therefore can further be divided in terms of which type of signal they carry: i.e. analogue or digital.

VIDEO	AUDIO	CONTROL
		<p><i>Kettle Plugs</i></p> <p><i>These can be either mini or full size</i></p> <p><i>- Identification: These are your standard kettle-looking cables, so called because that's what they were originally used for.</i></p> <p><i>- Usage: Kettle plugs are control cables which carry the power to control specific devices</i></p>
<p><i>BNC Cable</i></p> <p><i>- Identification: This is the cable with the round head; the metal prong in the centre; plastic around that; and metal round that</i></p> <p><i>- Usage: This is a video cable only.</i></p> <p><i>This is the cable that would go into monitors, video machines, basically anything that carries a high quality video output</i></p>		

<p>- Features: not subject to a lot of interference.</p> <p>The male point is attached to the device and the females connect these</p> <p>- Extra: * see bottom</p> <p>[analogue]</p>		
<p>RCA</p> <p>- Identification: this is the black cable with the red jack- looking end (like the ones used for DVD players)</p> <p>- Usage: Carries video and audio signals</p> <p>- Features: This is not a professional cable and offers more resistance than BNC cables</p> <p>[analogue]</p>		
<p>Firewire 1394</p> <p>- Identification: The cord with the computer-fitting bit on one end and the USB cord looking bit on the other.</p> <p>There are three types of Firewire cables, namely 4to 6; 4 to 4; and 6 to 6 (these numbers refer to the size of the end bits) [we use 4 to 6 aka small to big]</p> <p>There are two speeds, namely 400 and 800. We use 400; 800 is for more modern machines or Macs and this is the same speed as a USB 2 port.</p> <p>- Usage: For video and audio use</p> <p>- Features: Originally developed by Apple Mac and uses their encoding.</p> <p>[digital]</p>		
<p>Component</p> <p>3 streams: R, G & B</p>		
<p>S Video or SVHS cable or Y/C cable</p> <p>Features: This offers a cleaner signal</p>		
		<p>9-pin remote aka RSS</p> <p>Usage: Digital or analogue</p>

		<i>control info</i>
	<p><i>XLR</i></p> <ul style="list-style-type: none"> - <i>Identification: This is the male to female cable, which has three prongs on one side and three holes on the other.</i> - <i>Usage: It operates on three channels, which are common, left and right.</i> - <i>Features: Therefore, this cable can take stereo.</i> 	
	<p><i>Jack</i></p> <ul style="list-style-type: none"> - <i>Identification: This is a jack and has the jack-looking silver prong attached to a cable.</i> - <i>Usage: The females are plugs and receptacles for male jacks, connecting and creating a pathway.</i> - <i>Features: A black ring around the base of the silver point indicates a stereo jack.</i> 	

** Additional info about the BNC cable: an extra piece of hardware can be used with this cable to split the signal. This is known as the BNC T-piece. It is a T-shaped device that you plug into the end of the BNC cable and it takes the video signal and sends it to more than one device (useful if you want to broadcast on multiple monitors).*

The only drawback with this tool is that it increases the resistance thus making the signal weaker and the quality subsequently lower.

In order to fix this lost signal however, there is a tool known as a Distribution Amplifier (DA), which improves the signal. This can also be used over long distances.

Video Paths

There are various video pathways which determine the quality of the signal. Generally the better the cable that is used, the better the picture will be. So if a bad cable is used there'll be more crawl and noise, whereas a more advanced cable can help to produce a cleaner picture.

1. Composite → Analogue

This is just video and produces pretty crappy, noisy, slow picture.

2. Component → Analogue

More advanced and produces a better, more professional picture

3. Remote Cable → Control cable

Audio Paths

There are various audio pathways which determine the sound:

1. XLR

- Identification: This is the male to female cable, which has three prongs on one side and three holes on the other.

- Usage: It operates on three channels, which are common, left and right.

- Features: Therefore, this cable can take stereo.

2. Jack (also get mini-jack and mini-mini-jack)

- Identification: This is a jack and has the jack-looking silver prong attached to a cable.

- Usage: The females are plugs and receptacles for male jacks, connecting and creating a pathway.

- Features: A black ring around the base of the silver point indicates a stereo jack.

General

** Plugs → Plugs are referred to mainly in two ways:*

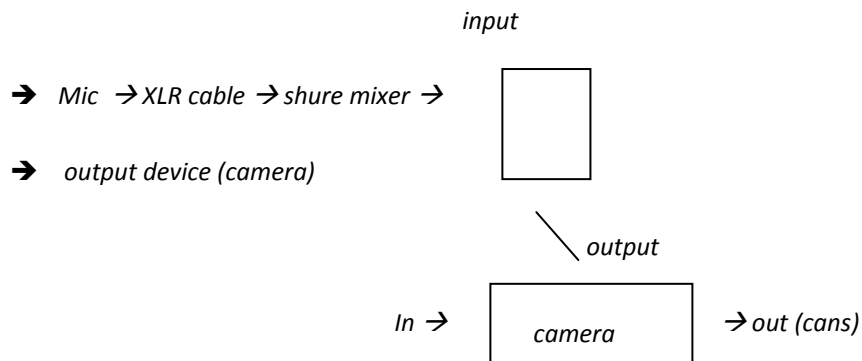
1. 3-prong 15 amp plug – goes to a 15 amp circuit breaker

2. 2-prong 13 amp plug – goes to a 13 amp circuit breaker

** Adapters → These can be used to change the plug sex.*

SOUND

The audio pathway between the camera and its various input/output devices is as follows:



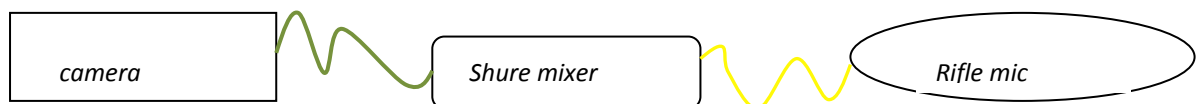
There are four different types of mic which we will use:

1. Stereo mic (this is the mic fitted to the front of the camera)
2. Rifle mic
3. Lapel
4. Sennheiser hand-held mic

Rifle Mic

A rifle mic is directional and so named because of its shape. A rifle mic is best used in situations where there is background noise and one wants to focus on one specific sound.

To get optimum sound it is good to use the rifle mic in conjunction with the shure mixer, in the following way:



A green cable runs between the camera and the shure mixer and a yellow cable runs between the mixer and the rifle mic.

The headphones then plug into the headphone jack of the shure mixer (use the big jack and not the small one as it is more reliable)

When using the rifle mic it is advised not to stand more than 1.5m away from the subject

The Shure Mixer

Basically the shure mixer serves as an interface between the camera and whatever mic you choose to use. Its purpose is to regulate the levels so as to ensure that you attain the best possible sound.

Before using the shure mixer one should callabrate the tones to ensure that the sound levels are all in synch. This makes sure that the recording levels on the mixer are callabrated with those on the camera, which is essential for getting good sound.

- *For callabration press the tone button on the shure mixer and once you hear the tone, set the master dial to -4.*
- *Switch Audio 1 on the camera to maual in order to change the frequency*
- *Set the level on the camera to -12 (It will be highlighted in a box on the dial)*
- *Switch the tone switch off once it is set*

Making the Mic Stereo

In order to check that the sound is working with bout the input device and the recording there is a black cable with various plugs which can be used. These plug into the devices to check the sound 'return'.

To do this one sets the knob on the mixer

This creates parity – This essentially means there is a double system whereby you check on sound coming into the mixer and being recorded.

XL1 AUDIO GUIDE

Digital Audio Recording

CANON DIGITAL AUDIO RECORDING

Canon's XL1 records in the (relatively) new DV format. This format makes for greatly expanded audio capabilities because of its use of Pulse Code Modulation (PCM).

→ this type of recording differs from analogue recording where sound waves are recorded as changes in the magnetic field on the tape.

→ with digital audio recording, sound is recorded as a 0 or 1, which is then converted to a pulse code. [binary vibe].

SOUND WAVES

- Sound waves = vibrations in the air; 2 properties:

→ The frequency goes from bass (low) to treble (high) and refers to the number of times per second the wave goes through a cycle. The more cycles per second, the higher the frequency

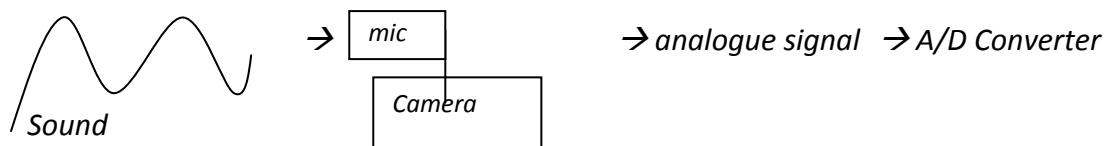
→ The amplitude goes from soft to loud and refers to the swing of the curve. The further the curve swings above or below the centre line, the louder the signal.

[together frequency + amplitude make up the sine wave]

- The average ear processes 20 (20Hz) to 20 000 cycles per second.

→ the wavelength becomes shorter as the frequency rises

HOW THE CAMERA PROCESSES DIGITAL SOUND



The camera picks up an analogue signal and uses an Analogue-to-Digital (A/D) converter.

For playback, the sound is processed through a Digital-to-Analogue (D/A) converter.

QUALITY

- Digital systems measure in steps, but the analogue signals they're measuring are continuous.

→ An analogue system has an infinite range of values which it can record

→ Digital systems can record only a finite number of those values

This means that digital systems have some inevitable mismatch in the recording, and every such mismatch adds noise and distortion to the signal.

- Digital systems use binary code – 1's and 0's.

→ each digit added doubles the number of possible values (i.e. a 1 digit number has 2 values, a 2 digit has 4, a 3 digit has 8, etc.)

→ each time a digit is added the amount of inaccuracy is cut in half

→ 1 digit reduces noise and distortion by 6dB (the digit is multiplied by six to get the dB)

So whatever the bit system is, multiply by 6 to get its range.

e.g. a CD = 16 bit so it's 96dB

DIGITAL FEATURES

- Copying a signal degrades it, but not in digital reproduction

- Digital has no wow or flutter, because the buffer circuit smooths out speed variations.

- A/D converter

→ in this conversion process the quality is affected by 2 variables:

1. Sample rate – the higher the sample rate the better; this gives you that hi-fi sound

2. Bit depth - the more bits the more accurate the measurement

3 Digital audio modes on the XL1

1. 16-bit Stereo (48 kHz, 2 channel)

- highest sound quality

- 16 bit = the amount of data recorded and the range

- Need a sampling rate of 48 kHz, 44.1 kHz or 32 kHz

2. 12-bit Stereo (32 kHz, 2 channels)

- Records on 2 of the 4 channels

- Leaves stereo 2 available for additional sound (music, narration, etc) – post-prod sound

3. 12-bit Stereo (32 kHz, 4 channels)

- Simultaneous recording on 4 channels (1 and 2)
- Can use camera sound and 2 remote mics – all on separate channels
- Post-production selections can be made

XL1 MICS

- MA-100 attachment allows the use of 2 professional XLR mics or 2 wireless mics
- XL1 records sound in 'unlocked audio'
 - completely in sync with video, but sample rate isn't fixed
 - unlocked allows for slight variation in the number of samples per frame
- Audio Monitor
 - only when using 12 bit (Stereo 1 and 2)
 - For sound checks

PROCEDURE

- Audio input – 2 channel recording (Stereo 2) – using mini-jacks

Mic = supplied sound source/ ext mic plugged into mini-jacks

Tip: ATT – Attenuator → useful for loud environments, reduces noise for more natural sound

- Audio 1 Input for 2 channel recording (Stereo 1) – using RCA jacks.

Sound source = VCR, CD.

- Audio Input for 4 channel recording (Stereo 1 and 2, simultaneous)

Using RCA jacks, sound source = mic, external mic, VCR/ CD, line-in devices

Tip:

In difficult sound situations, such as obtaining bathroom sound, it is useful to cut the baselines. These are on the knobs on the shure mixer and you just adjust the dial. This gets rid of the hollow sound and gives a more natural sound.

Lighting

There are three basic shots:

1. Pack Shot

→ This is a perfectly lighted shot, but the lighting is subtle

→ Clear lighting

→ Pleasing to the eye and de-narrativised

→ More neutral colour temperature

Examples include magazine covers

[TIP: White umbrella technique – this scatters the rays of light and is good if you've only got one light]

2. Standard Three-point interview

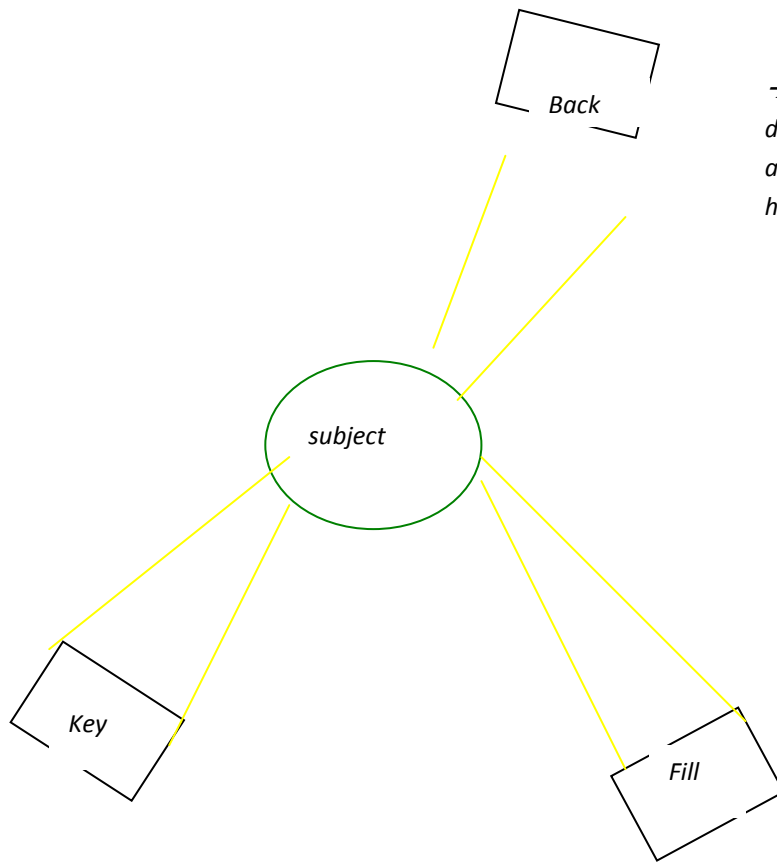
→ Not very stylised

→ Often used for documentaries

→ Good for giving the correct depth and features of subject

→ Uses three points of light as follows

→ the key light is the strongest light and sits at about a 45 degree angle



→ the back light gives depth and this can be altered by angling it higher

3. Night/ Moonlight

- For a more dramatic and moody effect
- This is a more narrational approach
- Requires a different colour balance

Then, for lighting when there is natural light available:

- Ambient lighting

With ambient lighting, one should try to mimic, for example, the standard three point technique using whatever natural light is available. For example one may use light coming in from the window as key, and then lights turned on in the room as the fill and back lights. During our workshop we got some of our best shots using ambient light. If used properly it can be very clean, pleasing to the eye, and make subjects look very attractive.

NEW TERMS

- Blondes: these are extremely powerful lights that you wouldn't commonly take into the field. [Tip: be careful when using them in areas which have a low power supply because they may blow the circuitry with their ridiculous power – not the best option for shooting in a rural school, or the like].
- Redheads: These are less powerful, more versatile lights which you would take into the field.
- Gels: the coloured plastic papers which you put over a light to change its tone
- Scrim: the clear gel paper which you put over a light
- Gobo: a shortening of 'go between' – this is a medium between the light and the subject which reflects the light.

These can be used in creative ways, such as a fan with strips of newspaper stuck to it and blowing to create the effect of rippled light. Or a body of water to create a more dappled effect; in this way one can mimic pools or lakes, or generally create a more interesting shot.

A gobo is used when you need to reflect the light off something else because it isn't giving the desired effect shining directly on the source, or when it's impossible to place the light directly in the path of the source. Sometimes the room may be too small to do this, or an odd shape, or you may be in an awkward place, and so a gobo becomes very useful.

Fresnel lens: *This is a fancy little gadget which forces the light rays (which are naturally inclined to scatter) to be dispersed in a parallel fashion.*

TIPS

- *When lighting black people it is best to use green gels. This gives their skin a very attractive quality (not unlike that on Yizo-Yizo).*
- *When lighting white people (especially the paler ones) we found it useful to try out a yellow gel to make the shot look more natural. This was especially helpful in our night shot (placed on the fill light).*
- *When lighting shots to mimic night time it is useful to use blue gels to give the effect of moonlight. One has to play around to get it right but we ended up using a number of blue gels to create a darker blue colour.*

THE CAMERA

- *When all else fails (lighting and gels) then you should turn to your iris. Adjusting this will help to fix up your shot.*

Compression

Why do we need to compress files in the first place?

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.

Video Compression

Below is a table showing data rates and storage requirements for different DV media types:

BITSTREAM TYPE	DATA RATE	TIME ON 1 700MB CD-ROM
<i>Uncompressed high definition (1920 x 1080 29.97 fps)</i>	<i>745750</i>	<i>7.5 seconds</i>
<i>Uncompressed standard definition (720 x 486 29.97 fps)</i>	<i>167794</i>	<i>33 seconds</i>
<i>DV25 (miniDV, DVCAM, DVCPRO)</i>	<i>25000</i>	<i>3 min, 44 seconds</i>
<i>Typical DVD</i>	<i>5000</i>	<i>18 min, 40 seconds</i>
<i>VideoCD</i>	<i>1167</i>	<i>80 minutes</i>
<i>Broadband web video</i>	<i>100-2000</i>	<i>3 hours, 8 minutes at 500 Kbps</i>
<i>Modem web video</i>	<i>18-48</i>	<i>48 hours, 37 minutes at</i>

		32Kbps
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FEATURES OF COMPRESSION

- The ratios between data rates used for authoring video and for distributing compressed videos can be huge. Essentially compressing a video is taking away from the original video and often only small percentages of the original video data remain.

- In addition, different types of compressed video may vary in bit rate.

- Video format is distinct from compression type: i.e. one video format may support multiple compression types and ratios, and a type of compression may be used in multiple formats. But most standard video formats include requirements that specify compression types and data rates.

DVD FORMATS

- Extremely popular format

- With technological developments DVD capacities are increasing

- A DVD that plays in a DVD player = a DVD-Video

- One that plays in a computer = DVD-ROM (specifically computer-formatted disc)

- Hybrid DVD-Video/DVD-ROM discs allow for both

- DVD-Video discs = mastered in National Television System Committee (NTSC) format or Phase Alternating Line (PAL) format

VideoCD FORMATS

- Older disc-based format

- Lower compression and higher resolution ratio than DVD = lower quality

- Can play in most devices

- Can be either NTSC or PAL

CD-ROM FORMATS

- Not so popular anymore because of the web

- Higher bandwidth than web video

- Capable of DVD quality on fast computers

INTERNET FORMATS

- Less bandwidth so every bit of data has to count

- Web video can use either real-time streaming mode or progressive-download mode

- Real-time requires specialised streaming server software and are limited in quality by the bandwidth available between the server and the end user.

- Progressive-download files load from standard web servers, and may take a long time to download, but may also provide higher and more reliable video and audio quality.

MOBILE DEVICES

- These devices have small screens and slow processors, even compared to a laptop computer, but the ability to play video back on extremely small and lightweight devices can have great value.

- Most compressed video formats can be played on some mobile devices, including Adobe® Flash® Video, MPEG-4, Microsoft® Windows Media, and RealMedia. Dedicated mobile formats, like Kinoma, are also available.

- There are no universal formats or settings for mobile devices. Instead, content has to be optimized for a small class of devices or even a particular model. When the optimization is successful, the results can be great.

The Fundamentals

HUMAN SENSES

- Limitations in our senses of sight and hearing make compression possible

- 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 as possible.

- A matched pair of a compressor and a decompressor, better known as a codec, 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

→ Intraframe

→ Affects only a single frame at a time

→ Makes random access to any point in the video and editing easy

→ Finds redundancy within a frame (eg. similar colours or areas that look like other areas) and encodes these similar areas by reference, rather than by a literal description for each and every pixel

→ Based on Discrete Cosine Transformation (DCT) technique which are good with smooth gradations, but struggle with random details or sharp edges at lower bit rates → can cause visible degradation of the image = artifacts, -- such as ringing (halo or smudge) and blocking (smooth edges become blocky)

Temporal Compression

- *Interframe*
- *Can use other frames as references*
- *A Frame tends to be similar to the frame preceding it*
- *So TC encodes only the changes in one frame to another*
- *With the exception of key frames*

FRAME TYPES AND COMPRESSION

** A keyframe = a complete image compressed using intraframe compression*

- *not based on any other frames...always the first frame*
- *important for random points as they the only frames that can be decoded all by themselves*
- *most authoring codecs, like Motion JPEG and DV use only keyframes – makes editing easier*

** Delta frame = compressed using interframe compression + contains only portions of the adjacent frame that are different*

- *For typical content, a delta frame might be only 10-20% the size of the same frame at the same quality as a keyframe*
- *2 main types: P-frames (predictive – based on previous frame) & B-frames (bi-directional – based on previous and subsequent frames)*

Note:

Codecs vary in how well they encode complex frame transitions. For example, fades up and down are very difficult for some codecs, but some newer codecs have code built in to handle fades.

COLOUR MODES

- *Way codecs describe colour = important*
- *3 basic types of colour in today's codecs:*

1. Monochrome:

- only luminance (brightness) matters.
- works great for black-and-white movies.
- Most video codecs don't have an explicit grayscale mode.

2. Red, Green, Blue (rGB):

- Computer screens and televisions are natively RGB—the screen has red, green, and blue phosphors for CRTs and planes for LCDs.
- Unefficient for video content, so RGB codecs aren't used for broadcast video delivery anymore. However, RGB is widely used for screen recordings and motion graphics.

3. Y'CbCr:

- These codecs encode luminance and two color-difference channels
- Because there are three colors, you can convert Y'CbCr to RGB for display.
- By separating out the chroma and luma channels, you can keep the critical luma information at full resolution and use less resolution for the chroma information.
- Greatly reduces data rate and processing requirements. You can convert RGB to and from Y'CbCr adequately, but there are always some colors that are available in one mode but not the other, and there can be rounding errors as part of the conversion. (By working in tools that support 16-bit-per-channel RGB, like Adobe After Effects® software, you significantly improve the quality of this conversion)

COLOUR DEPTHS

- Define the precision of the colors and determine how many gradations of intensity there are.
- Measured in the number of bits per channel (bpc)

Categories:

1. 8-bit (indexed) color (often called 8-bit or 256 color)

- doesn't work well for video because even the simplest scenes use more than 256 colors. The only significant format that still requires 8-bit indexed color is GIF.

2. 5 bpc (often called Thousands of Colors or High Color)

→ The 5-bpc color mode was used for some very early video-compression codecs. Today, it is mainly used for screen recording applications where it may provide better compression and performance than 8-bpc color without any obvious degradation.

4. 8 bpc (also called Millions or True Color) Sometimes called 24-bit or 32-bit mode. → The 32-bit mode still uses 8 bits per channel but with an added alpha channel.

5. 10 bpc

→ This mode is used in high-end Y'CbCr authoring systems (such as Digital Betacam and D1) and some analog capture cards.

→ It provides 1024 gradations instead of 256, which reduces banding (uneven transitions in gradated colors), especially with multiple generations of effects.

→ It isn't used in any delivery formats, although some authoring codecs support it. → provides 4X more accuracy per channel than 8-bpc color when converting to or from 16-bit-per-channel RGB in After Effects.

6. 16 and 32 bpc

→ Some high-end applications use 16-bpc or 32-bpc colour to preserve more colour detail.

→ especially useful when you have a multi-step authoring process, need to apply visual effects to your images, or when you convert from and then back to Y'CbCr.

COLOUR SAMPLING

- Color sampling records fewer pixels of chroma (color) information than luma (intensity) information.

- The terminology for color sampling uses an X:Y:Z format. X = number of luma samples that are described. Y = number of chroma samples per luma sample on the first, third, fifth, and succeeding odd lines. Z = number of chroma samples per luma sample on the second, fourth, sixth, and succeeding even lines. If this number is zero, the chroma sample from the first line is used.

- 4:4:4 - Chroma is sampled every pixel with no subsampling.

→ Y'CbCr delivery codecs don't use this format because it uses a lot of bits and doesn't provide any additional apparent quality. RGB is always 4:4:4.

- 4:2:2 - This format is used for high-end video authoring

- 4:2:0 - The vast majority of delivery codecs use this format.

→ There is one chroma sample per 2 x 2 block of pixels. This chroma sample looks nearly as good as 4:4:4, but at half the bits per frame.

- 4:1:1- NTSC DV and PAL DVCPRO use this format.

→ It contains the same number of bits per frame as 4:2:0 but with one sample per

4x 1 block of pixels.

→ better for interlaced content because each field gets its own sample; however, it can result in visible chroma artifacts in areas of high saturation

- yUV-9 - This format has one chroma sample per 4 x 4 block of pixels.

→ results in noticeably degraded quality, so it isn't used in modern codecs.

Audio Compression

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.

The table below shows the typical sample rates for common use.

SAMPLE	USED	SUFFICIENT FOR
8 KHz	Phone system	Speech
11 KHz	Old multimedia standard	Better Speech
22.050 KHz	Old multimedia standard	Recognisable music

32 KHz	<i>Common in broadband video</i>	<i>Minimum for decent music</i>
44.1 KHz	<i>Audio CD</i>	<i>Music</i>
48 KHz	<i>DVD, DAT</i>	<i>Music</i>
96 KHz	<i>High-end audio recording</i>	<i>Music mastering</i>

BIT DEPTH

→ number of bits used for each sample in each channel—the higher the bit depth, the better the audio quality.

- 8-bit sampling

→ Originally, multimedia audio used 8-bit sampling = measurement of volume from 0-255 for each sample.

→ produces fairly poor quality audio

- 16-bit sampling

→ current standard for audio distribution. Most modern codecs and all audio CDs use 16-bit sampling as well.

- 20-bit sampling

→ used for professional audio recording to provide a better dynamic range than 16 bits

- 24-bit sampling

→ rapidly becoming the standard for professional audio recording

→ provides more sonic detail than 16-bit sampling

Channels

- *Most audio from computers is either mono with a single channel or stereo with two channels.*
- *Low bit rates generally use mono because it requires fewer bits. The industry is evolving to use multichannel (5.1 and 7.1) audio support as well.*

Perceptual audio compression

- *Most modern codecs use perceptual encoding techniques:*
 - *an internal model of the human auditory system determines the important parts of an audio source and spends the available bits on those parts.*

Compression efficiency

- *defined by how many bits are required to reach a particular quality level.*
- *When improving compression efficiency, you can choose to lower the data rate while keeping the quality the same, increase the quality while keeping the data rate the same, or pick a point in between.*
- *Typically, the higher the data rate, the smaller the quality differences.*

Authoring video for future compression

- *One key to high-quality compression is creating content that compresses well.*
- *There are a variety of techniques for doing this: You can apply these techniques during preproduction, production, or post-production.*
 - *Preproduction: It's best to introduce the idea of compression early in a project, so all members of the team can consider the implications.*

→ *Production*

1. Interlaced versus progressive scan

- NTSC video has a frame rate of 29.97 frames per second (fps), or roughly 30 fps, with two fields per frame (59.94 fields per second). PAL video is 25 fps (50 fields per second).

- Interlaced video does not look good on progressive scan monitors. Compression techniques for the web usually change the video from interlaced scan to progressive scan. The most basic method for this change is to discard one field and duplicate the other to create the full frame.

- This process reduces the amount of data you started with by 50%, which can adversely affect the final quality. The more complex method is for the encoder to read both fields and interpolate (blend) them into a single frame by changing the pixels to smooth out the timing difference between the fields. This more complex method allows you to still use all the original data from the video and produce higher-quality output for progressive scan monitors.

2. Camera motion

- Camera motion changes every pixel of every frame. Lack of camera motion is the simplest, of course.

- But modern codecs can encode camera motion, such as that created using dollies, quite well. Tilts and pans are more difficult.

- Depending on the codec, rotating the camera (a Dutch) can be trivial or extremely costly in compression efficiency.

- The most difficult motion for any codec is hand-held camera motion with random jostling.

- For compression, it's much easier to handle changes of view by editing rather than camera motion, especially at lower data rates.

- In post-production, the motion stabilization tools in After Effects can remove unwanted camera motion before compression to reduce the size of the output video file.

3. Shutter speed

- Slower shutter speeds let through more light, and hence less grain, which helps compression.

- Slower shutter speeds also cause moving parts of the image to become blurry, which makes them easier to compress.

4. Backgrounds

- A difficult motion for codecs is foliage rustling in the breeze

5. Depth of field

- A useful and subtle technique for controlling the complexity of images is depth of field.

→ Post-production

Because post-production techniques occur later in the process, it is often possible to adjust them based on the results of test compressions, making fine-tuning much easier.

1. Static versus moving images

- As in production, superfluous moving images aren't appropriate for content that you plan to aggressively compress. They are not that important for DVD, but they are for web and CD-ROM.

2. Motion blur

- In the same way that a real-world shutter speed introduces motion blur that helps compression, you can use the virtual shutter in rendering applications. For effects that support motion blur, render them with a shutter speed that matches that of the source.

3. Anti-aliasing

- This rendering technique softens the edges of rendered elements, letting a pixel at the edge of an area be an intermediate value. Smoothing out transitions among parts of the image improves compressibility and appearance.

4. Progressive rendering

- When working with interlaced source video, it may be appropriate to render motion graphics as progressive scan when making the compression master. By rendering the project in progressive scan mode, you can deinterlace the interlaced source, but the graphical elements remain a perfect progressive.

Capturing video

- 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.

- The higher the quality of the source material used, the higher the quality of the final compression results.

→ Today's editing software, such as Adobe Premiere® Pro, and many compression software tools, can capture content in a variety of ways. Video can be captured from analogue or digital sources. Both have a variety of different video and audio formats available and various physical connection types that can be used.

SIGNAL FORMATS AND CABLES

• Analogue formats:

- Analog video uses fluctuating voltage and frequency signals to transmit image

data.

- Ranges greatly in quality but is inherently susceptible to visual interference from electronic noise and suffers attenuation, or the loss of signal power and quality over long cable runs (usually 300 meters or more).

- Equipment that supports analog signals is generally more affordable

Because computers only use digital data, the analog source must be converted to a digital copy to be captured. When it is sent back to an analog medium like videotape, it is converted back to an analog signal. This conversion can lead to minor errors (quantization errors) being introduced.

→ You can minimize these quantization errors by using the right format, good equipment, cables, and connections.

• Composite:

- A composite video signal carries the luminance and the chrominance channels in a single signal.

- Biggest problem = that luma information can leak into chroma, and vice versa. This leakage can lead to noise, known as chroma crawl, which can be amplified by the video capture process and reduce the overall quality.

- Generally understood to be the lowest quality video signal that you can use and is more appropriate for video delivery (broadcast) than as a source for content creation (video editing, DVD authoring, or encoding for the web).

- The connectors common to composite video are RCA or Cinch for consumer equipment and BNC (Bayonet Neill-Concelman).

- As the quality of the RCA or BNC cable that is used increases, the noise and attenuation decreases.

- **S-Video:**

- Major advance in quality for consumer and professional video editors.

- S-Video splits the luma and chroma channels into two separate wire pairs, which eliminates generally half of the composite noise artifacts. The two chroma channels are still combined and still interfere with each other, leaving some noise in the signal.

- While no longer considered true professional grade, it is a big improvement from composite and can be considered a good video capture minimum standard for editing and compression.

- Mostly use a specific four-pin connector on S-Video cables. These cables are intended for short distances (usually 100 feet or less). Some types of professional and broadcast equipment use two BNC cables, one for luma and one for chroma, to carry S-Video signals. This setup provides a connection that can be run farther and that can be locked into place to prevent the cable from falling out and losing the signal.

- **Component analog:**

- Also known as YUV (Y for luminance, U for one chroma channel, and V for the other chroma channel) was the professional and broadcast standard for many years and it is still widely used today.

- The luminance signal and the two color signals are all transmitted over their own dedicated cables. Because all three components or channels of the video signal are transmitted independently, the quality of the signal is quite high. Noise is very low and the colors in the video are richer and more precise.

- In broadcast and professional environments, component analog has mostly yielded to digital video formats.

- Component analog has become very popular in the consumer market, though, as the preferred format for connecting home DVD players to new television sets

- In professional environments, the component analog signals are carried by three individual BNC cables because of their ability to accommodate long runs and locking connections. In the new home

DVD players, it is common to see RCA or Cinch connectors used that are color-coded red, green, and blue to make it easy to connect the DVD player correctly.

- *Unbalanced audio:*

- *This type of audio connection consists of a single wire that carries the signal, surrounded by a grounded shield.*
- *Used commonly in consumer audio products because the connection and circuitry are less complex.*
- *Downside is that unbalanced connections are more susceptible to interference, so they are not often used in professional applications.*
- *There are three basic kinds of unbalanced audio connectors. The most familiar to consumers is traditional unbalanced audio that uses RCA or Cinch jacks (normally red for right and white or black for left). To connect a stereo signal, you can use a single RCA cable for each channel, or a stereo cable that has two single cables molded into one.*
- *There are other single-cable unbalanced connectors as well. The quarter-inch connector is common to high-end headphones and is standard on most home stereo equipment. Similar but smaller is the eighth-inch connector that is standard for portable audio devices and computer sound cards.*

- *Balanced audio:*

- *This type of connection consists of two wires, which serve to balance the signal, and a shield.*
- *A balanced connection is far less susceptible to interference, so it is possible to maintain high quality with long cable runs.*
- *Normally uses the XLR, or three-pin, locking connector, which provides a much tighter and robust connection than the connectors used for unbalanced audio. Once again, longer cable runs and a locking connector form the basic standard for a professional connection.*

ANALOG-TO-DV CONVERTERS

Certain devices can perform a live conversion from analog video formats to DV25 for capture.

They usually offer composite, S-Video, and unbalanced analog audio conversion to the DV format for storage on the computer. The 25-Mbps data rate of DV is sufficient for content that camcorders produce, but it can be troublesome for converting sources with significant analog noise on lower-end versions of the converters.

Digital formats

- DV formats the original video signal on tape using digital data similar to that used by computers.

→ All brightness and color data is stored in this very accurate computer-style method and as such suffers no problem of interference or noise between the channels of the video signal.

→ Digital signals are therefore cleaner and crisper than analog sources.

Below are the most popular acquisition formats of digital video:

- *DV25 (DV):*

- This format is most commonly known by the physical connection standard it uses,

IEEE-1394 or FireWire

- It revolutionized the video editing industry

- Video is compressed 5:1 during acquisition or recording in order to reduce the data rate of the signal to 25 Mbps, and is only slightly higher quality than the S-Video analog format.

- Higher-end DV camcorders can produce a DV signal that is almost as good as component analog video at the same DV data rate because of better recording technology.

- The DV format includes a series of computer-style 1s and 0s and no analog

- The data on the computer is exactly the same data as on the tape, so the result is a perfect copy.

- Many nonlinear video editing applications, like Adobe Premiere Pro, can read and edit this format natively, and finished video is virtually the same as the original source footage.

- Few to no processing errors are introduced.

- Both the audio and video signals are carried on a single FireWire or IEEE 1394 cable. The cable also carries device control signals that allow the computer to control the DV camcorder.

- In addition to DV25, there are a number of other popular DV formats, such as DV50 and DV100, which have data rates of 50 Mbps and 100 Mbps, respectively.

- Adobe Premiere Pro supports DV25 and DV50 over standard FireWire ports.

- *SDi (serial Digital interface):*

- High-end, professional format for digital signals.

- The SDI format, technically known as CCIR-601 or 601, is superior in quality to component analog video and is the standard in professional and broadcast television.
- Because it is digital and uncompressed, it can be edited and copied many times with no detectable loss of quality.
- Originally meant for standard definition, but a high-definition version, HD-SDI, is growing in popularity as HD becomes more common.
- SDI is typically only supported in high-end gear and can be expensive, especially for SDI video monitors.
- The video, and sometimes the audio, is carried in a single BNC cable.

- **Digital audio:**

- There are many different digital audio formats.
- Consumer-grade digital audio is carried on electronic (such as S/PDIF) or optical (such as square TOSlink or round Miniplug) connection cables.
- Digital video carries an embedded digital audio signal with the digital video signal. - The most common professional-grade digital audio format is Audio Engineering Society/European Broadcasting Union (AES/EBU). A stereo channel of AES/EBU can be transmitted over single BNC or single XLR connection cables.

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.

1. DV codecs:

- Ideal when capturing from a DV25 deck. Over a FireWire connector = perfect copy. - The data rate of DV25 isn't quite enough for optimal encoding from source with analog noise
- The 4:1:1 color space also entails a loss in quality.

2. Motion JPeG codecs

- Have 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.
- Typically, data rates of 50 Mbps or greater are considered broadcast quality.

3. 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 Professional, are able to process video in more than 8 bits per channel, improving the quality.
- 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.

Exporting video

- If features in other encoding tools are required, for example, volume encoding to multiple output formats, it is useful to export an intermediate file from the timeline and use the exported file for further processing.

→ Exporting to file

A file you export for later processing is called an intermediate file. (Reason for this = to provide high quality in the most useful format without introducing any compression artifacts).

→ Choosing whether to preprocess or to avoid rendering

When to apply preprocessing? During the rendering phase or later?

- Preprocessing during rendering generally results in a smaller file, but adds more rendering time.
- Basically, to avoid rendering, you use the same codec and file format as your source video.
- If you don't preprocess, you don't need to uncompress and then recompress unmodified frames— instead, you copy them from the source into the output. - In Adobe Premiere Pro, you'd turn off the Recompress option in the Video

pane of the Export Movie Settings dialog box. For this process to work, the video must truly be unchanged with the same frame rate, frame size, pixel aspect ratio, and so on. The simplest way to

ensure that no changes were made to the video is to use the same project preset for export that was used for import, which is the default behavior in Adobe Premiere Pro.

- There is one exception to exporting with the source codec: when the source is DV25 and contains a number of motion graphics or compositing.

- When you preprocess, choose the highest frame rate and largest frame size that you will use. If you are targeting web codecs, use square pixels (pixel aspect ratio of 1).

→ Choosing a file format for rendering

- The most common formats are QuickTime and AVI; both offer good-quality intermediate codecs.

- You can also use MPEG-2 at high data rates.

- It is essential to make sure that the encoding tool supports the file format.

→ Choosing a codec for exporting

- When you export an intermediate file, pick a codec and a data rate that doesn't introduce compression artifacts.

- When you are not preprocessing, it's typical to use the source codec or Motion

JPEG. When you use Motion JPEG, use it in single field when you export as progressive scan, or interlaced when you export as interlaced.

- For AVI files on Windows, the Huffiyuv codec is quite popular.

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. – Goal = to transform the video into the final format.

- Preprocessing is very important for quality, and getting it right can dramatically improve the quality of the final video. A well preprocessed video can look better than the same source file poorly preprocessed, but can be encoded at twice the data rate.

- Preprocessing is critical for web video, but generally it is not needed when you convert to video formats like MPEG-2 for DVD or SVCD.

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.
- So, at the same bit rate, deinterlaced video shows fewer artifacts than interlaced video.

Understanding telecine and inverse telecine

- A special case of progressive scan is film source and film-like 24P production. – Traditional motion picture film runs at exactly 24 frames per second (fps) progressive scan, which doesn't convert to the 59.94 fps of NTSC or the 50 fps of PAL.
- Converting from film to PAL is easy. The video is sped up 4% to 25 fps and converted into progressive PAL.
- NTSC is a little more complex to perform. The film is first slowed down to 23.976 fps, and then it is converted to the 59.94 fps by using 3:2 pulldown.
- The first frame of film becomes three fields of video, and the next frame becomes two fields of video, and the next becomes three fields, and so on.
- This process results in two out of five frames having fields that come from different source frames.
- When possible, it is best to convert to 24P on import and then do all the work on the project in 24P mode.

Cropping

- The safe areas exclude the edges of the screen, which may be cut off or distorted on some televisions (especially older ones).
- In some digital video editing applications, you can crop an image using a filter. In others, such as

- When converting from 486 line to 480 line (for example, in DVD authoring), you'll need to crop six lines. Generally, four lines off of the top and two lines off of the bottom works well.
- Conversely, if you're going from 480 line to 486 line, you'll need to add six lines - Doing odd numbers can switch field order, resulting in substantial problems.

Scaling

- Scaling is resizing the cropped source rectangle to the proper output frame size, for example, going from a 720 x 480 source frame to a 320 x 240 output frame for web video.
- Scaling up on either axis forces a video editing application to make up data that's not in the source. It's always preferable to scale down on both axes if possible.
- Aspect ratio correction is important here
 - Most production formats, like DV, use nonsquare pixels. But DV isn't ever 3:2; instead, it's either 4:3 or 16:9.
- Nonsquare pixels are also used for MPEG-2 for DVD and MPEG-1 for SVCD and with different shapes for MPEG-2 for SVCD.
- Conversely, most web video formats use square pixels, which makes it easier to do the math.
- The key to getting aspect ratio correction right when you convert to square pixel sources from nonsquare pixel sources is to make sure that the output frame size matches the source aspect ratio.

Noise reduction

- Removing noise, especially grain, from an image makes it easier to compress.
- The commonly used Median filter is a good blur for noise reduction. More advanced algorithms try to blur only the parts of the image that have grain and may take advantage of differences among frames.
- You don't always need to apply noise reduction. Very clean source isn't helped by noise reduction, and noise reduction may hurt the source audio. Typically, you should use only the minimum noise reduction required to suppress poor quality in the source.

Image processing

- Today, for the most part, modern formats and tools automatically take care of image adjustment, so it is mainly done to improve the suitability of the content for compression and isn't required for most projects.

Tools for Video Compression

- * *Luma Range Expansion*
- * *Black Levels*
- * *Gamma Correction*

Tools for Audio Compression

- * *Resampling Audio*
- * *Setting Volume*
- * *Adjusting channels and bit rates*
- * *Reducing Noise*

ENCODING

- *Encoding means defining the correct parameters, such as data rate, frame size, and frame rate, to get optimum results for the project.*

- *It's most important to understand the goals that the compressed video is meant to achieve.*

→ *Choosing a data rate mode*

Data rate modes include:

- *average limited - 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.*
- *Most CD-ROM and QuickTime codecs work this way.*

- Average-limited encoding is used for most progressive download files where file size and data rate are the limiting factors.

- Peak limited encoding - 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.

- Peak-limited encoding also works well for high-resolution and high-data-rate web and CDROM files that need to play back on lower-end computers.

- Some codecs support encoding with both average limiting and peak limiting.

- Buffer limited encoding - the method of choice for real-time streaming.

- 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 - 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.

- Most codecs that perform quality-limited encoding specify the quality on a 0-100 range. However, actual visual quality produced by the same value can widely vary among codecs.

- Some codecs support average-limited and quality-limited encoding together; the quality limit sets a minimum quality for each frame. If a frame falls below the quality limit based on available bit rate, the bit rate for that frame is raised so it meets the minimum.

- Typically, one or more frames after the low-quality frame are dropped to preserve the average bit rate.

- This mode sacrifices smooth motion in favor of image quality.

→ *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

- 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 x 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. 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.

→ *Specifying aspect ratio*

- An important facet of frame size is aspect ratio. Most web and CD-ROM formats use square pixels, and many formats only support square pixels.

- Conversely, the disc-based VCD, SVCD, and DVD formats only use nonsquare pixels. - 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.

Adjusting the frame rate

Higher frame rates appear smoother, and lower frame rates appear choppier.

→ Anything below 20 fps doesn't appear smooth, and below 10 fps, the video looks more like a filmstrip than moving video.

→ Reducing or increasing the frame rate has much less effect than frame size on the data rate because reducing the frame rate requires encoding twice as much motion for each frame, a process that requires more bits for each frame. Also, each frame appears for twice as long, so there's more

time to notice each artifact; thus, the image quality per frame must be higher to provide the same perceived quality.

→ Consequently, 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.

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.

→ Various factors come into play here:

- Keyframe rate

- Sample rate

- Channels

Delivery methods for video

The method you use to compress content depends greatly on how you plan to deliver it.

→ Disc-based delivery

- Disc playback keeps getting better even as the focus of the industry moves to network delivery.

- Disc-based delivery works well, and the available data rates are radically higher than those for web video.

→ Downloadable files

- The most basic type of video on the web is a simple, downloadable file.

- The advantage of downloadable files is that users don't expect real-time playback during the download.

- Also, because the file is copied to users' computers, they can pass the file among themselves, thereby reducing your bandwidth cost per viewer.

- The drawback is that users can't view any portion of the file until the download is complete.

→ 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.

- Not affected by the video and audio glitches associated with real-time streaming. - However, progressive download can't provide reliable real-time performance.

[the whole buffering thing]

- Progressive download is the easiest, cheapest, and most forgiving type of web video to author and deploy.

→ Real-time streaming.

- 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.

- But provides real-time performance and random access to different parts of the file.

Choosing a compression format

Depending on the project, picking the correct format can be an easy or a difficult decision.

- After you choose a format, you need to determine the versions of players that support the format.

- Questions to ask when choosing a format:

- Features
- User base
- Platforms

Windows media format

- *Windows Media 9 platform, released early 2003, is a popular proprietary digital media platform.*
- *Offers streaming delivery*
- *Offers progressive download*
- *Offers disc-based delivery*

Windows media players

→ *There is a wide variety of different Windows Media players available for different platforms, making compatibility a moving target. Recent versions of the player aren't always available for some common operating systems, a condition that requires you to provide multiple versions of the content or exclude some platforms.*

- *The most commonly deployed players are:*

- * *Windows media Player 6.4 (Windows and Windows nt)*
- * *Windows media Player 9 and later (Windows)*
- * *Windows media Player 9 for mac os X (10.1 and later)*
- * *Windows media Player mobile*
- * *Windows media Player for Pocket PC 2002*
- * *WMP for Pocket PC 2000*

Windows media video codecs

→ *Windows Media has a broad set of codecs available, but the latest codec is considered to be clearly the best.*

- *These codecs include:*

- * *Windows media Video 9 (WmV9)*
- * *Windows media Video 8 (WmV8)*
- * *Windows media Video 7 (WmV7)*
- * *Microsoft mPeG-4 version 3*

* ISO mPeG-4 version 1

* Windows media Video 9 screen

* Windows media screen version 7

Windows media audio (Wma) codecs

→ Windows Media also has a variety of audio codecs optimized for different uses.

- These include:

* Windows media audio 9

* ACELP.net

* Windows media audio 9 Voice

* Windows media audio 9 Professional

* Windows media audio 9 lossless

Exporting to realmedia format

→ RealMedia is the oldest real-time streaming web format

- Unlike Windows Media, most RealMedia tools specify the total data rate from which audio data rate is subtracted to leave video data rate. However, some tools don't use this method.

- You can use realmedia for streaming delivery

→ Unlike Windows Media, it can mix and match codecs in different streams. All streams must share the same frame size, which can limit scalability.

- You can use realmedia for progressive download

→ While RealMedia is mainly considered a streaming format, it has supported the excellent .rmvb 2-pass VBR progressive mode for several years. These files actually use a different extension than the standard .rm files, indicating that the files won't work when placed on a streaming server.

- You can using realmedia for disc-based delivery

→ The .rmvb files also work fine from CD-ROM or DVD-ROM. While most software tools, such as Microsoft PowerPoint, don't allow RealMedia files to be directly embedded in them, the files play well from the disc in the RealOne player.

RealMedia is also a good high-definition playback solution.

RealMedia Video Codecs

RealMedia supports a smaller set of video codecs than the other formats. The most recent codec is always the best choice. The options are:

- RealVideo 10
- RealVideo 9
- RealVideo 8
- RealVideo G2

Realmedia audio codecs

Unlike other formats, a RealAudio codec is defined by a combination of a codec, data rate, sample rate, and channels. Instead of picking a codec and other parameters, the user picks an inclusive combination. Another twist with the RealMedia audio support is that many tools require audio codecs to be specified for video and music content, for both video and audio files and audio-only files. The user picks the one based on the mode the file was encoded with. It's important for the user to pick the correct setting for the mode that is actually being used.

→ The following audio codecs are available:

- RealAudio 10
- RealAudio 10 lossless
- RealAudio 10 Multichannel
- RealAudio 8 Stereo Music
- RealAudio 8 Surround
- RealAudio Speech
- RealAudio Stereo Music
- RealAudio Music

Exporting to Quicktime format

- *Less advanced than RealMedia and Windows Media for real-time streaming.*
- *The greatest strength of QuickTime is that it supports rich interactivity and rich media.*
- *By default, QuickTime data rate is set as total kilobytes per second, not the total kilobits per second of RealMedia or the kilobits per stream per second of Windows Media. However, many tools that support multiple formats provide the rate in Kbits.*
- *Quicktime can be used for real-time streaming, progressive download and disc-based delivery.*

Quicktime video codecs

- *Given the long heritage of QuickTime for flexibility and support for third-party codec vendors, the range of codecs supported in QuickTime is broader than in the other formats. However, the best codecs are often not provided for free. Below is the QuickTime codec range:*

** Sorenson Video 3*

** Sorenson Video 3 Pro options*

** Sorenson Video*

** MPEG-4*

** H.263*

**Cinepak*

** VP3*

** Animation*

** Graphics*

** PNG*

** Microcosm*

** None16*

** Photo-JPEG*

** Motion JPEG*

** Component*

* None

Quicktime audio codecs

QuickTime audio codecs don't have a specific data rate control in their main user interface. Instead, you set the data rate, if controllable, in the Options dialog box. The following are QuickTime audio codecs:

* MPEG-4

* QDesign music 2

* QDesign music 2 Pro

* Qualcomm PureVoice

* IMA

* MP3

* None

* 24- and 32- bit integer

* Floating point

Exporting

One has the following exporting options:

* MPEG-1 format

* DVD and mPEG-2 formats

* MPEG-4 format

* AVI format

EXTRAS

EXTENSIONS

- There are many different file types and extensions for Windows Media format. Here are some of the most common extensions and their meanings:

*** .asf**

→ The file format used for Windows Media files is called the Advanced Streaming Format, and the original extension was .asf. However, this extension didn't discriminate between audio-only and video .les, and so the extensions .wmv and .wma were introduced with Windows Media 7.

*** .wmv**

→ A Windows Media Video file (.wmv) is an .asf file that contains video.

*** .wma**

→ A Windows Media Audio .le (.wma) is the same as an .asf file, but it only contains audio.

*** .asx**

→ An .asx file is a metafile for Windows Media Streaming. The .asx file goes on the web server and points to the media on the streaming server. The .asx file format itself hasn't changed, but with the advent of WM7, the .wvx and .wax file extensions have been used more commonly.

*** .wvx**

→ A .wvx file is a metafile that contains video and, optionally, audio.

*** .wax**

→ A .wax file is a metafile that contains only audio

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