Understanding Digital Compression Jargon

I. Introduction

A. The best computer video possible is nearly valueless if the creator doesn't have a basic understanding of compression in order to deliver it to viewers.

B. If you're going to always output your movies back to your camcorder tape, you don't need to know about codecs, but if you plan on creating DVDs, video e-mail, Video CDs, or web videos you'll need to know a little about codecs. Now we not only need to keep in mind the MAC & PC formats, but more and more PDA's are becoming available with video capabilities.

C. Understanding -digital compression is the most difficult, but also the most critical, aspect of digital editing. It is not necessary for the amateur video editor to memorize the ever changing complexity of digital compression, but a basic understanding along with several bookmarked strategic resource sites will save a great deal of time and frustration.

D. Beginning a video editing program often looks like a banquet of alphabet soup.

E. What is compression and why is it important? A single uncompressed frame of full-screen video consumes nearly 1 MB of storage. Compression uses mathematical equations to scan a file for repeating patterns in the data, and then it replaces the data with smaller codes that take up less room.

F. The goal of compressing your video is to get the highest quality output at a given bit rate.

II. Digital Camcorders

A. Visual and audio information that comes into a camcorder is encoded into a digital format. Raw or uncompressed, full-frame size, full-frame rate NTSC video data might occupy 30MB (megabytes) for every second of video, which is a huge amount of space.

B. Mini DV, Digital8, DVCAM and DVCPRO formats all use the same 25Mbps data rate
-They all use the same 5:1 DCT intra-frame compression scheme
-They all use the same 4:1:1 sampling scheme (NTSC)
-They all deliver the same 720x480 resolution (NTSC) and frame rate
-IEEE 1394 (FireWire) is supported in all four video formats

III. Lossless vs. Lossy Compression

A. Lossless Compression

1. Ensures that all of the information in the original clip is preserved after compression.

a. This maintains the full quality of the original, which makes lossless compression useful for final-cut editing or moving clips between systems.

b. However, preserving the original level of quality limits the degree to which you can lower the data rate and file size, and the resulting data rate may be too high for smooth playback on many systems.

2. Examples of Lossless Compression Formats

In order for the files to be useable on a computer the files that are extracted from a compressed data file must be identical to the original file (before it was compressed). Lossless compression is great because it makes perfect copies, but it doesn't yield very high compression ratios. That means it doesn't save huge amounts of disk storage space. Common lossless compression formats include:

- HQX: Binhex (MacOS) **http://kb.indiana.edu/data/acma.html**
- SIT: Stuffit (MacOS & PC) **http://www.stuffit.com/**
- ZIP: Zip (PC) **http://www.winzip.com**
- TAR: tar (Unix)

A Zip file is a compressed archive of one or more files. While the files are being zipped, any unnecessary code is removed from the files. This creates a single file that's much smaller than the original files. The Zip format is popular because it provides the perfect medium for distributing files over the Internet. Since a Zip file is one compressed file that usually holds many different files, you don't have to wait for each file to download. Additionally, servers hosting download sites love them because Zip files take up less space on servers. In order to view files that are stored inside a Zip file, you must unzip it first. You must use a program that's compatible with the Zip format. The program that popularized the Zip file is WinZip. It has gained a huge user base over the years because it's recognized as the file compression standard.

B. Lossy Compression

1. Discards some of the original data during compression.

2. For example, if the pixels making up a sky actually contain 78 shades of blue, a lossy codec set for less-than-best quality may record 60 shades of blue.

3. Lossy codecs usually let you specify how much picture quality you want to trade to lower the data rate and file size so that you can tailor playback for your audience.

4. Since lossy compression allows much lower data rates and file sizes than lossless compression, lossy codecs are commonly used for final production of video delivered using CD-ROM or the Internet.

5. Some codecs are always lossy, such as JPEG, or always lossless, such as Planar RGB. Other codecs may or may not be lossy, usually depending on the settings you specify for the Quality and Data Rate options—lowering the value for these options saves more space by discarding more data.

IV. Broadcast Standards Formats

A. NTSC

NTSC stands for the National Television System Committee of the Electronics Industries Association. The organization defines the standard format adopted by the FCC for television broadcast in the United States, Japan, Canada, and Mexico. This is also called "composite video" because all of the video information, luminance, and color combined into a single analog signal. (30 frames per second – actually 29.97 frames per second at 60 MHZ) 720 x480 pixels

B. PALS

PAL stands for Phase Alternation by Line, the broadcast video standard used in West Germany, Great Britain and most Western European nations. By reversing the relative phase of the color signal components on alternate scanning lines, this system avoids the color distortion that appears in NTSC. Otherwise, PAL closely resembles NTSC. Based on the 50 Hz power system, PAL displays 625 lines interlaced at 50 fields per second (25 frames per second).

C. SECAM

SECAM stands for Sequential Couleur A Memoire" (sequential color with memory). Video format used in France, Eastern Europe, F.S.U and some Middle Eastern countries. Like PAL, SECAM is based on a 50 Hz power system, displaying interlaced lines at 50 fields per second. The color information is transmitted sequentially (R-Y followed by B-Y, etc.) for each line and conveyed

by a frequency modulated sub-carrier that avoids the distortion arising during NTSC transmission.

D. Resource for Worldwide TV Standards
http://www.ee.surrey.ac.uk/Contrib/WorldTV/

V. Codecs

A. Codecs are compression/decompression algorithms that are crucial for producing digital video and audio. Some codecs are more appropriate for certain kinds of work than others. The DV format compresses at a 5:1 ratio. Video you access on the Web might be compressed even more.

B. Codecs may be found in hardware – for example, in DV, camcorders or capture cards – or software. Some codecs have a fixed compression ration and therefore a fixed data rate. Others apply compression to a frame based on its content, resulting in a data rate that can vary over time. Some codecs allow you to choose to a quality setting that controls the data rate.

C. Already compressed data doesn't compress well.
Already compressed video can be recompressed with authoring formats such as DV – any time you change a frame, it needs to be recompressed when going back to a file or tape. Also, formats sometimes need to be converted from one to another. The problem with recompression is that it can take your existing compression artifacts, leaving less of the original image data behind. This causes a generation loss. Sometimes there are extreme conflicts and one needs to go back to the original video.

VI. Parameters to consider when choosing a codec. (Codec Resource Site *http://www.adobe.com/support/techguides/premiere/prmr_codecs/prmr_codecs.pdf)*

A. The key to good video compression is being able to experiment, quickly see the results, and adjust the values until you are getting optimal results.

B. Trade-offs you have to work with include frame resolution, frame rate, compression codec, key frame compression amount (spatial quality), and (for interframe codecs) temporal frame compression amount (temporal quality), frame dropping, and peak bit rate management

1. **Resolution -** One of the most important parameters.

    a. Definition -- the sharpness and clarity of an image.

b. The term is most often used to describe **monitors**, **printers**, and **bit-mapped** graphic images. In the case of **dot-matrix** and **laser printers**, the resolution indicates the number of **dots per inch**. For example, a 300-dpi (dots per inch) printer is one that is capable of printing 300 distinct **dots** in a line 1 inch long. This means it can print 90,000 dots per square inch.

Printers, monitors, **scanners**, and other I/O devices are often classified as *high resolution, medium resolution,* or *low resolution*. The actual resolution ranges for each of these grades is constantly shifting as the technology improves.

C. For graphics monitors, the *screen resolution* signifies the number of dots (**pixels**) on the entire **screen**. For example, a 640-by-480 pixel screen is capable of displaying 640 distinct dots on each of 480 lines, or about 300,000 pixels. This translates into different dpi measurements depending on the size of the screen. For example, a 15-inch **VGA** monitor (640x480) displays about 50 dots per inch.

d. The three standard NTSC full-screen capture resolutions are 640x480, 720x480 (DV), and 720x486.

e. Most iMacs and iBooks and many desktops Macs run at about 800x600 resolution. However, iMovie runs more effectively at 1024X768 resolution which makes everything on the screen appear a bit smaller, but allows more information on the screen at once.

f. It is strongly advised to keep both horizontal and vertical dimensions a multiple of four (i.e. 240 wide is good; 241 is not). A good starting point for key frames is one every 10 seconds. This is 10 times your frames per second.

g. Movie sizes

720x480 – Digital Video Resolution

640x480 Full Screen – standard resolution for TV

320X240 (one-quarter the size of a standard TV)

240x180 (close to one-eighth the size)

160x120 (one-sixteenth the size). This is the common resolution for movies destined for the Internet or for CD-ROM playback – the smaller the movie, the less storage space it requires.

2. **How to use keyframes.**

a. A keyframe is a complete and distinct full frame of video.

b. If you are editing your video you need every frame to be a keyframe. Obviously this requires more data. Lossless codecs limit the number of keyframes utilizing a technique called frame differencing which takes advantage of the similarity between frames to save data. A codec utilizing frame differencing will only encode the changes in pixels. Any pixel that remains the same from frame to frame will not be redrawn.

3. **Bit Rate or Data Rate?**

a. The ratio of the number of **bits** that are transferred between **devices** in a specified amount of time, typically one second. The more bits, the better quality is usually going to be, but more bits also results in larger file sizes.

b. *Bit rate* is the same as *data rate*, ***data transfer rate*** and *bit time*.

c. Extremely critical parameter when compressing files for delivery on the Web, CD-ROM, or any place where there are limits on bandwidth or file size.

d. Compression efficiency measures how few bits are needed to achieve good enough quality in difference circumstances.

5. DV is locked 25 MBps (Megabites per second).

6. Data rate modes

(a). The VBR (Variable Bit Rate) versus CBR (Constant Bit Rate) distinction is especially confusing. All modern video codecs are variable in the sense that not every frame uses the same number of bits as every other frame. This is a good thing – if every frame were the same size, keyframes would be terrible compared to delta frames. Even codecs labeled “CBR” can vary data rate quite a bit throughout the file.

(b). 1-pass versus 2-pass

(1). By default most, codecs function in 1-pass mode, which means compression occurs as the file is being read. As each frame is input, a compressed

version of it is output. Live broadcasting/Webcasting requires 1-pass codecs. The limitation of 1-pass codecs is that they have no foreknowledge of how complex the content after the frame they're currently processing is.

(2). 2-pass codecs

First does an analysis pass, where they measure the relative complexity of each frame. Once the entire file has been analyzed, the codec figures out the optimal way to spend the available bits over the entire file to achieve the highest possible average quality.

2-pass can yield substantial improvements in compression efficiency, typically from 10 to 50 percent.

e. Limiting factors in data rate

(1). Drive Space -

(2). Drive Speed – If hard drive isn't fast enough to capture all the video, frames may be dropped.

(3). Capture codec – Lower-end systems, have a maximum data rate they can pump out In some cases it's better to capture at 640x480 instead of 720x480.

f. Determining the Bandwidth of the intended audience

a. Most video players allow the video can be played progressively, as it downloads. You decide what kind of user experience you are shooting for and what speed of the viewer's Internet connection speed you are designing for.

(1) 28Kbps modem

(2) 56K modem

(3) Single ISDN 64 and Dual ISDN is 128

(4) Cable Modem 200-5000

(5) T1 Line 1500

(6) T3 Line 45,000

VII. Still Graphics Compression

A. Graphic Formats

1. The most common graphics file formats on the Web are those with the extensions .jpg and .gif. The **.jpg** is short for **JPEG**, (Joint Photographic Experts Group). It is both a file format and a technique to compress image files.

a. One of the popular compression standards for photographs and other images.

b. Great for photographs that will be transmitted over the Web because of its small file size that maintains a lot of color and image detail.

2. The **.gif** extension stands for **Graphics Interchange Format**, a standard developed by CompuServe in the late 1980s. Both these graphics formats are platform-independent, which means you can use them on a PC, Mac or UNIX machine as long as you have a viewer for them.

3. .**pict** extensions are used as Macintosh Picture file format.

a. Uncompressed images (such as uncompressed PICT files) are better for iMovie video clips.

4. BMP is the Windows Bitmap format.

B. Graphic Converters

1. Capable of Changing the resolution and dimensions of an image so it can fit into a movie clip.

2. Generally included in most photo editing software packages.

2. Shareware program for editing images on a Mac.

3. Deals with many different types of graphics files and formats.

VIII. Digital Video Formats (Achieving Balanced Mediocrity with Video Compression)

A. QuickTime (.mov)

B. AVI

1. Works in multiple media architectures including QuickTime, DirectShow, and a smattering of UNIX apps.

2. Avis' advantage of QuickTime is that Windows machines don't typically need additional software installed if you stick to standard codecs.

C. MPEG

(MPEG Starting Points and FAQs
http://www.mpeg.org/MPEG/starting-points.html)

1. MPEG 1 is the format used in VideoCDs and offers good picture quality but losses some picture data.

2. MPEG 2 is really a lesser compressed version of mpeg 1, this means more of the original picture is kept and results in an overall better picture but less compressed. This is used in SVCD and DVD.

3. MPEG 4 is also called DivX. It is an extremely highly compressed format. DivX is a new standard of video compression that is both high quality and low bit rate. They are usually only a fraction (around 15%) of the size of a standard DVD, even at 640x480 resolutions, making them the best home video format thus far. They only take half the time to encode, and yet at the same time is smaller in size than MPEG-1 - due to their incredible compression technology - some have even called MPEG-4 the "MP3 of the video world". Quality ranges from net-streaming quality to DVD and better!! **(This means that anybody with a decent Internet connection can go and download a film at a low file size and convert it to VCD or SVCD!! Free movies!!!)**

a. There are three kinds of DivX codec now and an alternative one: DivX3.x which is the better known one and has been around for a while. It's also known as DivX. The 2nd DivX codec is DivX4, by DivX networks, a completely new codec written from scratch but which is not used anymore since the same company has released DivX5, which offers more features and better quality than DivX4. XviD is a newer codec and still in alpha state but it already gives very impressive results.

b. Whichever codec you chose is really up to you. If simplicity is your goal Gordian Knot offers easy DivX3 and DivX5 encoding whereas the XviD setup is still a bit more complicated.

D. DVD-Video

1. Typically the DVD-ROM portion of a DVD disc.

2. Right now, good control of DVD-Video playback from an application requires DirectShow, and hence Windows, although mediocre solutions are possible by using AppleScript to control the DVD Player on MAC. Straight playback of a DVD-Video disk works on most platforms now and the DVD-Video disc itself can contain a surprising amount of interactivity.

IX. Digital Video Players

A. Media players each recognize a different file format or extension (the letters to the right of the period in a file name).

B. QuickTime

1. .MOV extensions are recognized by QuickTime.

2. Most mature, and has the best functionality form more involved tasked. QuickTime provides a good range of audio and video codecs.

3. Leader for two-platform compatibility.

4. QuickTime is a file format and also architecture.

a. QuickTime 6 is the version of the architecture that supports a few of the most useful bits of the MPEG-4 format.

b. QuickTime is a codec container that holds literally dozens of codecs, most of which are wildly inappropriate for any given compression project.

B. Windows Media

1. The **.avi** file extension is recognized by Video for Windows, built into the Windows operating system

2. Available on more platforms than other such as Win 32, Oac OS Classic, Mac OS X, PocketPC, and Solaris. However, differences among platforms are substantial.

3. Performance across platforms is impressive and it's designed to be easy to port to a variety of devices.

4. Because it can play via DirectShow, applications that support DirectShow can play .wmv files like any other media type. It has excellent codecs and a great 2-pass VBR mode.

5. Integrating Windows Media limits playback to only recent versions of Windows.

C. Real Player

1. .rm are RealPlayer files.

2. .rm files are usually **.avi**, **.mov,** or .**wav** files encoded for playing on the Internet.

3. Currently, the RealOne (Real v9) player is only available for Windows (and in beta for MacOS X).

D. Flash MX

1. . Flash MX replaces Flash 5 which was born as an animated vector graphic format, which has been progressively enhanced to add rich and interactive features.

2. While Flash may be best known for those annoying home page animations, it can now deliver a much more media-rich experience than tradition HTML-based sites.

3. Macromedia's new Flash MX platform with Spark Pro video is available for CD-ROM delivery. With Flash MX, you can convert a Flash movie into a stand-alone app for Windows or MacOS Classic and X. Video playback performance isn't as good at high resolutions as Director, but no installer is needed for video playback

E. Macromedia Director

1. For years was used for interactive CD-ROM. Director can compile standard applications for both Mac (Classic only so far, not MacOS X) and Windows.

2. Director uses Shockwave as a way to deliver platform-neutral, compressed multimedia presentations.

X. Audio Compression

A. Formats

1. 8 bit – Mono – equivalent to 48dB (decibels). Similar to FM broadcast in monophonic sound.

2. **8 bit – Stereo** – equivalent to 48 dB; similar to FM broadcast in stereophonic sound.

3. **16 bit – Mono** – equivalent to 96 dB; used by CD audio in monophonic sound.

4. **16 bit – Stereo** – equivalent to 96 dB; used by CD audio in stereophonic sound.

B. Audio File Formats

1. Audio files on a MAC are generally **.aiff** files while audio files on a PC are generally **.wav**.

2. The major audio codecs include MP3, WMA, Real Audio, and now MP3 Pro.

C. Audio Codec Settings

1. General purpose codecs versus speech codecs

a. General purpose audio codecs – Designed to do well with music, sound effects, speech and everything else audio people listen to.

(1) 44.1kHZ is "CD-quality" and anything much less than 32kHz starts having audible reductions in quality. 22.050 kHz is about as low as you can go for "entertainment" quality music content. 8kHz is telephone quality, and about as low as you can go for speech.

b. Speech codecs

(1) can go to lower data rates than general purpose codecs, and generally provide better quality with speech below 32 Kbps. Speech codec generally only support monophonic, single channel sound. Any non-speech content in the audio will either be distorted or removed. Most speech codecs have a pretty low maximum bit rate and quality.

(2) RealAudio Speech goes up to 64Kbps and sound nearly perfect for audio book types of applications.

2. Trade-offs in compressing audio

a. Sample rate – For broadband and CD-ROM uses, set your sample rate to at least 32kHz.

b. Bit depth – Only use 16 bit.

c. Channels – For most listeners, stereo is less important than having a high sample rate and few artifacts.

d. Data rate – Higher data rate make audio sound better, but they require larger files. Typically the data rate of a file allocated to audio is much less than video. Getting the data rate balanced correctly between audio and video is all about balancing mediocrity. **You've got it right when the quality gain of raising the audio doesn't match the quality loss of dropping the video data rate by the same amount.**

D. Digital Audio Players

A. Audio players include such players as Win Amp, MusicMatch and RealJukebox for PCs.

B. Liquid Audio for MACs.

C. Now download to external MP3 audio players instead of burning music CD's.

XI. Conversion between formats

A. Converting DivX to VCD or SVCD will mean a greater loss of quality, but DVD players can only play mpeg 1 and mpeg 2 files. DVD Ripping is the process of copying DVD files (eg. VOB, IFO, BUP files) from the DVD to your hard-drive, without the CSS (Content Scrambling System) scrambling the files during the copying process.

1. A guide is to give you step-by-step and precise instructions on how to convert your DVD to DivX or XviD.
. **http://www.digital-digest.com/dvd/articles/dvdtodivx.html**

2. This site will help you to make your own **VideoCDs**, **SVCDs** or **DVDs** that can be played on your standalone DVD Player from video sources like DVD, Video, TV, Cam or downloaded movie clips like DivX, MOV, RM, WMV and ASF. **http://www.vcdhelp.com/**

3. The definitive DVD backup resource **http://www.doom9.net/**

B. Windows Media Encoder

1. Designed for novice user.

2. Handles live broadcast, live capture, offline encoding, and recording screen activities.

C. RealVideo Encoding Tools

1. Helix Producer Basic (formerly RealProducer) is the free version of the RealVideo encoder, available for classic Windows and Linux.

2. Includes live broadcast and file-based encoding in the same software.

XII. What to look for in a Compression Tool. (Some videoediting software such as Adobe Premier along with several others contain compression tools within the program. However many have limited compression tools and users must also use separate compression tools to obtain the results they desire.)

A. Price – Run from free to $1,000.

B. Platforms – PC or MAC

C. Preprocessing – Hardest part of a compression tool to get right.

D. Input format support – At a minimum you want your software to be able to directly open files produced by any editing or capture software you want to use in your production pipeline. Avi, MPG-1, etc.

E. Output format support – Quicktime, Windows Media, RealVideo, etc.

F. Speed

G. Stability – Stability for compression products also extends to correctness and compliance in compression. It isn't okay if the app doesn't crash, but the encoded files crash computers on playback!

H. Integration – Some editing tools support direct exporting to compression tools from their time. This eliminates the need to make an intermediate file, and can substantially improve workflow.

I. Automation – For high volume encoding operations, some degree of automation is required.

J. Live Capture Support – Some tools can capture video and compress it in real time. Others can capture video from within the app, but still require offline compression after the capture.

K. Examples of compression tools: Cleaner 5, Canopus ProCoder, Adobe Premiere, Adobe After Effects, Virtual Dub (free software), Sorenson Squeeze. HipFlics, Helix Producer, Vegas Video, Windows Media Encoder.

XIII. Digital Media Delivery System – Two Broad categories – Disk-based and Web-based. (We can still transfer back to VCR analog format using conversion hardware such as WIN-TV, ATI All-in-Wonder, Dazzle along with a number of other products.)

A. Biggest advantages of disk playback over Web playback

1. Low Latency
2. High bandwidth
3. Because the video files reside on local storage devices, random access is nearly instantaneous – there's no buffering, no waiting.

B. Disadvantages of disk playback

1. User must have access to the media
2. There's always a limited amount of local storage space.

XIV. Distributing over the Internet

A. Types of Web Video

1. Downloadable file – The audience uses a file transfer mechanism such as FTP to download the file. No attempt is made to play it in real time.

2. Progressive download – Sits between downloadable files and real-time streaming. Like file-based content, progressive download files are served from standard Web and FTP servers. It is not real time, and it uses lossless file transfer protocols like HTTP and FTP. Modern progressive download systems can start playing the file while it's partially transmitted, but the video may have interruptions if the bandwidth is limited.

3. Real-time streaming – Works in real time. No matter the duration of the file, it'll start playing in less than a minute, and assuming stable and sufficient bandwidth, it will play all the way through. Real-time streaming also provides random access, so the user can fast-forward and rewind. Requires specific streaming video server software, vendor-specific for Windows Media and RealVideo, and with a variety of options for QuickTime and MPEC-4.

4. Multicasting – Real-time streaming which multiple recipients can all view the same content at the same time. This contrasts with the unicasting

model of normal real-time streaming, where a single on-demand stream is sent to each user who requests it.

5. Live broadcasting – A special form of multicasting in which the video is captured and compressed as well as transmitted in real time.

For distributing video from a Web site or via e-mail, it's generally best to stick with one of the following codecs, due to the fact that they're installed on just about every PC (and many Macs as well): Cinepak Codec by Radius or Indeo Video. Sorenson Video has been QuickTime's primary video codec since the release of QuickTime 3.

Compared with Cinepak, Sorenson Video generally achieves higher image quality at a fraction of the data rate. This allows for higher quality, and either faster viewing (on the WWW), or more movies on a CD-ROM (often four times as much material on a disc as Cinepak).

For WWW usage, the playback performance is more affected by the pixel rate (how many pixels are drawn to the screen in a given second), rather than the data rate. Therefore, if you don't mind delays for the web viewer, you can usually double the data rates listed. However, increasing the frame size and frames per second may impact playback performance and should be tested.

B. Streaming Audio – Internet Radio

1. **Real Audio**

a. **Real Audio** is the trademark name for a streaming media format developed by Real Networks. The term streaming means that you don't have to download the entire file before you can listen to it - you listen to it as it is downloaded to your Real Audio player. The file can also adapt to multiple bandwidths, so you can distribute to a much wider audience. Another feature of Real Audio is that you can limit your users to listening to your audio only when they are online. Unlike MP3s, the actual Real Audio file only passes through the user’s player. It is not saved to their hard drive, where they can distribute and manipulate it any way they want. Real Audio is currently the most popular format for streaming audio content on the Web.

b. Real Producer Basic (MAC/PC)
www.real.com
This is Real Networks entry level encoder. It can encode digital audio and video for either specified or multiple bandwidths (via G2 SureStream format). If you have access to a Real Audio G2 server, you can also produce live Webcasts. There is an encoding wizard as

a part of the program that helps answer any questions you may have.

Limitations: Only encodes for Real Player 8 (i.e., not backward compatible for older players), and you can only encode one file at a time

c. **Real Producer Plus** (MAC/PC/Linux/Solaris) - $149.95
www.real.com
This commercial version of the Real Producer includes much wider range of encoding schemes and filters for both audio and video, a bandwidth simulator to preview your end result, the ability handle larger files and also edit the Real Media after it has already been encoded. You can also make your files backwards compatible for older versions of the Real Player.

Part II

I. Shooting Compression Friendly Video

A. The more complex your image and the more it moves, the more difficult it is for a codec to reproduce that image well. Classic, sedate shooting and editing compress well. Jump cuts, wild motion graphics, and handheld (shakycam) camera work are difficult or impossible to compress well at lower data rates. "Mr. Rogers good, MTV bad," says it all.

B. When designing for low data rate delivery, avoid using elements that aren't essential to what you're trying to communicate. The lower the target data rate, the simpler the video needs to be. For 56k modem delivery, aim for Spartan simplicity. If your delivery platform is a DVD player, you'll be able to shoot just about anything you would for broadcast delivery.

C. Soft, diffuse, even lighting is much easier to compress than lighting that produces deep shadows and hard edges.

D. Always start with the highest possible quality audio to achieve optimal compression results.

E. Using a narrow depth of field can be a very useful technique to force the codec to spend bits on the elements you care about. If producing in an environment where the background can't be controlled, such as outdoors or on a convention floor, making sure your talent is in focus and irrelevant details aren't, will substantially improve the clarity of your communication.

F. Reduce Complex background detail. One of the most difficult things to compress is foliage blowing in the wind. While this is pretty boring content, the continual motion of the highly detailed leaves is incredibly demanding.

G. Use tight shots. A long panoramic shot may look great in the viewfinder, but the talent in the middle of the screen may vanish into insignificance when taken down to Web resolutions.

H. Use a tripod or dolly. Handheld shots with lots of changing angles require a lot of bits to encode.

II. **Production tips for good compression**

A. Use motion blur. The most difficult content to compress is rapidly moving complex images. With motion blur, static elements are sharp and moving elements become soft and blurred so there's never sharp AND moving images at the same time. Motion blur is usually found as a rendering option, as a plug-in, or as a filter in 2D and 3D graphic packages as well as video editing software. It can take longer to render motion blur.

B. Render in the highest-quality mode.

C. No rapid cutting. A cut every 10 seconds isn't a big deal, but MTV-style editing, with a cut every second or less, can cause that section of video to be reduced to incomprehensible mush after editing.

D. No complex motion graphics where multiple on-screen elements change simultaneously.

E. Don't rotate or zoom. Modern codecs support motion estimation which is the ability to find a portion of one frame that has moved from another frame.

F. Use simple backgrounds.

G. Do not use fine print. Sharp edges and details of small text are difficult to compress.

H. **Avoid cross-fades.** It's much more efficient to use hard cuts.

I. **Use animation source.** 3D animation software makes a great source for compression.

III. Preprocessing Compression Tips (The period between when the original source clips are ready and before it is rendered by the codec.)

A. Cropping – Includes trimming out unwanted portions of the frame.

B. Edge blanking – Broadcast video signals are over scanned – that is, they're larger than the viewable area on a TV screen. This is done to hide irregularities in the edges of aging or poorly adjusted picture tubes on old analog TVs. The area of the video frame that carries the picture is called the *active* picture. The areas outside the active picture area are called *blanking* areas.

Computer monitors and similar digital devices show every pixel. LCD displays physically have one pixel per pixel of the display. CRT displays are naturally analog, but instead of cutting off the edges of the video, the whole image is shown with a black border around the edge of he monitor. When displayed on a computer monitor or in a media player's window on a wireless device, blanking from the analog source is extraneous, and you should crop it out.

C. Safe areas – While blanking is used to accommodate the foibles of television picture tubes, *video safe areas* were designed to further protect important information from the ravages of aging analog television. Portions of an image that appear near the edge of the screen become distorted, making it difficult to read text or otherwise see fine detail. The action safe area is inset five percent from the left/right/top/bottom edges of the frame. Assume anything falling within this zone will not be visible on all TV sets.

D. Letterboxing – Originally standard film production was done in the 4:3 aspect ratio that television uses. Now most television productions are being shot in 16:0 in anticipation of the HDTV future, but currently most content ends up getting displayed on tradition 4:3 television.

1. How to Display a widescreen image on a smaller display

a. Pan and Scan – Entails chopping enough off the edges of the film frame for it to fit the 4:3 window.

b. Letterboxing – Displays the full width of the film frame on a 4:3 display and fills the areas left blank above and below the 16:9 image with black bars. This preserve the full image at the cost of making the overall image smaller, while not filling the available on-screen real estate.

E. Scaling – Cropping defines the source rectangle. Scaling defines the size and the shape of the output rectangle. Scaling can be trickier than it sounds because source is often not square-pixel or may have an unusual aspect ratio. The basic rule, when targeting square-pixel formats (as is the norm), is to make the aspect ratio of the output resolution match that of the input resolution.

F. Noise Reduction – Noise reduction refers to a broad set of filters and techniques that are used to remove errors from video frames. These errors encompass all the ways video goes wrong—composite noise artifacts, film grain and video grain from shooting in low light, film scratches, artifacts from DV

compression, and so one. While noise reduction can help some, it never results in content as good as if it were produced cleanly in the first place.

G. **Lowpass Filtering –** A lowpass filter lets low frequency information pass through and cuts out high frequencies. For video, frequency is a measure of how fast the video changes from one pixel to the next. Thus, a lowpass filter tends to soften sharp edges, but leaves other stuff alone.

H. **Composite Noise –** Composite noise is caused by high-frequency luma information leaking into the chroma channels when luma and chroma channels are combined into a single signal. This is one of the reasons you should avoid capturing video through a composite connector if at all possible.

M. **Brightness –** Brightness filters adjust the overall intensity of the light by raising or lowering the value of each pixel by a fixed amount. If brightness is used in compression, it is normally used to make the video darker overall, instead of lighter.

N. **Contrast –** Contrast increases or decreases the values of each pixel by an amount proportional to how far away it is from the middle of the range.

O. **Audio Preprocessing –** There's a lot less to do in audio preprocessing than video because there isn't as huge a difference between a stereo system and a computer with speakers as there is between a TV and a computer with monitor. Well-produced audio aimed for home stereo system or television delivery will already be normalized and clean, and it might not need anything further for successful compression.

1. **Normalization –** Normalization adjusts the level of an audio clip by finding the single loudest sound in the entire file, and then raising or lowering the volume of the whole clip so that the loudest sound matches whatever level has been specified. This doesn't change the relative volume at all, just the absolute overall volume.

2. **Compression –** There is an audio filter called a compressor. In audio, extreme transients (very loud, very short noises), such as explosions or cymbal crashes, can cause distortions in audio playback and recording devices. Likewise, extremely quiet passages can get lost in the noise floor (the always present hums and hisses). Audio compressors act on dynamic range, smoothing out peaks and valleys of a signal making it seem larger and louder – they're the reason television commercials seem so much louder than regular programs. Audio compression, when used properly, can tame wild level changes.

3. Noise Reduction – An audio can have a lot of tape hiss, air conditioners in the background, hum from power lines, wind in the mics, etc. A

number of professional audio tools are available to reduce this noise although the results are never as good as if the audio had been noise-free in the first place.

IV. Rendering or Compression of the video is the final step.

A. Some software can render in real- time while others take much longer than the original clip.