

UNIT III:

Animation : The power of motion-Principles of animation –Animation by computer- Making animations that Work. Video:Using Video-Working with Video and Displays-Digital Video containers-Obtaining Video clips-Shooting and Editing video .

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CHAPTER 5:ANIMATION

Definition :

- Animation makes static presentations come alive.
- It is visual change over time and can add great power to your multimedia projects and web pages.
- Many multimedia applications for both Macintosh and Windows provide animation tools.

The Power of Motion

- Animate your whole project, or you can animate here and there, accenting and adding spice.
- For a brief product demonstration with little user interaction, it might make sense to design the entire project as a video and keep the presentation always in motion.
- For speaker support, you can animate bulleted text or fly it onto the screen, or you can use charts with quantities that grow or dwindle; then, give the speaker control of these eye-catchers.
- Visual effects such as wipes, fades, zooms, and dissolves are available in most multimedia authoring packages, and some of these can be used for primitive animation.
- Animation is an object actually moving across or into or out of the screen;

Principles of Animation

- Animation is possible because of a biological phenomenon known as persistence of vision and a psychological phenomenon called phi.
- An object seen by the human eye remains chemically mapped on the eye's retina for a brief time after viewing.
- Combined with the human mind's need to conceptually complete a perceived action, this makes it possible for a series of images that are changed very slightly and very rapidly, one after the other, to seemingly blend together into a visual illusion of movement.
- The illustration shows a few cels, or frames, of a rotating logo. When the images are progressively and rapidly changed, the arrow of the compass is perceived to be spinning.

Additive Dissolve Image A fades into image B.	Displace The red and green channels of image displace the pixels of image B.	Page Peel Image A starts with a shaded back to reveal image B underneath.	Spin Away Image B spins from a perspective plane, covering image A.
Band Slide Image B slides over image A in horizontal or vertical bands.	Dither Dissolve Image A Dissolves into image B.	Page Turn Image A curls to reveal image B underneath.	Spiral Boxes Boxes wipe in a spiral to reveal image B under image A.
Band Wipe Image B is revealed under image A by horizontal or vertical bands.	Doors Image B swings in over image A on horizontal or vertical doors.	Paint Splatter Paint splatters, revealing image B under image A.	Split Image A splits and slides to the sides to reveal image B.
Barn Doors Image B is revealed under image A from the center outwards.	Fold Up Image A is repeatedly folded over to reveal image B.	Peel Back Image A curls in four parts, with a shaded back, revealing image B.	Stretch Image B stretches over image A.
Center Merge Image A splits into 4 parts and slides to the center to reveal image B.	Funnel Image A is pulled through a funnel, revealing image B.	Pict Mask A user selected PICT is used to mask image B onto image A.	Swap Both images move to the sides, then return to the center, swapped.
Center Peel Image A curls from the center, with shaded back, revealing image B.	Gradient Wipe A soft wipe follows the gradient of a user selected image.	Pinwheel Multiple wipes from the center of image A sweep to reveal image B.	Swing In Image B swings in over image A.
Center Split Image A splits into 4 parts and slides to the corners to reveal image B.	Inset A corner wipe reveals image B under image A.	Push Image B pushes image A to one side.	Swing Out Image B swings out over image A.
Channel Map Selected Channels from images A and B are mapped to the output.	Iris Cross A cross shaped wipe opens to reveal image B under image A.	Radial Wipe A wipe sweeps to reveal image B under image A.	Swirl Image B spins in from margin, swirling rectangles.
CheckerBoard Two sets of alternating boxes wipe to reveal image B under image A.	Iris Diamond A diamond shaped wipe opens to reveal image B under image A.	Random Blocks Random boxes appear, revealing image B under image A.	Texturize Image A is mapped into image B.
Clock Wipe A wipe from the center of image A sweeps to reveal image B.	Iris Points A pointed wipe closes to reveal image B over image A.	Random Wipe A moving wipe, with a random edge, reveals image B under image A.	Three-D The source images are mapped into the red and blue output channels.
Cross Dissolve Image A fades into image B.	Iris Round A circular wipe opens to reveal image B under image A.	Roll Away Wipe reveals image B under image A, with roll.	Transition Factory A user defined set of expressions defines the transition.
Cross Stretch Image B stretches from an edge as image A shrinks.	Iris Square A rectangular wipe opens to reveal image B under image A.	Slash Slide Image B slides over image A in many independent slashes.	Venetian Blinds Horizontal wipes reveal image B under image A.
Cross Zoom Image A zooms in, then image B zooms out.	Iris Star A star shaped wipe opens to reveal image B under image A.	Slide Image B slides over image A.	Wedge Wipe A wipe from the center of image A sweeps to reveal image B.
Cube Spin Image A splits to reveal image B, mapped onto two faces of a cube.	Luminance Map The luminance of image A is mapped onto image B.	Sliding Bands Image B is revealed under image A by horizontal or vertical bands.	Wipe A moving wipe reveals image B under image A.
Curtain Image A is drawn back to reveal image B.	Multi-Spin Image B spins in from many rectangles.	Sliding Boxes Image B slides over image A in moving bands.	Zig-Zag Blocks Blocks wipe in a back and forth pattern to reveal image B under image A.
Direct Image B is passed directly through.	Non-Additive Dissolve The luminance of image A is mapped onto image B.	Spin Image B spins over image A.	Zoom Image B zooms to cover image A.

Figure 5-1 Animation authoring applications typically offer many visual effects and transitions.



- Digital television video builds 24, 30, or 60 entire frames or pictures every second, depending upon settings; the speed with which each frame is replaced by the next one makes the images appear to blend smoothly into movement.
- Movies on film are typically shot at a shutter rate of 24 frames per second, but using projection tricks (the projector's shutter flashes light through each image twice), the flicker rate is increased to 48 times per second, and the human eye thus sees a motion picture.

Animation by Computer

- Using appropriate software and techniques, you can animate visual images in many ways.
- The simplest animations occur in two-dimensional (2-D) space; more complicated animations occur in an intermediate "2½-D" space (where shadowing, highlights, and

forced perspective provide an illusion of depth, the third dimension); and the most realistic animations occur in three-dimensional (3-D) space.

- In 2-D space, the visual changes that bring an image alive occur on the flat Cartesian x and y axes of the screen.
- A blinking word, a color-cycling logo (where the colors of an image are rapidly altered according to a formula), a cel animation (described more fully later on in this chapter), or a button or tab that changes state on mouse rollover to let a user know it is active are all examples of 2-D animations.
- These are simple and static, not changing their position on the screen.
- Path animation in 2-D space increases the complexity of an animation and provides motion, changing the location of an image along a predetermined path (position) during a specified amount of time (speed).
- Authoring and presentation software such as Flash or PowerPoint provide user-friendly tools to compute position changes and redraw an image in a new location, allowing you to generate a bouncing ball or slide a corporate mascot onto the screen.
- Combining changes in an image with changes in its position allows you to “walk” your corporate mascot onto the stage. Changing its size from small to large as it walks onstage will give you a 3-D perception of distance.
- In 2½-D animation, an illusion of depth (the z axis) is added to an image through shadowing and highlighting, but the image itself still rests on the flat x and y axes in two dimensions.
- Embossing, shadowing, beveling, and highlighting provide a sense of depth by raising an image or cutting it into a background. Zaxwerks’ 3D Invigorator (www.zaxwerks.com), for example, provides 3-D effects for text and images and, while calling itself “3D,” works within the 2-D space of image editors and drawing programs such as Adobe Illustrator, Photoshop, Fireworks, and After Effects.
- In 3-D animation, software creates a virtual realm in three dimensions, and changes (motion) are calculated along all three axes (x, y, and z), allowing an image or object that itself is created with a front, back, sides, top, and bottom to move toward or away from the viewer, or, in this virtual space of light sources and points of view, allowing the viewer to wander around and get a look at all the object’s parts from all angles.
- Such animations are typically rendered frame by frame by high-end 3-D animation programs such as NewTek’s Lightwave or Autodesk’s Maya.

Animation Techniques

- When we create an animation, organize its execution into a series of logical steps.
- First, gather up in your mind all the activities you wish to provide in the animation.

Cel Animation

- The animation techniques made famous by Disney use a series of progressively different graphics or cels on each frame of movie film (which plays at 24 frames per second).
- A minute of animation may thus require as many as 1,440 separate frames, and each frame may be composed of many layers of cels.
- The term cel derives from the clear celluloid sheets that were used for drawing each frame, which have been replaced today by layers of digital imagery.
- Cel animation artwork begins with keyframes (the first and last frame of an action).
- The series of frames in between the keyframes are drawn in a process called **tweening**.
- **Tweening** is an action that requires calculating the number of frames between keyframes and the path the action takes, and then actually sketching with pencil the series of progressively different outlines.
- As tweening progresses, the action sequence is checked by flipping through the frames.
- The penciled frames are assembled and then actually filmed as a pencil test to check smoothness, continuity, and timing.
- Today, animators use reflective sensors applied to a person, animal, or other object whose motion is to be captured.
- Cameras and computers convert the precise locations of the sensors into x,y,z coordinates and the data is rendered into 3-D surfaces moving over time.

Computer Animation

- Computer animation programs typically employ the same logic and procedural concepts as cel animation and use the vocabulary of classic cel animation—terms such as layer, keyframe, and tweening.
- The primary difference among animation software programs is in how much must be drawn by the animator and how much is automatically generated by the software
- In path-based 2-D and 2½-D animation, an animator simply creates an object (or imports an object as clip art) and describes a path for the object to follow.
- The computer software then takes over, actually creating the animation on the fly as the program is being viewed by your user.
- In cel-based 2-D animation, each frame of an animation is provided by the animator, and the frames are then composited (usually with some tweening help available from the software) into a single file of images to be played in sequence.
- ULead's GIF Animator (www.ulead.com/ga) and Alchemy's GIF Construction Set Pro (www.mindworkshop.com) simply string together your collection of frames.

- For 3-D animation, most of your effort may be spent in creating the models of individual objects and designing the characteristics of their shapes and surfaces.
- It is the software that then computes the movement of the objects within the 3-D space and renders each frame, in the end stitching them together in a digital output file or container such as an AVI or QuickTime movie.
- On the computer, paint is most often filled or drawn with tools using features such as gradients and anti-aliasing.
- The word inks, in computer animation terminology, usually means special methods for computing color values, providing edge detection, and layering so that images can blend or otherwise mix their colors to produce special transparencies, inversions, and effects.
- Usually set your own frame rates on the computer. 2-D cel- based animated GIFs, for example, allow you to specify how long each frame is to be displayed and how many times the animation should loop before stopping.
- 3-D animations output as digital video files can be set to run at 15 or 24 or 30 frames per second.
- However, the rate at which changes are computed and screens are actually refreshed will depend on the speed and power of your user's display platform and hardware, especially for animations such as path animations that are being generated by the computer on the fly.
- Although your animations will probably never push the limits of a monitor's scan rate (about 60 to 70 frames per second), animation does put raw computing horsepower to task.
- 3-D animations are typically delivered as "pre-rendered" digital video clips. Software such as Flash or PowerPoint, however, render animations as they are being viewed, so the animation can be programmed to be interactive: touch or click on the jumping cat and it turns toward you snarling; touch the walking woman and...

Kinematics

- Kinematics is the study of the movement and motion of structures that have joints, such as a walking man.
- Animating a walking step is tricky: you need to calculate the position, rotation, velocity, and acceleration of all the joints and articulated parts involved—knees bend, hips flex, shoulders swing, and the head bobs.
- Smith Micro's Poser (<http://my.smithmicro.com>), a 3-D modeling program, provides pre-assembled adjustable human models (male, female, infant, teenage, and superhero) in many poses, such as "walking" or "thinking." As you can see in Figure 5-3, you can pose figures in 3-D and then scale and manipulate individual body parts. Surface textures can then be applied to create muscle-bound hulks or smooth chrome androids.

- Inverse kinematics, available in high-end 3-D programs such as Lightwave and Maya, is the process by which you link objects such as hands to arms and define their relationships and limits (for example, elbows cannot bend backward).
- Once those relationships and parameters have been set, you can then drag these parts around and let the computer calculate the result.

Morphing

- Morphing is a popular (if not overused) effect in which one image transforms into another.
- Morphing applications and other modeling tools that offer this effect can transition not only between still images but often between moving images as well.
- Some products that offer morphing features are Black Belt's Easy Morph and WinImages (www.black-beltsystems.com) and Human Software's Squizz (www.humansoftware.com).
- The morphed images were built at a rate of eight frames per second, with each transition taking a total of four seconds (32 separate images for each transition), and the number of key points was held to a minimum to shorten rendering time.
- Setting key points is crucial for a smooth transition between two images.

Animation File Formats

- Some file formats are designed specifically to contain animations, so they can be ported among applications and platforms with the proper translators.
- Those formats include Director (.dir and .dcr), AnimatorPro (.fli and .flc), 3D Studio Max (.max), GIF89a (.gif), and Flash (.fla and .swf).
- Because file size is a critical factor when downloading animations to play on web pages, file compression is an essential part of preparing animation files for the Web.
- A Director's native movie file (.dir), for example, must be preprocessed and compressed into a proprietary Shockwave animation file (.dcr) for the Web.
- Compression for Director movies is as much as 75 percent or more with this t, turning 100K files into 25K files and significantly speeding up download/display times on the Internet.
- Flash, widely used for web-based animation, makes extensive use of vector graphics (see Chapter 3) to keep the post-compression file size at absolute minimums. As with Director, its native .fla files must be converted to Shockwave Flash files (.swf) in order to play on the Web.
- To view these animations within a web page, special plug-ins or players are required (see Chapter 6).

- In some cases, especially with 3-D animations, the individual rendered frames of an animation are put together into one of the standard digital video file containers, such as the Windows Audio Video Interleaved format (.avi), QuickTime (.qt, .mov), or Motion Picture Experts Group video (.mpeg or .mpg).
- These can be played using the media players shipped with computer operating systems.
- New with HTML5 is animation built within a .svg (scalable vector graphics) file, where graphic elements can be programmed to change over time (www.w3.org/TR/SVG11/animate.html).
- In the following simple code, a patch of red expands within a rectangle, filling it in three seconds. Type this code into a text processor and save it as plain text with a .svg extension. Open the file with “File Open...” from a HTML5-compliant web browser to see it work. Change some parameters (duration, colors, location) and reload or refresh the file to see the effects of your changes.

```
<svg width="8cm" height="3cm" viewBox="0 0 800 300" xmlns="http://www.w3.org/2000/svg"
version="1.1">
<rect x="1" y="1" width="800" height="300" fill="none" stroke="rgb(255,0,255)" stroke-
width="4" />
<rect id="RectElement" x="300" y="100" width="300" height="100" fill="rgb(255,0,0)" >
<animate attributeName="x" attributeType="XML" begin="0s" dur="3s" fill="freeze"
from="300" to="0" />
<animate attributeName="y" attributeType="XML" begin="0s" dur="3s" fill="freeze"
from="100" to="0" />
<animate attributeName="width" attributeType="XML" begin="0s" dur="3s" fill="freeze"
from="300" to="800" />
<animate attributeName="height" attributeType="XML" begin="0s" dur="3s" fill="freeze"
from="100" to="300" />
</rect>
</svg>
```

- Multimedia authoring systems typically provide tools to simplify creating animations within that authoring system, and they often have a mechanism for playing the special animation files created by dedicated animation software.
- Today, the most widely used tool for creating multi-media animations for Macintosh and Windows environments and for the Web is Adobe’s Flash.
- Flash directly supports several 2½-D features, including z-axis positioning, automatic sizing and perspective adjustment, and kinematics.
- External libraries can extend Flash’s capabilities: open-source Papervision3D (<http://blog.papervision3d.org>) provides extensive support for true 3-D modeling and

animation; Figure 5-5 shows GreenSock's TweenMax (www.greensock.com/tweenmax) providing sophisticated tweening capabilities within Flash.

A Rolling Ball

- First, create a new, blank image file that is 100 × 100 pixels, and fill it with a sphere.
- Create a new layer in Photoshop, and place some white text on this layer at the center of the image.
- To animate the sphere by rolling it across the screen, you first need to make a number of rotated images of the sphere. Rotate the image in 45-degree increments to create a total of



eight images, rotating a full circle of 360 degrees. When each is displayed sequentially at the same location, the sphere spins:

- For a realistic rolling effect, the circumference (calculated at pi times 100, or about 314



pixels) is divided by 8 (yielding about 40 pixels).

- As each image is successively displayed, the ball is moved 40 pixels along a line.

A Bouncing Ball

- With the simplest tools, you can make a bouncing ball to animate your web site using GIF89a, an image format that allows multiple images to be put into a single file and then

displayed as an animation in a web browser or presentation program that recognizes the format.

- The individual frames that make up the animated GIF can be created in any paint or image-processing program, but it takes a specialized program to put the frames together into a GIF89a animation.
- As with the rolling ball example, you simply need to flash a ball on the computer screen rapidly and in a different place each time to make it bounce up and down.
- And as with the rolling ball, where you should compute the circumference of the ball and divide by the number of images to determine how far it rolls each time it flashes, there are some commonsense computations to consider with a bouncing ball, too. In the formula, s equals distance, a equals acceleration due to gravity, and t equals time:

$$s = \frac{1}{2} at^2$$

- Gravity makes your bouncing ball accelerate on its downward course and decelerate on its upward course (when it moves slower and slower until it actually stops and then accelerates downward again).
- Unless your animation requires precision, ignore the hard numbers you learned in high school (like 32 feet per second per second), and simply figure that your ball will uniformly accelerate and decelerate up and down the pixels of your screen by the squares: 1, 4, 9, 16, 25, 36, 49, 64, 81, 100 are the squares of 1, 2, 3, 4, 5, 6, 7, 8, 9, and 10.
- With a bit of programming, you might allow the user to choose the elasticity of the object, the amount of gravity, and the length of fall. Some animation software provides tools for this: it's called "**easing**."
- Open a graphics program and paint a ball about 15 pixels in diameter (if you have an odd-number diameter, there is a middle pixel that can be your center alignment point).
- Fancy, make the ball with a 3-D graphics tool that will shade it as a sphere. Then duplicate the ball, placing each copy of it in a vertical line at the ten locations 1, 4, 9, 16, 25, 36, 49, 64, 81, and 100. The goal is to create a separate image file for each location of the ball, like the pages of a flip-book.
- With Photoshop, you can create a single file with ten layers to contain each ball at its proper location, and you can add an eleventh background layer, too. Then save each layer showing against the background as a separate file.
- This is a construction process also easily managed with Director or Flash, in which you can place the same cast member or object (the ball) where you wish on the presentation stage.
- Also add a background and other art elements, and each frame as a graphics file using the export function. probably also wish to set the size of your stage to a small area just sufficient for your animation, say 32 × 120 pixels. The smaller the better if users will be downloading this animated GIF file into their web browsers.

Creating an Animated Scene

- A creative committee organized a brief storyboard of a gorilla chasing a man. From a stock library containing many images licensed for unlimited use, a photograph was chosen of Manhattan's Central Park where a bridge crossed a small river and high-rise apartments lined the horizon.
- The chase scene would occur across the bridge. To produce frames of the running man, a real actor was videotaped running in place against an Ultimatte chroma-keyed blue background in a studio; a few frames of this were grabbed, and the blue background was made transparent in each image. The gorilla was difficult to find, so a toy model dinosaur about 25 centimeters tall was used; again, a few frames were captured and the background made transparent to form a composite. That was all that was required for image resources.

CHAPTER 6: VIDEO

Definition:

- Motion video is the element of multimedia that can draw gasps from a crowd at a trade show or firmly hold a student's interest in a computer-based learning project.
- Digital video is the most engaging of multimedia venues, and it is a powerful tool for bringing computer users closer to the real world.
- It is also an excellent method for delivering multimedia to an audience raised on television.
- Video standards and formats are still being refined as transport, storage, compression, and display technologies take shape in laboratories and in the marketplace and while equipment and post-processing evolves from its analog beginnings to become fully digital, from capture to display.
- The multimedia elements, video places the highest performance demand on your computer or device—and its memory and storage.
- Compression (and decompression), using special software called a codec, allows a massive amount of imagery to be squeezed into a comparatively small data file, which can still deliver a good viewing experience on the intended viewing platform during playback.
- Control the delivery platform for your multimedia project, you can specify special hardware and software enhancements that will allow you to work with high-definition, full-motion video, and sophisticated audio for high-quality surround sound.
- Or you can design a project to meet a specific compression standard, such as MPEG2 for Digital Versatile Disc (DVD) playback or MPEG4 for home video.
- You can install a superfast RAID (Redundant Array of Independent Disks) system that will support high-speed data transfer rates.

- You can include instructions in your authoring system that will spool video clips into RAM, ready for high-speed playback before they need to play.
- Having control of the playback platform is always good, but it is seldom available in the real world, so as you develop your video elements, you will need to make many choices and compromises based upon your assessment of the “lowest common denominator” playback platform where your project will be used.

How Video Works and Is Displayed

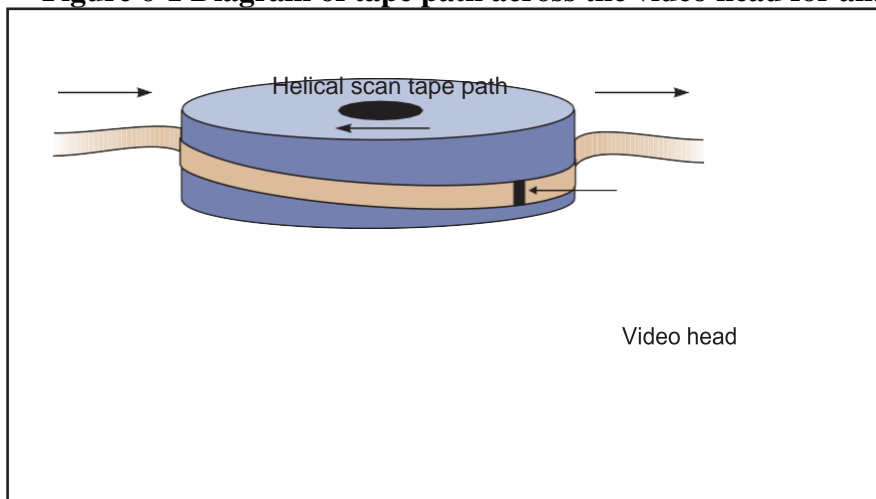
- ❖ When light reflected from an object passes through a video camera lens, that light is converted into an electronic signal by a special sensor called a **charge-coupled device** (CCD).
- ❖ Top-quality broadcast cameras and even camcorders may have as many as three CCDs (one for each color of red, green, and blue) to enhance the resolution of the camera and the quality of the image.
- ❖ It’s important to understand the difference between analog and digital video.
- ❖ Analog video has a resolution measured in the number of horizontal scan lines (due to the nature of early cathode-tube cameras), but each of those lines represents continuous measurements of the color and brightness along the horizontal axis, in a linear signal that is analogous to an audio signal.
- ❖ Digital video signals consist of a discrete color and brightness (RGB) value for each pixel.
- ❖ Digitizing analog video involves reading the analog signal and breaking it into separate data packets. This process is similar to digitizing audio, except that with video the vertical resolution is limited to the number of horizontal scan lines.
- ❖ For some multimedia projects you may need to digitize legacy analog video.
- ❖ The following discussion will help you understand the differences between analog and digital video and the old and new standards for horizontal lines, aspect ratios, and interlacing.

Analog Video

- ❖ In an analog system, the output of the CCD is processed by the camera into three channels of color information and synchronization pulses (sync) and the signals are recorded onto magnetic tape.
- ❖ There are several video standards for managing analog CCD output, each dealing with the amount of separation between the components—the more separation of the color information, the higher the quality of the image (and the more expensive the equipment).

- ❖ If each channel of color information is transmitted as a separate signal on its own conductor, the signal output is called **component** (separate red, green, and blue channels), which is the preferred method for higher-quality and professional video work.
- ❖ Lower in quality is the signal that makes up Separate Video (S-Video), using two channels that carry luminance and chrominance information.
- ❖ The least separation (and thus the lowest quality for a video signal) is composite, when all the signals are mixed together and carried on a single cable as a composite of the three color channels and the sync signal.
- ❖ The composite signal yields less-precise color definition, which cannot be manipulated or color-corrected as much as S-Video or component signals.
- ❖ The analog video and audio signals are written to tape by a spinning recording head that changes the local magnetic properties of the tape's surface in a series of long diagonal stripes.
- ❖ Because the head is canted or tilted at a slight angle compared with the path of the tape, it follows a helical (spiral) path, which is called helical scan recording.
- ❖ A single video frame is made up of two fields that are interlaced (described in detail later in the chapter).
- ❖ Audio is recorded on a separate straight-line track at the top of the videotape, although with some recording systems (notably for ¾-inch tape and for ½-inch tape with high-fidelity audio), sound is recorded helically between the video tracks.
- ❖ At the bottom of the tape is a control track containing the pulses used to regulate speed.
- ❖ Tracking is the fine adjustment of the tape during playback so that the tracks are properly aligned as the tape moves across the playback lead.

Figure 6-1 Diagram of tape path across the video head for analog recording



- ❖ Many consumer set-top devices like video cassette recorders (VCRs) and satellite receivers add the video and sound signals to a sub-carrier and modulate them into a radio frequency

(RF) in the FM broadcast band. This is the NTSC, PAL, or SECAM signal available at the Antenna Out connector of a VCR.

- ❖ Usually the signal is modulated on either Channel 3 or Channel 4, and the resulting signal is demodulated by the TV receiver and displayed on the selected channel.
- ❖ Many television sets today also provide a composite signal connector, a S-Video connector, and a High-Definition Multimedia Interface (HDMI) connector for purely digital input.
- ❖ Video displays for computers typically provide analog component (red, green, blue) input through a 15-pin VGA connector and also a purely digital Digital Visual Interface (DVI) and/or an HDMI connection.
- ❖ Three analog broadcast video standards are commonly in use around the world: NTSC, PAL, and SECAM.
- ❖ In the United States, the NTSC standard has been phased out, replaced by the ATSC Digital Television Standard.
- ❖ Because these standards and formats are not easily interchangeable, it is important to know where your multimedia project will be used.
- ❖ A video cassette recorded in the United States (which uses NTSC) will not play on a television set in any European country (which uses either PAL or SECAM), even though the recording method and style of the cassette is “VHS.” Likewise, tapes recorded in European PAL or SECAM formats will not play back on an NTSC video cassette recorder.
- ❖ Each system is based on a different standard that defines the way information is encoded to produce the electronic signal that ultimately creates a television picture.
- ❖ Multiformat VCRs can play back all three standards but typically cannot dub from one standard to another. Dubbing between standards still requires high-end, specialized equipment.

NTSC

- ❖ The United States, Canada, Mexico, Japan, and many other countries used a system for broadcasting and displaying video that is based upon the specifications set forth by the 1952 National Television Standards Committee (NTSC).
- ❖ These standards defined a method for encoding information into the electronic signal that ultimately created a television picture.
- ❖ As specified by the NTSC standard, a single frame of video was made up of 525 horizontal scan lines drawn onto the inside face of a phosphor-coated picture tube every 1/30th of a second by a fast-moving electron beam.
- ❖ The drawing occurred so fast that your eye would perceive the image as stable. The electron beam actually made two passes as it drew a single video frame—first it laid down all the odd-numbered lines, and then all the even-numbered lines.

- ❖ Each of these passes (which happen at a rate of 60 per second, or 60 Hz) painted a field, and the two fields were then combined to create a single frame at a rate of 30 frames per second (fps). (Technically, the speed is actually 29.97 Hz.)

PAL

- ❖ The Phase Alternate Line (PAL) system was used in the United Kingdom, Western Europe, Australia, South Africa, China, and South America.
- ❖ PAL increased the screen resolution to 625 horizontal lines, but slowed the scan rate to 25 frames per second.
- ❖ As with NTSC, the even and odd lines were interlaced, each field taking 1/50 of a second to draw (50 Hz).

SECAM

- ❖ The Sequential Color and Memory (SECAM) (taken from the French name, reported variously as *Système Électronique pour Couleur Avec Mémoire* or *Séquentiel Couleur Avec Mémoire*) system was used in France, Eastern Europe, the former USSR, and a few other countries.
- ❖ Although SECAM is a 625-line, 50 Hz system, it differed greatly from both the NTSC and the PAL color systems in its basic technology and broadcast method.
- ❖ Often, however, TV sets sold in Europe utilized dual components and could handle both PAL and SECAM systems.

Digital Video

- ❖ In digital systems, the output of the CCD is digitized by the camera into a sequence of single frames, and the video and audio data are compressed before being written to a tape or digitally stored to disc or flash memory in one of several proprietary and competing formats.
- ❖ Digital video data formats, especially the codec used for compressing and decompressing video (and audio) data, are important;

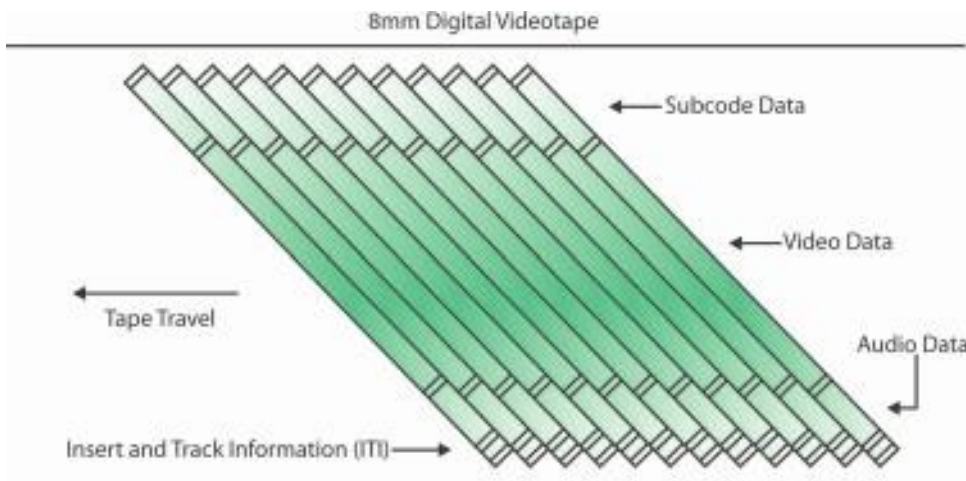
In 1995, Apple's FireWire technology was standardized as IEEE 1394, and Sony quickly adopted it for much of its digital camera line under the name i.Link. FireWire and i.Link (and USB 2) cable connections allow a completely digital process, from the camera's CCD to the hard disk of a computer; and camcorders store the video and sound data on an onboard digital tape, writable mini-DVD, mini-hard disk, or flash memory.

HDTV

What started as the High Definition Television (HDTV) initiative of the Federal Communications Commission in the 1980s changed first to the Advanced Television (ATV) initiative and then finished as the Digital Television (DTV) initiative by the time the FCC announced the change in 1996. This standard, which was slightly modified from both the Digital Television Standard (ATSC Doc. A/53) and the Digital Audio Compression Standard (ATSC Doc. A/52), moved U.S. television from an analog to a digital standard. It also provided TV stations with sufficient bandwidth to present four or five Standard Television (STV, providing the NTSC's resolution of 525 lines with a 3:4 aspect ratio, but in a digital signal) signals or one HDTV signal (providing 1,080 lines of resolution with a movie screen's 16:9 aspect ratio).

HDTV provides high resolution in a 16:9 aspect ratio (see Figure 6-3). This aspect ratio allows the viewing of Cinemascope and Panavision movies. There was contention between the broadcast and computer industries about whether to use interlacing or progressive-scan technologies. The broadcast industry promulgated an ultra-high-resolution, 1920 × 1080 interlaced format (1080i) to become the cornerstone of the new generation of high-end entertainment centers, but the computer industry wanted a 1280 × 720 progressive-scan system (720p) for HDTV. While the 1920 × 1080 format provides more pixels than the 1280 × 720 standard, the refresh rates are quite different. The higher-resolution interlaced format delivers only half the picture every 1/60 of a second, and because of the interlacing, on highly detailed images there is a great deal of screen flicker at 30 Hz. The computer people argue that the picture quality at 1280 × 720 is superior and steady. Both formats have been included in the HDTV standard by the Advanced Television Systems Committee (ATSC), found at www.atsc.org.

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- Both formats have been included in the HDTV standard by the Advanced Television Systems Committee (ATSC).

Displays

- Colored phosphors on a cathode ray tube (CRT) screen glow red, green, or blue when they are energized by an electron beam.
- Because the intensity of the beam varies as it moves across the screen, some colors glow brighter than others.
- Finely tuned magnets around the picture tube aim the electrons precisely onto the phosphor screen, while the intensity of the beam is varied according to the video signal.
- This is why you needed to keep speakers (which have strong magnets in them) away from a CRT screen. A strong external magnetic field can skew the electron beam to one area of the screen and sometimes caused a permanent blotch that cannot be fixed by degaussing—an electronic process that readjusts the magnets that guide the electrons.
- Flat screen displays are all-digital, using either liquid crystal display (LCD) or plasma technologies, and have supplanted CRTs for computer use.
- Some professional video producers and studios, however, prefer CRTs to flat screen displays, claiming colors are brighter and more accurately reproduced.
- Full integration of digital video in cameras and on computers eliminates the analog television form of video, from both the multimedia production and the delivery platform.

- If your video camera generates a digital output signal, you can record your video direct-to-disk, where it is ready for editing.
- If a video clip is stored as data on a hard disk, CD-ROM, DVD, or other mass-storage device, that clip can be played back on a computer’s monitor without special hardware.

Interlacing and Progressive Scan

- The process of building a single frame from two fields is called interlacing, a technique that helps to prevent flicker on CRT screens.
- Computer monitors use a different progressive-scan technology, and draw the lines of an entire frame in a single pass, without interlacing them and without flicker.
- In television, the electron beam actually makes two passes on the screen as it draws a single video frame, first laying down all the odd-numbered lines, then all the even-numbered lines, as they are interlaced.
- On a computer monitor, lines are painted one-pixel thick and are not interlaced. Single-pixel lines displayed on a computer monitor look fine; on a television, these thin lines flicker brightly because they only appear in every other field.
- To prevent this flicker on CRTs, make sure your lines are greater than two pixels thick and that you avoid typefaces that are very thin or have elaborate serifs.
- Capturing images from a video signal, you can filter them through a de-interlacing filter provided by image-editing applications such as Photoshop and Fireworks. With typefaces, interlacing flicker can often be avoided by anti-aliasing the type to slightly blur the edges of the characters.
- The term “interlacing” has a different meaning on the Web, where it describes the progressive display of lines of pixels as image data is downloaded, giving the impression that the image is coming from blurry into focus as increasingly more data arrives
- Most computers today provide video outputs to CRT, LCD, or plasma monitors at greater than 1024 × 768 resolution.
- Table 6-1 describes the various aspect ratios and width/heights in pixels used by computer displays since IBM’s VGA standard was adopted in 1987.
- The VGA’s once ubiquitous 640 × 480 screen resolution is again becoming common for handheld and mobile device displays.

Acronym	Name	Aspect Ratio	Width (pixels)	Height (pixels)
VGA	Video Graphics Array	4:3	640	480
SVGA	Super Video Graphics Array	4:3	800	600
XGA	eXtended Graphics Array	4:3	1024	768
XGA+	eXtended Graphics Array Plus	4:3	1152	864
WXGA	Widescreen eXtended Graphics Array	5:3	1280	768
WXGA	Widescreen eXtended Graphics Array	8:5 (16:10)	1280	800
SXGA	Super eXtended Graphics Array	4:3	1280	960

SXGA	Super eXtended Graphics Array	5:4	1280	1024
HD	High Definition (Basic)	16:9	1366	768
WSXGA	Widescreen Super eXtended Graphics Array	8:5 (16:10)	1440	900
HD+	High Definiton (Plus)	16:9	1600	900
UXGA	Ultra eXtended Graphics Array	4:3	1600	1200
WSXGA+	Widescreen Super eXtended Graphics Array Plus	8:5 (16:10)	1680	1050
HD-1080	Full High Definition	16:9	1920	1080
WUXGA	Widescreen Ultra eXtended Graphics Array	8:5 (16:10)	1920	1200

Overscan and the Safe Title Area

- It is common practice in the television industry to broadcast an image larger than will fit on a standard TV screen so that the “edge” of the image seen by a viewer is always bounded by the TV’s physical frame, or bezel.
- This is called overscan. In contrast, computer monitors display a smaller image on the monitor’s picture tube (underscan), leaving a black border inside the bezel.
- Consequently, when a digitized video image is displayed on a CRT, there is a border around the image; and, when a computer screen is converted to video, the outer edges of the image will not fit on a TV screen
- . Only about 360 of the 480 lines of the computer screen will be visible. Video editing software often will show you the safe areas while you are editing.

Digital Video Containers

- A digital video architecture is made up of an algorithm for compressing and encoding video and audio, a container in which to put the compressed data, and a player that can recognize and play back those files.
- Common containers for video are Ogg (.ogg, Theora for video, Vorbis for audio), Flash Video (.flv), MPEG (.mp4), QuickTime (.mov), Windows Media Format (.wmv), WebM (.webm), and RealMedia (.rm).
- Containers may include data compressed by a choice of codecs, and media players may recognize and play back more than one video file container format.
- Container formats may also include metadata—important information about the tracks contained in them—and even additional media besides audio and video.
- The QuickTime container, for example, allows inclusion of text tracks, chapter markers, transitions, and even interactive sprites.
- Totally Hip’s LiveStage Pro is an authoring tool that can produce interactive multimedia self-contained within a single QuickTime .mov container.

Codecs

- To digitize and store a 10-second clip of full-motion video in your computer requires the transfer of an enormous amount of data in a very short amount of time.
- Reproducing just one frame of digital video component video at 24 bits requires almost 1MB of computer data; 30 seconds of full-screen, uncompressed video will fill a gigabyte hard disk.
- Full-size, full-motion uncompressed video requires that the computer deliver data at about 30MB per second.
- This overwhelming technological bottleneck is overcome using digital video compression schemes or codecs (coders/decoders).
- A codec is the algorithm used to compress a video for delivery and then decode it in real time for fast playback.
- Different codecs are optimized for different methods of delivery (for example, from a hard drive, from a DVD, or over the Web). Codecs such as Theora and H.264 compress digital video information at rates that range from 50:1 to 200:1.
- Some codecs store only the image data that changes from frame to frame instead of the data that makes up each and every individual frame.
- Other codecs use computation-intensive methods to predict what pixels will change from frame to frame and store the predictions to be deconstructed during playback.
- These are all lossy codecs where image quality is (somewhat) sacrificed to significantly reduce file size.

MPEG

- The MPEG standards were developed by the Moving Picture Experts Group (MPEG, www.mpeg.org), a working group convened by the International Organization for Standardization (ISO) and the International Electro-technical Commission (IEC), which created standards for the digital representation of moving pictures as well as associated audio and other data.
- Using MPEG-1 (specifications released in 1992), you could deliver 1.2 Mbps (megabits per second) of video and 250 Kbps (kilobits per second) of two-channel stereo audio using CD-ROM technology.
- MPEG-2 (specifications released in 1994), a completely different system from MPEG-1, required higher data rates (3 to 15 Mbps) but also delivered higher image resolution, improved picture quality, interlaced video formats, multiresolution scalability, and multichannel audio features.
- MPEG-2 became the video compression standard required for digital television (DTV) and for making DVDs.

- The MPEG specifications since MPEG-2 include elements beyond just the encoding of video.
- As a container, MPEG-4 (specifications released in 1998 and 1999) provides a content-based method for assimilating multimedia elements.
- It offers indexing, hyperlinking, querying, browsing, uploading, downloading, and deleting functions, as well as “hybrid natural and synthetic data coding,” which will enable harmonious integration of natural and synthetic audiovisual objects.
- With MPEG-4, multiple views, layers, and multiple sound tracks of a scene, as well as stereoscopic and 3-D views, are available, making virtual reality workable.
- MPEG-4 can adjust to varied download speeds, making it an attractive option for delivery of video on the Web.
- The MPEG-4 AVC standard (Advanced Video Coding, Part 10) requires the H.264 codec for Blu-ray discs.

The Codec Wars

- The high bit rate requirements of video and the (relatively) low bit rates available from CD-ROMs, and later from the Web, have led to a long and occasionally confusing progression in the development of codecs.
- Generally, the greater the compression, the more processing “horse-power” (and waiting time) is needed to compress and decompress the video.
- So only relatively new computers are capable of decompressing highly compressed video at a rate that can keep up with the video data stream.
- Using the best or “latest” codecs in your project is a good idea, but it must be balanced by ensuring that the video will play on the widest range of computers.
- The Flash video container, which uses the older VP6 and a newer H.263 codec (depending upon version), is used by YouTube and at many web sites but requires the Flash plug-in to be installed in the user’s browser.
- For playing WMV containers, Macintosh computers require installing the Silverlight plug-in, a Microsoft development framework similar to Flash.
- The H.264 codec was developed by the Moving Picture Experts Group, is patented and proprietary, and is required on Blu-ray discs and used by YouTube, iTunes, and some broadcast services.
- Google’s open-source VP8 codec works within the WebM container (www.webmproject.org), and was launched as an effort to replace Flash and H.264 on the Web.
- Google is re-encoding all its Flash holdings at YouTube to work with WebM and VP8 as well as with the H.264 codec.

Because of this codec and container war, for web developers wishing to place video elements onto their pages, programming with the HTML5 <VIDEO> tag (which was supposed to simplify and standardize inclusion of video at web sites) remains as complicated as ever. This is a constantly changing area of development, so check these browsers from time to time to see which codecs and containers are currently supported:

Internet Explorer 9	Firefox 4.0+	Safari 3.0+	Chrome 6+	Opera 11.0+	Apple iPhone/iPad	Android Devices	
MP4 Container	Yes		yes	yes		yes	Yes
with H.264 video							
and ACC audio							
codecs							
MOV Container			yes			yes	
with H.264 video							
and ACC audio							
codecs							
OGG Container		yes		yes	yes		
with Theora							
video and Vorbis							
audio codecs							
WebM Container	Yes	yes		yes	yes	yes	Yes
with VP8 video							

and Vorbis audio codecs							
Flash FLV	plug-in	plug-in	plug-in	plug-in	plug-in		
Container with VP6 video and MP3 audio codecs	required	required	required	required	required		
Flash FLV	plug-in	plug-in	plug-in	plug-in	plug-in		
Container with H.263 video and MP3 audio codecs	required	required	required	required	required		
Flash MP4	plug-in	plug-in	plug-in	plug-in	plug-in		
Container with H.264 video and AAC audio codecs	required	required	required	required	required		

Table 6-3 Not All HTML5 Video Containers and Their Codecs Are Recognized as Playable by All Browsers

Video Format Converters

- ❖ DVD video uses MPEG-2 compression. Blu-ray video uses MPEG-4 AVC compression. These are known standards and few choices are necessary: simply click “Save for DVD” or “Save for Blu-ray.”

- ❖ But if you need to prepare a video file that will run on an iPod, a Droid, and an Atom-based netbook, as well as in all web browsers, you will need to convert your material into multiple formats.
- ❖ There are many free, shareware, and inexpensive file format converters available for multiple platforms.
- ❖ There are many sources for film and video clips: a friend’s home movies may suffice, or you can go to a “stock” footage house or a television station or movie studio.
- ❖ But acquiring footage that you do not own outright can be a nightmare—it is expensive, and licensing rights and permissions may be difficult, if not impossible, to obtain. Each second of video could cost \$50 to \$100 or more to license.
- ❖ It is important to understand at least the basics of video recording and editing, as well as the constraints of using video in a multimedia project.
- ❖ Setting up a production environment for making digital video requires hardware that meets minimum specifications for processing speed, data transfer, and storage.
- ❖ There are many considerations to keep in mind when setting up your production environment, depending on the capabilities of your camcorder:
 - ✓ Fast processor(s)
 - ✓ Plenty of RAM
 - ✓ Computer with FireWire (IEEE 1394 or i.Link) or USB connection and cables
 - ✓ Fast and big hard disk(s)
 - ✓ A second display to allow for more real estate for your editing software
 - ✓ External speakers
 - ✓ Nonlinear editing (NLE) software

The Shooting Platform

- ✓ If shoot handheld, try to use a camera with an electronic image stabilization feature for static shots, use a “steady-cam” balancing attachment, or use camera moves and a moving subject to mask your lack of steadiness.
- ✓ Even using a rolling office chair and sitting facing the back with the camera balanced on the chair-back makes a convenient, stable dolly.
- ✓ If you must shoot handheld, set the camera’s lens to the widest angle: at a wide angle, camera motion becomes smaller relative to the field of view and is thus less apparent.
- ✓ Many digital camcorders will allow you to choose 4:3 or 16:9 aspect ratios for your recording, one or the other.
- ✓ There is no easy way to convert between these aspect ratios, so you should decide up front which to use in your multimedia project.
- ✓ There are two ways to convert from 16:9 to 4:3. The Letterbox or hard matte method produces blank bars at top and bottom, but leaves the original image untouched;

- ✓ Pan and Scan, on the other hand, loses both sides of the original image. When using the Pan and Scan method for conversion, editors will carefully pan across wide scenes to capture the best area to show.
- ✓ Videographers and wide-screen moviemakers often consider a 4:3 “safe frame” area when setting up their wide shots, knowing that their work will be converted to 4:3 for the DVD aftermarket.
- ✓ Some DVDs use an anamorphic widescreen coding system to squeeze 16:9 widescreen image data into a DVD’s standard 4:3 aspect ratio format; with a compatible player, these “Enhanced for Widescreen Televisions” discs will play the original video properly on a 16:9 screen. Converting 16:9 to 4:3, Converting 4:3 to 16:9

Storyboarding

- ✓ Preplanning a video project is a factor that cannot be ignored without costing time loss, lots of unnecessary aggravation, and money that would be better spent elsewhere.
- ✓ Successful video production, of any sort, deserves the time it takes to make a plan to carry it out.
- ✓ It may take a little time at first, but you’ll find it to be very helpful in the long run. Storyboards are like any sequential comic you read daily.
- ✓ Every day there are three or four panels showing a progression of story or information.
- ✓ Take the time to structure your production by writing it down and then engineer a sequential group of drawings showing camera and scene, shooting angles, lighting, action, special effects, and how objects move through from start to finish. A storyboard can get everyone on one page quickly.

Lighting

- ✓ Difference between professional camcorders and consumer camcorders is their ability to perform at low light levels.
- ✓ With proper lighting, however, it may be difficult for uninitiated viewers to differentiate between shots taken with an expensive studio-grade video camera and an inexpensive camcorder.
- ✓ Using a simple floodlight kit, or even just being sure that daylight illuminates the room, can improve your image.
- ✓ Onboard battery lights for camcorders can be useful, but only in conditions where the light acts as a “fill light” to illuminate the details of a subject’s face.
- ✓ As in photography, good lighting techniques separate amateurs from professionals in video shoots.
- ✓ The standard lighting arrangement of a studio is displayed with fill, key, rim, and background lights.

- ✓ Changing any of these lights can make a dramatic difference in the shot. This project originally used a QuickTime container of several hundred single-frame images of the model as she is lit by every permutation of lamp and intensity; clicking a light switch instantly shows the effect of that combination.

Chroma Keys

- ✓ Chroma keys allow you to choose a color or range of colors that become transparent, allowing the video image to be seen “through” the computer image.
- ✓ This is the technology used by a newscast’s weather person, who is shot against a blue background that is made invisible when merged with the electronically generated image of the weather map.
- ✓ The weatherman controls the computer part of the display with a small handheld controller.
- ✓ A useful tool easily implemented in most digital video editing applications is blue screen, green screen, Ultimatte, or chroma key editing.
- ✓ When Captain Picard of Star Trek fame walks on the surface of the moon, it is likely that he is actually walking on a studio set in front of a screen or wall painted blue. Actually placing Picard on the moon was, no doubt, beyond the budget of the shoot, but it could be faked using blue screen techniques.
- ✓ After shooting the video of Picard’s walk against a blue background and shooting another video consisting of the desired background moonscape, the two videos were mixed together: wherever there was blue in the Picard shot, it was replaced by the background image, frame by frame.
- ✓ Blue screen is a popular technique for making multimedia titles because expensive sets are not required. Incredible backgrounds can be generated using 3-D modeling and graphic software, and one or more actors, vehicles, or other objects can be neatly layered onto that background.
- ✓ Video editing applications provide the tools for this.

When you are shooting blue screen, be sure that the lighting of the screen is absolutely even; fluctuations in intensity will make this “key” appear choppy or broken.

- ✓ Shooting in daylight, and letting the sun illuminate the screen, will mitigate this problem.
- ✓ Also be careful about “color spill.” If your actors stand too close to the screen, the colored light reflecting off the screen will spill onto them, and parts of their body will key out.
- ✓ While adjustments in most applications can compensate for this, the adjustments are limited..

Composition

- ✓ The general rules for shooting quality video for broadcast use also apply to multimedia.

- ✓ When shooting video for playback in a small window, it is best to avoid wide panoramic shots, as the sweeping majesty will be lost.
- ✓ Use close-ups and medium shots, head-and-shoulders or even tighter.
- ✓ Depending upon the compression algorithm used
- ✓ Consider also the amount of motion in the shot: the more a scene changes from frame to frame, the more “delta” information needs to be transferred from the computer’s memory to the screen.
- ✓ Keep the camera still instead of panning and zooming; let the subject add the motion to your shot, walking, turning, talking.
- ✓ Beware of excessive backlighting—shooting with a window or a bright sky in the background—is a common error in amateur video production.
- ✓ Many cameras can be set to automatically compensate for backlighting. If you adjust for this, the background may be “blown out” (so bright the video signal peaks), but at least the foreground image you’re focusing on will be visible. Of course, the best choice in this situation is to light the foreground.
- ✓ Non-professional cameras are set to always adjust the iris (the opening in the lens) to keep the image’s overall exposure at a constant level.
- ✓ When you go from a dark to light setting the camera will adjust, and you can often see this shift. Pro cameras allow the iris setting to be locked down to avoid this.
- ✓ In different situations, white may not be white, depending on the color temperature (warmth or coolness) of the light source.
- ✓ White balance corrects for bluish, orange, or greenish color casts resulting from an uneven distribution of colors in the spectrum your eye tells you is white, but your less forgiving digital camera says is not quite white.
- ✓ Many cameras automatically set white balance with best guesses, but they also offer adjust tab

Titles and Text

- ✓ Titles and text are often used to introduce a video and its content.
- ✓ They may also finish off a project and provide credits accompanied by a sound track.
- ✓ Titles can be plain and simple, or they can be storyboarded and highly designed.
- ✓ For plain and simple, you can use templates in an image editor and then sequence those images into your video using your video editing software.
- ✓ We can create your own imagery or animations and sequence them.
- ✓ More elaborate titles, typical for feature films and commercial videos, can become multimedia projects in themselves.
- ✓ Upasana Nattoji Roy’s title design for Director Indrajit Nattoji’s “Aagey Se Right,” for example, began with creative ideas transitioned into a detailed storyboard and animations and was finally rendered using AfterEffects..

If make your own, here are some suggestions for creating good titles:

- Fonts for titles should be plain, sans serif, and bold enough to be easily read.
- When you are laying text onto a dark background, use white or a light color for the text.
- Use a drop shadow to help separate the text from the background image.
- Do not kern your letters too tightly.
- If you use underlining or drawn graphics, always make your lines at least two pixels wide. If you use a one-pixel-wide line (or a width measured in an odd number of pixels), the line may flicker when transferred to video due to interlacing.
- Use parallel lines, boxes, and tight concentric circles sparingly. When you use them, draw them large and with thick lines.
- Avoid colors like bright reds and magenta that are too “hot”; they might twinkle and buzz.
- Neighboring colors should be markedly different in intensity. For example, use a light blue and a dark red, but not a medium blue and a medium red.
- Keep your graphics and titles within the safe area of the screen. Remember that CRT televisions overscan (see the earlier section “Overscan and the Safe Title Area”).
- Bring titles on slowly, keep them on screen for a sufficient time, and then fade them out.
- Avoid making busy title screens; use more pages or a longer sequence instead.

Nonlinear Editing (NLE)

- ✓ Top-of-the-line nonlinear editing (NLE) software includes Adobe’s Premiere, Apple’s Final Cut, and Avid’s Media Composer, the “A Team” of professional video editors.
- ✓ These are feature-packed and expensive packages designed to work hand-in-hand with fast and powerful computers (six gigabytes of RAM recommended) and dedicated file servers.
- ✓ Many hours of training and many days of experience are needed before users become proficient.

Table 6-4 contains a list of free video editing software applications to choose from.

Name	Platform	Download Address
Avidemux	Windows/Mac/BSD/Linux	www.avidemux.org
Cinelerra	Linux/Mac	www.heroinewarrior.com/cinelerra.php
iMovie	Mac	www.apple.com/ilife/imovie
Kdenlive	Linux/BSD/Mac	www.kdenlive.org

Kino	Linux/BSD	http://kinodv.org
LIVES	Linux/BSD/Mac	http://lives.sourceforge.net
OpenShot	Linux	www.openshotvideo.com
Pinnacle Videospin	Windows	www.videospin.com/Redesign
PiTiVi	Linux	www.pitivi.org
VideoLab	Windows	www.mitov.com/html/videolab.html
VideoThang TM	Windows	www.videothang.com
VirtualDub	Windows	www.virtualdub.org
Windows Live Movie Maker	Windows	http://explore.live.com/windows-live-movie-maker

- ✓ The video codecs used are lossy, so each time you finalize a file, it will be less true than the original material—this is called **generation loss**.
- ✓ Because NLE software works with EDLs (edit decision lists) based upon the raw source video, be sure you have sufficient disk space to store your original footage.