

UNIT –II

Images: Plan Approach –Organize Tools-Configure Computer Workspace-Making Still Images-Color-Image File Formats. Sound: the Power of Sound-Digital Audio-MIDI Audio - MIDI Vs Digital Audio – Multimedia System Sounds- Audio File Formats-Vaughan’s laws of Multimedia Minimums- Adding Sound to Multimedia Project.

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Chapter 3: Images

Definition

- ❖ Multimedia is an computer screen is a composite of elements: text, symbols, photograph-like bitmaps, vector-drawn graphics, three-dimensional renderings, distinctive buttons to click, and windows of motion video.
- ❖ The computer screen is where the action is, and it contains much more than your message; it is also the viewer’s primary connection to all of your project’s content.
- ❖ Graphic elements can usually be scaled to different sizes, colored or patterned or made transparent, placed in front of or behind other objects, or be made visible or invisible on command.
- ❖ How to blend these elements, how to choose your colors and fonts, the hallmarks of your skill, talent, knowledge, and creativity coalesced into the all-important visual connection to your viewers.

Plan Approach

- ❖ Whether you use templates and ready-made screens provided by your authoring system, clip art or objects crafted by others, or even if you simply clone the look and feel of another project—there will always be a starting point where your page is “clean.”
- ❖ To get a handle on any multimedia project, you start with pencil, eraser, and paper. Outline your project and your graphic ideas first: make a flow- chart; storyboard the project using stick figures; use three-by-five index cards and shuffle them until get it right.
- ❖ When you have a clear idea what they want, submit a few variations—different visual designs, color palettes, and layouts.

Organize Tools

- ❖ Most authoring systems provide the tools with which you can create the graphic objects of multimedia (text, interactive buttons, vector-drawn objects, and bitmaps) directly on your screen.
- ❖ Working with animated objects or motion video, most authoring systems include a feature for activating these elements, such as a programming language or special functions for embedding them.
- ❖ Tools will offer a library of special effects—including zooms, wipes, and dissolves.

- ❖ Many multimedia designers do not limit their toolkits to the features of a single authoring platform, but employ a variety of applications and tools to accomplish many specialized tasks.

Configure Computer Workspace

- ❖ When developing multimedia, it is helpful to have more than one monitor to provide lots of screen real estate (viewing area).
- ❖ In this way, can display the full-screen working area of your project or presentation and still have space to put your tools and other menus.
- ❖ This is particularly important in an authoring system such as Flash or Director, where the edits and changes you make in one window are immediately visible in the presentation window—provided the presentation window is not obscured by your editing tool!
- ❖ During development there is a lot of cutting and pasting among windows and among various applications, and with an extra monitor, open many windows at once and spread them out.
- ❖ Both Macintosh and Windows operating systems support this extra hardware.

Making Still Images

- ❖ Still images may be small or large, or even full screen.
- ❖ They may be colored, placed at random on the screen, evenly geometric, or oddly shaped.
- ❖ Still images may be a single tree on a wintry hillside; stacked boxes of text against a gray, tartan, or Italian marble background; an engineering drawing; a snapshot of your department manager's new BMW.
- ❖ Whatever their form, still images are generated by the computer in two ways: as bitmaps (or paint graphics) and as vector-drawn (or just plain “drawn”) graphics.
- ❖ Bitmaps may also be called “raster” images. Likewise, bitmap editors are sometimes called “painting” programs. And vector editors are sometimes called “drawing” programs.
- ❖ **Bitmaps** are used for photo-realistic images and for complex drawings requiring fine detail.
- ❖ **Vector-drawn objects** are used for lines, boxes, circles, polygons, and other graphic shapes that can be mathematically expressed in angles, coordinates, and distances.
 - A drawn object can be filled with color and patterns, and you can select it as a single object. The appearance of both types of images depends on the display resolution and capabilities of your computer's graphics hardware and monitor.
 - Both types of images are stored in various file formats and can be translated from one application to another or from one computer platform to another.

Typically, image files are compressed to save memory and disk space; many bitmap image file formats already use compression within the file itself—for example, GIF, JPEG, and PNG.

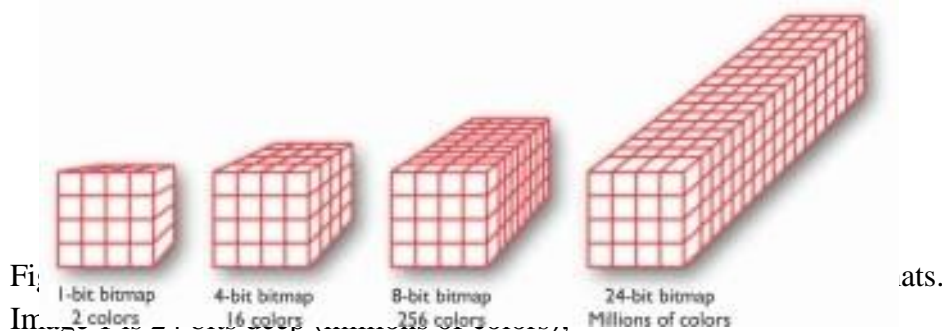
- ❖ Still images may be the most important element of your multimedia project or web site.

- ❖ A bit is the simplest element in the digital world, an electronic digit that is either on or off, black or white, or true (1) or false (0). This is referred to as binary, since only two states (on or off) are available.
- ❖ A map is a two-dimensional matrix of these bits. A bitmap, then, is a simple matrix of the tiny dots that form an image and are displayed on a computer screen or printed.
- ❖ A one-dimensional matrix (1-bit depth) is used to display mono-chrome images—a bitmap where each bit is most commonly set to black or white.
- ❖ Depending upon your software, any two colors that represent the on and off (1 or 0) states may be used.
- ❖ These picture elements (known as pels or, more commonly, pixels) can be either on or off, as in the 1-bit bitmap, or, by using more bits to describe them, can represent varying shades of color (4 bits for 16 colors; 8 bits for 256 colors; 15 bits for 32,768 colors; 16 bits for 65,536 colors; 24 bits for 16,772,216 colors).
- ❖ Four possible ways and can, then, describe only four possible colors:

Bit Depth	Number of Colors Possible	of Available Combinations Describing a Color	Binary for
1-bit	2	0, 1	
2-bit	4	00, 01, 10, 11	
4-bit	16	0000, 0001, 0011, 0111, 1111, 0010, 0100, 1000, 0110, 1100, 1010, 0101, 1110, 1101, 1001, 1011	

Figure 3-1 A bitmap is a data matrix that describes the characteristics of all the pixels making up an image.

- ❖ Each cube represents the data required to display a 4 × 4-pixel image (the face of the cube) at various color depths (with each cube extending behind the face indicating the number of bits— zeros or ones—used to represent the color for that pixel).



- ❖ Image 2 is dithered to 8 bits using an adaptive palette (the best 256 colors to represent the image);
- ❖ Image 3 is also dithered to 8 bits, but uses the Macintosh system palette (an optimized standard mix of 256 colors).

- ❖ Image 4 is dithered to 4 bits (any 16 colors); Image 5 is dithered to 8-bit gray-scale (256 shades of gray); Image 6 is dithered to 4-bit gray-scale (16 shades of gray); and Image 7 is dithered to 1 bit (two colors—in this case, black and white).

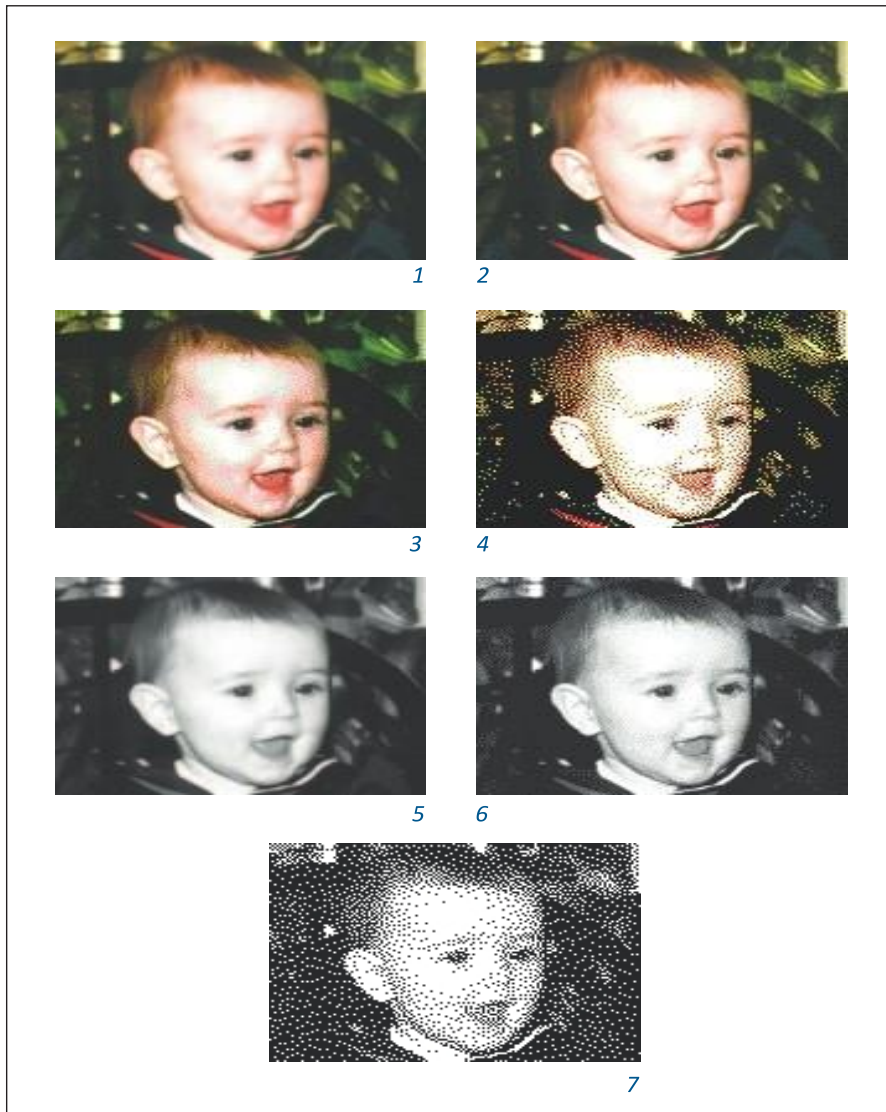


Figure 3-2 These images show the color depth of bitmaps as described in Figure 3-1. Note that Images 4 and 6 require the same memory (same file size), but the gray-scale image is superior. If file size (download time) is important, you can dither GIF bitmap files to the lowest color depth that will still provide an acceptable image.

Bitmap Sources

Where do bitmaps come from? How are they made? You can do the following

- Make a bitmap from scratch with a paint or drawing program.

- Grab a bitmap from an active computer screen with a screen capture program, and then paste it into a paint program or your application.
- Capture a bitmap from a photo or other artwork using a scanner to digitize the image. Once made, a bitmap can be copied, altered, e-mailed, and otherwise used in many creative ways.
- ❖ A clip art collection may contain a random assortment of images, or it may contain a series of graphics, photographs, sound, and video related to a single topic. Some 3-D modeling programs incorporate libraries of pre-made 3-D models into the application, allowing you to drag and drop common objects into a scene.

Figure 3-3 shows a page of thumbnails describing a commercially available resource of royalty-free images called **Photodisc**, a part of Getty Images (www.gettyimages.com).

- ❖ The Photodisc collections contain high-resolution bitmaps with a license for their “unlimited use.”

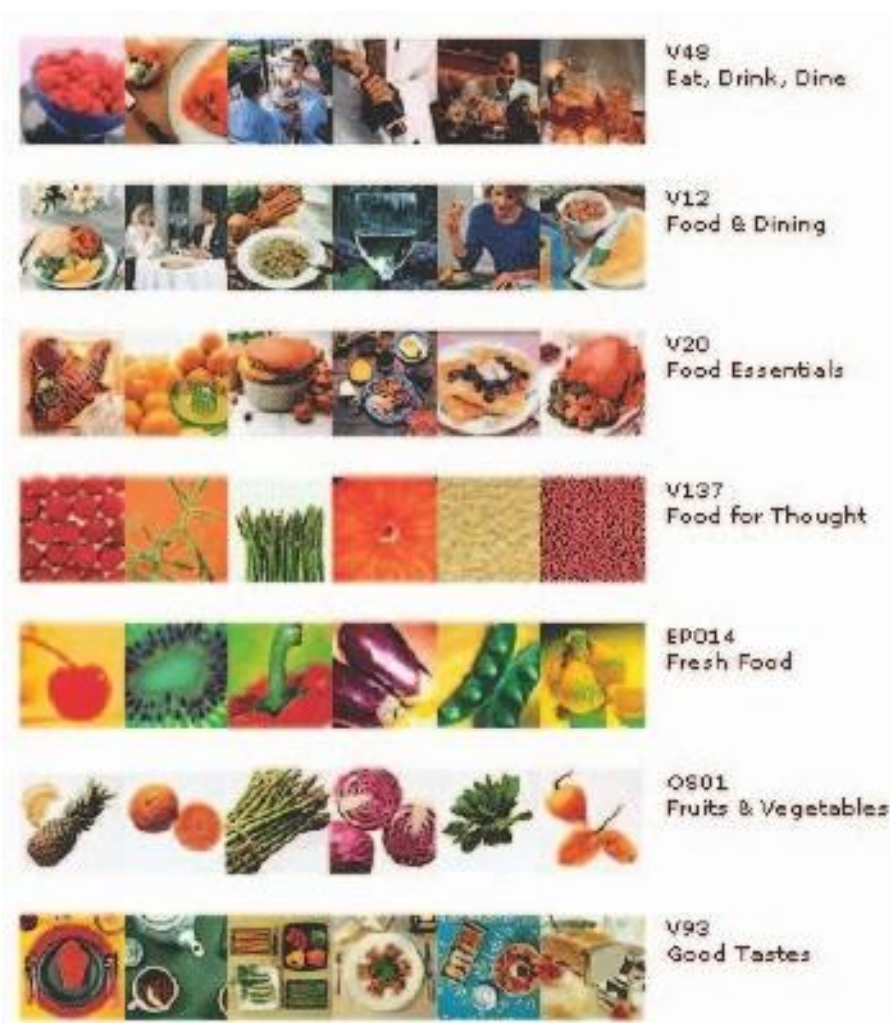


Figure 3-3 A page of thumbnails showing the content of various royalty-free Photodisc collections from Getty Images

- ❖ A bitmap, you can manipulate and adjust many of its properties (such as brightness, contrast, color depth, hue, and size).
- ❖ Cut and paste among many bitmaps using an image-editing program.
- ❖ If the clip art image is high resolution, may discover that you can grab just a tiny portion of the high-res image—say, a sheep in the far corner of a farmyard or a car in a parking lot—and it will look great when displayed at monitor resolution.

Bitmap Software

- ❖ The abilities and features of painting and image-editing programs range from simple to complex.
- ❖ The best programs are available in versions that work the same on both Windows and Mac platforms, and the graphics files make can be saved in many formats, readable across platforms.
- ❖ Many multimedia authoring tools offer built-in bitmap editing features. Director, for example, includes a powerful image editor that provides advanced tools such as “onion-skinning” and image filtering using common plug-ins.
- ❖ Adobe’s Photoshop, however, remains the most widely used image-editing tool among designers world- wide; it is available without some bells and whistles in a less-expensive version, Photoshop Elements, which may have all the features you need for your projects.
- ❖ Many designers also use a vector-based drawing program such as Adobe’s Illustrator, CorelDRAW, or InDesign to create curvy and complicated looks that they then convert to a bitmap.
- ❖ Image- editing software to create original images, such as cartoons, symbols, buttons, bitmapped text, and abstract images that have a refined “graphic” look, but it is virtually impossible to create a realistic-looking photo from scratch using an image-editing program.
- ❖ The artistic painting tools offered by Corel’s Painter (www.corel.com/painter) include hundreds of brushes, sprays, watercolors, inks, and textures to mimic the output of natural media in a bitmap (see Figure 3-4). There are also many open source and free bitmap editors available—just type “graphics editors” in a search engine. Figure 3-4 Painter is used



for creating original artwork; for book, medical, and architectural illustration; to transform photographs into realistic-looking paintings;

Capturing and Editing Images

The image you see on your monitor

- ❖ Both the Macintosh and Windows environments have a clipboard— an area of memory where data such as text and images is temporarily stored when you cut or copy them within an application.
- ❖ In Windows, when you press PRINT scREEN, a copy of your screen's image goes to the clipboard. From the clipboard, you can then paste the captured bitmap into an application (such as Paint, which comes with Windows).
- ❖ On the Macintosh, the keystroke combination coMMAND-SHIFt-3 creates a readable PNG-format file named Picture and places it on your desktop.
- ❖ Import this file's image into your multime- dia authoring system or paint program.
- ❖ Press coMMAND- coNTRoL-SHIFt-4 to drag a rectangle on your screen and capture what is inside the rectangle onto the clipboard, ready for pasting.
- ❖ **Morphing** is another effect that can be used to manipulate still images or to create interesting and often bizarre animated transformations.



Figure 3-6 Morphing software was used to seamlessly transform the images of 16 kindergartners.

- ❖ Image-editing programs may, indeed, represent the single most signif- ican advance in computer image processing during the late 1980s, bring- ing truly amazing power to PC desktops.

Scanning Images

- ❖ Objects can be scanned and manipulated using image-editing tools, such as those described in the preceding section, to create unusual, attention-getting effects.
- ❖ For example, to enliven a screen with a gardening motif, scan a mixture of seeds, some fall foliage, or grass-stained garden gloves.
- ❖ Open the scan in an image-editing program and experiment with different filters, the contrast, and various special effects
- ❖ Powerful filters and plug-ins are offered by most image-editing programs (see illustration to right) to manipulate bitmaps in many different ways.
- ❖ Experiment with your filters and plug-ins. Alien Skin's Exposure, for example, brings the creative tools of film photography to the world of digital editing with presets for many looks: discontinued films, dark-room tricks, lo-fi camera quirks like Holga and Lomo, vintage looks like Technicolor movie film and old Kodachrome that are distressed with dust, scratches, and lens blur, warped vignettes, and funky colors from cross-processing



(see Figure 3-7).

Figure 3-7 Exposure from Alien Skin, offering photography effects, is one of hundreds of commercial plug-ins and filters available for manipulating bitmapped images.

Vector Drawing

- ✓ Most multimedia authoring systems provide for use of vector-drawn objects such as lines, rectangles, ovals, polygons, complex drawings created from those objects, and text.
- Computer-aided design (CAD) programs have traditionally used vector-drawn object systems for creating the highly complex and geometric renderings needed by architects and engineers.
- Graphic artists designing for print media use vector-drawn objects because the same mathematics that put a rectangle on your screen can also place that rectangle (or the fancy curves of a good line-art illustration) on paper without jaggies. This requires the higher resolution of the printer, using a page description format such as Portable Document Format (PDF).
- Programs for 3-D animation also use vector-drawn graphics. For example, the various changes of position, rotation, and shading of light required to spin an extruded corporate logo must be calculated mathematically. (Animation is discussed in Chapter 5.)

How Vector Drawing Works

- ✓ A **vector** is a line that is described by the location of its two endpoints. Vector drawing uses Cartesian coordinates where a pair of numbers describes a point in two-dimensional space as the intersection of horizontal and vertical lines (the x and y axes).
- ✓ The numbers are always listed in the order x,y. In three-dimensional space, a third dimension—depth—is described by a z axis (x,y,z). This coordinate system is named for the French philosopher and mathematician, René Descartes. So a line might be simply

```
<line x1="0" y1="0" x2="200" y2="100">
```

where x1 and y1 define the starting point (in the upper-left corner of the viewing box) and x2 and y2 define the end point.

- ✓ A simple rectangle is computed from starting point and size: your software will draw a rectangle (rect) starting at the upper-left corner of your viewing area (0,0) and going 200 pixels horizontally to the right and 100 pixels downward to mark the opposite corner. Add color information like

```
<rect x="0" y="0" width="200" height="100" fill="#FFFFFF" stroke="#FF0000"/>
```

```
<circle cx="50" cy="50" r="10" fill="none" stroke="#000000" />
```

Vector-Drawn Objects vs. Bitmaps

- ✓ Vector-drawn objects are described and drawn to the computer screen using a fraction of the memory space required to describe and store the same object in bitmap form.
- ✓ The file containing the vector-drawn colored rectangle described in the preceding section is less than 698 bytes of alpha-numeric data (even less—468 bytes—when the description is tokenized or compressed as .svgz).
- ✓ File size advantage, web pages that use vector graphics as SVG files or in plug-ins such as Flash
- ✓ A single image made up of 500 individual line and rectangle objects, for example, may take longer for the computer to process and place on the screen than an image consisting of just a few drawn circle objects.
- ✓ A vector-drawn object is created “on the fly,” that is, the computer draws the image from the instructions it has been given, rather than displaying a precreated image.
- ✓ This means that vector objects are easily scalable without loss of resolution or image quality.
- ✓ A large drawn image can be shrunk to the size of a postage stamp, and while it may not look good on a computer monitor at 72 dpi, it may look great when printed at 300 dpi to a color printer.
- ✓ Resizing a bitmapped image requires either duplicating pixels (creating a blocky, jagged look called pixelation) or throwing pixels away (eliminating details).

- ✓ Because vector images are drawn from instructions on the fly, a rescaled image retains the quality of the original.

Converting Between Bitmaps and Drawn Images

- ✓ Most drawing programs offer several file formats for saving your work, and, if you wish, you can convert a drawing that consists of several vector-drawn objects into a bitmap when you save the drawing.
- ✓ You can also grab a bitmapped screen image of your drawn objects with a screen capture program.
- ✓ Converting bitmaps to drawn objects is more difficult.
- ✓ There are, however, programs and utilities that will compute the bounds of a bitmapped image or the shapes of colors within an image and then derive the polygon object that describes the image. This procedure is called **autotracing** and is available in vector drawing applications such as Illustrator or Freehand.
- ✓ Flash has a Trace Bitmap menu option that converts a bitmapped image into a vector image.

Drawing and Rendering

- ✓ Drawing in perspective or in 3-D on a two-dimensional surface takes special skill and talent.
- ✓ Creating objects in three dimensions on a computer screen can be difficult for designers comfortable with squares, circles, and other x (width) and y (height) geometries on a two-dimensional screen.
- ✓ Dedicated software is available to help you render three-dimensional scenes, complete with directional lighting and special effects, but be prepared for late nights and steep learning curves as you become familiar with nurbs, deformations, mesh generations, and skinning! From making 3-D text to creating detailed walkthroughs of 3-D space, each application will demand study and practice before you are efficient and comfortable with its feature set and power.
- ✓ Flat and colorless 2-D screens are no longer sufficient for a successful commercial multimedia project.
- ✓ 3-D-rendered graphic art and animation has become commonplace since the late 1980s, providing more lifelike substance and feel to projects.
- ✓ Autodesk's Maya (www.autodesk.com/Maya) are industry-standard, high-end animation programs used for everything from multimedia programs and game designs to special effects in films and even feature-length movies.
- ✓ For experimenting with 3-D, Google's SketchUp (sketchup.google.com) provides a simple (and free) cross-platform tool.

- ✓ To delve deeply into 3-D, the open-source Blender (www.blender.org) is a powerful tool—but its complex interface presents a steep learning curve.

Figure 3-9 3-D applications provide x, y, and z axes and adjustable perspective views.

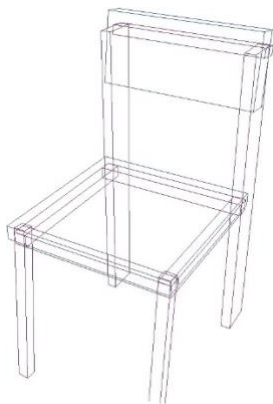
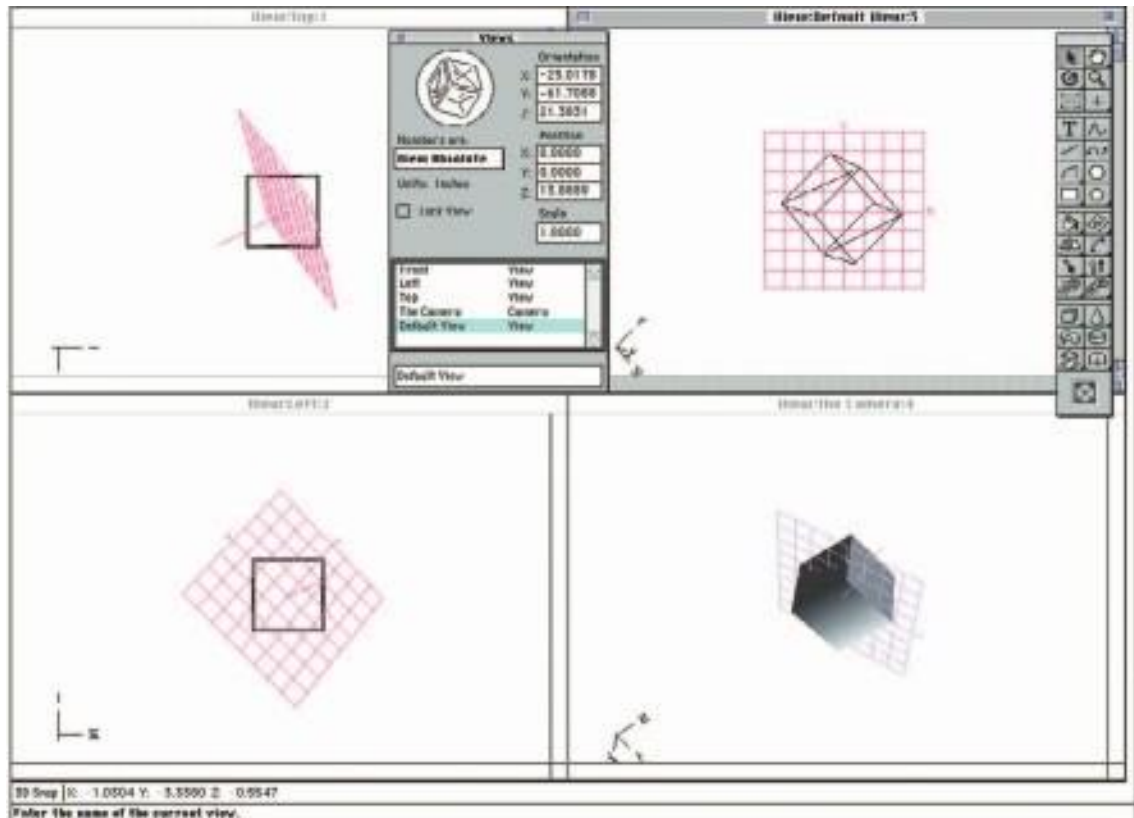


Figure 3-10 A chair modeled

- ✓ A great deal of information is needed to display a 3-D scene. Scenes consist of objects that in turn contain many small elements such as blocks, cylinders, spheres, or cones (described using mathematical constructs or formulas).
- ✓ The more elements contained in an object, the more complicated its structure will be and, usually, the finer its resolution and smoothness.
- ✓ Objects and elements in 3-D space carry with them properties such as shape, color, texture, shading, and location.
- ✓ A scene contains many different objects. Imagine a scene with a table, chairs, and a background. Zoom into one of the objects—the chair, for example, in Figure 3-10.
- ✓ It has 11 objects made up of various blocks and rectangles. Objects are created by modeling them using a 3-D application.

To model an object that you want to place into your scene, you must start with a shape. You can create a shape from scratch, or you can import a previously made shape from a library of geometric shapes called primitives, typically blocks, cylinders, spheres, and cones.

- ✓ In most 3-D applications, you can create any 2-D shape with a drawing tool or place the outline of a letter, then extrude or lathe it into the third dimension along the z axis (see

Shading can usually be applied in several ways. As illustrated in Figure 3-12, flat shading (b) is the fastest for the computer to render and is most often used in preview mode. Gouraud shading (a), Phong shading (d), and ray tracing (c) take longer to render but provide photo-realistic images.

- ✓ Rendering is when the computer finally uses intricate algorithms to apply the effects you have specified on the objects you have created.
- ✓ Rendering an image requires great computing muscle and often takes many hours for a single image, and you will feel the strength (or weakness) of your hardware.

Panoramas

- ✓ Media players such as QuickTime and RealPlayer let you view a single surrounding image as if you were “inside” the picture and able to look up or down, turn, or zoom in on features.
- ✓ To make this work, you need to stitch together many images taken from different angles around a circle. Software such as ULead COOL 360 (www.ulead.com/cool360) or Panorama Factory (www.panoramafactory.com) works by importing a sequence of photos and letting you adjust them precisely into a single seamless bitmap, where the right edge attaches to the left edge and the color and lighting differences among the image are smoothed.

Color

- ❖ Color is a vital component of multimedia.
- ❖ The next few sections explain where color comes from and how colors are displayed on a computer monitor.
- ❖ Management of color is both a subjective and a technical exercise.

Understanding Natural Light and Color

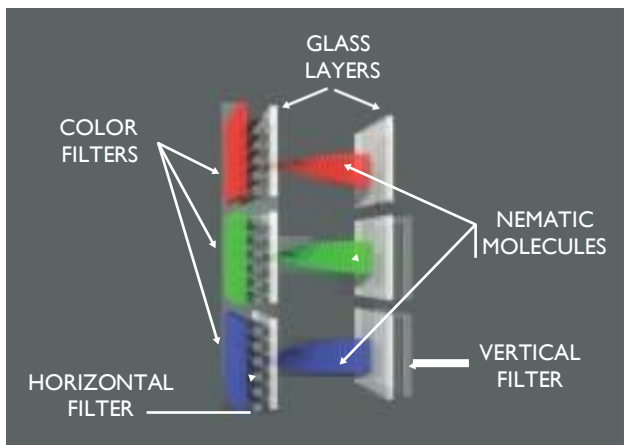
- ❖ Light comes from an atom when an electron passes from a higher to a lower energy level; thus each atom produces uniquely specific colors.
- ❖ This explanation of light, known as the quantum theory, was developed by physicist Max Planck in the late 19th century.
- ❖ Niels Bohr, another physicist, later showed that an excited atom that has absorbed energy and whose electrons have moved into higher orbits will throw off that energy in the form of quanta, or photons, when it reverts to a stable state. This is where light comes from
- ❖ **Color is the frequency of a light wave within the narrow band of the electromagnetic spectrum to which the human eye responds.**
- ❖ The letters of the mnemonic ROY G. BIV, learned by many of us to remember the colors of the rainbow, are the ascending frequencies of the visible light spectrum: red, orange, yellow, green, blue, indigo, and violet. Light that is infrared, or below the frequency of red light and not perceivable by the human eye, can be created and viewed by electronic diodes and sensors, and it is used for TV and VCR remote controls, for wireless communications among computers, and for night goggles used in the military.
- ❖ Infrared light is radiated heat. Ultraviolet light, on the other hand, is beyond the higher end of the visible spectrum and can be damaging to humans.
- ❖ The color white is a noisy mixture of all the color frequencies in the visible spectrum. Sunlight and fluorescent tubes produce white light
- ❖ The most common sources of light in the everyday (or every night) world. The light these sources produce typically reaches your eye as a reflection of that light into the lens of your eye.
- ❖ The cornea of the eye acts as a lens to focus light rays onto the retina. The light rays stimulate many thousands of specialized nerves, called rods, which cover the surface of the retina.
- ❖ Receptors in the cones are sensitive to red, green, and blue light, and all the nerves together transmit the pattern of color information to the brain.
- ❖ The eye can differentiate among about 80,000 colors, or hues, consisting of combinations of red, green, and blue.

As color information is sent to the brain, other parts of the mind massage the data en route to its point of cognitive recognition.

- ❖ Human response to color is complicated by cultural and experiential filters that cause otherwise straightforward color frequencies to carry pleasant, unpleasant, soothing, depressing, and many other special meanings. In Western cultures,
- ❖ Green, blue, yellow, orange, purple, pink, brown, black, gray, and white are the ten most common color-describing words used in all human languages and cultures.
- ❖ Although the eye perceives colors based upon red, green, and blue, there are actually two basic methods of making color: **additive and subtractive**.

Additive Color

- ❖ In the additive color method, a color is created by combining colored light sources in three primary colors: red, green, and blue (RGB). This is the process used for cathode ray tube (CRT), liquid crystal (LCD), and plasma displays.
- ❖ On the back of the glass face of a CRT are thousands of phosphorescing chemical dots. These dots are each about 0.30mm or less in diameter (the dot pitch), and are positioned very carefully and very close together, arranged in triads of red, green, and blue.
- ❖ These dots are bombarded by electrons that “paint” the screen at high speeds (about 60 times a second).
- ❖ The red, green, and blue dots light up when hit by the electron beam. Your eye sees the combination of red, green, and blue light and interpolates it to create all other colors.
- ❖ Like CRTs, LCD and plasma screens utilize tiny red, green, and blue elements energized through tiny transparent conductors.



Subtractive Color

- ❖ In the subtractive color method, color is created by combining colored media such as paints or ink that absorb (or subtract) some parts of the color spectrum of light and reflect the others back to the eye.
- ❖ Subtractive color is the process used to create color in printing.
- ❖ The printed page is made up of tiny halftone dots of three primary colors: cyan, magenta, and yellow (designated as CMY).
- ❖ Four-color printing includes black (which is technically not a color but, rather, the absence of color). Since the letter B is already used for blue, black is designated with a K (so four-color printing is designated as CMYK).

- ❖ The color remaining in the reflected part of the light that reaches your eye from the printed page is the color you perceive.
- ❖ High- end image-editing programs such as Photoshop deal with this problem by allowing you to calibrate your monitor with your printer.

The colors in 24-bit color, which is described in the next section. A zero indicates a lack of that primary color, while 255 is the maximum amount of that color.

RGB Combination (R,G,B)	Perceived Color
Red only (255,0,0)	Red
Green only (0,255,0)	Green
Blue only (0,0,255)	Blue
Red and green (blue subtracted) (255,255,0)	Yellow
Red and blue (green subtracted) (255,0,255)	Magenta
Green and blue (red subtracted) (0,255,255)	Cyan
Red, green, and blue (255,255,255)	White
None (0,0,0)	Black

Computer Color Models

- ❖ Models or methodologies used to specify colors in computer terms are RGB, HSB, HSL, CMYK, CIE, and others.
- ❖ Using the 24-bit RGB (red, green, blue) model, you specify a color by setting each amount of red, green, and blue to a value in a range of 256 choices, from 0 to 255.
- ❖ Eight bits of memory are required to define those 256 possible choices, and that has to be done for each of the three primary colors; a total of 24 bits of memory ($8 + 8 + 8 = 24$) are therefore needed to describe the exact color, which is one of “millions” ($256 \times 256 \times 256 = 16,777,216$).
- ❖ When web browsers were first developed, the software engineers chose to represent the color amounts for each color channel in a hexadecimal pair.
- ❖ Rather than using one number between 0 and 255, two hexadecimal numbers, written in a scale of 16 numbers and letters in the range “0123456789ABCDEF” represent the required 8 bits ($16 \times 16 = 256$) needed to specify the intensity of red, green, and blue. Thus, in HTML, specify pure green as #00FF00, where there is no red (first pair is #00), there is maximum green (second pair is #FF), and there is no blue (last pair is #00). The number sign (#) specifies the value as hexadecimal

Red	Green	Blue	Color
255 (#FF)	255 (#FF)	255 (#FF)	White (#FFFFFF)

255 (#FF)	255 (#FF)	0 (#00)	Yellow (#FFFF00)
255 (#FF)	0 (#00)	255 (#FF)	Magenta (#FF00FF)
0 (#00)	255 (#FF)	255 (#FF)	Cyan (#00FFFF)
255 (#FF)	0 (#00)	0 (#00)	Red (#FF0000)
0 (#00)	255 (#FF)	0 (#00)	Green (#00FF00)
0 (#00)	0 (#00)	255 (#FF)	Blue (#0000FF)
0 (#00)	0 (#00)	0 (#00)	Black (#000000)

- ❖ In the HSB (hue, saturation, brightness) and HSL (hue, saturation, lightness) models, you specify hue or color as an angle from 0 to 360 degrees on a color wheel, and saturation, brightness, and lightness as percentages.
- ❖ Saturation is the intensity of a color. At 100 percent saturation a color is pure; at 0 percent saturation, the color is white, black, or gray.
- ❖ Lightness or brightness is the percentage of black or white that is mixed with a color.
- ❖ A lightness of 100 percent will yield a white color; 0 percent is black; the pure color has a 50 percent lightness.
- ❖ The CMYK color model is less applicable to multimedia production. It is used primarily in the printing trade where cyan, magenta, yellow, and black are used to print process color separations.

Color	Degrees
Red	0°
Yellow	60°
Green	120°
Cyan	180°
Blue	240°
Magenta	300°

- ❖ Other color models include CIE, YIQ, YUV, and YCC.
- ❖ CIE describes color values in terms of frequency, saturation, and illuminance (blue/yellow or red/green, which in turn corresponds to the color receptors in the cones of the eye). CIE more closely resembles how human beings perceive color, but certain devices such as scanners are unable to replicate the process.
- ❖ YIQ and YUV were developed for broadcast TV (composite NTSC). They are based on luminance and chrominance expressed as the amplitude of a wave and the phase of the wave relative to some reference. Detail is carried by luminance (black and white), so reduction in color does not result in the loss of image definition detail.
- ❖ This analog process can be translated to a number value so that the computer can use a palette to assign a color to a pixel.

- ❖ The Photo YCC model has been developed by Kodak to provide a definition that enables consistent representation of digital color images from negatives, slides, and other high-quality input.
- ❖ YCC is used for PhotoCD images.



Color Palettes

- ❖ Palettes are mathematical tables that define the color of a pixel displayed on the screen. The most common palettes are 1, 4, 8, 16, and 24 bits deep:

Color Depth	Colors Available
1-bit	Black and white (or any two colors)
4-bit	16 colors
8-bit	256 colors (good enough for color images)
16-bit	Thousands of colors (65,536; excellent for color images)
24-bit	More than 16 million colors (16,777,216; totally photo-realistic)

- ❖ When color monitors became available for computers, managing the computations for displaying colors severely taxed the hardware and memory available at the time.
- ❖ 256-color, 8-bit images using a color lookup table or palette were the best a computer could do.
- ❖ 256 default system colors were statistically selected by Apple and Microsoft engineers (working independently) to be the colors and shades that are most “popular” in photographic images; their two system palettes are, of course, different.
- ❖ Web authorities also decided on a palette of 216 “web-safe” colors that would allow browsers to display images properly on both Macintosh and Windows computers.
- ❖ GIF files using 256-color palettes are saved in a lossless format.

- ❖ The PNG format also uses palettes (24-bits or 32 bits if an “alpha” mask is included for transparency), and is lossless. It was developed for the Internet (it supports only the RGB color space) to expand GIF’s limited 256 colors to millions of colors.
- ❖ In 24-bit color systems, your computer works with three channels of 256 discrete shades of each color (red, green, and blue) represented as the three axes of a cube. This allows a total of 16,777,216 colors ($256 \times 256 \times 256$).

Dithering

- ❖ 24-bit scanned image that contains millions of colors and need to reduce it to an 8-bit, 256-color image, you get the best replication of the original image by dithering the colors in the image.
- ❖ **Dithering** is a process whereby the color value of each pixel is changed to the closest matching color value in the target palette, using a mathematical algorithm.
- ❖ 256 colors available to represent the thousands or even millions of colors in the original image, pixels using the 256 remaining colors are intermixed and the eye perceives a color not in the palette, created by blending the colors mixed together.
- ❖ Dithered image renders a good approximation of the original depends upon the algorithm used and whether you allow the image-editing program to select the best set of 256 colors from the original image (called an adaptive palette) or force it to use a predetermined set of 256 colors (as, for example, with a System palette or the browser-safe web palette).
- ❖ Dithering concepts are important to understand when you are working with bitmaps derived from RGB information or based upon different palettes.
- ❖ Dithering software is usually built into image-editing programs and is also available in many multimedia authoring systems as part of the application’s palette management suite of tools.

Image File Formats

- ❖ Most applications on any operating system can manage JPEG, GIF, PNG, and TIFF image formats.
- ❖ An older format used on the Macintosh, PICT, is a complicated but versatile format developed by Apple where both bitmaps and vector-drawn objects can live side by side.
- ❖ The device-independent bitmap (DIB), also known as a BMP, is a common Windows palette-based image file format similar to PNG.
- ❖ PCX files were originally developed for use in Z-Soft MS-DOS paint packages; these files can be opened and saved by almost all MS-DOS paint software and desktop publishing software.

- ❖ TIFF, or Tagged Interchange File Format, was designed to be a universal bitmapped image format and is also used extensively in desktop publishing packages. Often, applications use a proprietary file format to store their images.
- ❖ Adobe creates a PSD file for Photoshop and an AI file for Illustrator; Corel creates a CDR file.
- ❖ DXF was developed by AutoDesk as an ASCII-based drawing interchange file for AutoCAD, but the format is used today by many computer-aided design applications. IGS (or IGES, for Initial Graphics Exchange Standard) was developed by an industry committee as a broader standard for transferring CAD drawings. These formats are also used in 3-D rendering and animation programs.
- ❖ JPEG, PNG, and GIF images are the most common bitmap formats used on the Web and may be considered cross-platform, as all browsers will display them. Adobe's popular PDF (Portable Document File) file manages both bitmaps and drawn art (as well as text and other multimedia content), and is commonly used to deliver a "finished product" that contains multiple assets.

Chapter 4: Sound

Definition

- ❖ The most sensuous element of multimedia. It is meaningful "speech" in any language, from a whisper to a scream.
- ❖ It can provide the listening pleasure of music, the startling accent of special effects, or the ambience of a mood-setting background.
- ❖ Some feel-good music powerfully fills the heart, generating emotions of love or otherwise elevating listeners closer to heaven

The Power of Sound

- ❖ When something vibrates in the air by moving back and forth (such as the cone of a loudspeaker), it creates waves of pressure.
- ❖ Sound waves vary in sound pressure level (amplitude) and in frequency or pitch.
- ❖ Many sound waves mixed together form an audio sea of symphonic music, speech, or just plain noise.
- ❖ Acoustics is the branch of physics that studies sound.
- ❖ Sound pressure levels (loudness or volume) are measured in decibels (dB); a decibel measurement is actually the ratio between a chosen reference point on a logarithmic scale and the level that is actually experienced.
- ❖ A logarithmic scale is also used for measuring the power of earth- quakes (the Richter Scale) and stellar magnitudes

The decibel scale, with some examples, is shown in Table 4-1; notice the relationship between power (measured in watts) and dB.

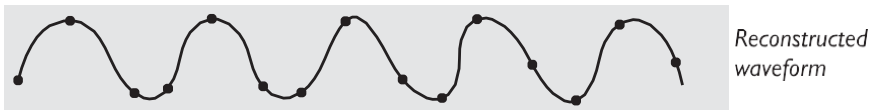
dB	Watts	Example
195	25–40 million	Saturn rocket
170	100,000	Jet engine with afterburner
160	10,000	Turbojet engine at 7,000-pounds thrust
150	1,000	ALSETEX splinterless stun grenade
140	100	2 JBL2226 speakers pulling 2,400 watts inside an automobile
130	10	75-piece orchestra, at fortissimo
120	1	Large chipping hammer
110	0.1	Riveting machine
100	0.01	Automobile on highway
90	0.001	Subway train; a shouting voice
80	0.0001	Inside a 1952 Corvette at 60 mph
70	0.00001	Voice conversation; freight train 100 feet away
60	0.000001	Large department store
50	0.0000001	Average residence or small business office
40	0.00000001	Residential areas of Chicago at night
30	0.000000001	Very soft whisper
20	0.0000000001	Sound studio

- ❖ Sound is energy, just like the waves breaking on a sandy beach, and too much volume can permanently damage the delicate receiving mechanisms behind your eardrums, typically dulling your hearing in the 6 kHz range.
- ❖ Human hearing is less able to identify the location from which lower frequencies are generated.
- ❖ Use of sound in multimedia projects will not likely require highly specialized knowledge of harmonics, intervals, sine waves, notation, octaves, or the physics of acoustics and vibration.

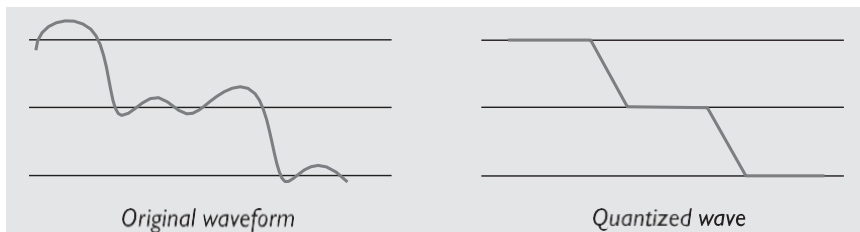
Digital Audio

- ❖ Digital audio is created when you represent the characteristics of a sound wave using numbers—a process referred to as digitizing.

- ❖ Digitize sound from a microphone, a synthesizer, existing recordings, live radio and television broadcasts, and popular CD and DVDs. In fact, you can digitize sounds from any natural or prerecorded source.
- ❖ Digitized sound is sampled sound. Every n th fraction of a second, a sample of sound is taken and stored as digital information in bits and bytes.
- ❖ The quality of this digital recording depends upon how often the samples are taken (sampling rate or frequency, measured in kilohertz, or thousands of samples per second) and how many numbers are used to represent the value of each sample (bit depth, sample size, resolution, or dynamic range).
- ❖ The three sampling rates most often used in multimedia are 44.1 kHz (CD-quality), 22.05 kHz, and 11.025 kHz.
- ❖ Sample sizes are either 8 bits or 16 bits.
 - The larger the sample size, the more accurately the data will describe the recorded sound.
 - An 8-bit sample size provides 256 equal measurement units to describe the level and frequency of the sound in that slice of time.
 - A 16-bit sample size, on the other hand, provides a staggering 65,536 equal units to describe the sound in that same slice of time.



Quantizing



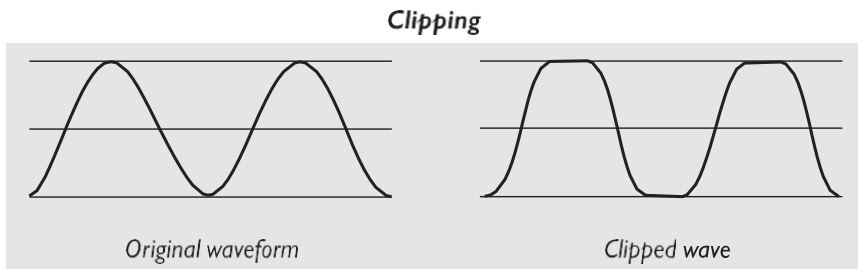


Figure 4-2 Examples of quantizing and clipping

- ✓ Quantization can produce an unwanted background hissing noise, and clipping may severely distort the sound.

Making Digital Audio Files

- ✓ Making digital audio files is fairly straightforward on most computers. Plug a microphone into the microphone jack of your computer.

Focus on two crucial aspects of preparing digital audio files:

- Balancing the need for sound quality against file size. Higher quality usually means larger files, requiring longer download times on the Internet and more storage space on a CD or DVD.
- Setting proper recording levels to get a good, clean recording.

Setting Proper Recording Levels

- A distorted recording sounds terrible

Editing Digital Recordings

- Audacity is a free open-source sound editing application for Windows, Macintosh, and Linux (<http://audacity.sourceforge.net>).
- With such a tool you can create sound tracks and digital mixes.
- The basic sound editing operations that most multimedia producers need are described in the paragraphs that follow.

Trimming

- Removing “dead air” or blank space from the front of a recording and any unnecessary extra time off the end is your first sound editing task.

- Trimming even a few seconds here and there might make a big difference in your file size.
- Trimming is typically accomplished by dragging the mouse cursor over a graphic representation of your recording and choosing a menu command such as Cut, Clear, Erase, or Silence.

Splicing and Assembly

- Using the same tools mentioned for trimming, you will probably want to remove the extraneous noises that inevitably creep into a recording.

Volume Adjustments

Figure 4-4 shows the normalizing process at work in Adobe's Soundbooth.

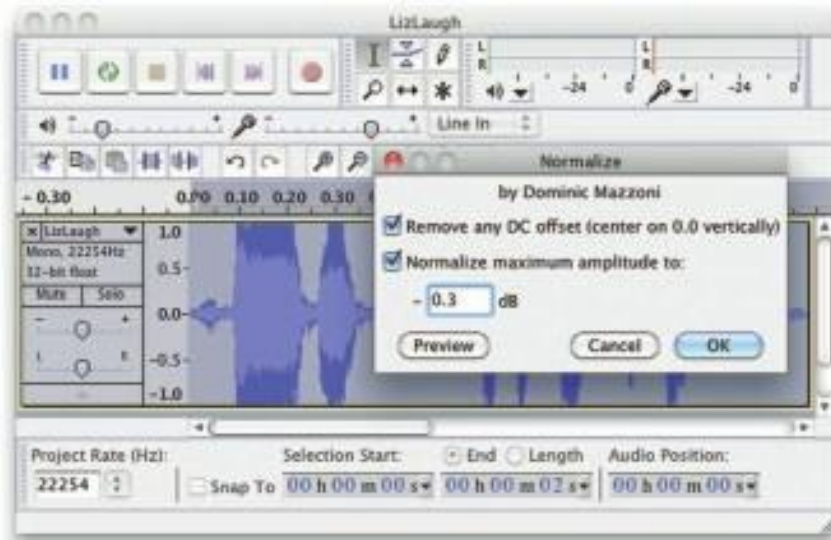


Figure 4-4 Normalizing evens out the sound level in an audio file.

Format Conversion

- Digital audio editing software might read a format different from that read by your presentation or authoring program.
- Most sound editing software will save files in your choice of many formats, most of which can be read and imported by multimedia authoring systems.
- Data may be lost when converting formats. If, for example, you have a Digital Rights Management (DRM)-protected M4P file downloaded from the iTunes store and burn that file to an Audio CD track, the DRM data will be lost because the Audio CD format does

not provide for DRM data. The now-unprotected tune on the CD can then be ripped into a playable MP3 format.

Resampling or Downsampling

- Recorded and edited your sounds at 16-bit sampling rates but are using lower rates and resolutions in your project, you must resample or downsample the file.

Fade-ins and Fade-outs

- Most programs offer enveloping capability, useful for long sections that you wish to fade in or fade out gradually.
- This enveloping helps to smooth out the very beginning and the very end of a sound file.

Equalization

- Some programs offer digital equalization (EQ) capabilities that allow you to modify a recording's frequency content so that it sounds brighter (more high frequencies) or darker (low, ominous rumbles).

Time Stretching

- Advanced programs let you alter the length (in time) of a sound file without changing its pitch.
- This feature can be very useful, but watch out: most time-stretching algorithms will severely degrade the audio quality of the file if the length is altered more than a few percent in either direction.

Digital Signal Processing (DSP)

- ✓ Some programs allow you to process the signal with reverberation, multitap delay, chorus, flange, and other special effects using digital signal processing (DSP) routines.

Reversing Sounds

- ✓ Another simple manipulation is to reverse all or a portion of a digital audio recording. Sounds, particularly spoken dialog, can produce a surreal, otherworldly effect when played backward.

Multiple Tracks

Being able to edit and combine multiple tracks (for sound effects, voice-overs, music, etc.) and then merge the tracks and export them in a “final mix” to a single audio file is important.

File Size vs. Quality

- Remember that the sampling rate determines the frequency at which samples will be taken for the recording. Sampling at higher rates (such as 44.1 kHz or 22.05 kHz) more accurately captures the high-frequency content of your sound.
- ✓ Audio resolution (such as 8- or 16-bit) determines the accuracy with which a sound can be digitized. Using more bits for the sample size yields a recording that sounds more like its original.

Sampling Rate	Resolution	Stereo or Mono	Bytes Needed for 1 Minute	Comments
44.1 kHz	16-bit	Stereo	10.5 MB	CD-quality recording; the recognized standard of audio quality.
44.1 kHz	16-bit	Mono	5.25 MB	A good trade-off for high-quality recordings of mono sources such as voice-overs.
44.1 kHz	8-bit	Stereo	5.25 MB	Achieves highest playback quality on low-end devices such as most of the sound cards in Windows PCs.
44.1 kHz	8-bit	Mono	2.6MB	An appropriate trade-off for recording a mono source.
22.05 kHz	16-bit	Stereo	5.25 MB	Darker sounding than CD-quality recording because of the lower sampling rate, but still full and “present” because of high bit resolution and stereo. Preferred for CD-ROM projects.
22.05 kHz	16-bit	Mono	2.5MB	Not a bad choice for speech, but better to trade some fidelity for a lot of disk space by dropping down to 8-bit.
22.05 kHz	8-bit	Stereo	2.6MB	A popular choice for reasonable stereo recording where full bandwidth playback is not possible.
22.05 kHz	8-bit	Mono	1.3MB	A thinner sound than the previous choice, but very usable. Any Macintosh or any MPC can playback this type of file. About as good as listening to your TV set.
11 kHz	8-bit	Stereo	1.3MB	At this low a sampling rate, there are few advantages to using stereo.

11 kHz	8-bit	Mon o	650KB	In practice, probably as low as you can go and still get usable results; very dark and muffled.
5.5 kHz	8-bit	Stere o	650KB	Stereo not effective.
5.5 kHz	8-bit	Mon o	325KB	About as good as a bad telephone connection.

Table 4-2 provides some commonly used sampling rates and resolutions, with resulting file sizes.

MIDI Audio

- ✓ MIDI (Musical Instrument Digital Interface) is a communications standard developed in the early 1980s for electronic musical instruments and computers.
- ✓ It allows music and sound synthesizers from different manufacturers to communicate with each other by sending messages along cables connected to the devices.
- ✓ MIDI provides a protocol for passing detailed descriptions of a musical score, such as the notes, the sequences of notes, and the instrument that will play these notes.
- ✓ But MIDI data is not digitized sound; it is a shorthand representation of music stored in numeric form.
- ✓ **Digital audio** is a recording, MIDI is a score—the first depends on the capabilities of your sound system, the other on the quality of your musical instruments and the capabilities of your sound system.
- ✓ A **MIDI file** is a list of time-stamped commands that are recordings of musical actions (the pressing down of a piano key or a sustain pedal, for example, or the movement of a control wheel or slider).
- ✓ When sent to a MIDI playback device, this results in sound. A concise MIDI message can cause a complex sound or sequence of sounds to play on an instrument or synthesizer; so MIDI files tend to be significantly smaller (per second of sound delivered to the user) than equivalent digitized waveform files.
- ✓ Composing your own original score can be one of the most creative and rewarding aspects of building a multimedia project, and MIDI is the quickest, easiest, and most flexible tool for this task.
- ✓ Yet creating an original MIDI score is hard work. Knowing something about music, being able to play a keyboard, and having a lot of good ideas are just the pre-requisites to building a good score; beyond that, it takes time and musical skill to work with MIDI.
- ✓ The process of creating MIDI music is quite different from digitizing existing recorded audio. If you think of digitized audio as analogous to a bitmapped graphic image (both use sampling of the original analog medium to create a digital copy), then MIDI is analogous to structured or vector graphics (both involve instructions provided to software to be able to re-create the original on the fly).

- ✓ For digitized audio you simply play the audio through a computer or device that can digitally record the sound. To make MIDI scores, however, you will need notation software (see Figure 4-5), sequencer software (see Figure 4-6), and a sound synthesizer (typically built into the software of multimedia players in most computers and many handheld devices).
- ✓ A MIDI keyboard is also useful for simplifying the creation of musical scores.



Figure 4-5 Notation and composition software such as Sibelius provides a way for composers and musicians to create and arrange scores using MIDI instruments.

- ✓ MIDI is device dependent. The sequencer software quantizes your score to adjust for timing inconsistencies (a great feature for those who can't keep the beat), and it may also print a neatly penned copy of your score to paper.
- ✓ An advantage of structured data such as MIDI is the ease with which you can edit the data. Let's say you have a piece of music being played on a honky-tonk piano, but your client decides he wants the sound of a soprano saxophone instead.

ID	Sound	ID	Sound
0	Acoustic grand piano	16	Hammond organ
1	Bright acoustic piano	17	Percussive organ
2	Electric grand piano	18	Rock organ
3	Honky-tonk piano	19	Church organ
4	Rhodes piano	20	Reed organ
5	Chorused piano	21	Accordion
6	Harpsichord	22	Harmonica
7	Clarinet	23	Tango accordion
8	Celesta	24	Acoustic guitar (nylon)
9	Glockenspiel	25	Acoustic guitar (steel)
10	Music box	26	Electric guitar (jazz)
11	Vibraphone	27	Electric guitar (clean)
12	Marimba	28	Electric guitar (muted)
13	Xylophone	29	Overdriven guitar

14	Tubular bells	30	Distortion guitar
15	Dulcimer	31	Guitar harmonics

Table 4-3 General MIDI Instrument Sounds

MIDI vs. Digital Audio

- ✓ MIDI data, digital audio data is the actual representation of a sound, stored in the form of thousands of individual numbers (samples).
- ✓ The digital data represents the instantaneous amplitude (or loudness) of a sound at discrete slices of time.
- ✓ MIDI data is to digital audio data what vector or drawn graphics are to bitmapped graphics. That is, MIDI data is device dependent; digital data is not.
- ✓ Just as the appearance of vector graphics differs depending on the printer device or display screen, the sounds produced by MIDI music files depend on the particular MIDI device used for playback.

MIDI has several advantages over digital audio and two huge disadvantages. First, the advantages:

- MIDI files are much more compact than digital audio files, and the size of a MIDI file is completely independent of playback quality. In

general, MIDI files will be 200 to 1,000 times smaller than CD-quality digital audio files. Because MIDI files are small, they don't take up as much memory, disk space, or bandwidth.

- Because they are small, MIDI files embedded in web pages load and play more quickly than their digital equivalents.

- In some cases, if the MIDI sound source you are using is of high quality, MIDI files may sound better than digital audio files.

- ✓ Change the length of a MIDI file (by varying its tempo) without changing the pitch of the music or degrading the audio quality.

- ✓ MIDI data is completely editable—right down to the level of an individual note. You can manipulate the smallest detail of a MIDI composition (often with sub millisecond accuracy) in ways that are impossible with digital audio.

- Because they represent the pitch and length of notes, MIDI files can generally be converted to musical notation, and vice versa. This is useful when you need a printed score; in reverse, you can scan a printed score and convert it to MIDI for tweaking and editing.

Now for MIDI's disadvantages:

- Because MIDI data does not represent sound but musical instruments, you can be certain that playback will be accurate only if the MIDI playback device is identical to the device used for production.

- Also, MIDI cannot easily be used to play back spoken dialog, although expensive and technically tricky digital samplers are available.

In general, use MIDI in the following circumstances:

- Digital audio won't work because you don't have enough memory or bandwidth.
- Have a high-quality MIDI sound source.
- Have complete control over the machines on which your program will be delivered, so you know that your users will have high-quality MIDI playback hardware.
- Don't need spoken dialog.
 - ✓ The most important advantage of digital audio is its consistent play-back quality, but this is where MIDI is the least reliable! With digital audio you can be more confident that the audio track for your multimedia project will sound as good in the end as it did in the beginning when you created it

There are two additional and often more compelling reasons to work with digital audio:

- A wider selection of application software and system support for digital audio is available for both the Macintosh and Windows platforms.
- The preparation and programming required for creating digital audio do not demand knowledge of music theory, while working with MIDI data usually does require a modicum of familiarity with musical scores, keyboards, and notation, as well as audio production.

In general, use digital audio in the following circumstances:

- Don't have control over the playback hardware.
- Have the computing resources and bandwidth to handle digital files.
- Have need spoken dialog.

Multimedia System Sounds

- ✓ Sound right off the bat on your computer because beeps and warning sounds are available as soon as you install the operating system.
- ✓ Open the Sound Control Panel to listen to your system sounds, change them, or make a new, custom sound
- ✓ In Windows, system sounds are WAV files, and they reside in the Windows\Media subdirectory. System event sounds include start.wav, chimes.wav, chord.wav, ding.wav, logoff.wav, notify.wav, recycle.wav, tada. wav, and the Microsoft sound.wav that typically plays when Windows starts up.

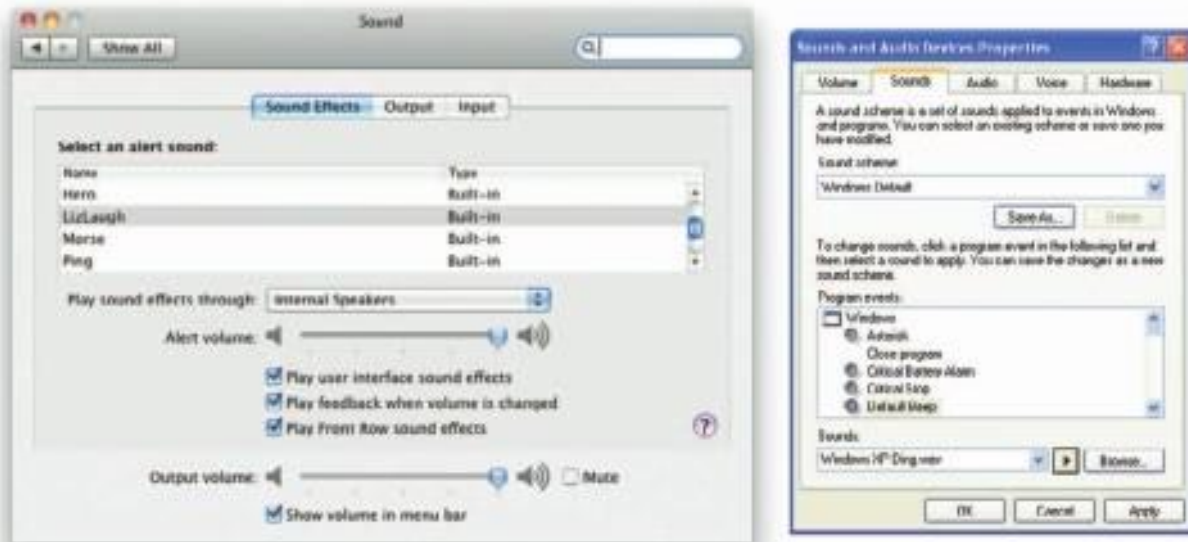


Figure 4-7 Sound Control Panels for Macintosh and Windows

Audio File Formats

- ✓ When we create multimedia, it is likely that we will deal with file formats and translators for text, sounds, images, animations, or digital video clips.
- ✓ A sound file's format is simply a recognized methodology for organizing and (usually) compressing the digitized sound's data bits and bytes into a data file.
- ✓ The structure of the file must be known, of course, before the data can be saved or later loaded into a computer to be edited and/or played as sound.
- ✓ The file name extension identifies which method of storage is used. There are many ways to store the bits and bytes that describe a sampled waveform sound.
- ✓ The method used for consumer-grade music CDs is Linear Pulse Code Modulation (LPCM), often shortened to PCM.
- ✓ The CD-ROM/XA (extended architecture) format for reading and writing CDs was developed later so you could put several recording sessions of music or data onto a single CD-R (recordable) disc.
- ✓ LPCM tracks from an audio CD are usually converted and stored on a computer in uncompressed AIFF (Audio Interchange FileFormat) or wave format (WAV) files when copied from the CD.

AIFF is historically used for Macintosh sound files.

- ✓ The WAV format was introduced by Microsoft when Windows was first released. Both formats contain uncompressed sound data.
- ✓ A codec (compressor-decompressor) is software that compresses a stream of audio or video data for storage or transmission, then decompresses it for playback.

- ✓ There are many codecs that do this with special attention to the quality of music or voice after decompression. Some are “lossy” and trade quality for significantly reduced file size and transmission speed; some are “lossless,” so original data is never altered.
- ✓ While editing your audio files, be sure to save your files using a lossless format or codec— with repetitive saves in a lossy format,
- ✓ A container format such as MP4, MOV, or OGG may encapsulate data streams that use one of many codecs available in that container.

On a Macintosh or in Windows, you will need to follow certain steps to bring an audio recording into your multi- media project. Here is a brief overview of the process:

1. Determine the file formats that are compatible with your multi- media authoring software and the delivery medium(s) you will be using (for file storage and bandwidth capacity).
2. Determine the sound playback capabilities (codecs and plug-ins) that the end user’s system offers.
3. Decide what kind of sound is needed (such as background music, special sound effects, and spoken dialog). Decide where these audio events will occur in the flow of your project. Fit the sound cues into your storyboard (see Chapter 10), or make up a cue sheet.
4. Decide where and when you want to use either digital audio or MIDI data.
5. Acquire source material by creating it from scratch or purchasing it.
6. Edit the sounds to fit your project.
7. Test the sounds to be sure they are timed properly with the project’s images. This may involve repeating steps 1 through 4 until every- thing is in sync.

Space Considerations

- ✓ The substantial amount of digital information required for high- quality sound takes up a lot of storage space, especially when the quantity is doubled for two-channel stereo. It takes about 1.94MB to store 11 seconds of uncompressed stereo sound.
- ✓ Many multimedia developers use 8-bit sample sizes at 22.05 kHz sampling rates because they consider the sound to be good enough (about the quality of AM radio), and they save immense amounts of digital real estate.

Audio Recording

- ✓ CD-quality digitized sound at 44.1 kHz and 16 bits, you should hire a sound studio.
- ✓ High-fidelity sound recording is a specialized craft, a skill learned in great part by trial and error, much like photography.
- ✓ Mobile phones can often record audio (and video), and applications and hardware attachments are available to manage external microphones and file transfer.
- ✓ USB and flash memory recorders range in quality, some suitable for voice only, some generating compressed MP3 files, and some recording in CD-quality stereo. Recordings can be directly downloaded as digital files using a USB cable or flash memory card reader.



Keeping Track of Your Sounds

- ✓ It is important to maintain a good database, keeping a physical track of your original material—just in case you need to revert to it when your disk drive crashes or you accidentally delete the work file.
- ✓ A database is particularly important because you may need to give your sound files such unhelpful names as `janesEyesOpenWide.aiff` or

Audio CDs

- ✓ The method for digitally encoding the high-quality stereo of the consumer CD music market is an international standard, called ISO 10149. This is also known as the **Red Book Audio standard**
- ✓ Developers of this standard claim that the digital audio sample size and sampling rate of Red Book Audio (16 bits at 44.1 kHz) allow accurate reproduction of all the sounds that humans can hear.

Sound for Your Mobile

- ✓ Ringtones are perhaps the most widely- and often-heard sounds in today's world. Unlike plain old telephones, where a pulsating 90-volt signal is sent down copper wires to energize a hammer that clangs a bell, there is no bell in a digital mobile telephone.
- ✓ When the mobile receives a notice that someone is calling, the unit's software takes over and, depending on the programmed options, plays the user's choice of ringtone—either generated by internal MIDI software or played from a stored sound file.
- ✓ Ringtones play on a very small speaker and often compete in a noisy environment. Perhaps an urban myth, it is reported that an inventive sales executive recorded herself coughing and sent that awful sound to her phone as a ringtone.
- ✓ When she received an incoming call during a meeting, she would quickly cover her mouth, continue the cough, and excuse herself from the room in order to take the call. Ringtones aren't the end of it. Into the daily lexicon have entered answertones, ringbacktones, truetones, realtones, singtones, videotones, and "ringles."
- ✓ Most are for sale from enterprising small and large businesses all over the world. MP3 files will play on most mobiles; check your phone's manual to be sure.

Sound for the Internet

- ✓ There are several methods for playing digital or MIDI sound from a web page.
- ✓ The sound is actually not part of the web page but is a separate file with its own address on the Internet, which is “embedded” in the page.
- ✓ Web browsers associate files with applications and plug-ins:
 Click here to play MySound!
- ✓ Media players are designed to play files as soon as enough of the data is cached in your computer’s buffer (a place where data is stored temporarily).
- ✓ Streaming files are dependent upon connection speed: you must wait longer (streaming latency) before the streamed sound begins to play when using a dial-up modem (low bandwidth) than when using a high-speed DSL connection (high bandwidth).
- ✓ Adobe’s Flash allows you to integrate the sound tracks that you have made using a sound editor into a Web-based multimedia presentation, including both event sounds like button clicks and streaming sounds like background music
- ✓ Because it can read and save MP3 files, Flash offers web designers serious and powerful options for solving the quality conundrum of high-quality (big) files and slow downloads versus low-quality (small) files and speedy delivery—with nice results.

Testing and Evaluation

- ✓ Putting everything together can be tough, but testing and evaluating what you’ve done can be even tougher—especially if your project involves a complicated live presentation,
- ✓ During editing and authoring, regularly test the sound-and-image synchronization of your project. If you are delivering your sound on the Web, test it with different browsers and different connection speeds.

Copyright Issues

- ✓ Ownership rights are significant issues for multimedia producers who would love to use a few bars of Beyonce’s latest hit or a nostalgic background of Bach suites played by Pablo Casals.
 - ✓ Producers may rightfully fret about copyrights and permissions.
 - ✓ Most developers play it safe by always making their own custom music from scratch in a sound studio, or with synthesizers, or by using sounds that have a clear and paid-for ownership and permission trail.
- Copyright issues and methods of securing permission for use .