

Animation

All animation is made from collections of single images. When quickly shown frame by frame, these images create the illusion of a moving picture. Traditional animators either drew their images or photographed models. Meanwhile, their modern successors rely heavily on computer technology.

Text

Animated films and cartoons are one of today's leading entertainment and art forms. Top films and series, such as *Shrek 2* (2004) and *The Simpsons*, earn huge amounts of money and are watched by hundreds of millions of people. Although many of these animated features are just pure entertainment, some give sly and biting takes on modern society—for example, the exaggerated violence of *The Itchy and Scratchy Show*, a cartoon within *The Simpsons*. Other animated films are strikingly beautiful in their visual art and animation, like Disney's *Fantasia* from the 1940s. While in recent years modern computer technology has made possible fantastic visual effects that look completely real, such as the incredible imagery throughout the *Lord of the Rings* trilogy.

All animation works by building up a moving picture one image at a time. These images create an optical illusion of smooth movement when rapidly displayed frame-by-frame. Scientists called this effect the "persistence of vision," since it happens because our brain stores images for a fraction of a second and automatically smoothes away minor jumps. Most films are displayed at a rate of 24 frames per second (FPS) to give an adequate look of realism. Hand drawn cartoons often use 12 FPS to save on labor, but do not appear too jerky because of their stylized nature.

Animated cinema has used a variety of techniques in its design and manufacture over the last century. Early animators laboriously drew their creations by hand. Meanwhile, modern computer animation creates and models images completely digitally. Future audiences can expect these visual effects to become even more stunning as computers steadily increase in power. Moreover, the present trend toward big name actors and screenwriters in animated features is likely to continue. These films should therefore continue to amuse and amaze children and adults alike.

Early animation

Early animation devices were mainly Victorian curiosities for impressing friends and amusing children. The first and simplest of these was the flick-book. It had a slightly different image on each page, giving the illusion of a moving picture when rapidly flicked through. This device was improved by British inventor William George Horner (1786-1837) in 1834 when he invented the more sophisticated "Zoetrope," a spinning drum lined with pictures. Then in 1876 Frenchman Émile Reynaud (1844-1918) modified Horner's invention to project images on to a large screen, creating the first cartoon theatre show.

At the beginning of the 20th century, motorized film projectors and cameras were gaining popularity. Early animators experimented with basic special animated effects by stopping and starting the camera. By 1905, French illustrator Emile Cohl (1857-1938) and U.S. illustrator John Bray (1879-1978) were creating fully animated stick figures. However, the first cartoon creature with full personality and life is now widely recognized as the star of *Gertie the Trained Dinosaur* (1914), by U.S. cartoonist and animator Winsor McCay (1871-1934).

Did you know?

Mickey mouse starred in the first animated film with sound, making him the first talking cartoon character. In Mickey's third film, *Steamboat Willie* (1928), Disney added talking narrative to create a much more realistic appearance of life. Disney was also the first animator to use synchronized music (*The Skeleton Dance*, 1929) and full Technicolor (*Flowers and Trees*, 1932).

Modern animation

Animation became a highly successful and profitable business in the 1920s as Austrian animator Max Fleischer (1883-1972) and U.S. Film Producer Walt Disney (1901-1966) established major animation studios. These studios produced weekly short cartoons with stars such as Betty Boop and Mickey Mouse. However, animation leapt forward in 1937 with Disney's first feature-length film, *Snow White and the Seven Dwarves*. From *Pinocchio* (1940) to recent classics like *Beauty and the Beast* (1991), Disney's studio is seen as the world leader in feature length animation.

Over the late 1940s and 1950s production costs became too expensive to continue full animation of Disney's quality. Most studios returned to a more basic animation style with jerky, limited movements and simple backgrounds—an example being *The Flintstones* by American cartoonists William Hanna (1910-2001) and Joseph Barbera (1911-). In the 1960s, photocopying machines helped reduce costs by replacing the need to trace images by hand. These techniques also allowed filmmakers to seamlessly combine animation and live-action photography, as in Disney's *Mary Poppins* (1964).

More recently, computer technology has revolutionized the animation process. Labor-intensive work, such as copying, moving, and redrawing images, is now usually performed digitally. Moreover, studios often release movies made entirely from computer-generated images. The first such film was *Toy Story* (1995), a collaboration between Disney and Pixar Studios. There then followed other blockbusters like *Finding Nemo* (2003) and *Shrek 2* (2004). Special effects in many live-action movies are also computer generated, such as the *Matrix* trilogy and the last few *Star Wars* films. In fact, in many modern films it is almost impossible to tell where live-action ends and animation begins.

The making of traditional animated films

Animators traditionally made their films and cartoons with a technique called cel animation. A scene is separated into the individual figures and a fixed background. Then the movements of each character are traced onto a series of transparent celluloid sheets. These sheets, or "cels," are carefully assembled on top of the background and photographed to make a single frame of animation. By carefully replacing each cel with the next movement of its figure, the artists build up the following frames of animation.

Traditional animated feature films are huge undertakings by the studios. Before film production can begin, it often takes more than a year's preparation to put everything in place. First, the directors and writers create the storyline, supported by sketches of the main scenes and characters. These are then turned into a more realistic visual "story board." After the script is finished, the voice actors record the dialogue and sound effects. In addition to giving a better impression of the characters, these sounds also give the animators crucial timing information about the movements of their characters.

The drawing of the animation can then begin. Key animators create the most important poses by drawing only particular postures that suggest the flow of movement. Typically, there may be one key animator for each of the main characters. Animation assistants, or "in-betweeners," draw the other images between these key poses to smoothly fill in the motion. These images are put together and projected to test that the movement is smooth. Any faults are corrected, and then the images are transferred to the individual cells. Meanwhile, teams of background artists paint the backdrops for the scenes, usually in much finer detail than the actual characters.

The next stage of the animation is to carefully piece together the various cells and backgrounds that make up a frame. When this is done, the photographer records the image with a specialized "rostrum" camera—this camera looks down on to the scene through glass plates that help keep everything in place. The rostrum camera can move up-down and left-right to simulate different viewpoints. Editors then cut the animation sequences to the correct length. After editing, musicians record the film soundtrack, which is synchronized with the appropriate events in the film. Finally, a marketing package is presented to the public, and the studio waits to see if their film is a blockbuster.

Technological developments

Recent technology has simplified and even removed parts of the animated filmmaking process. In addition to bringing down production costs, this has led to a surge in innovative new creations. It is now possible for fairly small studios to make good quality animated projects. However, the fully computer-generated films, such as *Monsters Inc.* (2001), still require powerful computers and large animation teams that are beyond the means of all but the largest studios.

An important use of computers is to digitally scan and store all drawings with accurate desktop scanners. These digital images include the individual cels in an animation sequence and the backgrounds for each scene. Animators can then digitally piece the separate parts of a frame together without the need for a specialized camera. Because the

frame is digital, the computer is able to simulate the effect of zooming in and out of a scene. Moreover, animation software can perform the work of in-betweeners. Thus the key animators draw only particular poses and the computer supplies the other images to fill in the remaining motion.

Animated models

Animators have used models since early cinema to portray realistic looking events that cannot be filmed in real life. One of the first creators of believable effects was U.S. animator Willis O'Brien (1886-1962), who created fighting dinosaurs in *The Lost World* (1925) and the impressive giant ape in *King Kong* (1933). Similar animated sequences have since appeared in many fantasy and science fiction films, from the fighting skeletons in *The 7th Voyage of Sinbad* (1958) to the vicious creatures in *Aliens* (1986).

Modelers give their puppets the appearance of movement through a technique called stop-motion animation. Essentially, the model is placed in the correct pose and photographed. The animator changes the puppet's posture slightly and takes another photograph, laboriously repeating the process until all frames of a particular scene are built up. However, this type of animation needs much time and hard work. Animators working on *James and the Magic Peach* (1996) were only able to make about 10 seconds of footage a day.

Fortunately, animators can ease their workload by using robotic models that automatically change their pose. For example, many of the close-up views of dinosaurs in Spielberg's *Jurassic Park* (1993) are "animatronic" models controlled by mechanical rods. Through the careful design of their makers, animatronic creatures often seem as real to us as their flesh-and-blood counterparts.

Models made from clay and plasticine are another type of puppet sometimes seen in films. These mainly appear in cartoon-like features, of which the best recent examples are British puppeteer Nick Park's (1958-) humorous films of talking animals. Examples of his work include the short *Creature Comforts* (1989) and the movie *Chicken Run* (2000). He has received several academy awards for his films.

Did you know?

The robotic model of a Spinosaurus in *Jurassic Park 2: The Lost World* (1997) is 43.4 feet (13.3 m) long and weighs 24,000 pounds (10,886 kg). It is powered entirely by hydraulics, made up of 2200 feet (670 m) of hoses and 42 hydraulic cylinders. All of its actions are remote-controlled.

Computer animation and special effects

Almost every blockbuster action film now contains some form of computerized special effect. These scenes often happen without the audience even noticing, such as computer-generated figures performing acrobatic stunts. At other times, the scenes look real but too

spectacular to be true, like the weather effects in *The Day after Tomorrow* (2004). Yet only a couple of decades have passed since computer animations first appeared in feature films. These early computerized effects in movies like *Tron* (1983) now look primitive compared to recent examples.

Animating computer graphics is similar to operating puppets, except the models are now just digital data. Initially, an artist either takes a three-dimensional scan of a real sculpture or directly designs a digital model. These models, which look like wire frames, are given numerous hinges around which they move. Using animation software, the animators then move the models like puppets. After the animation is complete, textures such as hair, clothing, and skin are added to the models. The scene is properly lit and the computer pieces the scene together into the frames of animation.

Computer graphics continue to push forward the limits of what is achievable with animation. As each year passes, a new type of realistic effect is modeled that has never been seen before. Flowing hair, clothing, fire, and water can now be digitally created at will. A growing number of films also contain digital characters, such as Gollum in *The Lord of the Rings* trilogy. In a sense, new films are limited only by the imagination of their makers. Future audiences can expect new fantastic and completely believable worlds in which anything is possible.

Did you know?

The vast armies in *The Lord of the Rings: The Two Towers* (2002) were composed of thousands of individually computer-generated figures. Each soldier was programmed to fight and behave independently. Then when the armies were put together, the computer simulated the complete battle with every soldier acting in its own way.