CHAPTER 1

3D Animation Overview

3D animation has become a mainstay in film, television, and video games, and is becoming an integral part of other industries that may not have found it all that useful at first. Fields such as medicine, architecture, law, and even forensics now use 3D animation. To really understand 3D animation, you must look at its short history, which is tied directly to the history of the computer. Computer graphics, one of the fastest growing industries today, drives the technology and determines what computers are going to be able to do tomorrow. In this chapter, you will look at present-day 3D animation and then look back at how the past has shaped what we do today.

- **Defining 3D animation**
- **Exploring the 3D animation industry**
- **Delving into the history of 3D animation**

Defining 3D Animation

3D animation, which falls into the larger field of 3D computer graphics, is a general term describing an entire industry that utilizes 3D animation computer software and hardware in many types of productions. This book uses the term *3D animation* to refer to a wide range of 3D graphics, including static images or even real solid models printed with a 3D printer called a rapid prototyper. But animation and movement is the primary function of the 3D animation industry. 3D animation is used in three primary industries:

- Entertainment
- Scientific
- Other

Each of these industries uses 3D animation in completely different ways and for different final output, including film, video, visualizations, rapid prototyping, and many others. The term *3D animation* is still evolving, and we have not yet seen everything that it will encompass.

A 3D artist is anyone who works in the production stage of 3D animation: modeler, rigger, texturer, animator, visual effects technician, lighter, or renderer. Each of these job titles falls under the umbrella term *3D artist*, and so each job can also be referred to more specifically: 3D modeler, 3D texture artist, 3D lighter, 3D animator, and so forth. These jobs are discussed in more detail throughout this book, to give you a good idea of the role of each on a day-to-day basis.

Exploring the 3D Animation Industry

Let's take a closer look at the three primary industries using 3D animation. This section details the various opportunities of each so you can see what a person wanting to get into 3D animation could do today.

Entertainment

The entertainment industry is the most widely recognized of the three primary 3D animation industries and includes film, television, video games, and advertising—each of which has subfields within it. The entertainment industry is dedicated to creating and selling entertainment to an audience.

Film

Two primary types of films are created in the 3D animation realm: fully animated films and visual effects films. In fully animated films, all the visual elements onscreen are created in 3D animation software and rendered. Examples include *Toy Story*, *Monsters vs. Aliens*, and *Shrek*. Visual effects films are typically shot with real actors, but the backgrounds or other effects are computer generated. *Jurassic Park*, *Sky Captain and the World of Tomorrow*, and *Tron* are examples of visual effects films.

The film industry is one of the largest industries using 3D animation. These films typically take about six months to four years to complete, depending on the scale of the project. The production crew can range from 3 people to 300, again depending on the scale of the overall film.

Fully animated full-length films can take two to four years to create and have a very large crew of hundreds of employees. One studio usually completes the whole

film internally. Short films (those shorter than 40 minutes) often are created by individuals or small studios. These short films are usually done on the side or after hours as personal projects. Large studios might create a short film to test a new technique or production pipeline. These films can be completed in a few months with a large crew or may take years depending on the artists' work schedules.

Visual effects films are different from fully animated feature films in that they are shot by a regular movie crew. A visual effects supervisor helps with camera work and with collecting any other data needed for the addition of the visual effects. Then the completed shots are sent to visual effects studios to complete parts or the whole sequence of effects as needed. Today most visual effects–heavy films use one or two primary studios for most of the work to keep the effects looking consistent, but then farm out smaller shots or sequences to other studios to save time. Visual effects studios can be very large to very small, depending on the type of work they are expected to complete.

Television

3D animation is still trying to make its mark in the television industry. Creating a single 3D animated television show is quite expensive and time-consuming. Still, several of today's shows are being created with 3D software, including *South Park*, *Mickey Mouse Clubhouse*, and *Star Wars: The Clone Wars*.

A more common usage of 3D animation in television is the addition of 3D visualizations to regular shows on networks such as the Discovery Health Channel, History Channel, and Science Channel. These visualizations typically are used in educational shows to help the audience understand certain topics.

The television industry doesn't have the film industry's luxury of lots of time and lots of money. Television shows need to be made in months, not years. The budgets are tremendously smaller, and more content needs to be created in a single season. 3D animation in television shows usually does not have the overall quality of that in film, but can still be very good if a stylized final look is used in the project.

Video Games

The video game industry enables artists to use 3D software to create virtual worlds and characters that will be played in a video game engine. This industry is massively popular and is at least as profitable as the film industry. There are two primary fields in the video game industry: in-game 3D animation, which creates the actual game world that players are immersed in while playing the video game, and game cinematics, which are cinematically created cut scenes of a video game that help drive the story forward in between levels.

Video game cinematics are like mini movies between levels that allow the game developer to control the storyline of a game while the player progresses.

Low-resolution polygon modeling is covered further in Chapter 5, "Understanding Modeling and Texturing."

The in-game side of this industry is closely tied to the computer programming that makes playing the video game possible. The creation of in-game art is limited by the hardware and software that is used to play video games in real time. For example, a game destined for a console such as the Xbox 360 or PlayStation 3 requires low-resolution models in order to allow numerous characters to appear in the game at once, along with the background elements and all the props and effects. To allow for real-time rendering and game play, the modeling artist must stay within a specific polygon count for these low-resolution models. Once the 3D animation assets are created, the video game programmers will create a system enabling the asset to be placed into the game to be played.

Triple-A video game titles are games that are expected to do well commercially and typically take longer to develop.

Most game cinematics, like film, are limited today only by the budget and time needed to create the 3D animation assets and to render the final frames to be played in video. Game cinematic artists are similar to film 3D animators. They do similar work but typically in a faster timeline (although not as fast as television). Many game cinematic trailers and in-game cinematic scenes are of a very high caliber that can rival film.

Video games created for smart phones and tablets typically take a few months to develop. A large triple-A title such as *Gears of War* or *Crysis* might take 2 to 4 years to create. It is not unheard of for a game-development cycle to last 10 years, however.)

Advertising

The advertising industry is all about very short animations. Typically, only 10 seconds to 4 or 5 minutes is needed to show or describe a product or service. These short animations must be able to provide a great deal of information in this brief time span. Like film and television, 3D advertising animation can utilize an all–3D animated form or incorporate mixed-media visual effects for the final overall look.

Typical projects in this industry are television commercials, web commercials which can include print ads, and still imagery. A lesser-known side of advertising is product visualization (discussed in detail in the next section), in which the artist creates a 3D model to serve as a prototype of an actual product to show to an investor to create an interest in that product.

Advertising can have a very high level of quality but is created in a very short amount of time. Studios specializing in advertising animation are medium sized and follow a solid workflow in order to provide the fast turnaround needed for this type of animation.

Scientific

The scientific industries utilizing 3D animation include medicine, law, architecture, and product visualization. The use of 3D in these industries is not well

known, however, because the final products are aimed at a specific audience and rarely are seen by the general public.

Medicine

The medical industry uses 3D animation in many ways, from creating a visualization of a specific medical event to depicting a biological reaction. For example, you can demonstrate what happens when plaque will build up in your arteries and will block blood flow to the heart, causing a heart attack. Art has been a part of the medical industry since the beginning of modern medical practices. Many of Leonardo Da Vinci's sketchbooks, for instance, focused on human anatomy and medical processes. These drawings, shown in Figure 1.1, were used by doctors to better understand early medicine. Even today you can see posters of human anatomy on the walls of doctors' offices. So it only makes sense that the medical field would take advantage of the new art form of 3D animation.

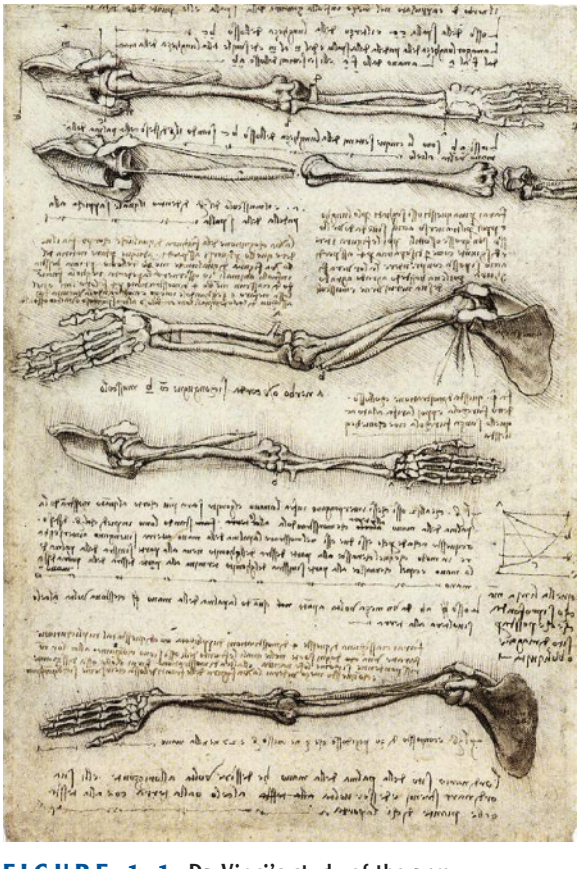

FIGURE 1.1 Da Vinci's study of the arm

The most popular medical 3D animation type is medical visualization used for education or marketing. This animation is used to educate the public and medical staff on new techniques or drugs. It is also used in marketing new medical products to investors or medical professionals, as shown in Figure 1.2. 3D animation can create a vastly rich visual guide to human and biological systems and can provide a great amount of information in a short amount of time.

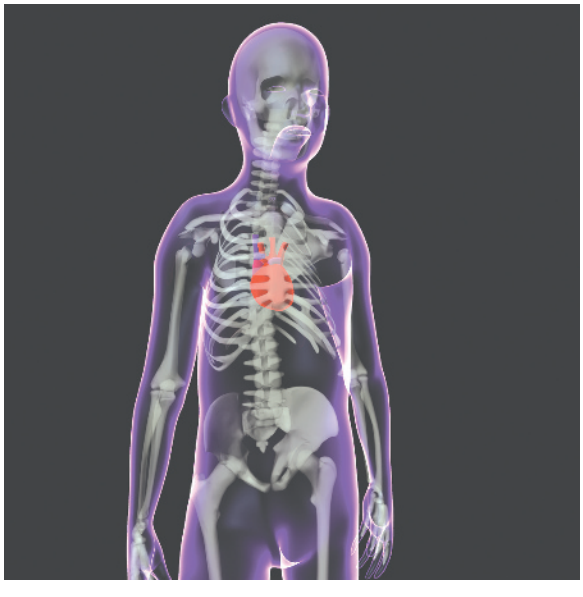

Image courtesy of and © Zachary Craw

FIGURE 1.2 Example of a medical rendering

***Motion capture*, a system of tracking human movement that can be used for medical research and the entertainment industry, is covered further in Chapter 9, "Industry Trends."**

3D animation can be used in simulations to help medical researchers predict the spread of a disease or understand which body part will fail first under great strain without actually putting a person at risk. By using motion capture, researchers can create a library of movements and then study the effects of various stresses on the human form. New probe-like technology enables researchers to track muscle strain as they watch which muscles are working the hardest during a specific movement or series of movements. The U.S. Department of Defense and professional sports have an interest in this type of data because it can help indicate how a new piece of protective equipment might be working or hindering.

One other form of medical 3D animation is tied to the video game industry. Ongoing studies are looking at how video games might be used to help heal brain injuries. These video games stimulate different areas of the brain, potentially helping the regrowth of brain tissue. These studies are very new but are

showing good results, which means that more of these types of games could be created for other healing applications.

3D animation in the medical sector is a vastly growing market that can be lucrative to an individual artist or small studio of professionals. The biggest drawback to this industry is that most people training today in 3D animation would rather work in video games or film and not for a drug company or university research project.

Law

Law animation falls into two fields: forensics and accident reconstruction and simulation. This type of animation is created to prove, disprove, or elaborate on facts in a court case, to help either the defense or prosecution. It can include pure computer physics simulations or just a hand-keyed animation of the crime scene to enable the judge or jury to move around or study the crime scene if needed. It can be used, for example, to prove that a gunman could or could not have shot someone from a specific location (see Figure 1.3) or to demonstrate a car accident scenario. These types of animations are often not allowed to be used as pure evidence but can be used to demonstrate a theory that the prosecution or defense may have on a specific case.

Forensics is a field that utilizes many different sciences to prove or disprove questions in the legal system.

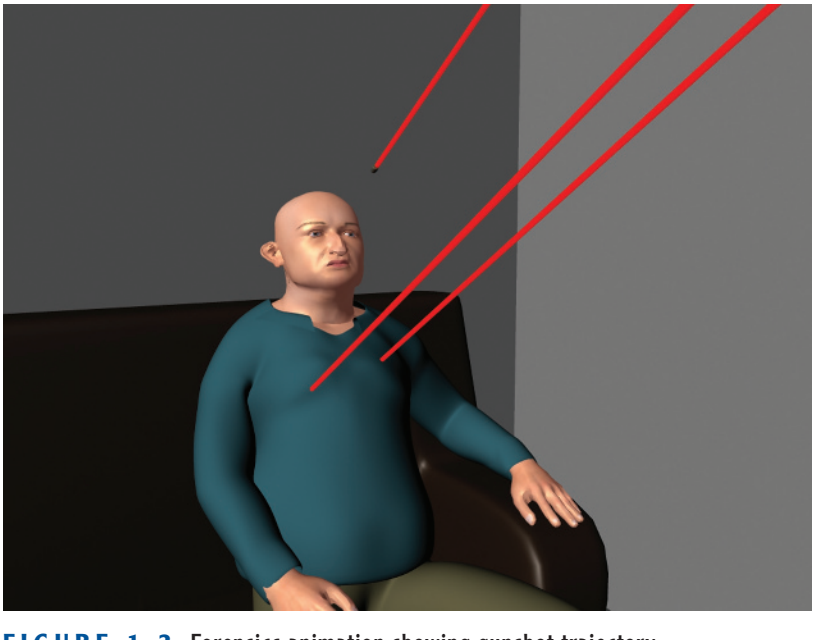

Image courtesy of and © Pat Howk

FIGURE 1.3 Forensics animation showing gunshot trajectory

Another aspect of this 3D animation field is the use of 3D laser scanning of a crime scene. This 3D laser scanning can create a perfect replica of a crime scene to be used as a reference when needed. This 3D scan can be accurate to within millimeters and therefore can be crucial to a court case or an investigation.

Architecture

Architects have been using computer-aided design (CAD) software since the 1980s to help them create better and more stable designs. Today architects use 3D software in conjunction with CAD programs not only to create models, but to test and visualize those models to see what structures would look like photorealistically before they are actually created. Software such as Autodesk AutoCAD and Autodesk Revit enable architects to test the stability of designs under certain conditions, to see whether they can withstand a specific type of natural environment or disaster. These CAD files can be converted and then rendered in software such as Autodesk 3ds Max and Autodesk Maya to enable investors and clients to see what a structure could look like from the outside and inside. This type of work is becoming more and more popular and can be a very cost-effective way to test certain material looks of a building before actually building it. You can see an example of interior and exterior architecture rendering in Figure 1.4.

Images courtesy of © Justin Canul and Zachary Craw

FIGURE 1.4 Example of indoor and outdoor rendering for architecture

Product Visualization

One last scientific area is product design and product rendering visualization. This is similar to architectural rendering in that products can be designed and tested in 3D software and then rendered to show investors. After the design is drawn up, a 3D artist will create a 3D model of the product in 3D design software to test its construction. Then a visualization animation will be created to show how the product will work and how it is assembled if needed. This type of visualization helps investors have a better grasp of what they may be investing in and can be used for commercial purposes as well, for presales.

Other

The 3D animation industry is in its infancy, and the technology that is driving this art form is changing on a yearly basis. This rapid pace of change necessitates the "other" category because some fields are so new that they do not fit into established mainstream categories. A trio of these new 3D animation fields are art, augmented reality, and projection mapping.

Using 3D animation in *art* is just what it sounds like: the creation of 3D elements incorporated in a final product to be shown in a gallery or other art-exhibition venue. This could include still imagery to be framed and posted on the gallery walls or a 3D statue created in 3D software and then rapid-prototyped and placed into the gallery as sculpture. Typically today 3D art animation is video installations that will use animated forms in a non-story-based structure. Sculpture might utilize moving 3D animations to enhance the piece. These types of 3D animations are typically not character- or story-based, but simply moving forms projected onto the sculptures.

Augmented reality might be considered by some as an advertising form of 3D animation, but because it is so new, it is premature to lump it into a certain field. In augmented reality, a user looks at the real world and sees 3D elements added to it. Typically, we would look through a webcam and use a *marker* (usually an image) to lock the position of the 3D elements though the camera as seen in Figure 1.5. Other viewing devices today are head-mounted with a see-through visor that add the 3D elements to the visual real world. There are also handheld augmented-reality devices and tracking with the use of GPS to add visuals to this reality.

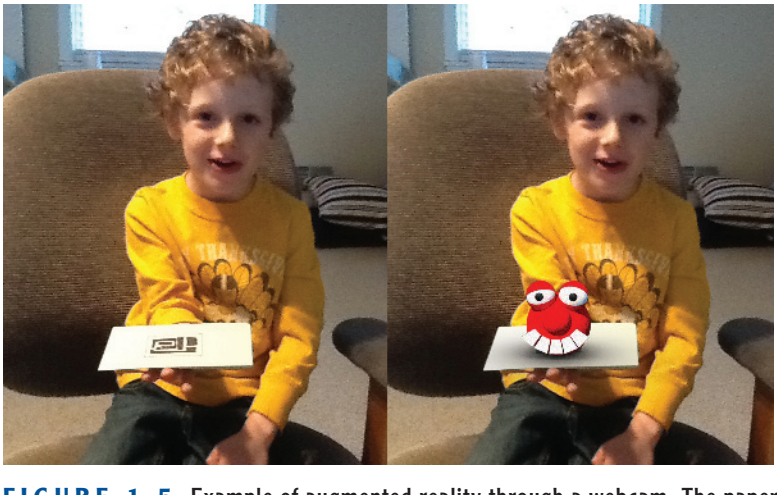

FIGURE 1.5 Example of augmented reality through a webcam. The paper the boy is holding has a marker that will allow the software to know where to place the image.

Projection mapping is a new technique that can make any surface, typically large buildings, into a video display. This technique uses projectors to project onto a building a 3D animation displaying new and exciting effects such as destruction of the building or lighting on that surface. This technique has been used to create many interesting effects, and it should become a mainstay in 3D animation in the future.

The History of 3D Animation

It is exciting to be part of the 3D animation industry today. Unlike drawing, painting, and other traditional art forms that have been practiced for centuries, 3D animation is still in its infancy. New ideas and techniques are created every year. To really understand the history of the art form, you must look at the technology behind it. 3D animation would not exist without computers, and many of the breakthroughs in computers have been directly driven by the 3D animation industry.

Early Computers

Some believe the first mechanical computer was the Z1, designed by Konrad Zuse in 1938. Figure 1.6 shows a replica in the German Museum of Technology. The other computer that is often said to be the first is the Colossus in 1943. Shown in Figure 1.7, this computer was used to help British code breakers decipher German messages. Neither of these resembles today's computers in appearance or behavior, but they put in perspective how young the 3D animation industry is, given that the tool required for this art form was invented only about 70 years ago.

FIGURE 1.6 Replica of the Z1 computer in the German Museum of Technology

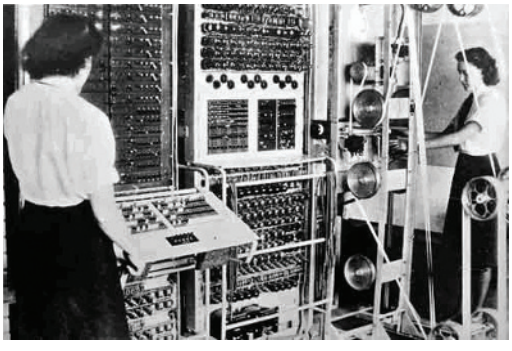

FIGURE 1.7 Colossus computer used to break coded messages in WWII

Not until the late 1950s did John Whitney Sr. use a computer to create art and the opening title sequence of the Alfred Hitchcock film *Vertigo*. Whitney used a handwriting recognition tablet (created by Tom Dimond) in collaboration with Saul Bass.

1960s: The Dawn of Computer Animation

The 1960s is when the beginnings of computer graphics and computer animation were created. This decade is when we saw the computer evolve from a strictly calculating device into a tool that allowed for creation and change. This is in the idea of hardware with user interaction devices and software that allowed for changes in real time.

William Fetter is credited with creating the term *computer graphics (CG)* in 1960. He is often thought of as the father of 3D animation because of his work at Boeing, where he used computers to create 3D models of objects and even of a human body that came to be known as the Boeing Man.

In 1962, computer programmer Steve Russell and a team from the Massachusetts Institute of Technology (MIT) created one of the first video games, *Spacewar*. In this two-player game, two spaceships try to destroy each other while also trying to not collide with a sun.

The amazing part of these first achievements in CG is that these computers had no graphical user interface, which is something we take for granted today. Instead, users would face only a blank screen and a blinking cursor and would have to understand the system and memory to access any information.

In 1963, Ivan Sutherland created a computer drawing program called Sketchpad that employed a light pen to draw simple shapes. This system paved the way for many of today's drawing and painting programs to be perfected as drawing

constraints enabled the creation of straight lines and perfect circles. The light pen used for Sutherland's system was one of the first human input devices into computers beyond that of a keyboard, switches, and dials. This system is also considered the first graphic interface for computers.

The computer mouse is one of the tools we all take for granted, but it was not invented until 1963. The original mouse, invented by Douglas Engelbart, was a block of wood with two wheels on the bottom, one facing vertically and one horizontally. The turning of the wheels controlled a pointer onscreen. Think about how you would have to interface with a computer today without a mouse.

1970s: The Building Blocks of 3D Animation

In the 1970s we saw the computer become smaller and faster, and the idea of 3D virtual surfaces was also being invented. Many of the basics of 3D animation we still use today like shaders and rendering were invented at this time. Also the first glimpse of 3D animation in film was witnessed.

In 1971, the microprocessor was developed, which allowed for the electronics of a computer to be miniaturized down to a single chip. Many of the building blocks of basic 3D animation were invented during this decade.

Researchers at the University of Utah created an algorithm enabling hidden surfaces to be rendered as 3D surfaces onscreen. Up to this point, the only thing a technician could do was draw wireframe lines, resulting in flat shading of polygons that made an object look faceted and blocky. But in 1971 Henri Gouraud created *Gouraud shading*, which allowed for the faceted polygon surface to render and look smooth. Figure 1.8 shows a comparison of flat shading and Gouraud shading.

Ed Catmull, while finishing his time at the University of Utah, created texture mapping in 1974 that allowed these early 3D graphics to achieve realism not seen to date. Catmull went on to create advancements in anti-aliasing and z-buffering and become the president of Pixar Animation Studios and Walt Disney Animation Studio.

In 1975, Martin Newell created the Utah teapot, or Newell teapot, to test rendering algorithms. That model is still used today, and some software programs have a Create Teapot button in honor of Newell and as an inside joke about the shape and its effect on the industry. The teapot was considered ideal at the time to test rendering because it has a round shape, a handle, and a spout to cast a shadow on itself (see Figure 1.9).

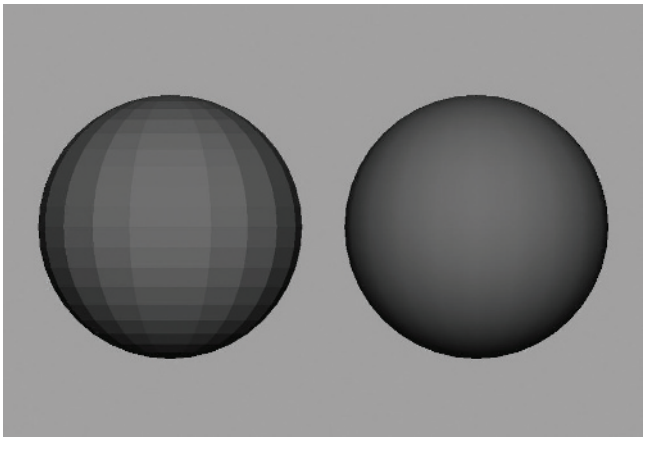

FIGURE 1.8 The same polygon sphere with flat shading on the left and Gouraud shading on the right

In 1978, James "Jim" Blinn introduced bump-mapping texturing techniques that can make a surface look as if it has bumps, bulges, and dents. This technique enables 3D models to look more realistic. He also created a texture mapping of surfaces called environment mapping to allow an object to look as if it is reflecting the world or environment around it. This was first demonstrated on the Utah teapot. At the same time, Bui Tuong Phong created a shading model to produce highlights on shiny objects, called the Phong reflection model. Later Blinn would modify the Phong shader to provide a softening effect on the highlights.

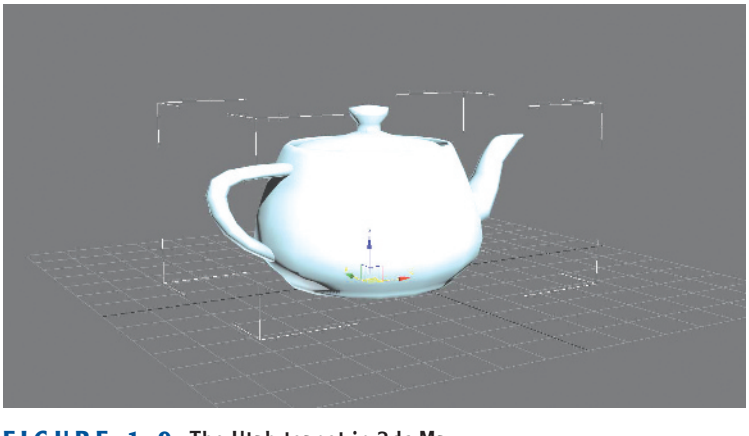

FIGURE 1.9 The Utah teapot in 3ds Max

Also in the 1970s, the first 3D animation studios were created, including Information International Incorporated (now known as Triple-I), Robert Abel and Associates, Digital Effects, and Lucasfilm. Lucasfilm also created a computer graphics division called Graphics Group, which eventually became Pixar.

In the mid to late 1970s, we began to see the first images of 3D animation in film, with a wireframe hand and face that Catmull and Frederic Parke created for the 1976 film *Futureworld*. In 1977, the Academy Awards introduced a new category of Best Visual Effects. Two years later, the movie *Alien* used a 3D animation sequence for the onboard computers screens to show a ship's landing sequence to help the film achieve a futuristic feel. In 1979, the Disney film *The Black Hole* used 3D computer graphics for its opening title screen.

The video game Pong, shown in Figure 1.10, was created in 1972 by Nolan Bushnell for Atari. One of the first video games developed, Pong is considered the impetus for today's commercial industry. Pong was a 2D game, but it laid the groundwork for the modern 3D games we see today.

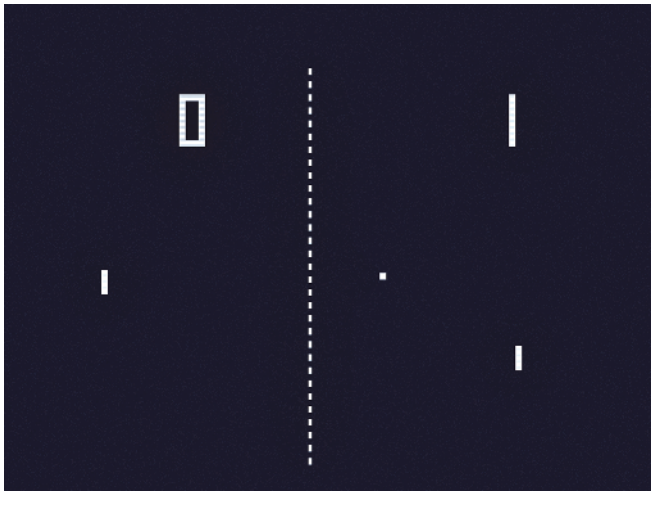

FIGURE 1.10 Screenshot of Pong

1980s: The Foundations of Modern Computing

To this point, computers were not readily available to people in their homes. Instead, computers were typically seen in university and government settings. Becoming an active user of these computers required a lot of knowledge. In 1975, Bill Gates created Microsoft. In 1980, IBM approached Microsoft to create an operating system for the company's first personal computer. At the same time that Microsoft was being born, Steve Jobs and Steve Wozniak were creating a personal

computer and began Apple in 1976. These personal computers had an interface that people with little to no computer training could use in their homes.

In the 1980s, many of the basic techniques were now developed and were making 3D animation a viable commercial industry. Turner Whitted introduced raytracing in 1980, in a paper titled "An Improved Illumination Model for Shaded Display." Raytracing is still used today as a render technique for creating realistic reflections on surfaces, and many of the latest techniques are based on this algorithm.

In 1982, Silicon Graphics (SGI) was created and began focusing on making faster, more-efficient computers for 3D animation. These SGI computers remained a mainstay in almost the entire industry for two decades.

Also in 1982, Autodesk was created, and the company released AutoCAD for personal computers. Autodesk is now the world's largest company for CAD and 3D animation software. Autodesk played a large role in the move from specialized computers to the use of personal computers for computer graphics.

In 1984, a company named Wavefront Technologies created the first commercially available off-the-shelf 3D animation software. Previously, each company had to write their own software to create 3D graphics and animation. Although some studios still use proprietary software, most now use commercially available programs. In addition, Photoshop was released in 1988 to small markets (Photoshop 1.0 was released in 1990 for the Mac). This program would become the foundation of all 2D and photo-manipulation software used today.

In 1984, Apple released the first Macintosh personal computer, which was the first widely distributed computer to use a graphical user interface. The Macintosh, shown in Figure 1.11, became the largest non-IBM computer option ever seen.

FIGURE 1.11 Original Macintosh computer with a graphical user interface

Virtual reality **uses computer-generated environments to simulate a 3D experience in a certain place, world, or event. At the time of its invention, people predicted that VR would replace many different technologies like computer screens and televisions and that almost all training for military and vehicle operation would happen in a VR world. The commercial application of VR has never really fully developed, however.**

In 1983, as researchers were working on new ways to interact and communicate with the computer, the *data glove* was invented. It allowed users to manipulate 3D objects in 3D space, which led to some of the first commercially available virtual reality (VR) systems.

Many animation studios were created in the 1980s including Triple-I, Digital Productions, Lucasfilm, Industrial Light & Magic, Pixar, and Pacific Data Images (PDI). Some of these studios lasted; some did not. With this industry being so new and small many of the artists and computer scientists all worked together at one time or another.

Long lasting studios

Many of the studios that are still in production today were created in the 1980s—for example, Lucasfilm, Industrial Light & Magic (ILM), Pixar, and Pacific Data Images (now PDI/Dreamworks).

Tron in 1982 had just over 20 minutes of 3D animated graphics including the bits, speed cycles, tanks, and game grid created by Triple-I. This 3D animation was extremely hard for the artists and researchers to complete, and *Tron* did not do that well in the box office. As a result, Hollywood at the time did not respect 3D animation's potential. Also in 1982, ILM created a few 3D animation sequences of a planet (during the Genesis Effect) in *Star Trek II: The Wrath of Khan*. ILM also created the digital Death Star projection in 1983's *Star Wars: Return of the Jedi*.

Lucasfilm created *The Adventures of Andre and Wally B.*, a short animated film all in 3D, in 1984. This short film was the first to incorporate complex backgrounds, squash and stretch animation, lighting with purpose, and motion blur. Although this film was not officially a Pixar project, many believe that it was the starting point for Pixar's later films, and it is on the DVD *Pixar Short Films Collection*.

In 1984, *The Last Starfighter* was the next Hollywood film to try large-scale 3D animation after the mediocre reception of *Tron*. Digital Productions created about 25 minutes of animation for the film, but it did not do well at the box office, and again Hollywood did not get excited about 3D animation.

In 1986, Disney again tried 3D animation in the film *The Great Mouse Detective*. At that time, Disney—which had a monopoly on the traditional animation market and was considered the best at animation—was pushing 3D animation forward. They also looked at expanding 3D animation for their next films.

In 1986 and 1988, Pixar (which was not then part of Disney) released two new short films, *Luxo Jr.* and *Tin Toy*. *Luxo Jr.* was the first film under the studio name Pixar. Created by Catmull and directed by John Lasseter, this short film showed people that 3D computer animation could create a worthwhile character performance and was not just a tool for coloring and backgrounds. *Tin Toy* was Pixar's second film, again with Lasseter directing. It was the first computer-generated short film to win an Oscar.

In 1989, ILM created a water creature for the film *The Abyss* that would move like a snake made of water though the underwater vessel to investigate the people aboard. No one had seen an effect like this with photorealistic rendering and movement; the water snake also interacted with the live actors and even mimicked them in the performance.

1990s: 3D Animation Achieves Commercial Success

In the 1990s, 3D animation really began picking up commercial steam in film and even in video games. *Terminator 2* was released in 1991, showcasing a liquid-metal terminator who looked like the actor Robert Patrick but had morphing abilities. New advances in digital compositing also enabled background elements to change seamlessly. Hollywood began to pay attention to what 3D animation could do for film. That same year, Disney released *Beauty and the Beast* with a large sequence of the ballroom dance utilizing 3D animation to create the camera movements and all of the background. The film's success reinforced Hollywood's decision to pay more attention to 3D animation as a new technique for filmmaking.

Two years later, *Jurassic Park* was released with photorealistic dinosaurs composited in with live-action environments and actors. The animated dinosaurs were able to interact with these live-action elements. At first the studio did not think computer-generated 3D creatures could achieve the look and believability needed to pull off a movie of the scope of *Jurassic Park*. The studio and director considered stop-motion animation for the dinosaurs, but ILM created a test that proved they could create the realism needed for these creatures. This film went on to win the Academy Award for Best Visual Effects.

In 1994, the first all-3D television series *ReBoot* was aired. This show was the first of its kind. No one to this point wanted to create a 3D animation show under the constraints of tight television timelines. *ReBoot* survived four seasons, and some efforts have been made to re-create the show.

In 1995, Pixar released the first fully 3D animated feature film *Toy Story* to great success critically and commercially. This film paved the way for more feature-length 3D animated films, 1998's *Antz* and *A Bug's Life*, and 1999's *Toy Story 2*.

In 1999, *Star Wars Episode 1: The Phantom Menace*, created by George Lucas and ILM, was released and was a huge success at the box office. *Star Wars Episode 1* had a main character that was fully 3D—a first—and 90 percent or more of the visual elements of the film were enhanced by 3D animation for computer graphics. Also that year *The Matrix* was released with the use of 3D animation helping in the Bullet Time effects that this film is known for. Also released in the 1990s were other films that utilized the advances in 3D animation, such as *Total Recall* (1990); *The Mask* (1994); *DragonHeart, Independence Day, Stuart Little*, *Twister* (1996); *Starship Troopers*, *The Fifth Element*, *Titanic*, *The Lost World: Jurassic Park* (1997)*; Armageddon*, and *What Dreams May Come* (1998).

In the video game realm, in 1994 the Sony PlayStation home console system was released and was one of the first home console systems to be able to handle 3D graphics with hardware accelerations. Games like *GoldenEye 007*, released in 1997 on the Nintendo 64, included free-roaming 3D levels and paved the way for more-complex gaming experiences compared the to the 2D side-scrolling games created before. Other games with this free-roaming 3D gameplay were *The Legend of Zelda: Ocarina of Time* (1998), *Shenmue* (1999), and *Driver* (1999).

A *graphics accelerator* is a video adapter that has its own processor to help the computer render graphics.

Changes in hardware also had a big impact on video games. In the 1990s, 3D graphic accelerators such as the 3dfx Interactive Voodoo Graphics chip and NVIDIA's TNT2 processor became standards in gaming on a personal computer. NVIDIA also released the first consumer-level graphics processing unit, the GeForce 256. These accelerators were needed because the gaming industry was using new 3D gaming engines such as Quake that needed all the horsepower possible to play the games at full quality.

2000s: The Refining of 3D Animation

In the 2000s, more technology was being created to support the growing 3D animation industry, and there seemed to be a race every year between what the industry wanted and how the technology would dictate the industry's advancement. In the early 2000s, personal workstations could handle most commercial 3D software so that very expensive graphic workstations were no longer needed. 3D video games were taking over the video game industry. NVIDIA took over the game graphics card industry and became a standard in home computers. New video game consoles were released with more-accelerated

hardware to make video game play more immersive and with better graphics and better frame rates.

The film industry was trying to outdo the last CG/3D film released with better graphics and visuals. Pixar's *Monsters Inc.* (2001) showed that 3D fur could be accomplished with good effect. *A.I.* (2001) pushed boundaries in 3D animation techniques in visual effects. *The Lord of the Rings: The Fellowship of the Ring* (2001) pushed new techniques with crowd simulations. *Final Fantasy: The Spirits Within* (2001) attempted to create photorealistic humans for the full 3D animated film. (This film did not do well critically but did push the 3D animation industry into trying to create more-believable human characters.) *The Lord of the Rings: The Return of the King* (2003) made great advances in 3D animation with the motion-captured 3D-animated Gollum character.

By the 2000s, people had become accustomed to seeing high-quality 3D animation and visual effects work. Almost all films were being touched up in one way or another. Even the advertising industry began using 3D animation, and most people did not even notice it. Car commercials, for instance, began using 3D models of cars, rarely using the real car.

The future of 3D animation is wide open today (Chapter 9 takes a look at today's cutting-edge trends). With so many new techniques, hardware, and software coming out every year, no one can say for sure what is going to happen. But an exciting factor of this industry is that because it is less than 50 years old, many of its pioneers are still alive today and are still creating. You can meet them online or at conferences around the world. This is like meeting Leonardo Da Vinci or Rembrandt and asking them for help or for their thoughts about their art. There has never been an industry or art form offering such access to the masters with the knowledge that they are the ones creating the new art. This is truly an exciting industry and will be for the foreseeable future.

The Essentials and Beyond

The 3D animation industry has grown so much and so fast in the last few decades that other fields are still figuring out how the potential of 3D animation may help them. And the hardware and software industry is driving and being driven by the 3D animation industry. Each of these industries will become stronger because of the other. 3D animation pushes the computer industry to create faster and smaller processors, and the 3D art field is pushed by the computer industry to come up with new techniques and software to match the hardware of today. The industry is truly alive and exciting to work in. 3D animation is constantly changing and evolving, and with the culture of today will become only larger and in more demand.

(Continues)

The Essentials and Beyond *(Continued)*

Review Questions

1. Which of the following is not considered a field within the entertainment industry?

   A. Film
   B. Product visualization
   C. Video games
   D. Advertising

2. True or false: 3D animation always means motion.

3. What are the two 3D animation fields within the video game industry?

   A. In-game animation
   B. Game publishing
   C. Cinematic animation
   D. Game programming

4. True or false: Forensic animation is used today to aid in court cases, but is not to be used as pure fact.

5. True or false: Architectural animation can be a time-saver by enabling architects to test a design under stress.

6. Why is the history of 3D animation so closely tied to computer technology?

   A. Because computers are the primary tool used to create 3D animation
   B. Because the computer art field has pushed computer technology forward
   C. Because both industries are being driven forward as each pushes the limits of what can be done each year
   D. All of the above

7. True or false: In the late 1980s and the 1990s, computer animation and visual effects really took off as an industry.

8. The computer mouse was invented in what year?

   A. 1955
   B. 1963
   C. 1968
   D. 1971

9. What year was the first commercial 3D animation software available?

   A. 1963
   B. 1978
   C. 1979
   D. 1984

10. What year was the first fully 3D animated film created?

    A. 1963
    B. 1988
    C. 1999
    D. 1995