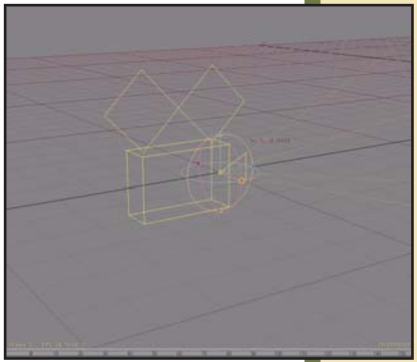
THE [DIGITAL] CAMERA

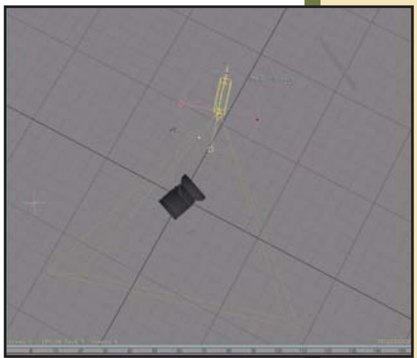
CHAPTER 2

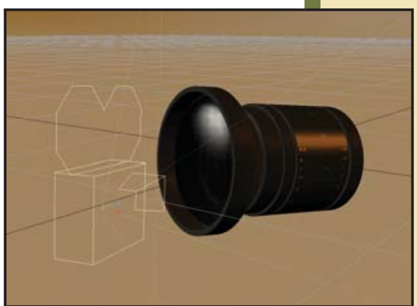
The [digital] Camera

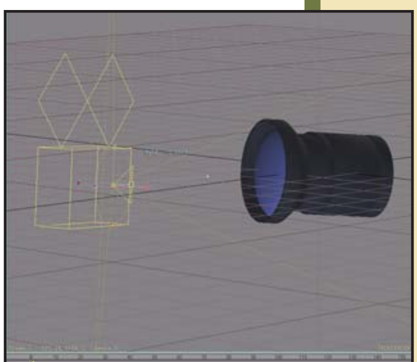
Titling this book was difficult. I wanted to call it *The Digital Camera*, but that would obviously lead to quite a bit of confusion. Today's ever-growing digital marketplace has branched to include digital photography, which continues to grow by leaps and bounds. The phrase "the digital camera" generally leads to one thought—digital photography.

This book is not about digital photography, although photographic and film principles are very important to digital cinematography. And, while carrying around a laptop that's running your favorite 3D application is possible, it's not quite the same thing as always having a camera around your neck. Perhaps you've taken an interest in photography, or maybe you like to critique movies and how they are filmed. Maybe during your last visit to the movie theater, you saw a few shots that felt uncomfortable, but you just couldn't put your finger on why. How does that all relate to working in computer animation? Good question! This book will answer those questions and many more. But first, you should understand how a real-world camera translates to the digital world.









"When you begin viewing the world through a camera lens, your senses sharpen as your mind and eyes are forced to focus on people and things never before noticed or thought about. I discovered that even if I didn't always take a picture, the simple act of carrying a camera and searching for something to photograph greatly sharpened my own powers of observation and allowed me to experience much more of life."

—Kent Reno

2.1 The Real and the Unreal

How would you describe the camera in your 3D application? It is digital, but is it a "digital camera" as you know it in the practical world? The best way to describe what it is, is to understand what it does. A real camera is often much like the "unreal" camera within your digital canvas. It can zoom, it can focus, and it can move in any direction you desire. Each type has advantages and disadvantages. You will find, however, that a digital camera offers an enormous range of control and flexibility. For example, the camera in your digital application can do just about anything you can imagine, such as rack-focus effects and shooting with extreme wide angles, fish-eye lenses, or telephoto lenses. What's even cooler is that your "digital" camera is devoid of wires, cables, and technicians! You can pan, swoop, twist, or spin the camera to your heart's content—without even paying union fees!

Just as a 3D artist trained in traditional painting has an advantage in the digital environment, the same goes for those with backgrounds in cinematography. But before you can use a camera in a 3D scene, take a look at how real-world principles translate to the digital world. This chapter will discuss:

- Aperture
- F-stops
- Focus
- Depth of field
- Aspect ratios and pixels
- Film and grain

The best place to start is with the most fundamental subjects: aperture and f-stops.

2.2 Aperture and F-Stops

If you have experience in film or photography, you should certainly know about aperture. Simply put, the *aperture* is an opening, generally a circular hole or similar shape, within a camera lens that controls the amount of light coming into the camera and onto the film or computer chip. The aperture is controlled by *f-stops*. The "f" refers to the focal length of the lens divided by the aperture. Camera operators are always concerned about aperture and f-stops, as these can make or break a shot.

The aperture on a real camera is a mechanical diaphragm that operates like the iris of an eye (see Figure 2.1).

The Origins of F-Stop

The origin of the lower case "f" in f-stop goes back to 1932 and renowned photographer Ansel Adams. He and a few others, Willard Van Dyke, Imogen Cunningham, Edward Weston, Hentry Swift, Sonya Noskowiak, and John Paul Edwards, formed a group called f.64. This group was dedicated to pure photography, including portraits and landscapes. Van Dyke originally proposed the name US256, but Adams thought it sounded like a highway. He simply wrote an "f" and then put a dot similar to the old aperture settings. They soon updated this to an f with a slash mark to read Group f/64.

The "f" in f-stop is a number or value that represents the ratio between the size of the focal length of the lens to the aperture. The "stop" portion of an f-stop is determined by a division of a lens' focal length and the aperture's diameter. This division is in millimeters. An example might be a 50mm lens with an aperture of 25mm in diameter; the f-stop is f2.

When you talk about f-stops, no matter what the measurement, the same measurement of light is reaching the film or digital chip. When a change in f-stop occurs, the light is either doubled or cut in half.

2.1 An aperture on a camera lens works like the iris of your eye, opening and closing to allow more or less light into the camera.

If this diaphragm is open wide, you have a low f-stop, which allows more light into the camera. Conversely, an aperture that is small (the diaphragm is closed to a tight opening) is a high f-stop, allowing very little light into the camera. It's confusing at first, but just think opposites:

- Low f-stop, more light (larger lens opening)
- High f-stop, less light (smaller lens opening)

NOTE

In addition to aperture and f-stops, real-world photographers also have to consider shutter speed and film speed. Think of the shutter as the eyelid of the aperture (the iris). When a photographer pushes the button on a camera to take a picture, the shutter opens and closes quickly, exposing either film or a digital chip to the amount of light specified by the aperture opening. Shutter speeds are measured in fractions of seconds, such as 1/30 sec or 1/125 sec. Higher shutter speeds are used for fast-moving action, such as sports. Lower shutter speeds are used for shots with less movement. Generally, you don't have to worry about shutter speed when working in the digital 3D environment. However, you may consider the animation frame rate to correspond to motion blur in 3D animation. Frame rates will be discussed more in detail in Chapter 10, "Resolutions, Compression, and Rendering."

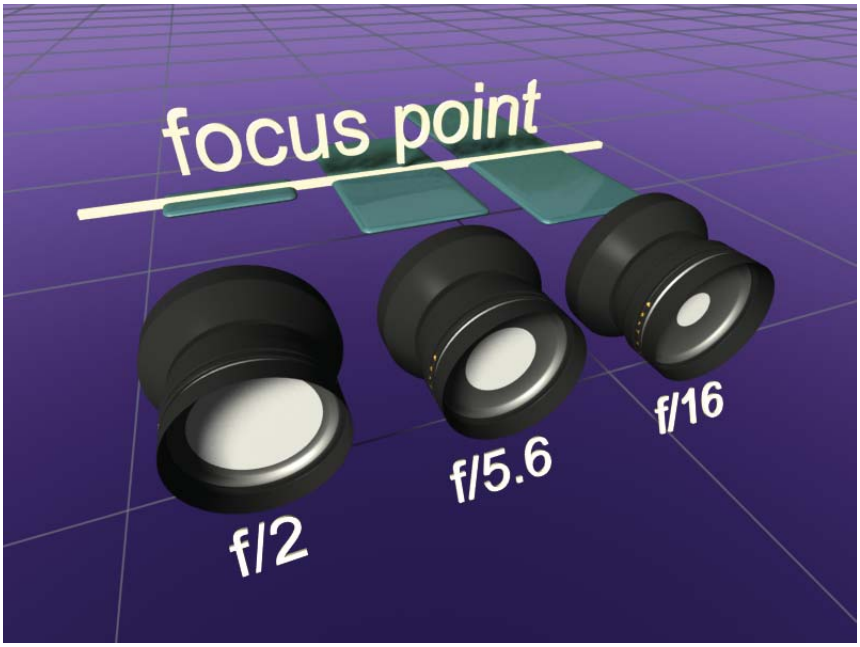
T-Stops

Along the lines of f-stops are t-stops. Often thought of as the same thing as f-stops, t-stops are actually quite different. The "t" stands for *transmission* and is a "theoretically perfect" f-stop. However, because of intermediums like the glass lenses, f-stops are never actually perfect, and there is always a loss of light. A t-stop's numbers are always higher than f-stops. A t-stop factors in the loss of light from a camera lens's optics. While t-stops are not used too much in photography, they are used in filmmaking and scientific work for more accuracy.

Aperture indirectly plays a role in digital cinematography because many 3D applications include settings for f-stops. Varying f-stops in the digital environment directly play a role when applying depth of field effects.

The "stop" portion of f-stop comes from original photographic technology in which the aperture was selected by turning a wheel that had various sized holes. Each hole let in twice as much light as the previous hole. With this in mind, you can understand what it means when someone says to "stop down" your lens. You can think of f-stops in terms of your own eyes. When you squint, you decrease the opening (larger f-stop) and block light from entering. Or, if you want to see more, you open your eyes wide (smaller f-stop) and let more light in. F-stops can range anywhere from f/1.4 to f/28. The lower f-stop number is considered "shooting wide open," meaning the aperture is at its largest opening, allowing more light to enter the camera lens. The higher f-stop number closes the aperture, allowing less light into the camera (see Figure 2.2). F-numbers are ratios. An f-stop is the ratio between the focal length of the camera lens and the diameter of the diaphragm (aperture) opening. For instance, f/2 means that the aperture diameter is 1/2 the focal length of the lens.

So when do you allow more or less light into the camera and why? And how does the f-stop play a role? More importantly, why in the world is this important to digital cinematography? A basic understanding of photographic principles can help you assess your 3D situation in terms of both lighting and depth of field.



2.2 With a wide aperture set to f/2, the focus point is concentrated to a specific point. As the camera lens is stopped down to f/16, an increased depth of field is created. A typical 3D animation without depth of field turned on will always render everything in focus, similar to a small aperture like f/16 or higher.

2.3 Depth of Field

One complaint in many 3D animations is that they look "too clean." So, what do you do? You can add more detailed textures, better lighting, softer shadows, and even radiosity. But watch any movie, and you'll see something not often put into 3D animations: *depth of field*. Planning a shot so that depth of field can be applied means properly setting up lights and cameras, as well as positioning subjects appropriately. Be sure to visit Chapter 7, "Staging."

Depth of field, often called DOF in computer software, can significantly change the look and feel of your shot. It can push the viewer's attention to specific subjects simply by changing the focal point. A large depth of field, often referred to as *deep focus*, keeps most everything in your shot clear and sharp (see Figure 2.3), while shallow depth of field leaves only a small area in focus, blurring what's in front and behind the subject (see Figure 2.4).

Depth of field is used in many animation settings, such as a subject focusing on a distant object. Or perhaps you have modeled and textured a small insect. When it's time to render, you want to create the most life-like image. If you shot the insect with a real camera, the area around the tiny object would be out of focus. A tight close-up creates a shallow depth of field, giving your digital shot added realism.

2.3 An image with a small diameter aperture (a high f/stop, such as f/18) provides a sharp focus throughout the image, both close and far from the camera lens. There is more depth of field in this shot.

2.4 An image with a large diameter aperture (a low f-stop, such as f/2.8) provides less (or shallow) depth of field. The objects before and after the point of focus appear blurred, calling specific attention to the subject.

The aperture controls not only the amount of light, but also the depth of field. The virtual camera in your 3D application often has its own aperture to match real-world settings. Although this digital version of a camera's diaphragm is merely a representation of an effect, the results can equal that of a real camera. You can use depth of field in a number of shots:

- Over the shoulder talking head shots
- Close-up objects
- Product shots
- Hand-held camera effects

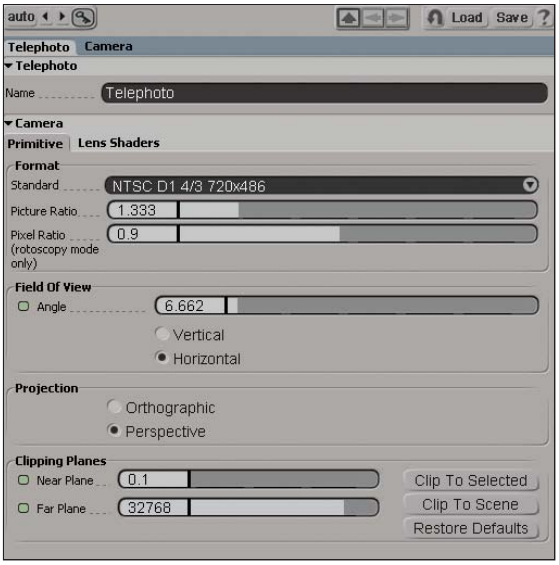
And there are many more opportunities to add depth of field when creating 3D shots, which you'll see throughout this book. But are there times when you wouldn't want to have depth of field applied? Yes. Everything should be in focus for:

- Landscapes
- Group shots, such as product line-ups or crowd shots
- Cartoon or cel-shaded animations
- Aerial shots

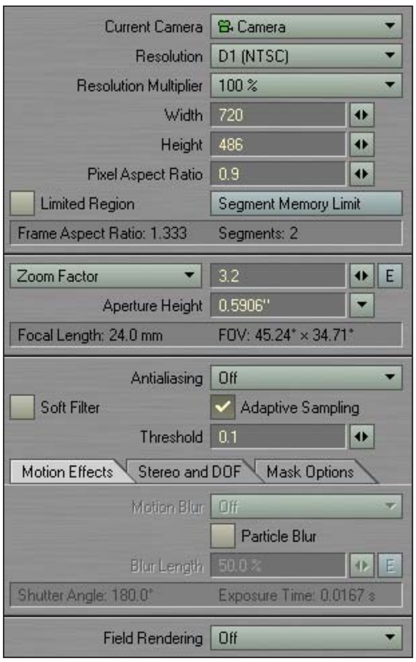
Depth of field can also be animated, at least in the digital world. For example, many shots in movies and television use *rack-focus* shots. These are shots that changes focus over time, perhaps from one person talking to another. The cinematographer needs to manually adjust the focus, aperture, and any other settings on the fly while shooting the scene. In the digital world, it's much easier. You can assign a focus point to your 3D camera, set an appropriate f-stop, and then simply keyframe that focus point at any desired time. Deliberately repositioning your focus to create animated depth of field can greatly improve the look and feel of your animations.

2.4 Lenses and Focal Length

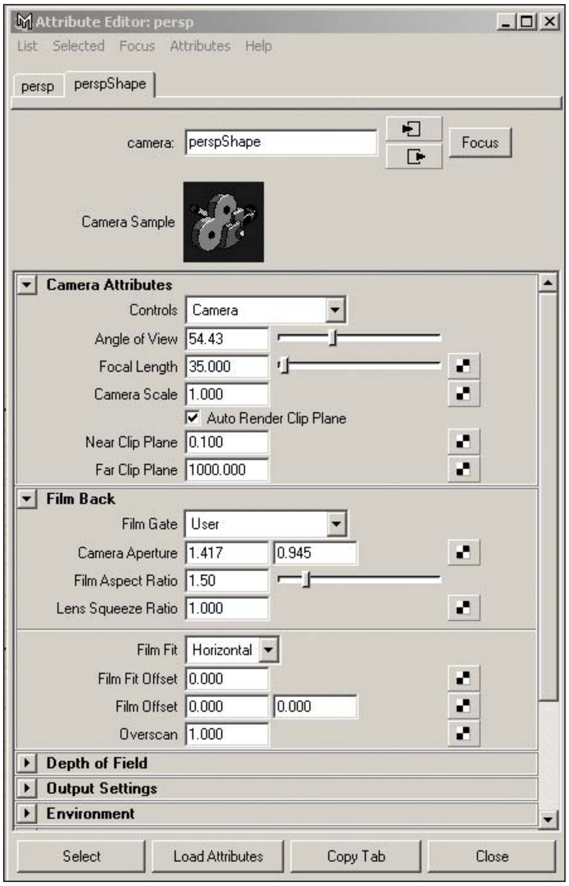
You can't really talk about apertures, f-stops, and depth of field without understanding a little more about lenses. Camera lenses vary greatly from brand to size, but they all have f-stops and perform the same function—they bring light into the camera. Film cameras and many new digital cameras have interchangeable lenses to change from wide-angle shots to telephoto. But in the digital world, you don't have to change lenses; instead, you change focal length and zoom factors. The focal length in most 3D applications equates to that of a real-world lens (see Figures 2.5–2.8). Although the values are not exactly accurate across the board, it's the focal length setting that will provide a wide-angle or telephoto look.



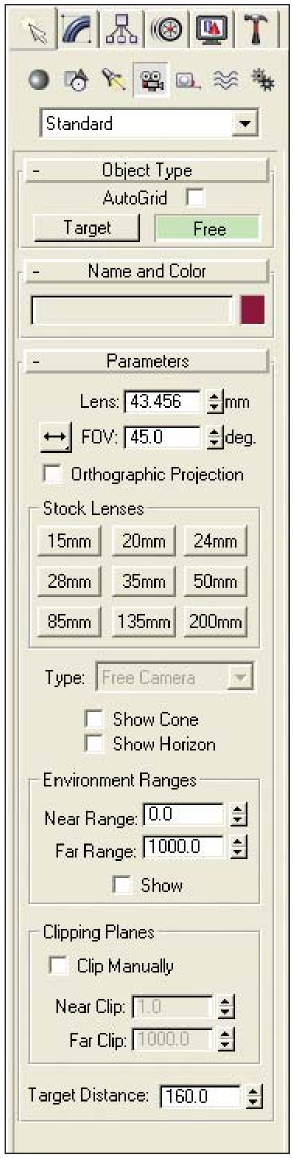
2.5 The SoftImage XSI camera panel offers specific presets for various types of lenses.



2.6 LightWave 3D 7.5's Camera panel offers a range of real-world settings to match camera lenses, as well as aperture.

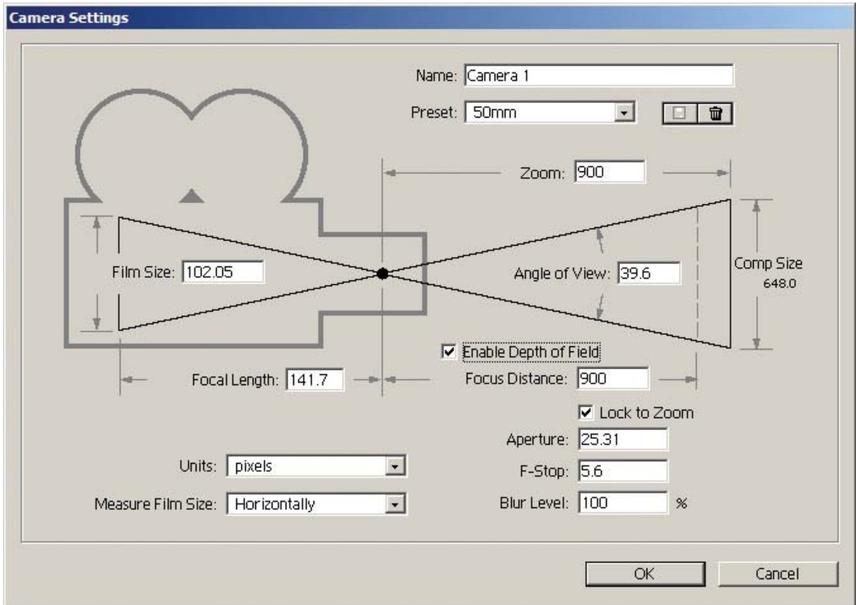


2.7 Maya's Camera panel also offers control over focal length and more.



2.8 3ds max's camera works like a real-world camera, as do the other 3D applications.

Adobe's After Effects 5.5 offers real-world settings, but, surprisingly, is not a true 3D application. Figure 2.9 shows the After Effects Camera panel, where you can visually see the camera lens settings, as well as specific aperture settings.



2.9 The After Effects 5.5 Camera panel is one of the more intuitive control areas available in software applications.

So what is focal length, and how does it work? *Focal length* is an optical term that means the distance, usually in millimeters, from the lens to the point of focus (the subject). The longer the focal length of a lens, the smaller its *field* or *angle of view*. Given that, a long telephoto lens, such as a 400mm, can view a small area only. This is not to be confused with how far the lens can see, only what it sees. For example, a camera lens with a 400mm focal length is twice as powerful, but has half the field of view, of a 200mm lens. On the flip side, a 20mm lens has a very wide angle of view (hence, it's called a *wide-angle lens*). You can very easily apply real-world camera lenses and focal lengths to your digital scenes simply by entering the desired values in your software application's camera control panel. (See Figures 2.10 and 2.11.) It's a lot easier than changing lenses!

In the digital environment, you can animate focal length to give your animation a very different look. This will be explained in detail in Chapter 6, "[digital] Directing."

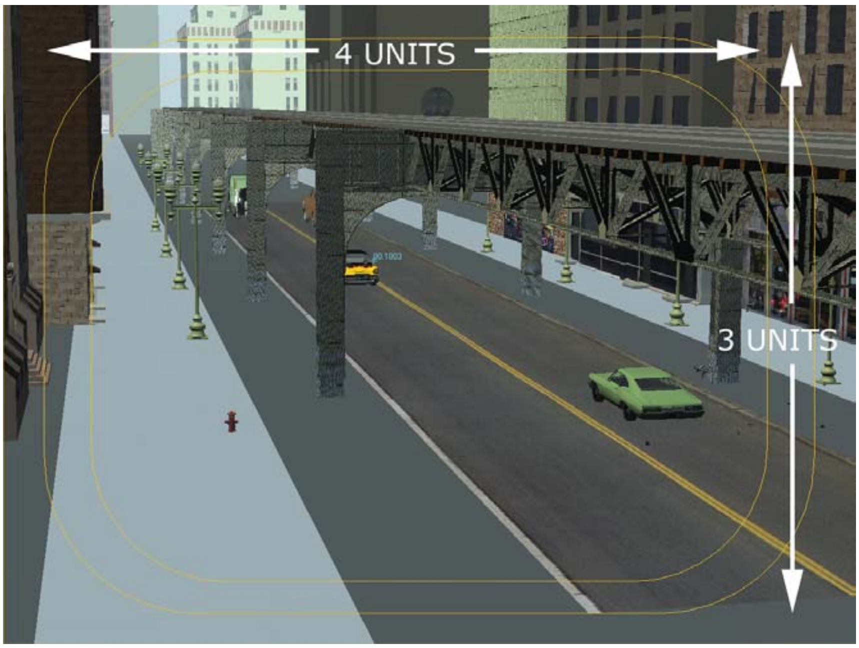
2.10 In this 3D scene, the camera's focal length (its lens) was set to 120mm. You can see that the overall look is tight on a specific area of interest.

2.11 This is the same shot as the previous figure, but with the focal length set to a 35mm lens. The field of view is much wider.

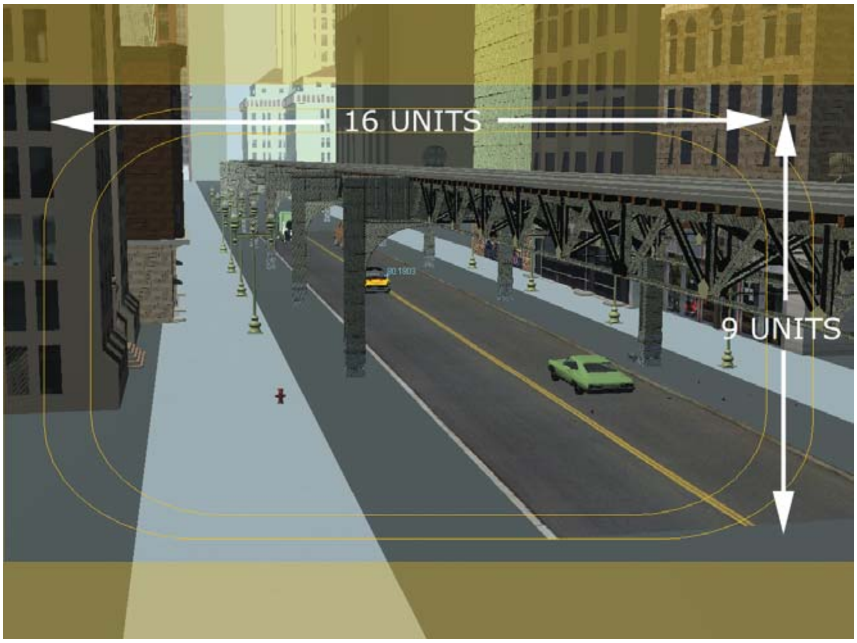
Knowing when to use specific focal lengths is really up to you as a digital cinematographer. Choosing the right focal length, f-stop, and other camera settings is what a true cinematographer must decide for each production. As a 3D animator and digital cinematographer, you must decide when and how the right camera settings will be used. The project example throughout this book will be used to help you understand many different situations you can encounter.

2.5 Aspect Ratios

Just as depth of field and focal length define the image you're capturing, the aspect ratio defines the image's display. An *aspect ratio* simply describes the shape of the viewing screen by defining the relationship between a frame's width and height. The typical aspect ratio for television and video is 4:3, which is also called 1.33:1 in cinematic circles (see Figure 2.12). The first number (4) refers to the screen's width, and the second (3), its height. Film in theaters is shown at 16:9 aspect ratio, also described as 1.78:1 (see Figure 2.13). Now, high-definition television sets (HDTV) are bringing the 16:9 ratio into our homes (see Figure 2.14).



2.12 Most television is shown in a 4:3 aspect ratio, while films in theaters are shown at 16:9. Although still rectangular, a 4:3 ratio is closer to a square screen shape than a 16:9 ratio.



2.13 The 16:9 ratio, sometimes referred to as "letterboxed," is used most often for film.

2.14 1.78:1, or 16:9, is the aspect ratio of new HDTV and wide-screen televisions, as well as many films.

How did these aspect ratios become the standard? When the first moving images were put on film, 4:3 was used, and it became the Academy Standard Aspect Ratio (see Figure 2.15). This aspect ratio remained until the 1950s, when wide-screen (16:9) aspect ratios emerged. In the '50s, television became immensely popular, and filmmakers needed a way to get people back to the movie theaters. By using an aspect ratio that was twice as wide as it was tall (2.35:1), they created a new cinematic experience. When an image extends to fill more of your peripheral vision, what you're watching is more engaging.

NOTE

Most films released are kept to a safe 16:9 area, but their actual aspect ratios are 1.85:1 or higher.

2.15 The 1.33:1 or 4:3 ratio was common in the early days of film.

Today, cinematographers use aspect ratios of 1.33:1, 1.37:1, 1.66:1, 1.78:1, 1.85:1, and 2.35:1. Each ratio is increasingly wider, and which you use is often determined by film stock, such as a large 70mm, or the type of production. The cinematographer must decide which aspect ratio works best for the budget and the overall look of the film. As a digital cinematographer, you have the freedom to experiment and mimic any of these real-world aspect ratios in your animation work.

2.6 The Next Step

This chapter took you on a not-so-technical journey of basic camera principles, all of which can be used in the digital realm. Before you begin setting up your 3D camera, however, you need something to shoot! And to shoot something, you must plan. Read on to learn how storyboards, concepts, and visualization can help you bring paper to pixels.