digitalphotography
the complete course

New York Institute of Photography

How To Choose A Digital Camera

Unit Two
Lesson Four

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Introduction.

Now that we've had an overview of the digital imaging process, it's time to return to digital acquisition. We'll begin by digging into the specifics of how to capture an image using either a digital camera or a scanner and how to get that digital information into your computer. We'll also explore ways of getting pictures out of your computer with a lesson on Basic Output. Finally, we'll end the Unit with the second in the Digital Eye series—Developing Your Eye.

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How to Choose a Digital Camera.

We'll cover cameras first with an emphasis on the types of digital cameras covered in the Unit One overview:

1. Consumer digicams used by photo hobbyists and Web photographers.

2. "Prosumer" digital cameras for users needing extra features.

3. The digital Single Lens Reflex Cameras (SLRs).

4. High-end professional studio cameras.

In this lesson we'll explore practical ways in which you can use a digital camera to acquire a digital image. Keep in mind that you do not need a digital camera for the Course. Many professional photographers who rely heavily on digital photography techniques capture all or almost all of their images on film first, then use a scanner to digitize those images. Until you purchase a digital camera, if indeed you ever do, you can still get digitized image files from your negatives, prints or slides by scanning them yourself, or by getting scans from a photo store or digital service bureau. You can also use the Totally-Free Images we've provided you in each Unit, and

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you can download some public domain images directly from the Web. If you missed the WebCenter One article on public domain photos, we suggest you pay a visit.

However, chances are that you'll find yourself using a digital camera before too long, since they're becoming less expensive—and easier and more fun to use—all the time.

Choosing vs. Using.

We've drawn a distinction between choosing and using a digital camera by separating the subjects into two lessons. In Lesson Four, we're going to discuss a number of features common to both film and digital cameras, and explain what all the cryptic camera numbers and acronyms mean. We'll also cover the special features that make digital cameras so interesting.

There's a tremendous amount of information in this lesson and the next. The titles of the two lessons -- "How to Choose a Digital Camera" and "How to Use a Digital Camera" -- represent an effort to split this information into two parts, although the distinction is a bit artificial.

In Lesson Five we will describe additional characteristics common to digital cameras, while we concentrate on how to use them. Armed with all this information, you will then be able to decide on the best camera for you.

We want you to study both Lesson Four and Lesson Five before you go shopping. As you'll see, some of the features of digital cameras won't begin to make sense until you try to use one.

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Copyright Issues.

Before we go further, let's take a moment to discuss the question of copyright.

Today's digital technology (including cameras, scanners, and the print station machines found in many camera stores) make it easy to produce a very high-quality copy of just about anything.

While it's great to be able to scan your own images or old family photographs, as a school for professional photographers we have a responsibility to remind all of our students of the following:

It is a violation of the copyright laws of the United States (and most other countries under the Berne Convention) to copy or reproduce the work of another photographer without permission.

In addition, any images, in whole or in part, including drawings, paintings and the like, produced by someone else should not be used without permission. This restriction includes incorporating a photograph taken by someone else (or any other type of art made by someone else) into your own work without permission.

We often hear horror stories about wedding clients who use the proofs supplied by the photographer to make high quality prints at a digital photocopy stand. This not only violates the photographer's copyright, but it probably also violates the photographer's contract with the client and damages the photographer's income.

So remember, just because we can make high-quality copies of all sorts of images does not mean that it is ethical or legal to do so.

Now, let's get back to photography.

Choose The Camera That's Right For You.

Unlike our Complete Course in Professional Photography, where we virtually insist that students use a Single Lens Reflex (SLR) camera, we've designed **Digital Photography: The Complete Course** so that you can do the assignments and get great photos using virtually any type of camera. That's one of the reasons we included the NYI Video Program Weekend Photo Workshop. It's designed to show you the potential—and the limitations—of the basic types of cameras.

But let's suppose that you're ready to buy your first (or perhaps, your second) digital camera. What features should you consider? What don't you need?

After reading this lesson and the next, you'll be prepared to reach your own conclusions about many of the features that are available. But in general, we think that a camera that allows you to select manual control over completely automated focus and exposure is a big plus. And modern zoom lenses give photographers the chance to change picture composition without having to change position. That's also a big plus.

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Regardless of the camera you're currently using, unless you've been trained in photography, odds are that your camera is probably better equipped to do its job than you are to do yours. The goal in learning about camera features is to show you how to get the best results with whatever camera you're using.

Digital Camera Tour.

This lesson is essentially a tour of the basic camera features that make it possible to take a photograph. We'll start by reviewing the basic picture-taking systems common to all cameras. Then, we'll look at some of the special features we associate principally with digital models.

We'll also cover all the basic features of your camera and lens that you need to know about in order to fully understand (and appreciate) the power of photography. It's this basic photographic magic that the computer then enhances. These features include the lens, the twin exposure controls of shutter speed and aperture, and special types of lenses that can be used for certain effects.

As we go along, we will compare digital cameras with traditional film-based models, since most students have some familiarity with those types of cameras.

How Digital is Different.
How Digital is the Same.

To appreciate how digital cameras differ from traditional film cameras, we have to start by examining their common characteristics, because in many ways a digital camera is quite similar to a conventional film-based camera. The differences are few, but important.

Both film and digital cameras have most of the basic parts in common.

In fact, the major difference is not in how the picture is taken, but in how that picture is treated after the shutter release button is pressed. Because many digital cameras allow you to preview the picture immediately after it is made, you can choose to accept the picture and store it in the camera's memory or on some type of storage device, or reject the photo and delete it. Once the picture is captured and then transferred to your computer, you can use it immediately. With film, as you know, the film has to be processed before you can even see the image. If you're using negative film, a print then has to be made of the developed film.

With a film camera, we all know what to do when we've finished the roll. We rewind the film back into the cassette (either manually or automatically), and then take the exposed film to our local photo lab, or send it off in the mail to a photo-finisher, or develop the film and print the pictures ourselves.

With a digital camera we may "download" the image right from the camera to the computer, or pop out the memory card—the digital equivalent of film—and use a card reader to transfer the image to the computer for processing and output.

It's also possible with some models to move the image directly to a Web site or other sharing location without transferring the image into our computer first. Other options, such as a printer, a digital picture frame, or a Personal Digital Assistant, allow us to download the images immediately into these devices.

A portion of Unit Five is devoted to output options like these, so we won't dwell on this topic here. For now, just realize two things:

First, that there are different ways to move our images to different media using different pathways after taking a photograph with a digital camera.

Second, the most important and exciting part of digital photography is what we can do with the photograph once it has been digitized and is on our computer. Whether it started as a piece of film or a digital image, we can rapidly and dramatically manipulate the image and then quickly make a print using our printer.

©Chuck DeLaney

A Few Pictures at a Time.

One important benefit to the digital process is that unlike film we don't have to shoot all the pictures that the memory card or camera memory can hold before we can get a print.

In fact, we can shoot just one picture, then move it onto the computer and get a print right away. By contrast, shooting just a few frames on a roll of film and then taking the roll in for processing is correctly viewed by people as a waste of money. As a result, the film sits in the camera for months until the entire roll of film is used up and taken to the processor.

While it's great to see those Christmas photos just after St. Patrick's Day, or even worse, a few days after the Fourth of July, it's so much better to be able to e-mail those photos off to your Uncle Jack on the other side of the world just a few hours, or even minutes, after you take them!

In this respect digital cameras are the next logical development in the "instant photography" realm, which was first made popular by Polaroid over fifty years ago. Both Polaroid and digital cameras offer the satisfaction of seeing your photos without having to wait for a lab to develop the pictures. This makes sharing your photos much more immediate.

But whatever type of photo system you're using, before you can start sharing those wonderful photographs, you have to make them. Let's begin with the picture-taking side of the equation.

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Basic Camera Features.

First we'll look at how a digital camera is similar to or may differ from a conventional camera. Then we'll look at the most important differences.

All cameras share four basic attributes:

Camera Feature 1.

Cameras are *light-tight boxes* that contain *light-sensitive material*.

Camera Feature 2.

Cameras have a *viewfinder system* of some sort that allows you to see what portion of the scene your camera will record. This makes it possible to compose your image.

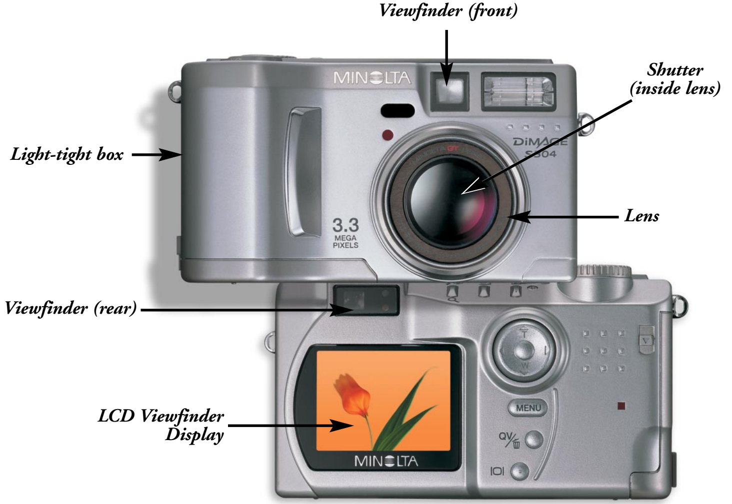
Camera Feature 3.

Cameras have a *lens that admits light and focuses that light* to expose the light-sensitive material inside the light-tight box. The mechanism that controls the size of this opening in the lens is called the *aperture*.

Camera Feature 4.

Cameras have *shutters* that open and close to allow light to enter the camera for varying lengths of time, controlled by some kind of shutter release.

These essential elements have been part of all cameras almost since the invention of photography. In addition, most modern cameras—both film-based models and digital ones—have these added features:



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Camera Feature 5.

Some cameras have an *automatic exposure control system* to measure the light and translate it into aperture and shutter speed settings.

Camera Feature 6.

Some cameras have a *built-in microprocessor* with software that has preset special program modes that allow you to easily shoot pictures in a way that matches individual scenes (such as Sports, Landscape, Close-up, etc.) These microprocessors also control other functions such as metering for exposure, adjusting aperture and shutter speed, and film advance.

Camera Feature 7.

Some cameras have a *built-in flash* to add light to dark scenes.

Camera Feature 8.

All electronic cameras have *batteries* or another *power system* to make the last three features we've listed possible. In addition, cameras with a power supply usually use that power to control the lens feature and the shutter system feature.

There's one more feature we insist your camera have:

©Jim Barthman

Camera Feature 9.

A *mount* that allows you to attach it to a tripod.

As you'll learn in the next lesson, and as we'll stress over and over again in the Course, a tripod makes it possible to take the sharpest possible photographs, especially, as we'll cover, when you're using a slow or even medium shutter speed. We'll discuss the use of the tripod in the next lesson.

Of course, there are variations on the above list with both conventional and digital cameras.

The lens may have a fixed focal length or be a zoom; the flash may have more or less power; and the autofocus system may work in different ways, all with the same result—to find focus without the photographer having to manually turn the lens to set focus. But with either a film or a digital camera you essentially raise the camera to your eye, frame the subject and take the picture. Point and shoot, as they say.

We're going to look at most of these systems in more detail in a moment.

So far, there isn't much in the above list that would be unfamiliar to you even if you've never seen a digital camera. Almost every household in the world has at least one simple camera. All these cameras, even the "disposable" single-use models sold in drugstores and supermarkets, have most of the features we've listed above.

Now let's go back over the first four basic camera features and review a few key differences between digital and film-based cameras.

Reusable "Digital Film."

Camera Feature 1: Cameras are light-tight boxes that contain light-sensitive material.

The traditional camera is a light-tight box into which you need to insert film, which is the light-sensitive material in traditional cameras.

In a digital camera, the light-tight box comes with a light-sensitive chip, usually a charge-coupled device (CCD), that is the light-sensitive element. Unlike film, most light-sensitive chips can be reused again and again. Instead of being physically changed by the light that strikes it (like film), the chip just sends out a series of electrical signals that are then converted to digital form. Once those signals have been internally processed and recorded, and then stored on a removable memory card or in the camera's memory, the chip is ready to capture another image.

As we'll cover in detail in Lesson Five, there are a lot of different memory storage options used in digital cameras today. We suspect that the current variety of products will continue to grow and change, especially in memory capacity. There are two key aspects to keep in mind. Each type of storage card (or memory card) has a limit on the number of images it can record and store. This limit varies with the resolution setting you use to capture your images. We'll cover this topic in detail later. For now, just bear in mind that most types of storage media can be reused after the memory has been cleared. Thus, like film, you have a limit to the number of pictures per card you can take. But unlike film, once the images have been cleared you can use the memory card or storage space again.

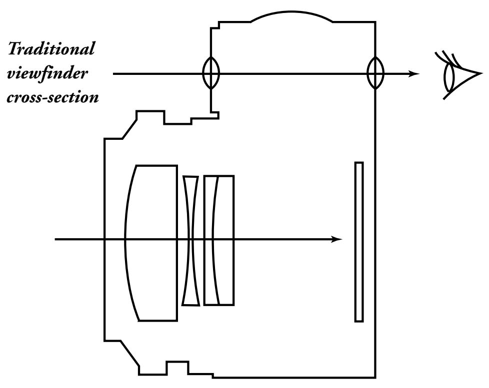
©SanDisk

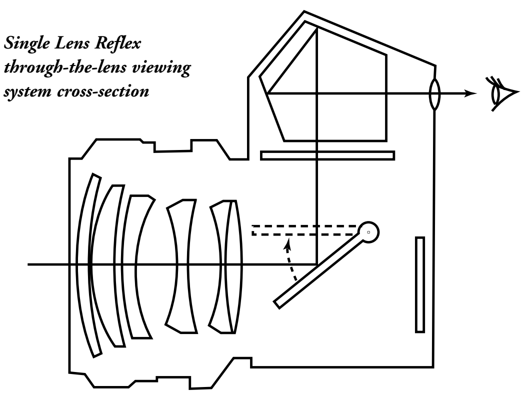
A New Viewfinder Option.

Camera Feature 2: Cameras have a viewfinder system of some sort that allows you to see what portion of the scene your camera will record. This makes it possible to compose your image.

The viewfinder systems in film-based cameras range from being inexpensive and somewhat vague to being very expensive and precise. In most point-and-shoot cameras, the viewfinder is a little window that gives a limited view of what will be recorded on the film. You can't even be sure if the camera is focused on your intended subject. If you're photographing an object that is closer to the camera than four feet, what you see in the viewfinder probably won't be the same as what gets recorded on the film.

Professional single lens reflex (SLR) cameras use a much more sophisticated viewing system which allows the photographer to see directly through the camera's lens and clearly observe focus. It also gives you an accurate view of what will actually be recorded on film, whether the subject is near to the camera or far away.





LCD Display "Viewfinder."

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What's different in digital cameras is the distinctive LCD (Liquid Crystal Display) screen on the back of digital camera models. This acts like a "live" video screen, allowing you not only to "see" your photo before you take it but also review it after you've recorded it.

That means digicams and "prosumer" digital cameras generally offer two options for viewing pictures before they are made: you either hold the camera up to your eye and look through a viewfinder (digicams and "prosumer"models usually have a viewfinder that resembles that found on a film-based point-and-shoot camera), or else struggle to "frame" your photo in the camera's picture-every-fraction-of-a-second LCD display. SLR digital models have precise through-the-lens viewfinders, in addition to an LCD display.

When you activate the Monitor switch or display, you can usually see the "action" on the LCD screen, albeit in a somewhat jerky motion. This shows you what the lens of your digital camera "sees." After shooting you can review your image to decide if you want to keep it or delete it. Organization of your photos may even begin right in the camera. Some models allow you to place the image in a pre-assigned "folder" that may be titled "vacation," "trade show," "portraits," and so forth.

With the right equipment, you can immediately send that image (via telephone lines or some sort of wireless technology) directly to a Web server or sharing site. You may also be able to e-mail right from the camera or incorporate the image directly into your Personal Digital Assistant. This activity, usually restricted to low-resolution images, has become very popular in Japan and other countries where digital consumer goods have caught on even more quickly than in the United States.

As we'll discuss in the next lesson, there are some shortcomings if you try to perform critical editing using your camera's LCD viewfinder. Put simply, the viewfinder is great for detecting obvious faults and weaknesses in an image when you're on location. This gives you the opportunity to delete those flawed images and take improved ones.

Check the Unit Two WebCenter for the latest technological advances in this rapidly growing digital industry.

©Handspring

Basic Photo Controls.

Camera Features 3 and 4: Aperture and Shutter Speed.

The aperture and shutter speed controls of a digital camera do not differ much from those of the film-based camera. Neither does the basic nature of the lenses used by digital cameras.

However, the interplay between aperture opening and shutter speed, in combination with the type of lens that the photographer uses, is at the very heart of the power of photography.

For that reason, we're going to cover this information in detail. For those students for whom this is a review, enjoy it. Review is rarely harmful. For those of you who have never studied this material, prepare to discover the full wonder of the image the photographer's lens records.

You may not have ever been able to really control aperture and shutter speed. Those controls may be of little concern to you if you're using a point-and-shoot type camera, regardless of whether the camera uses film or has a chip inside.

That's because when using point-and-shoot models, we have little or no control over what aperture opening and shutter speed the camera decides to use. If choices are being made about exposure, it's the camera that's doing the choosing. Since these "lens-shutter" cameras first appeared in the 1980s, they've made amateur photography much better in some respects. Photos are better exposed than before and, thanks to autofocus, something is usually in focus within the frame.

But that's still no guarantee that the photo has much meaning or content. That's where the Three Guidelines we introduced in Unit One come into play. In the last lesson in this Unit, Developing Your Eye, we're going to show you how the choice of lens, aperture, and shutter speed can be applied to enhance those Guidelines.

But first, we need to explain what effects are possible because of faster or slower shutter speeds, and larger or smaller lens openings.

The statements we've just made may sound confusing when you read them as words on paper, but let's look at some photos on the next few pages to illustrate what we mean.

©Chuck DeLaney

Here's a photo where the limited amount of sharp focus helps emphasize the subject, a child holding a pumpkin in the middle of a pumpkin patch. Notice that the child and the pumpkin she's holding are in sharp focus, but the pumpkins and the field in the background are in soft focus. Photographers would say that this photo has a relatively shallow depth-of-field, or shallow area of sharp focus. Shallow-depth-of field is created by using a large aperture opening.

©NYI Student Mary Pellegrino

This photo uses a very shallow depth-of-field to call attention to these hungry baby birds. Only the head and gullet of the bird in the center are in sharp focus, along with a bit of the nest below the bird. The back edge of the nest, the area behind, and even a bit of a tree branch in the left foreground are all in soft focus. Again, a large aperture opening is used to create shallow depth of field.

©NYI Student Jeong Hwa Min

In this photo everything that we can see is in sharp focus, the expressions on the marchers' faces, the replica of the Statue of Liberty and even the Coca-Cola sign at the far north end of New York's Times Square. We say that this type of photo has a great depth-of-field, meaning that everything from the front of the image to the back is in sharp focus. A small aperture opening is used to produce extreme depth-of-field.

©Chuck DeLaney

We can clearly see all the footprints in this snowy path in the woods. Again, a small aperture opening results in great depth-of-field, so the entire frame is in focus.

©NYI Student Charles Wright

Looking at this photograph, we know that the photographer used a very fast shutter speed to record the image. Notice that the rotor blades on the helicopter appear to be standing still. We know this isn't possible. If the blades weren't churning, the chopper wouldn't fly. The use of a very fast shutter speed can stop motion in a photograph. In fact, if we had viewed this scene with our eyes, we would not see the helicopter's blades the same way they appear here, since our eyes cannot stop motion the same way the camera can. We would see a blur of chopper blades.

©NYI Student Rob Bowman

Here is a great example of the result of a slow shutter speed on a moving object. The photographer used a two-second exposure to blur the lights on this pair of ferris-wheel type rides. The result is a ring of concentric bands of light that make us think we see a solid object. Just as our eyes can't see the blades of the rapidly moving helicopter as solid objects, here the camera can blur points of light into a solid object in a way that our eyes could not achieve.

©NYI Student Bonnie Nordoff

Here's an interesting image made using a 1/2-second exposure. The budding trees in the background and the May pole are sharp in the image, as are the children who are not moving. However, in the center of the frame we have one child in motion who is reduced to a blur. Notice also that the boy just to the left of center and the girl on the right were moving enough to reduce their heads to anonymous blurs.

©NYI Student Vince Reynolds

Sometimes the use of a slow shutter speed can be combined with a technique where you move the camera while taking the photo. This is called panning. By moving the camera at the proper pace, the photographer was able to keep the speeding hot rod sharp in the image while blurring the stands and the track's edge. Not only does this technique give a powerful sense of motion to the image, it also has the benefit of making the background a soft blur so that it is less distracting.

This short portfolio of images makes clear the power and control that a photographer can obtain if he or she can understand the principles behind choosing a specific shutter speed or aperture, and has a camera that allows them to control these important variables.

Lens Aperture and f-stops.

Let's Look at Lens Aperture.

Camera Feature 3: A camera has a lens that both admits light and focuses the light to expose the light-sensitive material. The mechanism that controls the size of this opening in the lens is called the aperture.

Regardless of whether you are using a film camera or a digital model, your camera's lens has an aperture ring that allows exposure to be controlled by letting in less than the maximum amount of light that the lens was designed to admit.
We're not going to go into great detail about the mathematics of light transmission, but we do need to introduce you to an important set of numbers.

To measure the amount of light a lens (which is really just one or more pieces of glass, or in less expensive cameras, plastic) can transmit, photographers use a measuring scale based on a system of computations that you don't need to know. These are the lens aperture numbers.

We're warning you in advance that this is a strange series of numbers. To make matters confusing right at the start, the

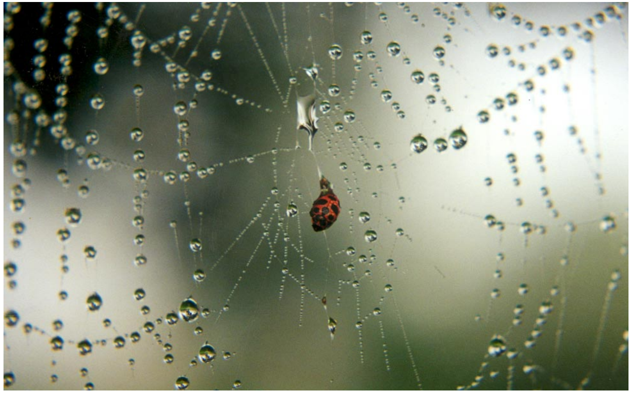


Photo taken with a large aperture. ©NYI Student Rachel C. Parent

Photo taken with a small aperture. ©NYI Student Jason Reed higher the aperture number, the less light is transmitted by that aperture.

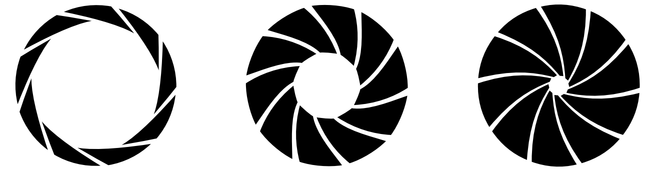
We call these aperture numbers "stops," and each aperture is designated by putting the symbol *"f"* in front of it. Hence, photographers call these numbers "f-stops"

What Is the Significance of These f-stops?

We've already explained that a larger opening will allow more light to enter the camera in a given period of time. What's equally important is that there is a visual difference between a photograph made with a large lens aperture as opposed to a small one.

The difference concerns how much of the scene in front of the photographer will appear to be in focus. It is the nature of photo lenses and optics that if you use a large aperture to record a scene, you will get a different visual result than if you use a small aperture. This is different from the way our eyes and brain "see" a scene. For most of us, most of the time, everything that we see with our eyes appears to be in reasonably sharp focus.

Use of a large aperture opening results in only a shallow portion of the subject matter in front of the lens being in focus. Professionals use this technique, called *selective focus*, to isolate important parts of the photograph.



Three different aperture settings

Use of a small aperture opening results in a large portion of the objects in front of the lens being in focus. This technique gives great depth-of-field to the resulting image.

If you're unfamiliar with the term "depth-of-field", it refers to whether the background, subject, foreground, or all of the above are in focus and it is dependent upon the aperture setting. If the subject, foreground and background are all in focus, that's a large depth-of-field. If only a narrow portion of the image is in focus, that's shallow depth-of-field—only the subject will be in focus, while background and foreground remain out of focus. You've just seen some examples of varying depth-of-field on the preceeding pages.

Most inexpensive consumer models of digital cameras do not give you the same amount of depth-of-field that a conventional camera does.

What Is the Relationship between f-stops?

What is the significance of the specific f-stop numbers? Once you understand how they work, they're magic. By knowing them—and using them whenever possible —you can control your exposure easily, and also know whether you're going to get great or shallow depth-of-field in your photographs. Here's how they work:

Opening up one full f-stop doubles the amount of light entering the camera. Closing down one full f-stop cuts the light in half.

The full sequence of f-stops is as follows:

f/1 *f*/1.4 *f*/2 *f*/2.8 *f*/4 *f*/5.6 *f*/8 *f*/11 *f*/16 *f*/22 *f*/32 *f*/44 *f*/64

Remember that *f*/1 is the largest possible aperture. *f*/64 is the smallest for all practical purposes. It's about the size of a pinhead.

These f-stops are standardized, which simply means that the amount of light transmitted by any lens set at *f*/8 is the same as any other. This may sound a little theoretical, but that's the way it is. Regardless of the lens manufacturer, lens focal-length, or type of camera body, a lens with an aperture set at *f*/8 will transmit the same amount of light into the camera at any given interval.

©NYI Student L. Forent

In fact, it is shutter speed and aperture that control the amount of light that enters the camera and strikes the film. For example, you could get exactly the same total exposure into your camera using different combinations:

1. A slow shutter speed and a small-size aperture;

2. A medium shutter speed and a medium-size aperture;

3. A very fast shutter speed and a very large-size aperture.

In the first example, the small aperture (which, we remind you will have a big *f*/stop number) will let in a little light in a given interval, but the shutter stays open for a long time.

In the second example, a somewhat larger opening admits more light, so the exposure can be shorter.

In the final example, the large opening admits light quickly (we call a lens that has a large maximum aperture a "fast" lens), so the lens can open and shut quickly.

Which of these combinations do you think would be best for sports photography?

If you said the third one—fast shutter speed and large aperture—you're right. That combination allows the photographer to get the image with little or no blurring.

In fact, since fast shutter speeds lessen the danger of camera shake, why wouldn't we always use a really fast shutter speed and a large aperture?

There are a number of reasons why we can't use a large aperture all the time. Some of the reasons are practical, some of them visual.

Let's start with the practical issues.

1. "Fast" lenses with maximum aperture openings such as f/2, f/2.8, and f/4 are very expensive.

Fast lenses tend to be purchased by professionals. For example, a top-brand SLR zoom lens with a focal range of 80 to 200mm and a *f*/2.8 aperture through the entire range of focal lengths—will cost you $1,000 or more! It's not unusual for a pro using 35mm SLR equipment to own $5,000 to $10,000 worth of lenses. In larger format cameras, fast lenses are even more expensive.

Large aperture = shallow depth-of-field.

Small aperture = great depth-of-field. ©Chuck DeLaney

Fast lenses need a lot of what pros call "glass," and glass costs money. In a point-and-shoot camera, it's unusual when more than about $20 of manufacturer's cost gets put into the lens. The lens found in single-use "disposable" cameras is a simple plastic meniscus lens like that on a magnifying glass. With the entire selling price of a disposable camera running between $5 and $10, how much could the manufacturer spend on that lens?

The fixed aperture on single-use cameras is usually *f*/8.

On zoom point-and-shoot cameras, it's not uncommon for the lens to have a maximum aperture of *f*/8 at the wide setting on the zoom and one stop less—that is, an aperture of *f*/11—when the lens is zoomed out to 115mm, 135mm or 140mm.

But cost is just a practical factor. There's another, even more important reason.

2. A photograph taken at *f*/2.8 will look significantly different from one of the same scene taken at *f*/16.

What's the difference? Well first, let's note that *f*/2.8 is a large aperture and *f*/16 is a small aperture. Which one lets in more light? Did you say *f*/16? If you did, you're wrong. Remember that larger *f*/numbers describe apertures with very small openings.

A lens with an aperture of *f*/2.8 lets in a lot more light than a lens with its aperture set at *f*/16. While we don't require that you understand the math, you might be interested to know that *f*/2.8 admits thirty-two times more light than *f*/16!

©Dynamic Graphics

These four photographs were taken at progressively slower shutter speeds. *©Chuck DeLaney*

Shutter Speed.

Camera Feature 4: Cameras have shutters that open and close to allow light to enter the camera for varying lengths of time, controlled by some kind of shutter release.

Regardless of the type of lens you use, or the size of the opening through which that lens admits light, the total amount of light that will be captured by the light-sensitive material will in part be governed by the length of time the light is allowed to enter the light-tight box. That's shutter speed.

We're not going to bother with the variety of shutter mechanisms that you can find in different types of cameras. It is sufficient to say that modern electronic shutters, as opposed to the mechanical models that predominated in cameras made before, say, 1985, are very reliable.

It's not so important for you to understand how they work. But it is essential to understand the effect of using different shutter speeds.

Most cameras today use shutter speeds of about 1/60th of a second or faster. Early cameras over 100 years ago needed to use much slower shutter speeds because early film was relatively insensitive to light. Typical shutter speeds available today for cameras with electronic shutters range from about one second down to 1/1000 or 1/2000 of a second.

In the days of mechanical shutters, each available speed was exactly half (or going the other way, double) the time of the one before. A typical camera might offer the following shutter speed settings: 1 second, 1/2 second, 1/4 second, 1/8 second, 1/15 second, 1/30 second, 1/60 second, 1/125 second, 1/250 second, 1/500 second, 1/1000 second.

There are some professional SLR models that have an extended range of slower and faster speeds, sometimes from eight seconds to about 1/8000th of a second.

It's important to realize that if your camera is controlling exposure, it is measuring the light in the scene and using different shutter speeds depending on a number of factors. You may be able to affect the camera's choice to a degree. We'll discuss that in the next lesson.

A slow shutter speed will make moving objects in your photo appear to blur in a way that can't be seen by the human eye. This is a great effect to have under your control.

A very slow shutter speed can make objects virtually disappear.

On the other hand, a fast shutter speed can freeze motion. This can show us rapidly moving objects in a way that we can't see with our eyes.

Camera Shake.

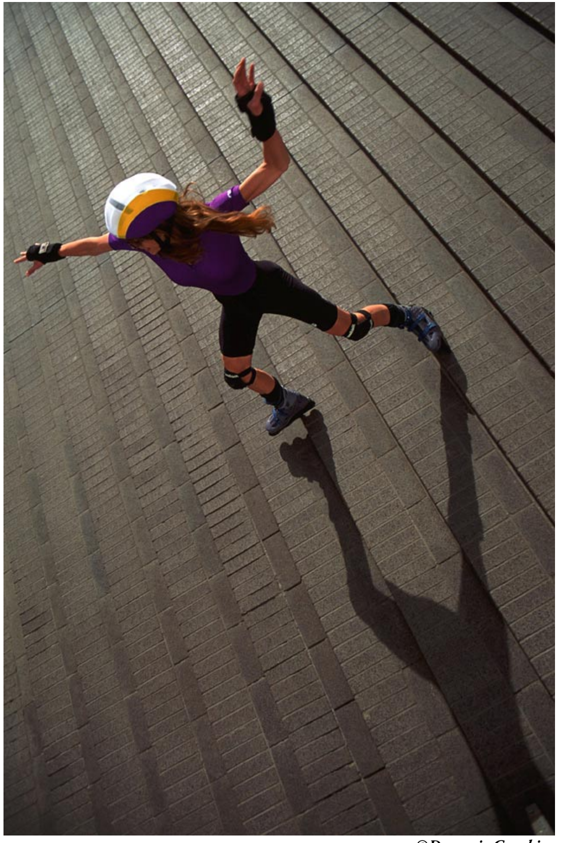
There's one other vital consequence of shutter speed: At slower shutter speeds, many photographs will be out of focus because of camera shake.

This is one of the most common faults we see in pictures submitted by beginning students—a lack of sharpness due to camera shake. While many professional photographers often shoot hand-held at shutter speeds of 1/15 and 1/30 because they don't have much time to get the shot, they also take lots of pictures because they know that some images will be compromised because of camera shake. There's just no avoiding it, even for the best pro. Most people cannot hold a camera steady at any shutter speed slower than 1/60th of a second.

That's why the shutter speed on single-use cameras and other no-control models is generally set at 1/60th of a second.

But even at 1/60th of a second, or even briefer shutter speeds, a handheld picture cannot be sharper than the same picture shot using the camera on a tripod.

We'll discuss tips on how to get sharp photos in the next Lesson.



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Controlling Exposure with Aperture and Shutter Speed.

A photographer who uses a camera that allows selection of shutter speed and aperture has the opportunity to use the camera's tools to enhance or dramatize the subject matter of the image.

If the control over these visual effects is appealing to you and you've never investigated the use of a single lens reflex camera, then we urge you to consider moving up to an SLR system—either a digital or film-based SLR. You'll enjoy a full range of shutter speeds and aperture openings, generally ranging from *f*/2.8 or *f*/3.5 on a zoom lens to *f*/16 or *f*/22. That can give you a lot of control.

There are very good film-based SLR systems that provide you with a camera body and a zoom lens for $400 or less. At the time of this writing, a digital SLR camera is considerably more expensive—about three to ten times more expensive. But prices of digital SLRs will continue to drop in the future. Just a few years ago, the key manufacturers were offering primitive digital models in the $10,000 to $20,000 range. Now there are functional digital SLRs selling in the $1,200 to $5,000 range, and the manufacturers are competing to bring out better and less expensive models, as well as point-and-shoot models with more

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advanced controls that give the photographer the ability to adjust the aperture and shutter speed.

In fact, 2001 marked the beginning of broad distribution of digital SLR cameras. Until then, paying $5,000 or $10,000 for a digital SLR made sense only for news and sports photographers because of the speed with which those digital images could be moved around the world.

This is where we come to the most significant benefit of the single lens reflex camera over all point-and-shoot models, whether the cameras in question are digital or film-based. That benefit has to do with lenses—the next topic in this Lesson.

The Photographic Lens And Your Camera.

The lens on a digital camera performs exactly the same function as it does on a film camera—it allows light to pass into the camera and focuses the light to form a sharp image on either the film or light-sensitive chip. In most cases, the lens also houses the diaphragm that controls how much light strikes the film.

©Tamson

What Is A Fixed-Focus Camera?

Many of the simplest point-and-shoot cameras are of this type. Single-use cameras are also fixed-focus models. Web cams are usually fixed-focus. You can use this type of camera to get a reasonably sharp picture of all objects that are more than a certain distance away, usually about four feet.

©Lily DeLaney

Here's a photo taken by a five-year-old using a single use camera with flash. As long as the subject is about four to ten feet from the camera, these popular, inexpensive cameras can yield great results.

What Is A Variable-Focus Camera?

Most SLRs have variable-focus lenses which can be moved back and forth over a range of different distances. This allows the photographer to control what is or isn't in focus. For example, by moving the lens forward or back, you can adjust it to focus on an object that is 12 inches away, or five miles away. This feature is invaluable for the advanced photographer.

Interchangeable Lens Versus Fixed Lens.

A major benefit of an SLR is the ability to select different types of lenses. Major manufacturers of SLR cameras offer a wide variety of lenses for different photographic situations. Some professional digital SLRs even allow you to use the lenses from the film-based SLR camera you already own.

Fixed lenses are those that cannot be removed from the camera or replaced with a different lens. Regardless of what kind of camera you're currently using, we need to investigate the range of lenses, focal lengths and other key aspects of this essential element.

Automatic Focus.

Most cameras today offer automatic focus. This is true of all types of digital cameras and film-based cameras. That is, they automatically focus on the subject at which you point them.

This is definitely better than fixed focus. These cameras can focus automatically down to four feet or even closer—for example, some cameras focus automatically down to 10 inches. And in "macro" mode, they automatically focus down to a couple of inches or less. What about "manual override" that will enable you to handle the focus yourself?

In some cases autofocus just doesn't perform very well, like when contrast is low or when there are extraneous foreground elements. Some digital cameras offer manual focus and can guide you electronically to get sharp pictures. Others have settings to lock the focusing system to infinity. This can come in handy when shooting distant scenes through a window, for example, where the glass in the window might otherwise throw off the automatic focus.

Focus in virtually every digicam and "prosumer" model today is automatic. You achieve focus by placing the focus indicator marks over the main subject in the viewfinder and pressing down on the shutter release button. Slight pressure locks focus and further pressure takes the picture. This is similar to most point-and-shoot film cameras.

You will not see the actual focus achieved on the viewfinder of non-SLR cameras. Many digital cameras have a focus confirmation indicator that lights up in the viewfinder when focus has been achieved. You can check focus on the digital camera's LCD after the picture is recorded, but the screens are often so small that any lack of sharpness might be hard to detect. This is not a good way to check for critical sharpness.

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Unfortunately, far too many photographs reveal the problem with autofocus systems. The photos are out of focus—automatically. That's because the camera is focusing on something that isn't the actual thing that the photographer intended to be the subject of the photograph.

For more information, review the section on "Focus Lock" on the NYI Weekend Photo Workshop Two video, or see "Sharp Photos" on the Unit Two WebCenter.

Thus far, we've discussed the basics of lenses that have fixed or variable focus. Now we must turn to the other key characteristic of a lens—its focal length.

18mm 24mm 28mm 35mm 50mm 70mm 85mm 135mm 200mm

©Chuck DeLaney

What Is Focal Length?

In optical terms, the focal length of a lens is the distance from the center of the lens to the sharp image it forms on the exposure plane, the place where the light-sensitive film or chip resides. (You don't need to understand the optics, and even experts argue about where the "center" of the lens resides—the technical term for the center is rear nodal point.) It is this distance that is used to describe lenses of differing focal lengths.

The important thing that you do need to know is this: The focal length of a lens determines the size of the image of your subject that the lens forms on the film, or the digital camera's chip.

Assuming you're taking a picture of the same subject from the same distance, the longer the focal length of your lens, the larger the image of the subject that is formed on the film.

With both film and digital cameras, the built-in lens may be of a fixed focal length—that is, a lens that provides one angle of view—or it may be a zoom lens, which provides a range of focal length choices within one lens.

Most zoom lenses on point-and-shoot film and digital cameras are motorized, which means that pressing a toggle switch or button on the camera body will change the view from moderately wide to telephoto settings, and the scene will shift in a corresponding fashion in the viewfinder.

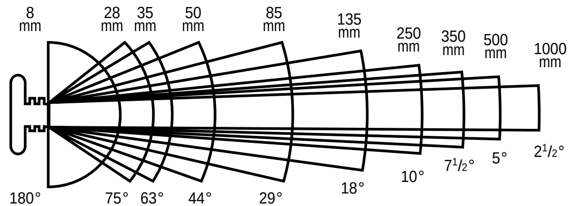
If you're new to photography, there are a number of basic aspects of the photographic lens that may be new to you. If that is the case, in the next few pages we're going to present a quick overview. To some more experienced students this will be old hat, but please bear with us.

Introduction to Focal Length.

The focal length of a lens determines how much or how little of a scene will fit into the picture area of a given size film, or a chip. The focal length of the lens determines what the camera will "see". There are two features of any lens that determines its focal length.

Look at the photos of the country church on the previous page. The same scene is photographed from the same camera position using lenses of different focal lengths and 35mm film.

The field of view is how wide the lens can see. For example, a telephoto lens has a narrow field of view. A wide-angle lens has a wide field of view.



What Do We Mean By Field of View?

Often people who are serious about optics will discuss lenses in terms of their "field of view" or "angle of coverage." These are simply different ways of stating that lenses of a shorter focal length will take in more of the scene in front of the camera. This means that short focal length lenses, which we also call wide-angle lenses, have a wider field of view and a greater angle of coverage than normal or telephoto lenses.

This illustration shows the angle of coverage of different focal length lenses when mounted on a 35mm film-based SLR. As you see, the angle of coverage depends upon the focal length—the longer the focal length, the smaller the angle of coverage. For example, a 28mm lens has a 75° angle of coverage, while a 500mm lens has a 5° angle of coverage.

These terms have great significance to people who deal with optics. As with other terms associated with lenses, such as aperture, you need only appreciate the visual consequence rather than the underlying optics.

We've already covered one principal difference. Longer focal length lenses get you closer to a portion of the subject in front of the lens, while shorter focal length lenses show you a much wider view of the same subject.

With 35mm film cameras, we describe lenses in terms of focal length. Many people are familiar with the notion that lenses from 20mm through about 35mm are wide-angle, that lenses ranging from about 38mm to 55mm give a "normal" (we'll get back to the concept of "normal" in a few paragraphs) angle of view, and lenses 85mm up to 200mm, 300mm, and even longer are telephoto lenses. A wide-angle zoom lens might run 17mm to 35mm, and 80mm-200mm would be considered a telephoto zoom.

Note: Before we go any further, we must stress that the field of view of a lens of a given focal length is generally not the same if the lens is used with a camera that takes 35mm film, as opposed to a digital camera. Most chips used in digital cameras are considerably smaller than a 35mm piece of film. That means that a 50mm lens that is "normal" with a 35mm film camera, will actually give a much smaller field of view and perform like a mild telephoto lens when used with a digital camera.

We will provide you with a comparison chart between the most common digital chips and 35mm film in a few moments. For now, just realize that in any general discussion of focal length, we are usually referring to the focal lengths that pertain to traditional 35mm film cameras.

Lens Types.

Normal Lens.

With all cameras the "normal" lens is determined by measuring the diagonal size of the image sensor. In a 35mm camera, the image sensor is film, and for years, the size of the image sensor has not changed. A 35mm piece of film is 24mm x 36mm. The diagonal measurement of a 35mm piece of film is 44mm. The camera industry has taken this number and rounded up to 50mm for SLR cameras, and sometimes rounded down to around 38mm for point-and-shoot models. As a result, any lens with a focal length in this range is considered to be a "normal" focal length for 35mm film cameras. Normal lenses are considered to show a field of view that is similar to what we see with our eyes.

In a digital camera, the CCD chip is the image-sensor and sizes vary from camera to camera. Because no standards have been established, a normal focal length lens for one digital camera may not be normal on another. Until digital camera manufacturers settle on a common image sensor size, focal length and how it relates to coverage will always be variable.

Consider a digital camera that has an image sensor that is

6.3mm square (¼"). In this case, the normal focal length would be about 9mm. A digital camera with a ½" square CCD would need a 12mm lens to be considered "normal." At this time, many digital cameras use ½" CCD chips, although it is not uncommon to encounter larger or smaller chips.

Here's a comparison of the focal lengths on a 35mm camera versus the focal lengths of a digital camera with a ½" CCD image-sensor.

FOCAL LENGTH COMPARISON

35mm Camera	Digital Camera: ½" CCD
20mm	4.8mm
40mm	9.6mm
50mm	12mm
80mm	19mm
100mm	24mm
200mm	48mm
300 mm	72mm

Remember, if your digital camera has a CCD that is either smaller or larger than ½" this chart is not valid. Consult with the manufacturer's documentation to determine what the conversions are for your camera.

Zoom Lenses.

Most mid-range digital cameras provide you with a zoom lens that allows you to take photographs at a variety of different focal lengths. For many of us who are used to 35mm film cameras, this is where the difference in field of view between a piece of 35mm film and the smaller digital chip can become really confusing.

For example, a 35-80mm zoom is a very standard mid-range zoom lens that might be a good choice with a 35mm camera—either a point-and-shoot model or an SLR. With a zoom lens, your choice is not limited to one or two possibilities; you can zoom to any focal-length between 35 and 80mm. This is a definite plus. With the zoom lens' focal length set to 35mm you get a slightly wide angle of view, and at 80mm you get a mild telephoto visual effect which can be great for portraits. A similar zoom range on a digital camera might be 8mm to 20mm.

Optical Zoom vs. Digital Zoom.

There's one big difference between some digital camera zoom lenses and zoom lenses designed for cameras that use film. On some digital cameras you are offered a feature called "optical zoom." Some digital cameras feature two types of zoom—optical and digital.

Optical zoom simply means that the actual glass elements of the camera's lens cover the entire zoom range offered by the camera. This is the same as any zoom lens used on a conventional film-based camera.

Just like a conventional camera, a higher quality lens will produce better quality images.

Digital zoom is used to extend the maximum magnification of the lens beyond that which can be captured optically by the lens. A digital zoom simply crops into its largest magnification and then "stretches" that information through interpolation.

The results of digital zooming are inferior to that of the optical zoom and it is not something we recommend you use. If you really need to get in closer, you will get much better results by simply moving closer to your subject. If you can't physically get any closer and your optical zoom is set to its maximum focal length, you can always simulate a digital zoom later in the digital darkroom. Image resizing in a program like Photoshop is usually much more successful than using the digital zoom in the camera.

©Nikon

©Tamron

Wide-Angle Lens.

A wide-angle lens is one that takes in a wider field of view than what is considered normal for your particular camera. For example if the normal lens for your digital camera is 12mm, any lens that has a smaller focal length number would be considered to be a wide-angle setting.

Telephoto Lens.

Lenses that see things more closely than our eyes are called "long" or "telephoto" lenses, because they take in a narrow field of view and magnify it. Sports photographers, news photographers and even fashion photographers often use these long lenses. Using the chart above, if your digital camera has a 1/2" chip, any lens with a focal length longer than about 24mm would have the effect of a telephoto lens.

There are two other key visual effects that differ from wide-angle to telephoto lenses.

The first of these is what we call perspective distortion. There's a reason we call certain lenses "normal." They tend to create images that show the world the same way we see the world with our eyes.

Specialty Lenses.

There are a variety of lenses that are designed to handle specific types of subject matter. Let's take a brief look at some of these different kinds of "specialty" lenses. While we're not going to delve into optical theory, you should be aware of these terms.

Portrait Lenses.

For many photographers, portraits are the most important photographs they take. To make portraits, the standard 38mm lens on a point-and-shoot camera is a poor choice. It tends to make the subject look pudgy. A longer lens, generally from 85mm on up, tends to avoid any distortion. Many professional portrait photographers using 35mm cameras employ focal lengths from 105mm to 150mm, sometimes even 200mm for high fashion work.

Translating portrait focal lengths to the equivalent for a digicam with a ½" sensor would mean that you would select focal lengths ranging from about 20mm to 28mm to achieve the same effect.

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Another advantage to using a longer lens for your portraits is that such a lens permits you to fill the frame while you stand at a comfortable distance from the subject. You can find a focal length that allows you to be close enough to maintain good psychological contact, yet be far enough away to avoid breathing down the subject's throat.

©NYI student Roger Brathwaite

Extreme Wide-Angle and Fish-Eye Lenses.

There are also specialty lenses known as "fish-eye" lenses that are designed to cover a very wide field of view. Although this type of lens tend to distort the image, they can be used very creatively and effectively.

In the digital camera world, these lenses can be used in conjunction with Virtual Reality software to create 360° panoramas allowing the viewer to "navigate" an image by simply clicking and dragging the cursor.

Powerful Telephoto Lenses.

How long a lens should you purchase when you're ready to buy one? Nothing is more tempting than a powerful telephoto lens to the amateur who dreams of photographing mid-field sports action close-up, or getting great "in-your-face" photos of animals in the wild. But how often will you really use that 400mm lens? Not very often, unless you're specializing in the kind of work that we've just mentioned.

Plus there are some disadvantages. Telephoto lenses are expensive. In addition, even with today's efficient designs and lightweight materials, they're large and bulky. After you've lugged one around all day, you'll know it.

In inexpensive digicams and prosumer models, such special lenses are not really an option. However, it's worth noting that because some digital SLRs use ½-inch chips, a photographer who owns a telephoto lens for his film-based camera will discover an interesting advantage when using that lens with his digital SLR. The Nikon D-series Digital SLR, for example, has a chip that's bigger than the standard ½-chip we find in digicams, but only about ⅔ the size of a 35mm frame. That means that if the photographer places a 80–200mm zoom with a standard Nikon mount on a D-series SLR, the effective focal length is altered to about 120–300mm! Keep in mind however, that not all digital SLRs will accept lenses made for film based cameras.

Long Lenses = Tripod Required.

And there's one other, very important point. And this applies to long zoom lenses as well: The longer the focal length of the lens, the more steady the camera must be held to avoid blurring the image.

We discussed how hard it is to handhold a camera at slow shutter speeds. Because of the smaller field of view of a long focal length lens, even the slightest jiggle will ruin a photograph. The rule of thumb with film cameras is that you can handhold a lens only when your shutter speed is at least equal to the focal length in millimeters. That is, a 100mm lens should not be hand-held below 1/100 of a second; a 500mm lens should not be handheld below 1/500 and so on. As you will find in the next lesson when we discuss sharpness, we recommend that you set your shutter speed even faster to assure razor-sharp images. It's a good practice to double the speed—1/250 of a second for a 100 or 135mm focal length, and 1/1000 for a 500mm lens.

Bear in mind that there are other practical limitations. No matter how good the optics are on your lens, when you photograph an object at a distance, the image is at the mercy of atmospheric conditions such as dust, haze and heat refraction.

If you have a camera that allows you to switch lenses, we suggest you spend your money, when you're ready, on a lens that you'll use more often, perhaps an 80-200mm zoom. If you have occasional need for extra length, you might consider a tele-extender. This is an optical adapter that attaches between any lens and the camera body. It magnifies the image at the expense of cutting light transmission. To learn more about this, go to the Unit Two WebCenter and read article on lens adapters.

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Macro Lenses and Lenses with Macro Settings.

A lens that has a macro setting is one that can get a very close-up image of your subject. A true macro lens can focus from just a few inches away, on the subject. Most digital cameras offer a macro setting. Some digital cameras can focus more closely on an object than a traditional film-based point-and-shoot model.

©Chuck DeLaney

A true macro lens is one that can be focused so close to an object that the image it forms on the film is about the same size as the real-life object itself. The relationship of the size of the image on the film to the size of the actual object is called the reproduction ratio. A ratio of 1:1—pronounced, one to one—means that a life-size image is produced on the film. A 1:2 ratio means that the image on the film is one-half the size of the actual object. A 1:3 ratio means that it is one-third, and so on.

There are specially designed macro lenses made for 35mm SLR cameras. It is also common to find zoom lenses with a "macro" setting, though these offer limited power for close-ups.

In a lot of digital cameras, the relationship between the small chip size and the short focal length of lenses makes it possible to design lenses that can focus very close to the subject. That means there are many digital cameras that feature great macro potential.

For example, most point-and-shoot film cameras cannot focus closer than two or three feet; most "normal" SLR lenses can focus on objects that are 12 to 18 inches from the lens. However, there are digital point-and-shoot models that can focus as close as one inch from the front of the lens!

If your camera doesn't offer this option, chances are you can't focus closer than two-and-a-half to four feet. Is macro-focusing important? It's a plus...and it can be a big plus if you want to photograph flowers, butterflies, documents, or small objects that you might want to sell on a Web auction site. It's also great for capturing close-up detail of bigger subjects.

There are a few things you have to watch out for when you're photographing a subject that close to the lens, but we'll cover those practical matters in the next lesson.

Auxiliary Lenses for Digital Cameras.

There is one other way to expand the capability of the lens on digital point-and-shoot cameras that have a fixed lens. Some manufacturers offer auxiliary lenses that can be attached in front of the camera's lens to augment the field-of-view. Common auxiliary lenses include the extreme "fish-eye," wide-angle close-up, a regular wide-angle view, and telephoto.

You can get more information about their auxiliary lenses in the Unit Two WebCenter.

We've covered the camera's lens in depth. If most of what you've read so far in this lesson is new to you, your head may well be spinning. However, remember the old maxim that the eyes are the windows of the soul. In the same way, the lens on your camera is perhaps the single most important tool you have to decide how you capture your subject. Using the right shutter speed helps, and we expect you to demand proper exposure in all your photos. But time and again, you'll be using aperture size to control depth of field, and selecting a focal length that will work best for your subject and the way you wish to portray the subject.

We can also assure you that we'll be presenting these concepts to you again and again whenever we look at photographs in relation to this Course. If you don't feel that you're completely clear on all the lens-related information yet, don't be concerned. You will be by the time you've worked your way through the Course.

Perspective Distortion.

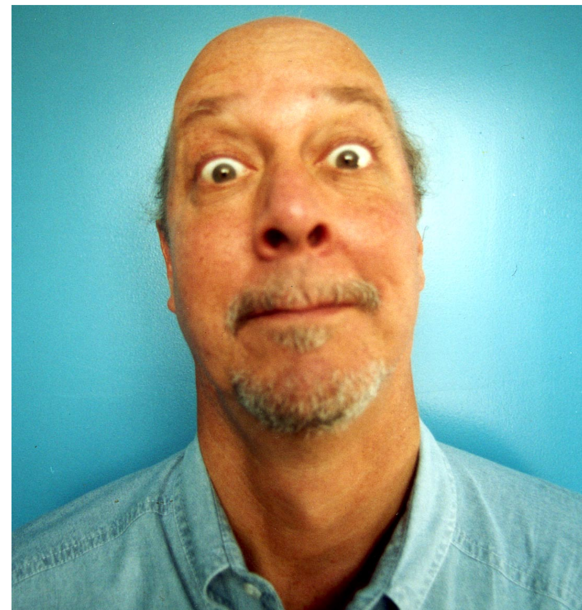
We've all seen close-up portraits that make the subject's nose look grotesquely large compared to the rest of the face. These were taken with wide-angle lenses and represent a form of perspective distortion.

To understand why this distortion occurs, let's first discuss normal perspective. You know that one way our eyes perceive near or far is by the relative size of an object. Our mind tells us that objects farther away appear smaller—the further they see, the smaller they seem.
Distant objects appear smaller than nearby objects of the same size. For this reason railroad tracks appear to get closer and closer as you look farther down them, until they appear to converge. What is happening is that the apparent distance between the rails is getting smaller.

With any subject you photograph, and with whatever lens you use, the farther away the object, the smaller it will appear. But the farther away the lens is from the object, the less the apparent change in size.

So, let's suppose that we're looking at a scene through a "normal" lens, or a zoom lens set to a normal focal length—let's say a 50mm lens on a 35mm film camera or a 12mm lens on a digicam with a ½" chip.

If there's a subject standing five feet in front of the lens and the subject steps back five feet so that she is now ten feet



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from the lens, there will be a big difference in the apparent size of the subject in the photograph.

However, if the subject is standing twenty feet from the lens and steps back five feet so that she is now twenty-five feet from the lens, there won't be nearly as significant a difference in the subject's apparent size.

A wide-angle lens often creates a distorted perspective because when you're using a wide-angle lens and the subject is up close to the lens, the perspective effect is stronger. If you're using a wide-angle lens for portrait subjects it makes sense to step back a few extra feet from your subject, unless you want that type of distortion.

A telephoto lens creates just the opposite type of problem with perspective distortion. As the subject gets farther and farther away, things begin to flatten out. Objects that are far away appear to be on top of one another. The distance between distant objects appears compressed.

There are lots of ways to use this perspective distortion in your photography. Realize that you can't always believe your eyes, even when there has been no digital manipulation. Photographers who specialize in architecture know that they can take photos with wide-angle lenses that will make even the tiniest motel swimming pool look Olympic-sized.

In the same way, using a 200mm, 300mm or longer lens (or a focal length that's considered to be telephoto for your digital camera), it's possible to "stack" items in the distance on top of each other.

Before we leave the subject of perspective distortion, we need to cover one other important aspect—linear distortion. When you tilt the camera up or down, lines that are actually parallel will start to converge. That's why when you photograph tall buildings or tall trees with a normal lens they appear to be falling over. You aimed your lens up, a direction that caused the sides of the building or trees to act like the railroad tracks we described earlier—they converge toward the center creating the normal perspective of depth.

The easy way to avoid buildings that tilt or look uneven is to back up and take the photograph so you don't have to tip the camera up. Then again, any distortion can be a good effect if you design your photo so that the distortion enhances the image.

There are special techniques and lenses that professionals use to avoid this type of distortion. One class of cameras, called view cameras, have characteristics that make it possible to avoid linear distortion, and there are special lenses, called perspective control lenses that can be used on smaller format cameras.

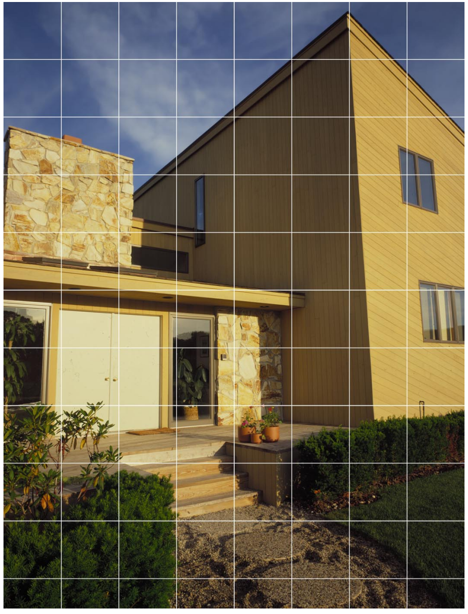

Image taken with point and shoot camera showing linear distortion.

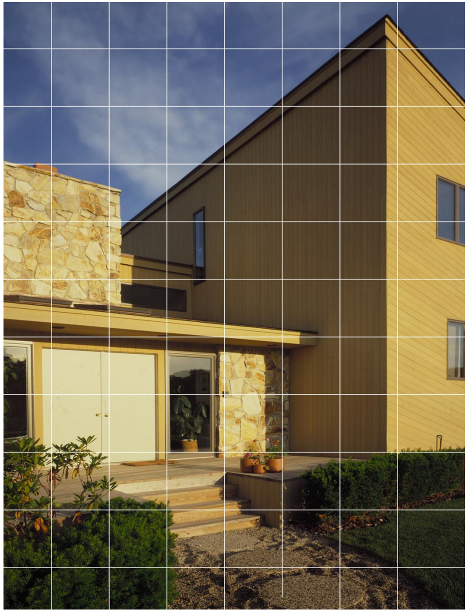

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Image taken with view camera eliminating linear distortion.

Other Basic Camera Features.

Now we need to look at some other basic camera features, paying particular attention to the specific needs of digital cameras.

Built-in Flash.

Today the vast majority of digital cameras come with a built-in flash. In a few pages, we'll discuss the power supply that makes the flash possible. Flash gives the photographer the opportunity to add light to a scene. This may be very helpful in many situations. Other times it may not be desirable.

The important thing is that you learn to control your flash and to know its limitations.

The flash built into most digital cameras has a fairly limited output, usually ranging from only six to twelve feet. We mention this because low light in a digital camera can result in artifacts and lower picture quality, so check your range and lighting before shooting. When you're using flash, try to keep your subject close to the camera—ideally, no farther than eight or ten feet.

Most digital point-and-shoot cameras allow you to turn the flash on or off depending on the ambient light. There may be certain situations when you don't want to use a flash, even though the camera's metering system says otherwise. Control of this feature will be advantageous as you develop as a photographer.

SLR cameras can also accommodate more sophisticated and powerful flash systems. This makes it possible for all types of photographers to capture properly exposed images, cleanly and consistently.

We will explore more lighting possibilities in a digital eye lesson later in the course.

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©Olympus

Preview Mode.

One of the main advantages of a digital camera is that it gives you an immediate preview of the photograph that has been made, using the camera's built-in LCD monitor.

Using this preview mode also lets you see the pictures that you've just made before you decide whether to delete them or save them.

But this method has one major drawback. The quality of LCD monitors varies and your monitor may not give you an accurate rendition of what you've just recorded—but it's better than nothing. Also bear in mind that use of the monitor can put a heavy drain on the camera's power supply. We'll cover other aspects of the LCD monitor in Lesson Five.

Power Supply.

There is no such thing as an all-manual digital camera. Some film cameras are still made that require no electrical power source to make them work. The shutter is wound as the film is advanced by hand. A spring system, not unlike that of a mechanical watch, propels picture taking.

There will never be a digital camera that is spring-powered, since you need to transfer electronic information in the process of recording a digital image.

There are two power supply options for a digital camera: Portable and AC power supply.

Most of time, particularly when you're outdoors or traveling, you will use a battery. And, you may be surprised to learn, you're likely have to use lots of batteries.

Batteries.

Almost all digital cameras use regular AA batteries that you can buy in any store that stocks batteries. Some cameras will also use non-rechargeable lithium batteries, available at photo stores. When the batteries are depleted, you simply throw them away and insert a fresh batch. Some digital cameras are powered by rechargeable batteries or give you the option to use them.

For many electronic gadgets we use, we get great service from regular AA or lithium batteries. There doesn't seem to be much reason to fool with taking out rechargeable AA batteries, putting them in a charger, and reloading them into the device.

But digital cameras can go through batteries pretty fast. If you are using rechargeable batteries, when the batteries run down you simply take them out of the camera, place them in the charger, and recharge them. While regular batteries may cost less initially, in the long run they cost much more than rechargeable batteries. Digital cameras are battery hogs.

For this reason, we think rechargeable batteries are a bargain in the long run. Rechargeable batteries come in three "flavors"—NiCad, Ni-MH, and Lithium Ion.

©*Energizer*

The first type of rechargeable to appear on the market some years ago were NiCad batteries. They are made with nickel-cadmium. While less expensive than NiMH (nickel metal hydride) batteries, they suffer from one major defect—memory problems. What is memory? Picture the battery as a bucket. When you charge the battery, you are filling the bucket with electrical energy. Then as you use the digital camera, you use up the electrical energy, lowering its "level" in the bucket. When you've used all the energy in the battery, you've reached the bottom of the bucket.

So far, so good. But with NiCad batteries a problem arises if you don't use up all the energy in the battery—that is, if you don't reach the bare bottom of the bucket—before you recharge.

Very often, a NiCad battery will "remember" the level at which you started recharging—and it will "assume" that this starting level represents the bottom of the barrel. For example, if you start to recharge when a NiCad battery is half-full, the NiCad battery will often "assume" that this half-full level is absolute bottom. Result: When you subsequently use the fully-charged battery, it will stop sending out energy when it reaches the half-full level because it "thinks" it's empty even though it's actually half full. This is the dreaded memory effect.

If you use NiCad batteries, you can avoid this problem by completely draining a battery each time before you recharge it. By so doing, you eliminate memory problems because the "bottom" that the battery may "remember" is actually the real bottom of the bucket!

There is, however, an easier way to avoid memory problems—use NiMH or Lithium Ion batteries. These batteries don't suffer nearly as much from memory effect. You can recharge them at any "level," and they will still send out energy until they are truly empty.

If you want the convenience of throwaway batteries, or want a spare set in case you run out of charge in the field and can't get to an outlet (though you can buy a car cigarette lighter recharging device), we recommend that you buy the so-called "high energy" type of AA battery rather than regular alkaline. You can also purchase lithium AA batteries, which also offer additional run time over standard alkalines. These batteries cost more, but definitely give you more run time.

Most battery makers now brand their top performance batteries as "high drain" or "for digital devices." These are the best choice.

You can also help conserve battery power by being power conscious when you shoot. The LCD monitor on digital cameras is one of the most power-consuming parts of the camera. We're not saying that you shouldn't use it, but if you compose and frame pictures using the monitor, rather than the optical viewfinder, you might find yourself out of power before you even fill up one memory card's worth of images. So use the monitor for review and editing, rather than taking and framing shots, and you'll increase your run time substantially.

©Rayovac

AC Adapter.

This item is a must. Surprisingly, there are many digital cameras that are sold without an adapter. Imagine your pleasure at shelling out hundreds of dollars for a high-end "prosumer" digital camera that eats $4 worth of batteries every time you turn around, and discovering that an AC Adapter for the camera is a $59 accessory!

Make sure an AC Adapter is part of the camera unit you purchase or buy one, as you'll use it to power the camera when doing direct downloading to the computer rather than the camera batteries.

When you're working indoors, or reviewing the images you've recorded, we strongly recommend that you switch to AC power. In addition, you'll want to be sure to be "plugged in" whenever you're downloading images to your computer. If your batteries fail in the middle of this process, you might lose your images.

Digital Considerations.

Auto-Advance.

There are a few other picture-taking features that the digital camera may have in common with your conventional camera. With both, you can take a single picture with one press of the shutter release button and then be ready to take the next photograph without the need to wind anything. The camera has *auto advance* to prepare for the next picture. In a traditional camera the film must be advanced to a fresh frame of film before the next exposure can be made, and a digital camera must transfer the information to a card or memory device and reset the CCD to be ready for the next picture.

Time Delay.

But with digital cameras, there's another factor to consider: Time Delay.

After you push the shutter release, there's a brief interval before the image is actually captured. After the exposure is completed, there's a second interval while the reusable chip clears itself of the information related to the exposure that has just been captured and readies itself for the next incoming image.

Let's call the first delay *Shutter Lag* and the second one *Recycling Time*.

Shutter Lag.

SLRs react quickly when you press the shutter. When you're photographing action, such as in sports, this is great because you want to capture the image that you see at the instant that you press the shutter release. Both film and digital SLRs are relatively free of shutter lag.

With most point-and-shoot cameras—both digital and film models—there is a brief delay between the instant that you press the shutter and the time the actual photo is taken. This is called shutter lag, and it can be very frustrating. For example, if you want to take a photo of your child at bat in Little League, and you wait until she starts to swing at the pitch, by the time your point-and-shoot actually takes the picture, the ball will probably be either hit into the air or resting in the catcher's glove.

You need to learn the amount of shutter lag that takes place in your camera. See the Unit Two WebCenter for a couple of easy exercises that will allow you to determine for yourself how well your camera functions.

Recycling Time.

There is one major difference in the shooting rate of most digital cameras as compared to film models, and that is the recycling time required from the moment when the image is actually captured until the camera is ready to take another photograph.

Before a digital camera is ready to take another picture, many need additional time to process an image—that is, shift it from the CCD capture chip to the on-board processor and then to memory—after one image is taken and before the next image can be captured. This lag time may be anywhere from a 1/2-second to a few seconds. You press the release to take one shot, then press it again, but the camera holds you up on the second picture.

This lag can be bothersome or downright annoying, depending on what kind of action you're looking to photograph. It's definitely something to get used to when you make the switch to a digital camera.

Compare this with auto advance on SLR film cameras, which is very fast. With an SLR and a motor drive it is possible to take a series of sequential pictures by keeping pressure on the shutter release. This can be great for catching the peak of sports action, or simply getting the best expression in a portrait of a child.

Film advance can be two to four frames-per-second (fps) or on a few pro models, as fast as ten fps. Some high-end digital cameras offer "burst" mode (that is, a fast capture rate), but usually at a lower resolution. In "burst" mode the CCD chip is divided into a fraction of the full size. This allows for the camera to make multiple shots but each shot can only utilize a small portion of the image-sensor resulting in lower-quality individual images.

For the most part, the double delay in most digital cameras from Shutter Lag and Recycling Time won't bother the real estate agent taking pictures of houses that are for sale, or the proud Daddy taking pictures of his new-born baby, or the police officer taking a "mug" shot. These types of subjects are not moving too fast.

On the other hand, the brief delays caused by shutter lag and recycling time can seem like an eternity when you're trying to take pictures of your fast-crawling child, your frisky pet or a hotly contested little league game.

But wait a minute, photojournalists—especially, sports photographers—need fast-recycling cameras, don't they? And didn't we say that many photojournalists today use digital cameras? Yes. But remember one thing: We're talking about the delay in amateur digicams and "prosumer" models, and photojournalists are usually using expensive professional SLR digital cameras that have different circuitry that allows them to take a fast sequence of pictures without the same delay.

"Movie" Mode.

Some digital cameras offer "movie" mode that allows you to record a burst of six to thirty seconds of still images taken in rapid sequence. Shooting such a sequence in movie mode usually fills the entire memory storage capability of the camera.

Light Sensitivity.

There is another key way that digital cameras differ from conventional film models.

With traditional film, the ability of the camera to record a scene is governed by the aperture opening, the shutter speed, and the "speed" of the film that you use. Film speed is defined by ISO (which merely stands for International Standards Organization, the outfit that oversees this standard). ISO 50- and 100-speed films are slow films. ISO 400-, 800- and 1000-speed films are "fast" films, in that they can record an image in lower light.

Every time the ISO number doubles, it indicates that a given film is twice as fast. Therefore, an ISO 200-speed film is twice as "fast" (that is, twice as sensitive to light) as an ISO 100-speed film. That means an ISO 400-speed film is twice as fast as an ISO 200 film and four times as fast as an ISO 100 film.

Most digicams have a degree of light sensitivity that is the equivalent of an ISO 100 film though some offer higher ISO options. That means they're not terribly effective for taking photographs in low light situations. We expect this will change on most digital cameras in the future, because it is definitely a limitation. For more information on this aspect of film vs. digital see the article "The Right Tool for The Job" in the Unit Two WebCenter.

With conventional cameras, you record an image on whatever film is loaded into the camera. If you shoot with an ISO 100 color print film, for example, you have a set light sensitivity; if you shoot with a faster, or more light sensitive film such as an ISO 400 film, you have more sensitivity to light and can shoot in dimmer light without using flash. There are also special high-speed films that can be used in low-light situations, and fast films can be made even faster by using a special developing technique called "push processing."

Digital Camera ISO or "Film Speed".

Some digital camera specifications will refer to ISO or film speed as well. This refers to the sensitivity of the chip using an ISO number, the standard used for film speed. The faster a film—that is, the more sensitive it is to light—the higher its ISO rating. The sensitivity of a chip can be measured using the same ISO standard. So, if you read that a camera's chip has an ISO rating of, 100, this is the same sensitivity that you would get with film rated ISO 100. However, there's a big difference here.

With a traditional camera if you want more light-sensitivity, you simply use a faster film. With a digital camera you can't do this. If the chip in the camera is ISO 100, that's it. You can't replace this chip with a faster chip.

It has often been said that digital cameras are "unfriendly" to low light. That they "hate" low light. This is just another way of saying that the typical chip in an low end digital camera has a fairly low ISO rating.

What does this mean to you? It means that unless you are taking a picture in outdoor light you will probably have to add light to a picture made indoors. How do you add light?

By using flash. This is the reason that most amateur digital cameras have a built-in flash that automatically fires in low-light conditions.

What happens if you don't use the flash? In outdoor sunlight you will usually produce a well-exposed image. But in low light and indoors most areas in your picture may come out dark and shadowy. Not only will these areas be underexposed, but you'll find them "noisy"—that is, filled with visual static—one type of unwanted artifact.

When selecting among different digital cameras, should you opt for a camera that features a "faster" chip? It's a good idea…but not really practical for three reasons. First, all CCD chips in today's amateur cameras have roughly similar ISO ratings—from about ISO 90 to ISO 150. So you really don't have much to choose from. However, if the digital camera you are looking to purchase allows you to change the ISO setting to 200 or 400, this would be a benefit to consider, though not without drawbacks. Second, some manufacturers don't include ISO information in their specs. So you may not even be able to make an intelligent choice. Third, by using the camera's built-in strobe you pretty much overcome the problem. So the problem's not as serious as it first appears.

There is a big difference between using a conventional camera with a film speed of ISO 1000 and a digital camera that cannot contain a recording material with a light sensitivity faster than ISO 100. Some "pro" digital cameras have higher speed ratings, but some of these are attained through applying "gain," or extra voltage, to the chip. This can result in additional "noise" and other image artifacts, but it will help you get the picture in lower light without flash.

High-End Digital Photography.

This is a good point to get back to the larger formats that are used by certain studio professionals.

Scanning Backs.

The first breed of digital camera that caught the eye of many professional photographers was the digital scanning back. Scanning backs are units that are designed to slip into the rear portion of a conventional 4" x 5" View Camera.

Instead of inserting a film-holder, the photographer simply slips in the capture device, essentially replacing the film with the scan back. Scan backs can capture very large amounts of information by moving a CCD image sensor across the film plane. Because they can be used with existing professional view cameras and lenses (both of which, as you might guess, are very expensive) this technology was the logical extension for the photographer looking to integrate digital imaging into his or her normal workflow. Low-end scan backs can capture file sizes up to 30MB. Others have the ability to capture upwards of 500MB! That's a huge file, and only someone who is producing very large reproductions would even consider a camera with these capabilities.

Sophisticated software is typically bundled with these capture devices giving the photographer a good amount of control at the capture stage, including sharpening and tonal manipulation.

One major drawback of scan back technology is that a long exposure is required to complete the scan. As a result, the subject must be motionless for the duration of the capture. Depending on the size of the file selected, capture times can be as short as a minute or so, or as long as 30 minutes or more.

There are two principal ways that photographers use these scanning backs.

The first is to create a digital image that is the final image for output.

There are lots of photo jobs that professionals take on where there's no need for a final piece of film. Not long ago, we heard a presentation by a Midwest professional photographer who photographed a giant mail-order catalog for a major clothing company. Each year he would expose and process about six to eight thousand pieces of 4" x 5" film. That amounted to many thousands of dollars in film and processing. And, since all the clothing styles and colors changed every year, the final film was of no value once the catalog was printed.

Then he switched to digital. While initial investment was costly, the first year after the switch he only exposed twenty pieces of film to handle a few tricky shots. All the rest of the images were captured digitally. It's easy to see why digital photography was quickly embraced by catalog photographers. The second way professionals use these scanning backs is to produce a digital image that can be used by the client and the photographer to make final decisions on layout and lighting. This used to be a task handled by a Polaroid back, a tool that the photographer could insert into the view camera to hold a 4"x5" sheet of Polaroid film rather than traditional film. The photographer would build the set, position the lights and then make a Polaroid picture that could be viewed by both the photographer and the art director or client.

It wasn't uncommon for the photographer to wait while a messenger took a Polaroid by taxi to the client's office so that the photographer and client could confer about the appearance of the image before the final film exposure was made. This way the photographer could make a final exposure on film and then "strike" (take apart) the set with a high degree of certainty that the photo that had been captured would be acceptable to both the photographer and the client.

Today, a photographer can capture a digital image and send a low or medium resolution file right to the client's desk via e-mail in a matter of seconds. No expensive Polaroid film, no waiting for messengers in taxis, just big savings in time and money. Again, it's no surprise that many photographers are happy to use "digital proofing" to ensure client satisfaction.

©Betterlight

Medium Format Backs.

Digital camera manufacturers have taken advantage of the interchangeable film back feature offered by many medium format cameras as well.

Interchangeable film backs were originally intended to allow a photographer to swap a used film roll for another, fresh roll loaded in a different back. This is essential for wedding photographers and others who use medium format cameras and cannot take time to unload and reload film during an event.

The existence of the interchangeable back makes it easy for a photographer to attach a digital back to the camera instead of one that holds film. This allows photographers to create large digital files using existing equipment with which the photographer is familiar.

For a decade, there were two kinds of medium format backs—so-called "three-shot" backs and "one-shot" backs. The three-shot back produced digital images by making three separate exposures, one for each of the three color channels: red, green, and blue. Like the large format scanning backs, these models require a stationary subject. These backs are perfect for the still life photographer, but unusable for the fashion or portrait photographer.

The one-shot back is a more recent innovation and dominates the marketplace today. It allows photographers to operate their medium format cameras with the fast shutter speeds and strobe units that they've become accustomed to using. This design has allowed fashion and portrait photographers that use medium format cameras to become part of the digital movement. For a portrait photographer, instant capture can mean instant results and the potential for increased sales.

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Digital Camera Technology is in Flux.

We anticipate that there will be a steady stream of announcements from chip-makers and digital camera manufacturers over the next few years as the speed and efficiency of the chips that are available for digital cameras are improved.

As you read earlier in this Course, the CCD chip has been the chip used as a sensor in almost all digital cameras in the past five years. Many manufacturers are also using CMOS (pronounced *SEÉ-moss*) technology, which stands for Complementary Metal Oxide Semiconductor. One of the big advantages to CMOS chips is that they use less power.

Chip technology is changing and we simply can't predict the future. However it is apparent that the quality is constantly improving and the prices are dropping. The key is to continue to learn and explore what these changes mean, if anything, to your personal workflow.

When Discussing Digital Camera Features There's No End.

In the next lesson, we'll turn to the techniques for using any camera, and the special steps for using your digital camera. It's the application of these photographic techniques that will enable you to make professional-looking photographs.

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