Photographic Technologies

Sections
12.1 Cameras
12.2 Recording the Image
12.3 Processing the Image

What You’ll Learn
- Name the main parts of a camera.
- Compare film and digital cameras.
- Describe how images are captured on film.
- Explain how images are captured with a digital camera.
- Summarize how film negatives are processed.
- Discuss how digital images are processed.

Explore the Photo
Making a Splash You have to open this camera’s waterproof battery compartment to find its rechargeable battery and SD flash memory card. Do you think this is a film or digital camera? Why?
Process Photographs

At the end of this chapter, you will be asked to process and edit film and/or digital pictures. Get a head start by using this checklist to prepare for the Technology Lab.

PROJECT CHECKLIST

✓ Pass your classroom’s safety test for film processing.
✓ Select an old photo you want to edit or repair.
✓ Practice repairing photos with your classroom’s photo editing software.
The Evolution of Photography

When was the first digital camera sold?

The first consumer film camera went on sale in 1888. The first consumer digital camera, the Apple QuickTake 100, went on sale in 1994. Once introduced, each of these photographic technologies went through a slow, methodical process to improve their performance, one product cycle at a time. Today photography is changing from a chemical technology into a digital technology.
Parts of a Camera

What is the purpose of a camera lens?

Digital cameras and film cameras have the same basic components: a lens, shutter, aperture, and viewfinder. See Figure 12.1. Film cameras record images on light-sensitive film. Digital cameras record images electronically. Otherwise, they are basically the same.

Lens

Photography uses reflected light from a scene to record images. The lens on your camera focuses this reflected light and magnifies the image. A moderately priced camera might have a zoom lens that can be adjusted from wide angle to telephoto. A wide-angle lens makes close objects appear further away, and a telephoto lens makes far away objects appear closer.

To learn about new lenses, type “Octopus Camera Lens” or “Ceramic Lens” into your favorite Internet search engine.

Shutter

The shutter lets the reflected light from the scene enter the camera. It blinks open for a very short time. On more expensive cameras, shutter speed is adjustable. A slow shutter speed can help compensate for low-light conditions. The photo on this page demonstrates how a fast shutter setting keeps moving objects in focus, which is the sharpness of the image.

Aperture

The aperture is an adjustable opening that controls how much light will enter the camera when the shutter opens. Most inexpensive cameras have an aperture that cannot be adjusted. The aperture setting effects how much of a picture is in focus.

Shutter Speed

Shutter speed helps determine what is in focus. For the photo on the left, the shutter speed was slow. For the photo on the right, the shutter speed was fast. How did the photographer keep the cyclists in focus in the second picture?
The size of the aperture is indicated by units called “f-stops.” A larger f-stop number indicates a smaller aperture opening. A smaller aperture opening allows a larger area of focus. (See Figure 12.2.)

**Viewfinder**

The viewfinder on a camera allows you to view your picture before you take the shot. Film and digital single lens reflex cameras (SLRs) let you view your subject directly through the camera lens. Most digital cameras, including SLRs, have a small video screen that displays the picture and functions as a viewfinder and stored-picture viewer.

**Range of Focus**
The photo on the left was taken using a large aperture. Only one car is in sharp focus. The photo on the right was taken using a small aperture. **What aperture setting would you use to shoot in low light?**

**Field of Focus** The relationship between the f-stop and the size of the opening is shown here. **What aperture setting would keep a viewer’s attention on a single element of a photograph? Why?**
Film and Camera Memory

What is used to record an image?

Do you and your friends take photographs using film or digital cameras? Do you have a digital camera or one in a cell phone?

Film

In a film camera, photographic film records the image. This film is made with different levels of sensitivity to light. This light sensitivity is known as film speed. The International Standards Organization (ISO) uses a number system to rate the speed of film. If the number is higher, the film speed is “faster.” If you know you will be taking photos where the light levels are low, you should use faster (higher number) films.

Digital

A digital camera does not use film. Light from the image falls on the CCD or CMOS microchips that convert light into an electrical signal. At one time, CCD sensors produced higher-quality images than CMOS sensors, but CMOS sensors consumed less energy than the more expensive CCDs. Today both sensors are equal in picture-taking quality and energy consumption. Digital cameras store their images in the camera’s memory or on separate flash memory cards. Unlike film, a digital camera’s memory can be erased and reused many times.

Looking at Lenses

Lenses are curved on one or both sides. The curvature determines the lens’s effect on light waves. Concave lenses spread the light waves. Convex lenses bring them together.

Apply

Obtain a series of photo lenses. Use them to observe the same object to determine their effect. Write two paragraphs about the strengths and weaknesses of different types of lenses.

Self-Check

1. Name at least three camera components.
2. Describe the purpose of a camera aperture and shutter.
3. Explain what creates the electrical signal in a digital camera.
4. Forecast how trends in photography, such as combining cameras and telephones will evolve.

Practice Academic Skills

English Language Arts/Writing

5. The first camera was the camera obscura. Research the camera obscura and answer the following questions in a short report: How did they work? What does camera obscura mean? Who used them, and how are they similar to modern cameras?

Mathematics

6. The shutter speed on Anna’s digital SLR camera is set at $\frac{1}{125}$. She wants to photograph a friend running in a race at a shutter speed that is four times faster. What shutter speed should Anna choose?

Math Concept

Understanding Operations

When thinking through this problem, do not be confused by the word faster. In this case, the smaller the fraction of a second, the faster the shutter speed.

1. Think about the question asked in the problem.
2. Divide the starting shutter speed by four.

For help, go to glencoe.com to this book’s OLC and find the Math Handbook.
Images on Film

*How does photographic film record a color image?*

Photographic film consists of a sheet of thin plastic that is coated with chemicals that are very sensitive to light. Color film has three layers of chemicals. Each layer is sensitive to one of the three primary colors of light—red, green, or blue. When color film is exposed, the chemicals in each of these layers undergo changes that record the image.

The image stored on the film is invisible until after the film is developed. This invisible image is called a **latent image**.
**Digital Images**

*How does a digital camera record a picture?*

In digital photography, a CCD or CMOS microchip records pictures. See Figure 12.3. The microchip contains millions of photosites, which are tiny, light-sensitive cells that convert light into an electrical charge.

The brighter the light that strikes a single photosite sensor, the greater the electrical charge. These charges become a photo file stored in the camera’s memory or removable flash memory card.

**Converting Light** In a digital camera, the light goes through filters and light sensors to create the tones and colors on the final photograph. In what ways are color filters on a digital camera’s microchip similar to four-color process printing? How are they different?

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**Ethics in Action**

**Protecting an Image**

Digital technology is so advanced that almost anything is possible. For example, the famous actor Fred Astaire died in 1987. Nine years later, he appeared in a new television commercial, dancing with a vacuum cleaner.

**Happily Ever After?** Fred Astaire’s widow authorized use of his image for the commercial. But the relatives of other deceased celebrities want to stop people from cashing in on their fame. They feel that a person’s likeness and image should be protected.

**English Language Arts/Writing**

**Now Showing** Advertisers have already used deceased actors to promote soft drinks, clothing lines, and personal computers. Thanks to digital technology, you could see them starring in new movies.

1. Henry David Thoreau, the great American writer, once said, “Men have become the tools of their tools.” What did he mean by this?
2. Do you agree or disagree? Write a one-paragraph response.
Color Filters

To record the colors in the scene, color filters are placed in front of the photosites. The filters separate the light into red, green, or blue—the three primary colors of light. Each photosite records only one color, and each color produces a different electrical signal. These varying signals create the range of tones and colors that appear in the final photograph. (See again Figure 12.3.)

Pixels

The image from each photosite appears as a tiny dot called a “pixel.” Pictures shot with a digital camera are collections of pixels. Cameras equipped with a CMOS use filters to record colors.

Motion Pictures

How are motion pictures recorded?

The invention of the film camera led to the invention of the movie camera. Film and digital movie cameras produce movies using the same components in a still camera. They are designed to rapidly photograph many still pictures per second.
Multi-Use Cameras
Camera makers realized they could combine the still camera and the movie camera. At first these dual digital cameras were superior in one type of photo shooting and inferior in the other. Newer digital cameras are true multi-use machines.

Frame Speed
Film cameras capture 24 frames per second, and video cameras capture 30 frames per second. The faster recording speed of video relates to the way video is refreshed on video screens. When played back, the images create an illusion of motion. Our eyes cannot see the quick change from image to image. See Figure 12.4.

Self-Check
1. Describe the effect that exposure to light has on film.
2. Summarize how a digital camera records a picture.
3. Compare a CCD to a personal computer’s CPU.

Think
4. Discuss the meaning of the word photography.

Practice Academic Skills
5. Cameras can show us places and things we cannot usually see, such as very small things, things that are very far away, and things that are under the ocean. Write a short report about this.

Mathematics
6. The fastest camera can shoot 20,000,000 frames per second. How many frames can it shoot in one minute?

Math Concept Large Numbers Working with large numbers is often easier if you eliminate as many zeroes as possible.
1. Think of 20,000,000 as 20 million. Multiply 20 by 60 seconds. $20 \times 60 = 1,200$.
2. Think of a simpler way to express 1,200 million.

For help, go to glencoe.com to this book’s OLC and find the Math Handbook.
Film Processing

How is film developed?

Commercial film processing centers develop your film by using a wet chemical process. This process is performed in a machine that looks very similar to a very large photo copier.

Negatives

Film processing must take place in total darkness since film is sensitive to all light. Your film is first bathed in a developer solution that turns the latent images into negatives. A negative is exposed film in which normally light-colored areas appear dark, and dark-colored areas appear light. Other chemical solutions in a “stop bath” are then used to end the film’s sensitivity to light.
Making Prints
To print your photographs, light is projected through your negatives onto photographic paper. The distance between the negative and the paper determines the print size. Most automated equipment is pre-set to print all pictures to a single size.

Color Prints
Color print photographic paper has three layers that are sensitive to the three primary colors of light. Light passing through the negative causes a chemical reaction in the paper. The proper colors are produced after the paper travels through a number of chemical baths.

Darkrooms
Professional photographers and hobbyists develop and print their own film by hand in a photo darkroom. Film must still be developed into negatives in total darkness, but this process can be performed in a light-tight developing tank. Special color safelights can be used during the printing process.

Reading Check  Summarize  How are film negatives processed?

Digital Processing
What do you need to process digital pictures?
Chemicals are not needed to process digital pictures. This makes digital photography much friendlier to the environment. Computer software is used to transform digital photographs into prints. You need to download the pictures from the digital camera into your computer or take or upload your memory card’s information for processing.

Snapshots of the Future
You have probably seen holograms on credit cards or in science fiction movies. Holograms are 3D images created using mirrors and lasers. Until recently, the images did not look very real. But French holographer Yves Genet developed a film coating that produces holographic images so true to life you have to touch them to know the difference. In the future, your HDTV and computer monitor will have images that seem to float off the screen.

How would holograms change TV, movies, and the Internet?

Go to glencoe.com to this book’s OLC for answers and to learn more about holograms.
Downloading Digital Images

The download process usually involves placing the camera or a removable flash memory card in a cradle attached to a USB port on your computer. The software copies the digital files into computer memory.

You can then use the software that comes with your camera. Photoshop®, Google’s Picasa®, and Hyperstudio® are programs used to crop, enlarge, improve color, and improve contrast. If the feature is available with your software, you can even change your photo into a work of art.

**Explanation** How can you process digital images?

Printing Digital Images

New home and commercial printers have also been designed to print your pictures without using a computer. To use this type of printer, you plug in the memory card, view the pictures on a screen, and pick the pictures you want to print on special paper. Digital pictures can be printed at home, at a local store, or uploaded to an online photo printing company. These companies make it easy to electronically share your pictures with friends and family.

**Self-Check**

1. Identify how the image on a negative differs from the original scene.
2. Explain why digital processing is easier on the environment than film processing.
3. Recall what causes a chemical reaction in photographic paper when you develop a color print.

**Think**

4. Describe how you think digital cameras and processing have affected film-processing businesses.

**Apply**

5. Using either a film or a digital camera, create a photo essay about technology and the future. As you work, keep in mind your audience, medium, purpose, and the nature of your message. Write an introduction to your photo essay and a caption for each photo.

6. Draw a diagram showing how the eye works. Then draw another diagram showing how a camera lens works. Write a paragraph or two discussing the similarities and differences between the two.
Ben Clark
FREELANCE PHOTOGRAPHER

Q: What do you do?
A: I am a freelance photographer. Assignments or projects come from clients such as lifestyle magazines, clothing companies, skateboard gear manufacturers, event coordinators, and stock film agencies. I also shoot photos for artistic purposes.

Q: What kind of training and education did you need to get this job?
A: I started taking photos when I was in high school and concentrated on fine art photography when I attended college. After graduating, I had to go out, gain experience, and learn the business side of my work. I now run my own business and create my own jobs.

Q: What do you enjoy most about your job?
A: It isn’t repetitive, and I don’t have to be at a desk from 9 to 5. Every assignment is different. When I arrive at a shoot, I have to figure out what kind of photos I can get out of my subject. I consider the person’s appearance and mood, the environment, and the client’s expectations. When I’m finished with a job, I move on to the next one.

Q: How did you become interested in your field?
A: I’ve always had an interest in cameras, and I really enjoy the process of photography. I still feel excitement when I snap a picture and anticipate how the image will look. Using digital photography, I can create the image that I need.

English Language Arts/Writing
Make a Brochure  Write a description of photographic services offered by a photograph. It can be portraiture, event photography, product shots, or other jobs.
1. Using a word-processing document, describe your services as well as the technology you offer.
2. Using a spreadsheet program, create a table listing your services and their prices.
3. Combine the pieces to make a brochure. It can be factual or artistic, but should include information such as services, prices, and contact information.

Go to glencoe.com to this book’s OLC to learn more about this career.

Real-World Skills
Speaking, listening, interpersonal, problem-solving

Academics and Education
Mathematics, English language arts, marketing

Career Outlook
Growth as fast as average for the next ten years
Source: Occupational Outlook Handbook
Photography is an important tool of communication technology. It is changing from a chemical to a digital technology. A camera has several main parts: the lens, shutter, aperture, and viewfinder. The lens focuses the light on the film and can magnify the size of the object. The shutter allows light to enter the camera.

Photographic film is coated with chemicals that are very sensitive to light. In a digital camera, tiny devices called "photosites" convert the light into an electrical charge. A movie camera uses the same components as a still camera. It photographs 24 pictures per second and creates an illusion of motion.

Chemical developer is used to reveal the latent image in exposed film, creating a negative—areas that appeared light in the original scene appear dark, and dark areas appear clear. Information from a digital camera can be fed directly into a computer. The information does not have to be changed because it is encoded as electrical charges.

1. On a sheet of paper, use each of these terms and words in a written sentence.

   - **Content Vocabulary**
     - lens
     - shutter
     - focus
     - aperture
     - CCD
     - CMOS
     - latent image
     - photosite
     - developer
     - negative

   - **Academic Vocabulary**
     - compensate
     - demonstrate
     - undergo
     - equip
     - determine
     - feature

2. List a camera’s main parts.

3. Discuss the similarities between film and digital cameras.

4. Explain how images are captured on film.

5. Define the term *latent image*.

6. Describe how digital cameras capture images.

7. Summarize how moving pictures are recorded.

8. Describe how photographic film is used to record a color image.

9. Recall the process of developing film negatives.

10. Explain how digital images are processed.
11. **Evaluate Digital Cameras**  You want to buy a digital camera. Make a list of ways in which you intend to use it. Research the various cameras available. List their costs and features. Write a paragraph about the camera you would choose to purchase and why.

12. **Make a Pinhole Camera**  You can make a simple camera using a discarded frozen orange juice can or an oatmeal box and some tape. Use the Internet to research how to build a pinhole camera.
   a. Use your pinhole camera to take some pictures in bright daylight.
   b. Write a set of instructions someone could use to build a pinhole camera. Include photographs or illustrations of the one you built.

13. **Social Studies**  Write a two-page report about the earliest forms of image capturing and projection. When were the first images displayed on a screen? How were moving pictures first shown? Who are key inventors in photography?

14. **Mathematics**  Lonnie’s family stores their photos on a computer. They have 1,560 pictures stored. Lonnie’s mother deletes 1/3 of the pictures. Then his father deletes 45. Write and solve an equation to find how many pictures are left.

**Solving Equations**  Do the math within the brackets first. Start with multiplication or division, and then perform addition or subtraction, left to right.

**Photographer**  

**Situation**  Develop a portfolio of digital photographs depicting the importance of family and friends.

**Activity**  Use digital photography to capture moments that show the connections you have with your family and friends. Make a series of photographs. Select your best shots and edit them. Finally, arrange them in a portfolio.

**Evaluation**  The portfolio and photographs will be evaluated by the following criteria:
- Originality
- Art—communicates the importance of family and friends
- Technical—effective use of the principles of photography

Go to glencoe.com to this book’s OLC for information about TSA events.

**Test-Taking Tip**  If each item on a test is worth the same number of points, do not spend too much time on questions that are confusing.
Set Your Goal

For this activity, you will develop and print a roll of black-and-white film. You will also use a computer either to process digital photographs or to repair a scanned image of an old, damaged photograph.

Know the Criteria and Constraints

In this lab, you will:
1. Select three of the best film photos to submit to the teacher. Indicate any changes you would make if you could alter the negative.
2. Select three of your best digital photos to submit and describe how you changed the picture on the computer to improve its appearance.
3. Turn in “before” and “after” prints that show how you removed scratches, cracks, and other defects from the damaged photograph.
4. Dispose of all chemicals properly when you have finished the lab.

Design Your Project

Follow these steps to complete this lab.

Film Processing
1. Set up the trays and other darkroom equipment following your teacher’s instructions.
2. Load the film into a developing tank in darkness using only safe lights.
3. Develop your negatives according to the manufacturer’s instructions.
4. Place the film in the stop bath for the proper time.
5. Place the film in the fixer for the proper time.
6. Wash the film and dry it.
7. Follow your teacher’s instructions for making prints.
Digital Processing
Request teacher approval before starting this activity. Your teacher will determine if you know proper procedures for the computer, scanner, and software that you will be using.

1. Scan a photo needing repair and save it as two computer files, one as it is originally ("before") and one with the changes you will make to it ("after").
   - Make repairs on the “after” version of the photo.
   - Print copies of the original photo and the retouched photo.

2. Download new photos into the computer.
   - Select three for processing.
   - Use the software tools to improve the photos by removing red eye, cropping unwanted areas, and fixing backgrounds.
   - Print copies of before and after versions.

3. Select a series of photos that you can “morph” together. Place the photos in the desired order and use the morphing tools to make your changes.

4. Show the results to other students.

Evaluate Your Results
After you complete the lab, answer these questions on a separate piece of paper.

1. What part of this lab did you find most interesting?
2. Describe any hardware or software problems that you experienced and the way you solved them.
3. If you were to repeat this activity, what would you do differently?

Academic Skills Required to Complete Lab

<table>
<thead>
<tr>
<th>Tasks</th>
<th>English Language Arts</th>
<th>Math</th>
<th>Science</th>
<th>Social Studies</th>
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<tbody>
<tr>
<td>Learn to process photo film in darkroom using chemicals.</td>
<td>✓</td>
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<tr>
<td>Learn to use digital photography software.</td>
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<tr>
<td>Make a print in the darkroom.</td>
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<td>Scan and retouch a photo on the computer.</td>
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<td>Show the results to others.</td>
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SAFETY
Picturing Safety
Wear rubber gloves and OSHA-approved safety glasses, and use tongs when you work with photographic chemicals. Wash your hands with soap and water as soon as you leave the darkroom. Read labels before using chemicals. Follow your teacher’s directions and shop safety rules.