6.1 Introduction to Forensic Archiving

The term “forensic archiving” is a departure from the usual terminology used to refer to preserving a scene’s record. From a contemporary perspective, it is also more appropriate than the more frequently used terms: forensic photography, imaging, or documentation. Archiving has a broader scope and encompasses more than simply applying photographic, sketching, or imaging techniques because it connotes a modern relationship with a digital world. Although subsequent discussions may use the older terminology—forensic photography and documentation—they should not be confused with or equate to the broader, more relevant term forensic archiving.

One might inquire why forensics should embrace a new semantic standard. The simple reason is that the current standard no longer reflects current practice. Times change and so does the professional lexicon. The American Heritage College Dictionary [1] considers “archive” a noun, and defines it as: “1. a place or collection containing records, documents, or other materials of historical interest, and 2. A repository or collection especially of information.”

Modern computer usage considers “archive” a verb in the context of backing up digital files, and PC Magazine [2] defines “active archiving” as “Moving data to a secondary storage medium that can be readily accessed if required.” While PC Magazine is a specific reference in context, in light of current crime scene practice as well as what happens afterward, it is appropriate.

With respect to preserving a crime scene, information is put into an archive, which can be a case file, a file cabinet, and/or digital photographs on a computer hard drive or a CD backup or both. In contemporary investigations, archiving usually employs a form of digital media, whether photographs taken using a digital single-lens reflex (SLR) camera, a Digicam video recorder, a computer-aided design (CAD) system, software to enhance images, or three-dimensional (3D) digital imaging systems. Even the hand sketch of the scene as well as the handwritten notes of an investigator can be captured in digital format. Archiving, then, is an adequate and timely replacement that brings the practice of scene preservation into modern vernacular. The crime scene archive is, in fact, a place where the historical record of the crime scene exists. The mechanism used to archive the scene can and should include multiple techniques.

Archiving is critical responsibility of the crime scene investigative unit, which must preserve the scene as found, so that investigators, attorneys, scientists, and so on, can “see” in some nebulous future timeframe what the original investigators saw. Thus, capturing
the essence of the scene is critical because it is impossible to predict a priori when another pair of eyes will need to review the “original.” Importantly, too, no single archiving method is sufficient, and the approaches vary from the simple process of taking notes and writing reports to using increasingly complex technology. An agency using only 35 mm or digital cameras coupled with sketching and measuring is not doing its job properly. Similarly, videography alone is insufficient and inadequate as are the newer 3D archiving systems, though they are certainly capable of providing more accurate measurements. Each archiving method has attributes and deficiencies such that a complete and competent archive of the scene requires a battery of techniques.

The bottom line is that pictures are not enough. The reason requires a brief discussion of passive and active archiving and why the active process is the most appropriate approach for archiving a scene.

6.1.1 Passive Archiving

Many authors of crime scene investigation texts use the term “scene processing” to describe what happens during the scene investigation. When the crime scene unit enters a scene for the first time and starts getting a “feel” for what happened, a myriad of thoughts echo through each investigator’s mind. Questions like those raised in Chapter 1 are relevant. However, once the team begins the archiving process, the actual steps involved may seem rote and removed. This is the connotation of what the term “scene processing” seems to imply, a passive process of taking pictures. All scene investigators know they must photograph and sketch the scene, which includes measuring critical items of evidence in order to fix their location. Experienced scene investigators realize that photography, sketching, and videography are techniques that complement each other and should not stand alone as the only visual representation of the scene.

The investigator who goes into the scene and begins taking photographs without thinking about what the scene is saying with respect to how the macroscene elements fit together is not truly an active part of the investigation and, truthfully, is hardly engaged mentally. He is simply taking pictures or sketching. This is a passive activity. But is that all there is? Emphatically, No! Then, what else, is there? The answer is to engage the brain and make it an active partner in the process, which, with respect to this discussion, is termed active archiving.

6.1.2 Active Archiving

Active archiving is the process of combining the “rote,” the passive aspect of archiving, with an engaged brain. Taking establishing photographs (i.e., overviews) of a room with a dead body, while simply moving from one perspective to another, is passive archiving. What is wrong with this? Nothing, if the investigator is a robot.

For example, the forensic photographer should think about the scene elements being captured. Is it enough to record the body lying on the floor in a pool of blood or is it also important to ensure that the photograph also includes, say, the tip of the knife sticking out from under the forearm of the deceased? Is the depth of field (DOF) sufficient to capture that information and the knife sticking out from under the sofa 6 ft behind the body of the deceased? Missing the knife from either perspective might be a critical part of the eventual scene reconstruction because subsequent photographs might miss that angle. The single line of blood droplets on the wall behind where the body lies might have come from blood
castoff from a knife. This blood pattern must be captured in the same perspective as the body and the knives, because it is important to understand the relationship of all items of potentially probative evidence. This means thinking carefully about each and every photograph.

In every sense, the forensic photographic process is the visible investigation of the scene, and it is an essential part of an active investigation, where recreational and forensic photography part ways. The artist wants to be creative and capture the scene from an artistic sense. The forensic photographer should not care about being artistically creative but about being creative in the forensic sense. Each photograph must capture the best perspectives at the scene in order to capture its story. Like the artistic photographer who allows the landscape to guide the artistic process, the forensic counterpart permits the scene to guide the continuum of photographs from relevant evidence to relevant evidence. Indeed, this might seem paradoxical because the forensic photographer must capture everything.

The following list reviews the differences between passive and active archiving. The most important is that the photographer/sketcher uses the scientific method to ensure success during the process.

- **Passive**
  - Unthinking documentation of a crime scene using photography, sketching, and other archival media.
  - No distinct evidence recognition process occurs before or at this point.
  - The scene is archived as found.

- **Active**
  - Rigorous use of the scientific method yields greater thoroughness, objectivity, and evidence recognition.
  - A process to record physical evidence but which transcends rote archiving.
  - Uses the criminalist’s holistic approach.
    - Recognize physical evidence.
  - Answers relevant investigative questions.
  - Guarantees the most complete archive.
  - Minimizes bias in the investigation.

### 6.2 Techniques of Forensic Archiving

Archiving is classified into technology types: SLR digital photography, digital/high-definition videography, manual sketching, CAD systems that render scenes in 3D, and 3D imaging systems that use infrared (IR) lasers to make the measurements. An emerging method that has not yet gained widespread application to crime scene work utilizes 3D printing technology. Here, the data from a 3D imaging system is sent to a ceramic printer that prints a 3D ceramic mold of the original scene.

#### 6.2.1 Digital Forensic Photography (Photographic Archiving)

It might seem like a mistake to consider only digital applications because it does not consider the vast history of photography in a forensic context. Modern scene investigators, though, mostly use digital photography. For this reason, it is important that students and
novice investigators understand the basic functions of the digital camera and how it is used to photograph scenes of crimes. Certainly, any forensic student should be aware of this interesting history, but digital applications are considered because they are more relevant for students; digital is the present and the future.

Photography is an essential skill, and all scene scientists/investigators must be familiar with its principles as they relate to forensic archiving. Several texts have been written on the subject [3–7], and students should be aware of specialized texts on the subject as well as published material on specialized aspects, for example, ultraviolet (UV) and IR applications.

After reading several of these texts, one might come away with the impression that forensic photography is magical or a mystical manifestation of the medium. However, this is not true. It is photography pure and simple, and, like any worthwhile endeavor, expertise takes time and practice. The purpose of this chapter is to acquaint the forensic student and novice investigator with the basics of photography and forensic applications so that they can learn to archive mock scenes competently. One caveat, though. This discussion will not consider digital evidence comparisons, software enhancements of images, or image processing except, perhaps, as simple examples.

6.2.2 The Purpose of Forensic Photography

When asked what the purpose of forensic photography is, students generally respond with a puzzled expression, maybe a shrug. Maybe the question is too simple or naive. Often, the reply is, “To document the scene.” The true response is not quite that simple. Forensic photography has much more far-reaching implications. The most obvious are straightforward and listed below:

- Record and preserve the as-found condition of the scene
- Show the relative position of evidence at the scene
- Establish the relative dimensions of evidence
- Cross-complement other archiving techniques
- Preserve the as-found scene for future reference

Certainly the above are important reasons, but there are others. Consider the hypothetical case where the defendant is convicted of a murder and sentenced to life imprisonment or even the death penalty. If, on appeal, the defense finds potentially exculpatory evidence and if a judge rules that the convicted defendant should be granted a new trial, the investigation begins anew. The first investigators—defense and prosecution—will be looking for anything supporting the original conviction or an acquittal. This information might be the original scene photographs. One might say, “Well, those photographs were standard operation procedures for documenting the scene.” Maybe, but those photographs should bring the scene back to life and thus play an integral part in the second investigation.

But what if the photographs were not good? Maybe at trial, the only photographs of the body shown to the jury had been taken by the medical examiner during the autopsy. This means the jury did not see the position of the deceased at the scene relative to the evidence there. In light of the judge’s ruling, scene scientists/investigators will be scrambling to examine all of the original scene photographs in order to find something that had not been considered carefully during the first investigation. Maybe that something turns out to be a bloodstain pattern that had been ignored during the original investigation. Since that blood-
stain pattern is no longer available, the photograph is the only record available, and if the photograph did not have the proper forensic perspective it might be worthless as an investigatory tool or as evidence. If captured properly, it could play a pivotal role in a retrial.

The importance of scene photography/archiving relates to the overriding responsibility of the investigator to capture the details of the scene without missing anything and the integral relationships of evidence. The paradox is that forensic photography, per se, is an insufficient medium to capture everything. Regardless, this is the challenge.

### 6.2.3 Critical Aspects of Forensic Photography

Since this discussion focuses solely on digital photography, discussing categories of digital cameras might seem important, but only two digital camera types should be used in forensic work: the SLR digital camera with interchangeable zoom lenses. One other example of a digital camera, which really is not a different category of camera, is one that has been modified for IR and/or UV photography. Most of the commercially available digital cameras can be modified for IR photography.

The first step for the student and the novice investigator is to become familiar with the camera’s functions. Experience shows that even students who have had a course in photography are not prepared to photograph crime scenes. For appropriate forensic photography, the following photographic equipment is required:

- An SLR digital camera having, minimally, the capability to take burst photos, adjustable white balance (WB) choices, and a menu for manipulating the WB, International Standards Organization (ISO) selections ranging from 100 to 6400, manual override modes (aperture, shutter, and manual, and program priorities), and exposure compensation. It should also have an external flash attachment.
- Close-up (macro) lens—f/1.4 or f/2.8, 60 mm.
- Zoom lenses: f/2.8, 18–70 and 70–200 mm, or f/3.5, 18–200 mm.
- Polarizing lenses to eliminate glare.
- Ball-head tripod.
- External flash.
- Lighting slaves.
- Light towers.
- Appropriate filters for use with an ALS: yellow, orange, and red.
- Ring flash attachment.
- Scales.

### 6.3 The SLR Digital Camera

Several SLR cameras are available in the marketplace, most of which are upgraded periodically or discontinued as new models arrive. Once a camera is chosen, there is no need to continually upgrade. But, why are SLR digital cameras appropriate for forensic photography? In a word, they are versatile, and their specific attributes are listed below:

- Changeable lenses are to meet specific photographic challenges
- The investigator sees exactly what the lens “sees” unless the camera is modified for IR photography.
- Higher-quality digital SLRs have large image sensors and produce higher-quality photos.
- Near-zero lag time.

Operating digital SLR cameras is not complicated, although students sometimes struggle to learn its functions. The basic camera operation is rather simple, as explained below, although its advanced functions are typically software-controlled. The basic operational aspects of the digital SLR camera are easily found on the Internet [3,4]. In most professions technology and techniques have a specialized lexicon, and digital cameras and photography are no exception, so it is important to understand and use the terminology. See Table 6.1 for a list of terms commonly used in digital applications.

<table>
<thead>
<tr>
<th>Term</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Megapixels</td>
<td>More megapixels give you the ability to make larger prints and to crop your photos. They do not necessarily have higher image quality.</td>
</tr>
<tr>
<td>ISO (and image noise)</td>
<td>Increasing the ISO, say from 200 to 800, lets you take clear photographs in dim light without a flash, but at the expense of image degradation.</td>
</tr>
<tr>
<td>Dust control</td>
<td>Dust on an SLR sensor appears as small black spots in photographs. Dust control systems attempt to prevent and eliminate this.</td>
</tr>
<tr>
<td>Image stabilization</td>
<td>Two types of stabilization: one that is included inside the camera and one that is inside the lens.</td>
</tr>
<tr>
<td>Live view</td>
<td>Composing photographs using the LCD screen on the back and the viewfinder.</td>
</tr>
<tr>
<td>Dynamic range</td>
<td>SLR cameras do not match the human eye with regard to seeing details in a scene, even when there is extreme contrast.</td>
</tr>
<tr>
<td>Crop factor [4]</td>
<td>A digital SLR sensor is smaller than a frame of 35 mm film, so only a portion of the image that passes through the lens is captured digitally. The effect is an artificial zoom of the image. The eye captures everything. Crop factors are manufacturer-specific, but generally a wide-angle lens on a Nikon digital camera (e.g., 28 mm) will be similar to having a 42-mm lens camera (28 \times 1.5) (see Figure 6.1).</td>
</tr>
<tr>
<td>Auto-focus systems</td>
<td>Auto-focus systems can include anywhere from three to more focus points. Number of focus points reflects the accuracy of the SLR digital system.</td>
</tr>
<tr>
<td>Continuous drive</td>
<td>A continuous drive allows multiple photographs in rapid succession.</td>
</tr>
<tr>
<td>File formats</td>
<td>Forensic photography should be shot in dual format—RAW and JPG. When a digital camera captures images in the RAW format, it does not process the data; the images remain unedited. When a camera captures image data in the JPG format, the camera processes the files such that information is lost: color saturation, sharpness, and contrast. Processing cannot be undone [5].</td>
</tr>
<tr>
<td>Digital sensor</td>
<td>Light hits a digital sensor that varies in type and expense. The two most common sensors are the CCD and the CMOS. The CCD is the most common and is typically found in lower-end SLR cameras. Most higher-end SLR digital cameras use the CMOS sensor. Benefits of the latter are lower power consumption, less expensive to produce, and, since each pixel has a linked amplifier, it can transfer data easier. Other digital sensors include the super CCD found on Fuji Film’s cameras and the Foveon found in the Sigma range of digital SLRs [5].</td>
</tr>
</tbody>
</table>
Workshop I on forensic photography introduces students to the digital camera. Expectedly there is a progression or learning curve. At the end of the first afternoon, the students are unsure of their photographic abilities because they have not yet established a relationship with the camera. Unknown to them, they have started taking baby steps toward archiving mock crime scenes. In the ensuing weeks they learn about several scene-related topics (e.g., fingerprinting, etc.), and some forget some of the camera basics. Instructors restructure them as they work through the mock scenes, and, by the end of the course, they are as proficient as many professionals forensic archivers. The students encounter several purposefully set photographic challenges and explore the forensic aspects of IR photography that can have important applications in forensic investigations. By the end of the course, the students have taken giant steps in proficiency, but they still need practice before becoming experts.

6.4 Essential Skills of Forensic Photography

6.4.1 Focus: “If it’s not in Focus, the Rest doesn’t Matter”

Gone are the days when the photographer has to wait for the film to be developed before learning whether a photograph is in sharp (tack sharp) [6] focus because the liquid crystal display (LCD) viewer on digital cameras allows for immediate inspection of the results. However, the LCD viewer on the digital camera can fool you. Its images are small, and photographs may appear in focus on the LCD but out of focus on the computer screen. Thus, the LCD is a useful guide but not the final arbiter of whether a photograph is in focus. Having photographs in sharp focus, called “tack sharp,” is vitally important to professional and forensic photographers. Blurry photographs have little use to either, and serve no legitimate investigative purpose in forensic archiving. The following guidelines listed are designed to help ensure that photographs are in sharp, “tack sharp,” focus.

• Use a tripod with a ball-head mount or at least a monopod. Hand-held photography is for amateurs, and forensic archivers are not supposed to be amateur photographers. There are times during investigative situations where a hand-held procedure is the only way to get the correct photograph. In these situations, the photographer must be extra careful.
• Pressing the shutter while taking the photograph moves the camera. The solution is not to press the shutter. Instead, use a cable release, the self-timer function on the camera, or the IR wireless remote shutter.

• Lock the camera’s mirror in the “up” position. Normally, the camera moves the mirror up and locks it while taking the photograph. This causes movement inside the camera. The solution is to move the mirror up manually using the camera’s “exposure delay mode” (Nikon) or “mirror lockup” (Canon) before taking the photograph. According to Kelby [6], this is the second most important precaution next to the use of a tripod to keep photographs tack sharp.

• Vibration reduction (VR) (Nikon) or image stabilization (IS) (Canon) is designed to minimize vibration that comes from pressing the shutter on the camera. This function is resident in either the lens or the camera. Regardless, it works by looking for a vibration and tries to minimize it. If the camera is on a tripod, where there is no vibration, the VR system searches for it, during which it causes a slight vibration.

• The rules of thumb: If the camera is hand-held, activate the VR system. If the camera is on a tripod, inactivate the VR system.

• Shoot at the sharpest aperture of the lens. Generally, this is about two full stops smaller than wide open. So, if the lens being used is f/2.8, the sharpest apertures for that lens would be f/5.6 and f/8 (two full stops down from 2.8). Not always absolute, this is a general rule; a place to start. Each lens has a sweet spot from which it delivers its sharpest images. The photographer ascertains the characteristics of the lenses used at scenes.

• High-quality lenses make a difference. Use high-quality “glass” for tack sharp photographs.

• Avoid high ISOs if possible. When shooting on a tripod in dim light, do not increase the ISO. Keep the ISO at the lowest possible setting. The resulting photographs will be sharper. If the camera is handheld in dim light, it may be impossible to get the photograph without using a higher ISO.

• Because the LCD on the camera back is an unreliable gauge of focus, use the zoom feature on the camera to examine the photograph detail for focus.

• Out-of-camera image manipulation (e.g., Photoshop) can help with focus. Software manipulation of images for forensic purposes is not necessarily bad, but the original image must remain with modification. In fact, there is a trend to avoid or not even allow software manipulation of photos. If this continues, the burden is on the photographer to capture forensically perfect photographs every time.

• Hand-holding the camera in anything but direct sunlight increases the likelihood of obtaining out-of-focus photographs. A trick is to use the camera’s burst function. The chances are good that one of the resulting photographs will be in focus.

• In hand-holding situations, bracing the camera against something (e.g., a wall, a railing, etc.) can steady it sufficiently to obtain sharp photographs.

6.4.2 The Correct Forensic Exposure

Exposure refers to the amount of light entering the camera and has been defined as, “The duration and amount of light needed to create an image” (pp. 32–33, [7]) or “The subjection
of sensitized film to the action of light for a specific period” (p. 266, [8]). The first definition makes more practical sense. The basic unit of exposure is the “stop,” where one stop is the equivalent of doubling or halving the amount of light entering the camera, which the photographer controls by adjusting the aperture, shutter speed settings on the camera or the ISO. The ISO setting plays a role in how the digital sensor handles light.

The difference between a shutter speed of 1 and 2 s is one stop and between 1 and 4 s, two stops. Controlling exposure allows the photographer to obtain that perfect forensic perspective, the one that tells the best forensic story. Only then does the photograph have the correct forensic exposure. Said in another way, the correct forensic exposure allows the perfect amount of light into the camera so that the scene can tell its “story.” A challenge is that different camera settings can allow the same amount of light to enter the camera. These are known as equivalent exposures. For example, the following camera settings allow the same amount of light to hit the digital sensor.

### 6.4.2.1 Equivalent Exposures

The following camera settings allow the same amount of light into the camera, so they are considered equivalent exposures.

- f/8—f/stop and 1/4 second shutter speed
- f/11—f/stop and 1/2 second shutter speed
- f/16—f/stop and 1 second shutter speed

Photographs taken at each of the above exposures vary subtly. From a forensic perspective, the photographer chooses the best exposure(s). Interestingly, the photograph telling the best forensic story may not be the one chosen by a casual viewer. The reason is that a casual viewer does not consider forensic detail but instead how the overall photograph appeals esthetically. The sets of photographs in Figure 6.2, of a bloodstain spatter at a mock scene, were purposely shot using identical exposures using an 18–55-mm zoom lens without a flash.

In Figure 6.2, photograph no. 1—blood spatter on a tile floor, the camera (Nikon D50) was set on aperture priority and an appropriate f/stop chosen; the camera selected the shutter speed. For photograph nos 2–4, the camera was set to manual priority and then adjusted so that each f/stop and shutter combination resulted in the same amount of light entering the camera as for photograph no. 1. A quick glance shows that the photographs are similar but not identical. The most obvious difference is the color of the tile floor and the overall darkness of the photograph. From a forensic perspective, photograph no. 2 has the best forensic exposure. First, the color of the floor is the closest to the actual color. Second, the detail in the photograph is the best, and, third, the overall complexion (darkness) of the photograph, although photograph no. 3 appears slightly lighter, is more appropriate for forensic purposes.

So, what makes this photograph more forensically relevant? None of the photographs were shot at the lens extremes; however, the f/11 photograph is better because the shot is closer to the middle of the range of the lens, about two stops down from the maximum of the lens. The lens is an 18–55-mm zoom with two maximal apertures: f/3.5 and f/5.6. This is a kit lens that compromises the ability of the lens to work in minimal light at low f/numbers. Thus, the f/3.5 maximal aperture at the low end of the range is not optimum for forensic work (see above discussion on focus in Section 6.4.1).
Keep in mind that the photographs in Figure 6.2 were not taken with a flash and they were purposely shot using equivalent exposures. A darker exposure, though not the darkest, was chosen as the best for forensic work. The reason is that slightly darker photographs are often better forensic choices because software enhancements can lighten the photograph without losing detail, but darkening them is usually not as successful. Additionally, overexposed photographs often lose detail, which is critical for properly archiving the crime scene. Kelby believes the opposite, reasoning that overexposure produces less noise, which is usually present in shadows. He believes that lightening the photograph using software increases noise in the resulting photograph [9]. For artistic purposes this is probably true, but forensic archiving is all about detail and overexposed photographs can lose important forensic information that is not always easily recovered. The following discussion centers on the camera functions that students must master in order to control exposure.

### 6.4.3 Aperture

Aperture refers to the size of the hole through which light enters the camera. This opening to the camera’s external world is covered by a mechanical shutter that closes more quickly or more slowly (shutter speed), which limits the time the digital sensor is exposed to the light. The camera settings used to adjust the size of the hole are called f/stops or f/numbers. For most students, the two terms are confusing and counterintuitive because the larger the f-number, say f/11 or f/22, the smaller the hole and vice versa. Aperture settings are the forensic equivalent of gold. It is the first camera setting that the photographer considers when photographing anything at the crime scene because it controls the most important perspective: What is in focus. This is another way of referring to DOF (see Section 6.8.3.4 below).
The relationship between aperture opening and \( f \)/number is illustrated in Figure 6.3. As shown, the \( f \)/number or \( f \)/stop, \( f/4 \), has a larger opening than the \( f \)/number \( f/11 \).

In older 35-mm and digital cameras, the \( f \)/stops were available in only what was termed “full stops,” and moving from one to the other either doubled or halved that amount of light entering the camera. Moving from \( f/11 \) to \( f/8 \) opens the aperture (the hole) sufficiently to allow twice the amount of light into the camera. Similarly, cutting the \( f \)/stop from \( f/4 \) to \( f/5.6 \) decreases the amount of light entering the camera in half. Newer digital cameras give photographers more control over light entering the camera. The Nikon D50 and D40 cameras used in this course have \( f \)/stop stops in one-third and one-half stop numbers: \( f \)/numbers—5, 5.6, 6.3, 7.1, 8, 9, 10, 11, 13, 14, 16, 18, 20, 22, 25, 29, and 32. Instead of moving a full stop, say from \( f/5.6 \) to \( f/4 \), called “stopping down,” the photographer can move from \( f/5.6 \) to \( f/6.3 \), which gives the photographer finer control over the final exposure.

The “\( f \)” designation can also be confusing, but it shouldn’t be. As shown in the list below (Definitions), the “\( f \)” is the focal length in millimeters (mm) and the “\( / \)” is the “divided by” function used in mathematics. The \( f \)/stop is related to the size of the lens opening, which means that there is a mathematical relationship between the size of the lens opening in millimeters (mm) and the \( f \)/number, as shown below.

- Definitions
  - \( f \) = focal length (in millimeters—mm)
  - \( f/ \) = divided by
  - \( f/ \) Number = the specific stop setting on the camera

- Calculating the size of the lens opening in millimeters
  - A 50-mm lens (focal length) with an aperture of \( f/1.4 \)
  - Divide the focal length by the \( f \)/number
  - Lens opening = 50/1.4 or 35.7 mm

The aperture is thought of as either “wide” or “narrow.” For example, an \( f \)/stop or aperture of \( f/2.8 \) is wide, meaning the “hole” is larger, whereas an \( f \)/stop of \( f/22 \) is a narrow opening, meaning the hole is smaller. The digital SLR camera communicates with the lens via electronic contacts, which open and close the aperture depending on what the investigator wants to capture. In contrast to the one-third \( f \)/numbers above, a standard set of full-stop aperture numbers would be: \( f/2.8, f/4.0, f/5.6, f/8, f/11, f/16, \) and \( f/22 \).

Figure 6.3 Aperture basics.
The lens is an important player in determining the lens opening because the quality of the lens can limit the effective maximum opening available, called the “maximum aperture.” An example compares two zoom lenses having the same focal zoom, the 18–55-mm zoom, but different maxima f/numbers. At their wide open settings, one is f/3.5 and the other f/2.8 (usually labeled on the lens). The latter is the better of the two lenses because it can allow nearly twice as much light to hit the digital sensor at its most wide open setting. Thus, the f/2.8 lens is useful in dimmer light situations, which can have important forensic implications.

Some lenses have two aperture maxima. The 18–55-mm zoom lens packaged with the Nikon D40 is known as a kit lens and is typically of lower quality than higher-end lenses. In the kit lens, the 18-mm focal length (wide angle) has an f/stop maximum of f/3.5 and the 55-mm (zoom) of f/5.6. Known as a variable maximum aperture, it is typical of the less expensive lenses sold in camera kits. These lenses typically lose sharpness at the extremes, such as at 18 mm (f/3.5) and at 55 mm (f/5.6). This is important for the forensic photographer because photographing in dimmer light can compromise the clarity and thus the quality of the photograph.

6.4.3.1 Telling the Scene’s Story: The Importance of Aperture
Although only one of the big three players in solving the correct forensic exposure puzzle, aperture should be the first setting chosen by the photographer. The reason is that each crime scene has its own story to tell and each photograph has a specific forensic perspective the photographer must capture. This is a question of focus, not as in tack sharp, but that which the photographer must decide, “What at the scene and in my particular photograph should be in focus?” The aperture setting determines this. By choosing the aperture first, the photographer is not only determining what should be in focus but is also making a thought-out decision after critically evaluating the scene. This is an example of active archiving.

The concept of what is in focus in a photograph refers to a concept known as “depth of field” or DOF. In evaluating the crime scene, the photographer must consider the DOF because it tells the scene’s story. The reason for discussing DOF at the same time as aperture is that the size of the opening controls what is in focus at the scene. In simple terms, the DOF refers to “what is in focus.” An illustration of how aperture controls what is in focus is shown in the photographs in Figure 6.4[7]. Each photograph of the man in front of a pink blooming tree has the same amount of light entering the camera—equivalent exposures. What is obvious is that the background becomes progressively more in focus as the f/stop changes from f/4 to f/5.6 to f/22; the lens opening decreases from 8.75 to 6.25 to 1.59 mm. The illustration also shows that the larger the f/number (smaller the lens opening), more of the photograph will be in focus. For forensic applications this is critical because one of the first activities of a scene investigation is to archive the scene photographically.

In the photographs in Figure 6.4a–d, the American flag is the focal point. The tree, the writing on the street, the vehicle behind the tree, the white building to the right of the vehicle, and the brick building in the left top segment of the photograph are important background elements. The photographer determines what should be in focus by changing the lens opening—the aperture. Generally, the larger the f/stop (larger f/numbers), the narrower the DOF and more of the background will be in focus. Conversely, smaller f/stops mean a shallower DOF and, thus, progressively less of the background will be in
focus. In Figure 6.4a, all of the background elements are blurry because the $f$/stop, $f/4$, offers minimal DOF; the photograph’s focal point, the American flag, is in focus. In Figure 6.4b, the aperture has been narrowed (1 stop) to $f/5.6$ which increases the DOF slightly and brings the tree and the writing in the street more in focus. The vehicle and the buildings, though better, are still rather blurry. A further narrowing of the aperture to $f/11$ (2 stops) is shown in Figure 6.4c. Here, the tree, the writing on the street, the vehicle, and the white building are in focus. The focus of the brick building is better, but close examination (arrow) shows that it is still not as crisp as the white building. In Figure 6.4d, the photographer has narrowed the opening to $f/22$. This improves the DOF and brings most of the background elements into focus. At first glance, Figures 6.4c and d appear very similar with respect to focus. However, a close examination of the brick shows that the narrower opening in Figure 6.4d has brought the building into better focus. With the exception of close-up photographs (Table 6.2), a rule of thumb for forensic photography

Figure 6.4 Illustration of aperture and depth of field (DOF).
Crime Scene Forensics

requires a maximum DOF. For other photographs, this means shooting using large f/stops so that the aperture is as narrow as possible. However, where DOF is unimportant or non-existent, such as in close-ups, smaller f/stops (larger openings) are permissible, even necessary.

Crime scene scientists/investigators take three obligatory types of photographs (some argue there are four [10]). The commonly used types and the reasons for using them are shown in Table 6.2.

Establishing photographs are overviews of the scene. This means that as much of the scene should be in focus as possible. In other words, there must be a broad DOF, and larger f/numbers (smaller aperture) are necessary. The purpose of establishing photographs is to present the investigator with a continuous, overlapping perspective of the entire scene, which can be accomplished only by ensuring that everything in the photograph is in focus. Mid-range photographs are designed to capture specific areas of the scene where potentially probative evidence is in the immediate area. Again, the f/stop must be chosen so that everything in the photograph is in focus. Close-up photographs capture critical detail of specific items of potential evidence that might have probative value. All on-scene close-up photographs must be the last in a series of photographs that show the evidence in the context of its original (scene) environment.

With zoom lenses, determining the DOF by examining the markings on the lens is difficult if not impossible. It can be determined on fixed focal length lenses, however. Figure 6.5 illustrates how to estimate the DOF from fixed focal length lenses.

In the upper part of the diagram, the camera is set at 7 ft from the object of interest and the camera is set on an f/stop of 16 (f/16), a mid-level opening. The brackets illustrate what will be in focus: Everything from 5 ft in front of the camera to a depth of 15 ft will be in focus. The lower diagram shows the f/stop set at f/5.6, a wider aperture opening and typically a shallower DOF. In fact, the objects in focus will have a narrow range: 5–10 ft.

The aperture opening is the gateway to light entering the camera, which makes it an important player in determining the exposure. How long that gateway remains open to the outside world is also important. This is known as the shutter speed, and it, too, plays a role in determining the correct exposure.

<table>
<thead>
<tr>
<th>Category of Photograph</th>
<th>Reason for the Photograph</th>
</tr>
</thead>
<tbody>
<tr>
<td>Establishing</td>
<td>Continuous, overlapping perspective of the scene. No scales are necessary. Maximum depth of field (f/11–22).</td>
</tr>
<tr>
<td>Mid-range</td>
<td>Capture immediate surroundings and relative relationship of items of potentially probative evidence. Scales may be necessary depending on subject. If so, photographs should be with and without scales. Maximum depth of field (f/8–16).</td>
</tr>
<tr>
<td>Close-up or microphotography</td>
<td>Capture detail of potentially probative evidence. Photographs with and without scales. Shallow depth of field (f/1.4–4). Weiss [10] characterizes close-up images as a way to capture evidence in relation to its discovered location, which for this text is also considered as mid-range photography. Weiss considers microphotography a way to &quot;document the evidence itself.&quot;</td>
</tr>
</tbody>
</table>
Depth of field: If $f/5.6$ is used, objects from $15'$ to $5'$ in focus.

**Figure 6.5** Estimating depth of field (DOF) from fixed focal length lenses.

### 6.4.4 Shutter Speed

As discussed above, the aperture controls the size of the opening, which is critical, but that hole must close in order to capture the correct amount of light. Regardless of the size of the opening, if the digital sensor is exposed too long, the resulting photograph will be overexposed and meet neither forensic nor artistic standards. The role of the shutter is to shut off the light reaching the digital sensor, which it does by opening and closing the door (diaphragm) over the aperture. The speed at which this happens determines the specific amount of light entering the camera. The markings in the viewfinder or on the LCD of the digital camera displays to the photographer how quickly the diaphragm (shutter) is opening and closing in front of the lens opening or aperture, a measure of the shutter speed. The shutter is, in essence, a door to the outside world that remains open for fixed periods of time.

Like aperture settings ($f/stops$), shutter speeds follow a standard scale: $1/8000$, $1/4000$, $1/2000$, $1/1000$, $1/500$, $1/250$, $1/125$, and so on, where the denominator refers to fractions of a second. Thus $1/8000$ means that the shutter is open for $1/8000$th of a second. This list shows progressively longer shutter speeds, each changing by one-half, which means that one-half the amount of light enters the camera with each change in shutter speed. This is equivalent to one full stop. Modern cameras have shutter speeds in less than one full stop increments, such as $1/2$, $1/3$, $1/4$, $1/6$, and so on. The viewfinder of the camera displays the shutter speed by showing only the denominator, such as $2$, $3$, $4$, and $6$, of the fractions listed above.

The length of time the shutter is open is a concern for photographers because the longer it is open the longer the photographer must hold the camera. A rule of thumb is that a shutter speed of $1/60$th of a second is necessary to feel confident that there is no camera movement (camera shake). Modern digital cameras and lenses sometimes have an anti-shake function, which can lower the holding time (shutter speed) from $1/60$th to near...
1/15th of a second. Below this value, the photographer should use a tripod or some other way to keep the camera from moving.

6.4.5 Exposure Values

Each combination of aperture and shutter speed has what is known as an exposure value (EV), which is essentially the value of equivalent exposures. Thus, 1/60th at f/4 has the same EV as 1/125th at f/2.8. Different photographs can have the same exposure, but the photographs can have subtle differences. These subtle differences make a particular scene photograph better than another for capturing specific detail.

6.4.6 International Standards Organization

The ISO rating is the third leg of the exposure puzzle solution, and is a measure of the digital sensor’s sensitivity to light. The higher the ISO number, the more sensitive the sensor is to light. For forensic work, the practical implication is that larger ISO numbers offer an opportunity to shoot in dim light. The trade-off is that, as the ISO numbers increase, say 800 and higher, the resulting photograph begins to deteriorate or acquire noise, in digital terminology. In practical terms, the more noise, the less opportunity there is to “blow up” the photograph in order to observe fine detail.

ISO settings affect the exposure like aperture and shutter speed because a change in ISO from 100 to 200, for example, effectively doubles the light available to the photograph, or a full stop. Although more light does not come into the camera, the digital sensor is more sensitive to light entering the camera, which in essence changes the sensitivity of the camera significantly, a full stop.

6.4.7 Focal Length

The focal length is lens dependent and, for practical applications, refers to how far (distance) an object must be from the camera lens in order for it to fill the viewfinder (photograph). Figure 6.6 illustrates the point. The three lenses used in the course (Nikon D40 or D50 cameras) are zoom lenses with focal lengths of 18–55, 55–200, and 12–24 mm. The diagram shows that the “normal” zoom lens—18–55 mm (55 mm is the closest to what the human eye perceives) is in the middle of the range. This lens may be most appropriate for mid-range photographs. The wide-angle zoom (12–24 mm) allows the photographer to capture more of the scene without moving back and may therefore be more appropriate for establishing photographs. Also, it may be appropriate in a tight space. The telephoto lens (55–200 mm) captures detail from further away from the object photographed. These lenses have value at outdoor scenes used as either or both a mid-range/establishing (55 mm) and mid-range (200 mm) setting.

Digital cameras have lenses with focal lengths that based on 35-mm camera equivalents, supposedly based on “film size.” Actually, the focal lengths are based on the size of the CCD or CMOS digital sensor, which differs by manufacturer. Still, the photographic industry uses 35-mm equivalents for digital lenses, although digital focal lengths are not equivalent to 35-mm camera focal lengths. There is a formula, however, that can convert digital focal lengths into approximate 35-mm equivalents: Digital lens “focal length/0.19” = 35-mm equivalent.
6.4.8 Metering

Cameras need to know how much light is being reflected from an object in order for it to decide what an appropriate exposure should be. Modern digital cameras accomplish this by using through-the-lens (TTL) metering systems, which means the camera measures the amount of light that is reflected from an object or the light that hits the digital sensor. The light that should be measured is the incident light that hits an object.

As mentioned, typically the light entering and measured by the camera is reflected light, which is only an approximation of the incident light. It is important to remember that the incident light is the important light. If all objects reflected the same amount of light, the TTL system would work perfectly. However, that is hardly the case, and the TTL system often forces the camera into making poor decisions, the result being underexposed or overexposed photographs. Older cameras did not have built-in metering systems, which is why the photographer needed a hand-held meter to measure the incident light hitting the object. Figure 6.7 shows reflected versus incident light.

In addition to the metering system, the digital SLR camera typically gives the photographer choices to tell the camera how to measure light hitting the digital sensor. Less expensive, beginner SLR cameras often have three metering choices: matrix, center-weighted, and spot. In the matrix mode, the camera meters a wide area of the frame and sets the exposure according to the distribution of brightness, colors, distance, and composition. In the center-weighted mode, the camera meters the entire frame but assigns the greatest weight to the center area. In spot metering, the camera meters the center focus area only. This ensures that the subject is correctly exposed even when the background is brighter or darker.

For most forensic shooting situations, the matrix mode gives the most consistent results. However, situations may exist that require the photographer to use a different type of metering. An example is of backlighting, such as photographing someone standing in front of a sunlit window, where the person ends up looking like a silhouette in front of an overexposed window. In these situations, the photographer can fool the camera into using a better exposure by changing the camera settings after using spot metering on either a gray card or a darker area in the focus area. The camera responds to the spot metering by opening the lens and letting in more light.
If all objects reflected the same percentage of incident light, the TTL would work just fine. Real-world subjects vary greatly in their reflectance.

In-camera metering is standardized based on the light reflected from an object appearing as middle gray.

Camera aimed directly at any object lighter or darker than middle gray, in-camera light meter will incorrectly calculate under or over-exposure.

Hand-held light meter calculates the same exposure for any object under the same incident lighting.

**Figure 6.7** Measuring light: Metering.

### 6.4.9 Exposure Compensation

This camera function alters the exposure up to \(+/-5\) EV (depending on the camera) to make the photograph brighter or darker. It is available only for user priority modes (manual, shutter, program, aperture modes) and is most effective with center-weighted or spot metering. Generally, positive (+EV) values lighten a photograph when the main subject is darker than the background and negative (−EV) values darken a photograph when it is lighter. Digital SLR cameras have a function button for adjusting the exposure compensation, which is displayed in the viewfinder to alert the photographer when a photograph might be underexposed or overexposed.

### 6.4.10 White Balance

There is nothing more frustrating than sorting through students’ crime scene photographs that have a blue cast. It signifies sloppy work, someone simply going through the motions of taking pictures without paying attention to the business of forensic photography—passive archiving. It means there was little or no thought to the consequences of selecting—or not selecting—the proper WB. The WB setting on digital cameras tells the camera how to “see” white. Actually, WB settings allow the camera to produce accurate colors under a variety of lighting conditions, but the camera relies on the photographer to specify the lighting condition via the WB setting.

The concept of WB is important because all color has what is known as a color temperature, which is measured in degrees Kelvin. If the photographer chooses the incorrect color temperature, the colors present in the photograph can be “off,” which for forensic work is unacceptable (WB can only be corrected using software if the original photograph was taking using the RAW setting). Table 6.3 illustrates how the color temperature changes with the color photographed.

The blue cast in the photograph in Figure 6.8 occurred because the student failed to set the WB properly. The wall in the photograph and the “white” on the sneakers should appear white. The floor is darker blue than seen with the eye.
Table 6.3 Color Temperature: Degrees Kelvin and Visible Color

<table>
<thead>
<tr>
<th>Color temperature (K)</th>
<th>1800</th>
<th>4000</th>
<th>5500</th>
<th>8000</th>
<th>12,000</th>
<th>16,000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Visible color</td>
<td>Red</td>
<td>Yellow</td>
<td>White</td>
<td>Light blue</td>
<td>Blue</td>
<td>Dk. blue</td>
</tr>
</tbody>
</table>

Luckily, modern digital camera manufacturers do not rely on photographers to memorize or even understand the Kelvin temperature scale in order to set the WB. Instead, the camera makes a menu of either icons or described situations available, with the choices usually based on common shooting situations. Those available on the Nikon D40 camera are shown in Table 6.4 [11].

The auto setting allows the camera to determine what is “white” and it sets the camera’s WB automatically. On the incandescent or fluorescent settings, the operator chooses it from the menu function on the back of the camera, selected when the scene has either dominant incandescent or fluorescent light. If two rooms are linked in the scene where one room has, say, fluorescent light and the other incandescent, the result can appear strange. The WB will be correct in one room but the other will be “off.” This can be corrected using photographic tricks, but, for most scenes, the WB should be set for the particular area of the scene of interest for that specific perspective. The linked area can be photographed at a later time.

The outdoor settings on the Nikon D40 menu are self-explanatory. The “custom” setting is the only one that gives the photographer control over the specific coloring in the scene. In this mode, the photographer must “train” the camera to recognize “white,” accomplished by showing the camera something white in that light at that location or by using a gray card exposed to that specific lighting condition. This is the most accurate way to capture the correct color temperature of the scene. Most photographers begin by setting the camera on “auto” because this usually produces acceptable photographs.

Figure 6.8 Inappropriate white balance setting.
Table 6.4 Nikon D40 White Balance Settings

<table>
<thead>
<tr>
<th>Camera Option</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Auto</td>
<td>The camera sets the white balance.</td>
</tr>
<tr>
<td>Incandescent</td>
<td>Majority of the light comes from incandescent light (common light bulbs).</td>
</tr>
<tr>
<td>Fluorescent</td>
<td>Majority of the light comes from fluorescent lights.</td>
</tr>
<tr>
<td>Direct sunlight</td>
<td>Subjects lit by sunlight.</td>
</tr>
<tr>
<td>Flash</td>
<td>When using the built-in flash—mimics daylight.</td>
</tr>
<tr>
<td>Cloudy</td>
<td>Daylight when the sky is overcast.</td>
</tr>
<tr>
<td>Shade</td>
<td>Daylight for subjects in the shade.</td>
</tr>
<tr>
<td>Custom</td>
<td>Use a gray or white object at the scene as a reference for the camera to set the white balance.</td>
</tr>
</tbody>
</table>

Some digital cameras allow WB bracketing, which means the photographer can shoot a sequence of three images. One frame will be at the WB setting chosen by the photographer, one will be slightly warmer and the other slightly cooler. This gives the photographer a better chance of accurately capturing the colors at the crime scene. Another way of setting WB is to shoot the photograph using the RAW file setting and then alter the WB using appropriate photo editing software.

6.4.11 Capturing Forensic Content Properly

After learning the basic functions of the camera, mastering the craft of forensic photography requires practice. There is a way to speed-up the learning process. The illustration in Figure 6.9 presents a step-wise approach to acquiring properly exposed, forensically relevant photographs. The process begins with choosing the proper perspective.

As discussed, this is more than simply pointing the camera and taking a photograph. There must be a reason for taking the photograph and the perspective considered carefully before pushing the shutter release button. This is time when the scene scientist/investigator decides what the scene, as reflected in that specific photograph, is going to say to future investigators.

**Figure 6.9** Capturing the perfect forensic photograph.
The second step is to examine the lighting at the scene (incandescent, outdoors, fluorescent, etc.) and set the WB. With the WB set, the aperture is next, which is typically accomplished by moving a selector knob to the “A” aperture priority (a first photograph taken on “auto” can provide a first approximation for setting the aperture and shutter speed). This is when the photographer considers and decides the type of photograph needed—establishing, mid-range, or close-up—and hence the DOF required. After the aperture is set, the camera chooses what it believes is an appropriate shutter speed based on the reflected light entering the TTL metering system. The resulting photograph tells the photographer whether the camera is reading the scene properly.

The next step is to examine the WB and exposure in the viewfinder. If they appear perfect, no other adjustment is necessary, and the photographer can move on. However, this is rarely the case. Once the WB and the exposure are set, the next step will likely require setting the camera on “manual” priority and changing the shutter speed to get the best forensic exposure, which can take some trial and error and a few photographs. The forensically perfect photograph is the photographer’s reward. The final step is to bracket the shots at different shutter speeds and/or the WB as well.

6.5 Forensic Aspects of Photography

Although forensic photography is simply the application of photographic principles to forensic situations, there are archiving rules that are inviolate.

- The first photograph in a series must have an incident photographic worksheet or cover sheet. This is usually a gray card with colored stripes, the case number, date, location, and name of the photographer.
- Photographs must be listed in a photographic log. As shown in Text Box 6.1, the log must have all of the relevant photographic data.
- Scenes must be preserved using establishing, mid-range, and close-up photographs.
- Close-up photographs must include one with scales and another without.
- Illumination (metering) should be appropriate to capture impression evidence detail.
- There should be a continuity of overlapping establishing photographs.
- Tripods should be used for all photographs where the camera must be steady: close-ups, certain mid-range photos, luminol (BlueStar™) photography, and dim-light situations.
- The camera (and tripod) should be perpendicular to the plane in which the evidence lies and horizontal (parallel).
- Scales must be in the same plane as the object photographed.
- Photographs should be taken before and after each on-scene manipulation (enhancement attempts) of evidence.
- The pop-up flash on the camera should never be used except in specific circumstances.

6.5.1 Scene Incident Photographic Worksheet

The scene incident photographic worksheet is the cover for a book of photographs; each book or series of photographs has a separate cover sheet. The cover sheet has specific data
including the date, time, case number, and the name of the photographer. It also has color stripes used to determine whether the camera is “seeing” colors correctly.

### 6.5.2 Photographic Log

The photographic log is a list of all the photographs taken in a specific series. Each entry contains the specific photographic and forensic information needed about a specific photograph: camera settings, description of what the photograph was, and the type of photograph—establishing, mid-range, close-up. In addition, it has other case-specific information. An example of a photographic log used for the Penn State Forensic Science Program is shown in Figure 6.10.

![Photographic log: Focusing at the scene.](image)

Strive for maximum depth of field
1. Shorten focal length (wide angle lens)
2. Smaller aperture opening (larger f/number)
3. Greater distance to point of focus (evidence)
6.5.3 Types of Photographs

Forensic investigations require complete coverage. Unlike artistic photography where the landscape, the portrait, or the action scene is the object of interest, the forensic photographer must comprehensively cover the entire crime scene as though filming a documentary. This means wearing several photographic hats ranging from that of a landscape photographer to that of a close-up photographer. The forensic archiver must be an expert in not only recognizing evidence at the crime scene but also capturing it in three principle photographic types: establishing, mid-range, and close-up. Although all scene photography, regardless of the scene type, is designed to capture evidence, one text refers to the photographs as overall photographs, evidence-establishing photographs, or evidence close-up photographs. Regardless of the terminology, the result must be the same.

6.5.3.1 Establishing—Overview or Overall—Photographs

Establishing photographs are overviews of the scene and the first stage of the archiving process. These are designed to depict the general orientation of the scene. This job begins when the crime scene team initiates its investigation, typically before evidence collection. Photography (or videography) represents the first archived sense of the scene and is a form of archival visual investigation. During the walkthrough with the first officer, the team leader may mark fragile evidence in order to prevent anyone from inadvertently destroying it. Certainly this is important and proper, but it should not interfere with the photographic and overall archiving process.

The scene view should be photographed as found, ideally before evidence markers are placed (fragile evidence excluded), which is often portrayed incorrectly as photographing from the four corners of, perhaps, a room. More importantly, the photographs taken should be shot in sequence so that the end result is a series of overlapping images of the scene.

Gardner [12] recommends taking establishing shots a second time after markers are in place in order to position the relative location of evidence found in areas of interest (see p. 140 in [12]). The reasoning is to capture first the unaltered scene and then to show the relationship of the scene to the marked evidence. The concept is appropriate and it should be considered for all scenes because it shows investigators who examine the scene the relative location of various items of evidence. For mid-range photographs too, it is appropriate to have evidence markers in place.

Importantly, it is critical that the photographer take proper establishing photographs. While not necessarily archiving the scene as found, protecting fragile evidence is a critical investigative function, which means that there may be situations in which the fragile evidence markers will be in the photograph. The challenge for the photographer is not to fret unnecessarily about fragile evidence markers but to be certain not to miss archiving the critical evidence. Anyone looking at the photographs at a later time should be able to orient themselves to how the scene originally appeared, even with a few evidence markers in place.

A problem with photographing a scene with evidence markers in place may occur at a later time. Evidence markers are placed at the scene to mark obvious potential evidence, and investigators might sometimes “over mark” what they consider evidence on first blush. Sometimes, a marker may be removed because what had been marked might be no longer considered important. However, if the marker is in a photograph and the item relating to
that marker is not collected, someone will likely question the “missing evidence discrepancy” during testimony. Avoiding the problem is simple: Evidence markers in photographs must tally with a photographic evidence log indicating any uncollected evidence and the reason for not collecting it.

Capturing all that a scene has to offer is not easy. The relative position of all evidence (not necessarily marked with evidence markers), even evidence not yet found, should be in the photograph unless obscured somehow. Schematics on establishing shots designed for photographers to capture the essence of the scene exist. These are guides and roadmaps used for searching a scene and are designed to minimize mistakes. Regardless of how it is accomplished, the team leader has the responsibility to archive the scene properly and completely. The photographer does the work of visual archiving, which means, because each scene is unique, careful and critical thought is important and necessary before embarking on a photographic campaign.

For example, photographing from the corners or middle points in a room might capture the overview of the room’s dimensions, but this may not be sufficient to capture the front and back of furniture. Areas with a lot of clutter will require more than four-corner photography. The photographer decides how the essence of that room will be archived. Generally, scales are not required for establishing photographs.

For most establishing photographs, the photographer aims to obtain maximum DOF. This means using an appropriate lens, one capable of allowing the photographer to set the DOF so that, when focusing about one-third of the way into the scene, the first third and the final two-thirds are in focus. This is illustrated in the scene schematic Figure 6.10. For this scene, the focus should be approximately 10 ft into the scene (blue arrow), which is in front of where the body lies. Focusing on the body may bring other areas of the scene out of focus. As an establishing shot, this photograph is not just about the body but about the relationship of the body to everything in the specific area. The hatched arrow in the middle of the schematic shows the first choice for focus. Experimental photographs will help determine the optimal focal point, easy with digital SLR cameras.

The illustration in Figure 6.10 suggests using a shorter focal length; however, too short a focal length can cause distortion problems. Recall that the 55-mm lens is the closest the digital camera gets to what the human eye sees. Establishing photographs should represent as much as possible of what investigators see. If the photographer uses a wide-angle lens to capture more of the scene, the resulting photographs can appear “off.” That is, it may not be a best representation of what investigators saw. There are circumstances, however, where the photographer needs to use a wide-angle lens to get the entire scene into the photograph. In these instances, the photographer must be wary of focal lengths less than 24 mm and should ensure that the mid-range photographs are taken using a 55-mm lens so that distortion is minimized.

### 6.5.3.2 Mid-Range Photographs

After taking establishing photographs, the next step is to “get closer” to the evidence photographically so that the relative position of the evidence in a specific area of the scene is clearer. For example, the establishing shot may show a knife lying some distance from the outstretched right arm of the deceased. It is critical to pinpoint the knife’s position perfectly, which may require more than a single photograph encompassing multiple perspectives:
taken from the feet of the deceased, from the outstretched right arm, looking from the knife to the outstretched arm, from the left and right sides of the deceased, from the head of the deceased, from all doorways (if they not too far away), and so on. In this way, the knife’s position relative to the doorway, to the deceased, and to other rooms will be preserved—archived.

A bloodstain pattern on a wall should be captured in mid-range photographs, and the entire pattern captured. A procedure for accomplishing this is described in Chapter 15. Establishing photographs tell an observer that the bloodstain pattern is present, but the mid-range shot captures the size and shape of the entire pattern—evidence marker and scales in place. Subsequent close-up photographs detail specific droplets of interest: directionality, size, those having included air bubbles, pieces of tissue, and so on. Bloodstain patterns should never be photographed using a flash, especially using the camera’s pop-up flash, because the flash will washout stain detail.

Generally, scales are not necessary for mid-range photographs. There are exceptions, though, such as bloodstain patterns. Sometimes, mid-range photographs of an entire bloodstain pattern are not possible because of its size. In these instances, sectoring is a way to capture segments of the pattern, which are then spliced together to form an entire pattern.

A single bloodstain pattern at a scene should not present an archiving problem, but multiple bloodstain patterns should be labeled sequentially. That is, each pattern should have a specific designation different from other tagged evidence. Thus, if most of the evidence at the scene is tagged as, say, items 1–99, the bloodstain patterns could be tagged using alphabet markers A–Z. Another term used is “roadmapping” (attributed to Toby Wolson, Miami Dade County Crime Laboratory, p. 161, [12] (see Chapter 14). Scales should be present in all bloodstain pattern photographs.

6.5.3.3 Close-Up Photographs

Evidence details that have criminalistic or investigative value—knife length and width—must be preserved photographically. An important category of evidence that should be included is impression or pattern evidence: fingerprints, footwear impressions, tire tracks, tool marks, and so on. The first photograph is taken without scales and the second with scales. The scales chosen must also be appropriate: A fingerprint requires millimeter scales while a knife on the floor does not require that much detail and can be photographed using an inch rule. All close-ups should be shot using a tripod because any movement will blur or obliterate critical structural detail required.

Students often question which items to photograph in close-up views. A working rule of thumb is any evidence that will be removed from the scene that has direct comparative value. This includes weapons, bullet fragments, bullet impact marks, shell casing, impression evidence, fingerprints, and so on. Close-up photographs do not have a DOF issue, which means the photographer is free to open the shutter and concentrate on focus and filling the frame of the viewfinder with the image of the evidence. The photographic principles related to establishing and close-up photographs with respect to DOF is illustrated below.

Close-up photographs by definition do not have a DOF because they usually represent evidence on planar surfaces. There are instances, however, where surfaces are curved, for example, fingerprints on door knobs. In these instances, the selection of the proper f/stop is important.
6.5.4 Illumination

The foregoing sections included a discussion of exposure, the process of determining the “proper” amount of light that hits the digital sensor. Another topic deals with not the amount of light but the relative position and type of light entering the camera. In other words, the location of the light source relative to the position of light before it enters the camera. The type of light refers to something other than white light: IR, UV, or light from an ALS.

An example is the photography of impression evidence, a common category of physical evidence that has texture and surface topology. Photographing texture (topology), especially something subtle, such as a fingerprint or a dry residue footwear impression, can be tricky and usually requires an oblique light source. Using an oblique light source, per se, may not be appropriate unless the correct angle of the light entering the camera is determined, typically empirically.

For photographers, light is either controlled or uncontrolled. In a controlled setting, the photographer controls the type, the amount, and location of the light entering the camera, which can be accomplished by using flash, slaves, or a technique called painting by light. An uncontrolled environment uses primarily ambient light, which the photographer must make work. Figure 6.11 shows examples of how to control light sources for the direct lighting of evidence.

The slide in Figure 6.11 shows three different methods for obtaining direct lighting. The scene circumstances determine the specific positioning of the light source. Impression evidence—evidence having texture insufficient for casting—usually requires oblique lighting: A 45° or 10° light source is used for 3D textured impressions, such as footwear or tire track impressions in mud.

The slide in Figure 6.12 shows where to place the light source depending on the depth of the impression. Impressions that have a shallow texture—fingerprints and dry residue footwear impressions (see the example on the right in Figure 6.12)—require a near-floor-level light source. For deeper impressions (see the example on the left in Figure 6.12), less

![Figure 6.11 Controlled lighting of evidence.](image-url)
Low angle light for impression evidence:
Wet and dry residue footwear prints, tool marks, fingerprints

Camera
3D impression
Light source
Dry residue print
Wet and dry residue footwear prints, tool marks, fingerprints

Figure 6.12 Oblique lighting of impression evidence.

of an oblique light source usually suffices. The optimal position of the light source can be variable and will be determined by the scene circumstances.

A clear example of footprints is shown in Figure 6.13 [13].

Even a rocket scientist can see the dramatic effect that changing the angle had on the quality of the resulting photographs. Without question, the 10° oblique lighting gave the best result. Students typically fail to experiment with illumination angles to determine the correct one. Usually, they try to make the best of a situation using either ambient lighting or oblique lighting with a flashlight or other light sources near the floor. Clearly, the winner of the footwear impression photo contest is the one who takes the time to ascertain the most appropriate angle from which to obtain the most impression detail.

Figure 6.13 Three-dimensional footwear impressions highlighted using light at different angles. Used with permission.
Sometimes it is necessary to soften the light by bouncing it from a reflected source—paper, glass, the ceiling, and so on—to the object being photographed. Figure 6.14 illustrates how to accomplish this, understanding that these are meant to be guides and do not reflect all possible variations.

The ingenuity and experience of the photographer will ultimately determine whether the photography is successful.

**6.5.5 Filters**

Filters are useful to darken, make warmer (or cooler), or eliminate glare in photographs. The first commercial filters were made by Frederick Wratten and C. E. Mees, whose company was the forerunner of Eastman Kodak. Their filters had numbers associated with each, and these have become the standard notation and labeling for optical filters [14]. Filters exist for most photographic applications: Some specifically block or pass visible, UV (1A-2C), or IR (87C or 89B) light and some darken a photograph a specific number of stops (85N3, 85N6, and 85N9). Other manufactures make special lines of filters—FujiFilm and MaxMax—for specific UV or IR photography [15]. Most filters have limited utility. However, some are important depending on the subject photographed. For example, polarizing filters are used to filter out glare.

Other filters are used in conjunction with ALSs. Specific wavelengths of light interact with matter in basic ways: The light is absorbed, transmitted, or reflected. Sometimes, the light absorbs energy and then loses it in the form of a photon (light). In this instance, the light is called fluorescence. However, because of the light reflected from the object, the fluorescence may not be visible to the naked eye or the camera. That is, the reflected light masks the fluorescence. Losing the reflected light means blocking it so that it never makes it to the observer (camera and/or person). This is accomplished using barrier filters. Figure 6.15 shows the process. The orange barrier filter blocks the reflected light (green) from entering the camera (or the eye). The fluorescence (pink) enters the camera and is “seen” by the digital sensor.

![Figure 6.14](image)

_Figure 6.14_ Fingerprint photography using bounced (reflected) light.
6.6 Forensic-Specific Considerations

6.6.1 Camera Positions
Camera positioning is critical because criminalists in the forensic laboratory must make comparisons to exemplars (known standards) against the photographs taken at the crime scene. If the scene photograph is distorted or not perpendicular and horizontal to the plane in which the evidence lies, direct comparisons may be compromised. An inviolate rule is that all photographs must be taken parallel (horizontal) to the plane and the lens must be perpendicular (vertical) to the evidence. Figure 6.16 illustrates how to position the camera relative to the evidence. The dotted lines show the perpendicular (vertical) and the horizontal (parallel) aspects. If the “cross” is not parallel to the plane of the evidence, the resulting photograph will have minimal or conditional forensic value, even if scales are present.

6.6.2 Scales
All close-up and some mid-range photographs must have scales in at least one photograph. The problem with scales is that the exposure sometimes changes after placing the scale near the evidence. Students often complain that their photographs are darker with scales than without. The reason is that the scale (white scales) reflects additional light into the camera, which forces the camera to change the exposure by reducing the size of the aperture.

Additionally, the placement of scales is important. Properly aligning the scales along the width and length of the most important sides of the evidence is critical. This means placing a single scale along a fingerprint or on one side of the knife is not forensically proper. All sides of the evidence must have a scale. The photograph of a bullet through a windshield in Figure 6.17 is an example. Students were asked in an exam to critique it. One response said that the investigator used two different scale formats. Although not aesthetically appealing, this will not preclude a criminalist from making accurate measurements.
The answer to the question concerns the positioning of the scales. In this photograph, the scales were positioned incorrectly, not along the length and width of the bullet hole. The black lines illustrate how the scales should be positioned.

**6.7 Photography of Common Scene Scenarios**

All crime scene investigations follow a roadmap or menu of activities. The challenge is to follow a precise schedule without undermining the intellectual thought process. Chapter 3 discusses how these critical processes fit together and how and why logic is an integral and unifying part of that process. Photography is but one piece, a part, of the investigative puzzle. It is not independent, per se, but must fit into the logic of the investigation. This means that forensic photography as a critical archiving medium must always take place logically and fit into the investigation without hindering its flow.

**Figure 6.17** Bullet hole in windshield and incorrect placement of scales.
As discussed, establishing photography is one of the first activities on the agenda. This is as it should be, but this, too, must be done logically and based on the team leader's investigative philosophy. So, while establishing photography of the scene comes first, there is logic with respect to the specific location where it begins and the sequence of the process. Generally, photography should begin where most of the activity took place. Since this is also where the crime scene team will begin its investigative efforts and where the photographer and team will spend most of their time, scheduling will be critical. If one part of the process happens out of phase, such as photography, the investigation will be inefficient and the team may miss critical evidence. For example, photographing the body is certainly important, but it should be done properly and at the proper time, which will be dictated by how the investigation moves forward and the medical examiner.

Because of how the “Scene Processing Cascade” was presented, readers of Chapter 3 might have incorrectly concluded that all crime scenes are handled in the same manner. That would be an incorrect assumption. Each crime scene is unique, and while that discussion was partly philosophical, it left the responsibility of the scene management squarely up to the team leader, with the caveat that the investigation should be a logical and systematic process based on the scientific method. However, it makes sense that certain crime categories have evidence types in common. It also makes sense that students who are learning or honing their investigative craft should be aware of the array of evidence categories present in certain crime types, at least minimally, from an archiving perspective.

If logic is the guiding principle of scene investigations, and of archiving for this discussion, then defining scene types with respect to archiving might seem at odds with the philosophy of this text. However, taking into consideration crime types is important because certain ones, such as, vehicular accidents, homicides, sexual assaults, burglaries, hit-and-run, suicide, arson, and bombings, have specific recurring attributes. That said, there is always the consideration of logic and how it relates to what must be photographed at a particular scene type. And although the following suggestions should be taken seriously, there is the understanding that each scene is unique and therefore dictates the specific parameters required in order to archive it properly. Students should study these lists to familiarize themselves with the common characteristics and the differences among them. Hopefully, these will guide novice photographers so that they can successfully archive new scene situations.

### 6.7.1 Vehicular Accidents

Vehicular accidents are complicated, are almost always outdoors, and often occur in high-traffic areas. Importantly, archiving these scenes is as much a public service as an insurance issue because the trauma and the possibility of criminal as well as civil law suits loom large. As in all crime scene photography, the forensic archiver must strive for objectivity and thoroughness in approaching these scenes. As mentioned above, this discussion is not an in-depth study of accident scene photography, but simply a list of accident scene subjects that, if present, should be captured [15]. Certainly, evidence may exist that is not in the list. In addition to capturing these macroscene elements—vehicles, vehicle impact points, blood, debris, skid marks, and so on, it is important to portray those intangible but important characteristics endemic to accident scenes: the sightlines of the divers and witnesses and obstructions that might have hindered those sightlines. Traffic controls and the relative location of signals, yield and stop signs that might have or should have been observed
by the drivers, are also important. All such photographs should be taken at drivers’ eye level, if at all possible. For example, if one of the vehicles is a Honda Accord, the photographer must determine the sightline of that driver and then photographically portray this to the impact point. This does not mean simply kneeling down to a height that the photographer “believes” represents the drive’s sitting height in the vehicle and thus his/her sightline. It means taking measurements so that the height of the sightline is as accurate as possible, and the measurements should be recorded in an appropriate log. The following factors should be considered.

• How the weight of the driver may have lowered the vehicle and how that could have affected the sightline.
• The slope of the roadway and how that may have affected the driver.
• Obstacles in the sightline, such as trees, signs, or other vehicles.

If the drivers are not present because of injuries or death, all measurements will be estimates made on the fly. Information and sizes can be obtained from the medical examiner. Regardless, the exact heights at which the photographs were taken must be recorded, and, if estimates are needed, these must be recorded as well. If needed, more accurate measurements can be made at a later time. Since these scenes are usually outdoor incidents, accidents can occur because of factors outside the control of the driver; for instance, glare from sunlight, darkness, and bad weather can cause vision problems. Capturing this information is critical. For example, sun glare over a horizon may have temporarily blinded a driver from seeing a traffic light, stop sign, or another vehicle. The photographer must attempt to capture this, if possible. This means working quickly because time changes the perspective and location of the sun. It might mean returning to the scene when the proper conditions are present. This, of course, is an elusive target and extremely difficult to duplicate exactly. Still, it is important to make an attempt and even presenting a jury with an example of how the glare affected the driver’s vision can be important. Table 6.5 is meant as a guide for photographing vehicular accident scenes.

6.7.2 Homicide Scenes

Homicides translate to dead bodies and bodies are an aspect of the macroscene. They are also scenes unto themselves. They have critical evidence that can eventually help close the investigation or provide critical probative evidence. They also tend to become a focal point. A dead body is not necessarily a major source of fragile evidence requiring immediate attention, and it does not need to be removed from the scene immediately. It may, in fact, not be where most of the scene activity took place. In fact, indoor homicide scenes often display signs of activity that carries across several rooms. The forensic archivist must capture this activity in a continuum from photo to photo (and/or video) as though the filming took place while the crime was happening. While impossible, philosophically that is the goal: “Miss nothing.”

Philosophy often gets pushed aside in favor of what is practical. In fact, the true-grit scene investigation—fingerprinting, enhancements, trajectories, evidence collection, and so on, cannot begin until establishing photography is concluded, which is why the place to begin photographing (and sketching) is where most of the activity took place (struggle, bloodstains, etc.).
Many researchers believe the body is the most important part of the scene. Certainly, it is a vivid, visible, and visceral reminder of what happened, but this notion is far from correct. The medical examiner/coroner needs to conduct an investigation concerning the circumstances surrounding the death, and the scene is a part of that investigation. But the medical examiner also wants to transport the body to the morgue as soon as possible. Candidly, though, autopsies in large metropolitan areas do not often begin until the next day unless the case is special for any number of reasons. Routine cases, however, do not warrant that much attention. So waiting for a few hours before moving and transporting the body is not a big deal. It is more important to conduct the investigation logically, systematically, and completely, which means photographing the body is only one part of the archiving process.

Eventually, the body becomes the photographer’s focal point, even though the medical examiner and detectives have been likely hovering over it for some time. At this point, the photographer should use a specific set of procedures to document the entire body and its immediate environment properly. This means a serious consideration of the DOF is

<table>
<thead>
<tr>
<th>Subject of Photograph</th>
<th>Reason for the Photograph</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drivers' viewpoint</td>
<td>What the driver saw</td>
</tr>
<tr>
<td>Point of impact</td>
<td>Where hit took place in relation to other aspects of the scene</td>
</tr>
<tr>
<td>Traffic control devices</td>
<td>Their location is important to know</td>
</tr>
<tr>
<td>Skid marks</td>
<td>Movement before and after the impact: speed, acceleration/deacceleration</td>
</tr>
<tr>
<td>Roadway condition</td>
<td>Aspects of the road that could have had an impact on the accident</td>
</tr>
<tr>
<td>Roadway</td>
<td>Roadway environment: slope, potholes, defects, debris from impact location, position of vehicles</td>
</tr>
<tr>
<td>Instructions</td>
<td>Obstructions that would have hindered drivers’ or witnesses’ view of accident</td>
</tr>
<tr>
<td>Biological evidence</td>
<td>Blood, hair, flesh, or other biological evidence on the ground or on the vehicles’ underside, tires, windshield, and so on.</td>
</tr>
<tr>
<td>Tire tracks</td>
<td>Location and duration of tire tracks</td>
</tr>
<tr>
<td>Footprints</td>
<td>Location of shoeprints of drivers, passengers, and witnesses, if available</td>
</tr>
<tr>
<td>Impression prints in vehicle paint</td>
<td>Close-up photographs to document possible paint transfer and fabric impressions</td>
</tr>
<tr>
<td>Trace evidence</td>
<td>Fabric, glass, trace evidence on ground or imbedded in the vehicles</td>
</tr>
<tr>
<td>Defects in vehicles</td>
<td>Damage and noticeable defects, such as sagging springs to suggest instability. Aspects of vehicles not working—turn signals, headlights, and so on.</td>
</tr>
<tr>
<td>Debris</td>
<td>Location of debris from the collision—glass, plastic, metal, trace evidence</td>
</tr>
<tr>
<td>Roadside</td>
<td>Environment at accident site as well as leading to and from the collision point</td>
</tr>
<tr>
<td>Interior photographs of vehicles</td>
<td>Positioning of blood, speedometer reading, positioning of seats, position of shifting levers, footprints on pedals, and so on.</td>
</tr>
<tr>
<td>Establishing shots of vehicles</td>
<td>VIN numbers, license plates, overview of front, back, and sides of vehicles</td>
</tr>
</tbody>
</table>
important, and shooting for the maxim DOF using an f/number of 11–32 is not unreasonable. The top part of Table 6.6 (I: Body and Surroundings) shows how to photograph the body and why.

Homicide scenes have other important considerations. Importantly, though, no archiving activity should occur out of sequence (see Chapter 3). When an investigation goes on tangents, evidence can be easily missed, and there is the real chance of botching the investigation. The lower part of Table 6.6 (II: Ancillary Archiving) offers several suggestions with respect to winding down the photographic aspect of the investigation. These must be photographed at the proper time during the investigation. Generally, establishing photography occurs before mid-range and that before close-up photography.

### 6.7.3 Nonhomicide Sexual Assaults

Sexual assault/battery is an important crime category that, too, has a common thread of associated evidence categories. Although usually violent, these crimes are different in that a sexual assault survivor may be able to relate details having important investigative value. From the forensic photographer’s perspective, details of the attack location or locations may be critical in documenting the allegation. If the survivor was abducted from the street or on a jogging path in the woods, archiving the physical attributes of those locations is critical: macroscene elements, such as footprints, tire tracks, ripped clothing, and so on, photographed in situ to avoid confusion with respect to the location of the evidence. Thus, for the forensic photographer, the survivor can be a personal video camera of the attack. The details of what happened and where is key to locating probative evidence. A sexual assault nurse examiner (SANE) usually performs the physical examination, collects physical evidence from the survivor, and conducts the interview, often in the presence of the investigating detective. This interview is critical for the crime scene team leader and the team’s photographer.

These cases can take place inside a residence, inside vehicles, outdoors or any place where a woman can be attacked. As suggested above, this might be along a jogger’s path in the woods. New York City’s jewel, Central Park, for example, has the unfortunate distinction of being the location of many sexual assaults. Sometimes, the subsequent scene investigation takes place after the SANE nurse’s interview. It may be that the vehicle described by the sexual assault survivor may not be recovered quickly or ever.

Luckily for the investigators, unless there is blood present, semen, saliva, and trace evidence are not readily visible, especially on light surfaces, and there is good chance that critical biological evidence might remain at the location where the assault took place. The archivist has two responsibilities:

- Capture the location of the scene—as with any scene, such as a burglary (many sexual assaults begin as burglaries) or a homicide (many homicides are sexually motivated).
- Archive the location of biological evidence.

Appropriate archiving of biological evidence requires photography using ALS because this is the best way to visualize semen, saliva, and urine. The photographer should have a series of barrier filters (e.g., orange, yellow, and red) that fit onto the lens. In combination
Table 6.6 Guidelines for Photographing the Body at Homicide Scenes

<table>
<thead>
<tr>
<th>Reasons for the Photograph</th>
<th>I: Body and Surroundings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Capture surrounding area from an aerial view. The shot should be as vertical as possible.</td>
<td>Establishing overhead view</td>
</tr>
<tr>
<td>Perspective of body’s surrounding. Typically mid-range shots.</td>
<td>Mid-range photographs of body taken clockwise—head to feet, right arm and side, feet to head, left arm and side. A tripod may not be necessary.</td>
</tr>
<tr>
<td>Documents the detail of the body.</td>
<td>Close-up views—head, hands, feet, clothing, wounds, bite marks, and so on. Tripod may be necessary</td>
</tr>
<tr>
<td>Capture bullet holes in furniture, walls or other defects—knife marks, and so on.</td>
<td>Weapon-specific photographs</td>
</tr>
<tr>
<td>Knowing the precise location of the body helps if investigators must return to the scene. Photographs of markers of head, hands, and feet show their relationship to the scene.</td>
<td>Mark the position of the body with markers. It is not necessary to outline the entire body with chalk, just location of head, hands and feet.</td>
</tr>
<tr>
<td>To visualize biological evidence (semen, saliva, etc.) and fibers. Important at the scene to show relative location in relation to position of the body.</td>
<td>ALS photography of the body</td>
</tr>
<tr>
<td>Establishes the exterior boundaries of the scene location. It might be helpful in establishing egress and/or entry routes, possibly in retrospect.</td>
<td>Establishing photographs of the scene exterior, typically from a distance (e.g., from 75 to 100 ft). Shots of the front of the house and driveway. Move clockwise. Depending on weather conditions, may be the final photographs. Include landscaping and impression evidence. Aerial photographs may be necessary. On-line services may be able to provide these.</td>
</tr>
<tr>
<td>Perspective of the area surrounding the scene from the scene’s viewpoint.</td>
<td>All rooms that have activity</td>
</tr>
<tr>
<td>Areas where evidence is likely.</td>
<td>All areas that do not have activity</td>
</tr>
<tr>
<td>Unknown when nonactive areas of the indoor scene may provide important evidence.</td>
<td>Establishing, mid-range, and close-up photographs of areas where fingerprints are found or where they might be</td>
</tr>
<tr>
<td>Provide a visual perspective of perpetrator movement through the scene.</td>
<td>All impression evidence should be photographed.</td>
</tr>
<tr>
<td>Comparison with exemplars from suspects.</td>
<td>with the ALS at 450 nm (the CSS setting on the MiniScope™ 400), semen, saliva, and urine will fluoresce. The orange filter blocks reflected light and allows the fluorescence into the camera.</td>
</tr>
</tbody>
</table>

Correctly capturing these scene details supports the survivor’s allegation of where the attack occurred and provides her with a scientific ally in the courtroom. If the attack took place in a vehicle, finding semen and/or saliva on the seat and archiving it can be a critical piece of evidence. Not all investigators and even forensic scientists will agree. Their position is that DNA analysis is more important because it identifies the person who left the semen. In instances such as finding the attacker’s semen on the survivor’s bed sheet on her bed, this is certainly true. But in the example where the attack took place in the vehicle of the accused, this is conceptually different. Here, finding the attacker’s semen in the back seat of his car is not necessarily probative evidence that he raped the survivor. However, if
the survivor describes the vehicle and tells the jury that the attack took place in the back seat, the photographs of fluorescing semen on the seat in that location is strong support of her allegation. Her testimony, the on-scene photographs of the fluorescing semen, and the laboratory determination that the semen is the defendant’s should be enough to convict the defendant. If the semen stain is mixed with the survivor’s vaginal secretions (vaginal epithelial cell DNA), this, too, supports her allegation that the attack took place in the back seat of the defendant’s car, and it should seal the conviction.

A common strategy in the DNA era is that the sex was consensual. However, testimony from the SANE nurse concerning a survivor’s injuries should circumvent suggestions to that effect. Table 6.7 gives guidelines for archiving nonhomicide sexual assault scenes.

### 6.7.4 Suicides

The medical examiner/coroner is responsible for reporting the manner of death to the local health authorities and must classify the death into one of five categories: homicide, suicide, accident, medical intervention, and undetermined. For law enforcement, the medical examiner’s report is important because the determination that a suspicious death is a suicide closes the case for the police. Such a determination cannot legally be made by the police or the crime scene investigators, although each plays a part in the overall investigation.

Certainly, though, the crime scene unit, specifically the team leader, should never approach a death investigation with the preconceived notion that it was a suicide, accident, or homicide. The team leader might short circuit the investigation in a suicidal death, but only after the investigation has run its proper course. This means treating all deaths as though they were homicides. This is the only way in which suspicious deaths investigations will receive a proper and comprehensive investigation, which includes archiving.

For gunshot suicides, photographing the body is incredibly important, as it is for all death investigations. Here, photography of the entrance and exit wounds—if visible to the photographer—shows them in relation to the position of the body and the final location of the weapon. Many suicide gunshots occur at close range, which means that the presence of GSR, stippling, and fouling should be captured using establishing, mid-range, and close-up photographs, ideally in situ, so that their relationship to the position of the body is preserved. A gunshot wound to the chest may suggest a homicide, but suicide—at least in the early stages of the investigation—should not be ruled out. In these instances, the clothing

<table>
<thead>
<tr>
<th>Table 6.7 Guidelines for Nonhomicide Sexual Assault Scenes</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Sexual Assault</strong></td>
</tr>
<tr>
<td>Normal scene photography including entrance and egress points. Complete interior and exterior establishing shots such as those used in homicide investigations.</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>ALS photography of the scene</td>
</tr>
</tbody>
</table>
The deceased will likely be bloody, but the investigator needs to know whether GSR is under the blood. IR photography could help. The IR light goes through the blood to the underlying garment (or skin). The GSR particles absorb IR light, which means they are darker than the blood. If the garment does not absorb IR light, it will be possible for the camera to “see” the GSR, which can be photographed.

Figure 6.18 shows an IR photograph of GSR on a black T-shirt. The GSR particles are seen as black dots on a light surface. Under blood, the GSR is seen as dark spots on a lighter surface even though blood absorbs the IR light in the region of the electromagnetic spectrum. The black T-shirt does not absorb the IR light, so whatever absorbs the IR light under the blood is also visible. The LCD viewer on the digital IR camera allows the photographer to determine this at the scene.

Suicides are difficult. They can be extremely bloody, as much as the most violent homicide. Knife and bullet wounds and hanging are common. For these, the team leader and the photographer should never assume the manner of death is a suicide, even if it is abundantly apparent and the scene screams “suicide.” These cases have aspects that should not be ignored and must be archived: ligature marks on all sides of the neck, knots associated with a noose, injuries on hands, location of bruising, and so on.

In the absence of a suicide note, suicide cases are even more difficult to investigate. Even so, its presence, per se, should not automatically suggest a self-inflicted death. When the note is present, archiving its location and the writing on it is important. The deceased’s body should also be treated like any other death investigation (see the discussion on homicide cases in Section 6.7.2). The point is a suicide can appear like a homicide and neither the amount of blood nor its location should suggest one manner of death or the other until the investigation is completed and all evidence and metadata are available. If the medical examiner rules the death a suicide, proper archiving will be critical because the family will need to be convinced, and there may be insurance and other legal issues to with deal in the

![Figure 6.18 Infrared Photograph of gunshot residue (GSR) under blood on black T-shirt.](Photograph by Robert C. Shaler.)
future. The guidelines in Table 6.6 for photographing homicide scenes apply equally to suicide scenes.

6.7.5 Hit-and-Run Cases

Like most vehicular accidents, hit-and-run cases typically occur outside, and should be treated photographically in the same way (see Table 6.5). Unlike vehicular accidents, hit-and-run cases run the gamut from vehicular homicide, involuntary manslaughter, to leaving the scene of an accident or unintentional injury. The basic difference between a hit-and-run case and a vehicular accident case is that the latter often involves two vehicles while the former involves a vehicle that is missing after having fled the scene. The successful solution to the case is proving that one specific vehicle had been at the scene, which means archiving and collecting evidence at the scene, on the victim (if the victim is a person), and/or on another stuck vehicle. The collected evidence is compared by criminalists to evidence taken from the suspected missing vehicle.

One aspect of this proof is photographic. Table 6.5 for vehicular accidents is also appropriate for these cases. Documenting the driver’s and victim’s sightline, point of impact, debris field, and biological evidence photographically may be critical. Microscene evidence can be the critical parameter that leads to a conviction. Such evidence can include blood and tissue, paint and paint chips, fabric impressions, glass, and plastic. Documenting the location and photographically recording this evidence is critical, as is other possible forensic characteristics of the scene—tire tracks, shoeprints, roadway surface, and so on. If the hit-and-run case involves a pedestrian who dies at the scene, the guidelines in Table 6.6 apply.

6.7.6 Fatal Accidents: Body Inside the Vehicle

Like hit-and-run cases, accidents in which fatalities occur are similar to vehicular accidents discussed above, and the guidelines in Tables 6.5 and 6.6 are appropriate for these scenes. To be successful, scene scientists/investigators and forensic photographers should never take a case at face value, that is, assume a case is what it appears to be. Fatal accidents are no exceptions. The identification of the driver of the vehicle may be in question. The position of the body may be staged. The photographic record, subsequent DNA analysis, detective work, and criminalistics will tie the case together. The science applied should spell out the particulars of the case.

From the forensic photographer’s perspective, then, blood and other bodily fluids should be captured photographically. As in sexual assault cases, using ALS may be helpful in locating and then photographing saliva and bloodstains. The interior of the vehicle in these cases can be a particularly important source of probative evidence because this is where the participants of the crime (if it was a crime) were located.

Sometimes pinpointing who was driving can be critical because discrepancies occur from witness descriptions and/or descriptions by the person(s) who survived the accident. Those who participated in the scene or even witnesses may lie to investigators. Finding DNA evidence (blood, saliva, etc.) can help, but capturing the location where the DNA was collected photographically may be critical as is the location of blood spatter patterns, which an expert may need to interpret at a future time. Released airbags may also have surface biological evidence—saliva and/or blood—and their location can also help pinpoint who was sitting where.
6.7.7 Burglary: Breaking and Entering

The role of the forensic photographer in these cases is to provide visual evidence that a particular individual was the person who committed the crime. Thus, establishing photographs followed by mid-range and close-up photographs are critical. Table 6.6 gives an overview of the archiving process in these cases. Certainly, the characteristics of the case will dictate the photographic process. Capture those objects in order to identify who committed the crime because the evidence photographed might have DNA present. Fingerprints from the latex gloves are important because they may have the wearer’s DNA. The DNA in these cases is critical because, in addition to identifying the specific individual in the extant crime, it can link an individual to other burglaries or even more violent crimes, such as sexual assaults and homicides.

Impression evidence, such as tool marks and shoeprints, is another important class of evidence that might be present. This evidence can be compared to a tool or a shoe found in the possession of a suspect. Proper archiving of these impressions photographically is a skill the forensic photographer must master. Not only are the establishing and mid-range photographs important to show their location at the scene, the criminalist in the crime laboratory needs close-up photographs with scales to make proper comparisons.

6.7.8 Fire Scenes: Arson

Fire photography and videography are critically important. Ideally, the forensic photographer will be at the scene as soon as possible after its discovery. These scenes are difficult, tedious, dangerous, and complex. There may be dead bodies as an accidental consequence or the direct result of a murder. The forensic photographer’s role begins while the fire is burning and continues long after it is out, as the fire marshal sifts through the fire debris to uncover fire burn patterns.

Many consider fire investigations a combination of art and science, an opinion not shared in this text. Fire scenes must be considered and treated like any crime scene, and all crime scene investigations are scientific endeavors. When art becomes a part of the process, it is a mistake. Perhaps a better word for “art” in this context is the term “experience.” The National Fire Protection Association (NFPA) considers fire investigations a crime scene that, if properly done, requires the use of the scientific method [16]. Regardless of the terminology employed, the goal of a fire investigation is to first establish the origin(s) and then the cause (p. 313, [12]). The proper investigation of the origin and cause of the fire ideally begins while the fire is burning. Tables 6.8A and B show examples of what should be captured photographically with the understanding that a fire scene is actually a crime in progress, and that capturing the fire photographically while it burns and until it is out is archiving a living historical account of that crime.

6.8 Special Photographic Situations

The earlier sections discussed the basic functions of the camera—exposure, DOF, and so on—as they relate to forensic photography. The forensic archivist regularly encounters
Table 6.8A Guidelines for Photographing Fire Scenes while Burning

<table>
<thead>
<tr>
<th>Reason for Photograph</th>
<th>The Burning Fire Scene</th>
</tr>
</thead>
<tbody>
<tr>
<td>Establishing exterior shots of the fire—external meter necessary for digital photography, RAW files critical</td>
<td>Photograph all sides of the burning building while burning</td>
</tr>
<tr>
<td>External meter captures correct incident light. Use RAW files to obtain the proper white balance (is impossible with JPEG files).</td>
<td></td>
</tr>
<tr>
<td>• Fires flow upward and outward from a source in a three-dimensional pattern. Establishing shots capture this movement.</td>
<td></td>
</tr>
<tr>
<td>• Establishing shots may capture fire flow changing direction if a new fuel source is encountered or if fire reaches an obstruction.</td>
<td></td>
</tr>
<tr>
<td>• May capture flashover—fire is not suppressed in a confined space, reaches 1100°F, and ignitable items burn. Items below hot gas layer and not in direct contact with flame ignite. Help propagate the fire.</td>
<td></td>
</tr>
<tr>
<td>• Document color of flames—indicate type of material burning.</td>
<td></td>
</tr>
<tr>
<td>• Individuals in the crowd or standing alone watching the fire</td>
<td></td>
</tr>
</tbody>
</table>

challenging circumstances, some of which can be anticipated, others not so easily. Those that can be predicted, however, are important enough to require some discussion.

6.8.1 Night and Low-Light Scenes

Exposure is critical, and if incorrect, the photograph may be too dark or too light and can lose or minimize its forensic utility. Indoors and outdoors, exposure can be problematic for many reasons. At night or in dark situations, exposure poses more of a problem because the light the camera needs to record an image is either minimal or not available. If the ISO and aperture/shutter combinations do not compensate for the diminished light, an artificial source or an extended exposure time is necessary.

Table 6.8B Guidelines for Photographing Fire Scenes After Suppression Efforts

<table>
<thead>
<tr>
<th>Reason for Photograph</th>
<th>After the Fire is Out</th>
</tr>
</thead>
<tbody>
<tr>
<td>Establishing exterior shots</td>
<td>• Identify fire-flow patterns to correlate with those taken while the fire was burning. Elevated views help locate roof involvement.</td>
</tr>
<tr>
<td></td>
<td>• Difficult as many tracks and damage related to fire fighting efforts may obliterate traces of the perpetrator(s). Identify entrance/egress points of possible arsonists. Discarded items used to start the fire, tire tracks of nonofficial vehicles, and so on.</td>
</tr>
<tr>
<td>Establishing interior shots of the fire. External meter is necessary.</td>
<td>Purpose is same for any scene where the fire and fire suppression activities are archived. Indicates possible location of fire patterns and preserves damage and position of bodies or missing items.</td>
</tr>
<tr>
<td>Mid-range interior shots</td>
<td>• Document char, smoke, and soot patterns to understand development of the fire flow. Damage patterns on furniture: charring, soot, melting, and the location of vertical and low-burn patterns.</td>
</tr>
<tr>
<td></td>
<td>• Document immediate surroundings of evidence of a criminal nature, such as bodies and accelerant patterns pointed out by the fire marshal.</td>
</tr>
<tr>
<td>Close-up interior shots</td>
<td>Document fire patterns or signs indicating natural, accidental, or deliberately set fire.</td>
</tr>
</tbody>
</table>
With respect to artificial light sources, this means using a form of flash: pop-up flash that comes with the camera, an external flash attached to the “hot shoe” on the camera, slaves, floodlights, or other special techniques, such as painting with light or light fill.

The flash unit on top of the camera should never be used to photograph evidence directly except in extraordinary situations. The reason is simple—washout. The direct flash of the camera’s on-board flash can be too bright and can washout details of the evidence or obliterate it entirely. For most digital photography—not film photography—at crime scenes, flash should be a secondary consideration, not the first choice of light source, unless the scene is so dark that extra light is necessary. That is not to imply that flash photography has no forensic value. It does in specific situations.

Flash has value when the evidence and the background on which it lies are essentially the same color, that is, when there is too little contrast. Impression evidence is an example (see the explanation in Section 6.8.2).

6.8.1.1 Painting with Light
Painting with light is a technique for illuminating large outdoor scenes. The photographer sets the camera on a tripod to stabilize it, opens the shutter to “bulb (B),” and keeps it open while moving a flash unit around the area photographed. A long synchronization cord is necessary that allows the attached flash to illuminate up to 150 ft. Generally, the following sequence will suffice [17].

- Mount the camera on a tripod; up to 500 ft can be captured.
- Set the camera shutter to “B” (bulb setting) and the f/stop to a mid-setting, such as f/8 to f/16.
- Remove extraneous light from the scene.
- Trip the camera shutter to open the shutter.
- Fire flash at farthest point from the camera and repeat at various locations, changing flash angle and moving back toward the camera.
- Retrip the shutter to finish the photography.

6.8.1.2 Slaves
Slaves are non-camera-attached flash units that trigger when another flash goes off. Using slaves is similar to painting with light except that the photographer places individual flash units in strategically located positions at the crime scene. There are two methods of using the slaves. When the on-board flash of the camera goes off, the light triggers the slaves to flash simultaneously. In small areas at indoor scenes and small outdoor scenes, this technique may be preferable to the painting-with-light technique.

An example of using slaves to illuminate a completely dark patio is shown in Figure 6.19. Here, four slaves were positioned appropriately and triggered by the on-camera flash.

6.8.2 Impression Evidence Photography
Impression evidence photography is all about creating contrast between the surface on which the impression lies and the texture of the impression. Although impression evidence is discussed in detail in another chapter, a discussion of archiving impression evidence is appropriate here. Generally, this requires the same technique as that used to locate the impression evidence at crime scenes—oblique lighting. While shoeprint impression
evidence is the focus of this discussion, the principles apply to all impression evidence: the positioning of the light dictates how well the texture of the evidence will appear in the photograph. And that in turn determines how well the forensic scientist can match the scene imprint to a standard taken from a suspect.

The concept of establishing and mid-range photography relative to the location of impression evidence in the scene is still relevant but will not be covered in this discussion. However, close-up photography is critical, and impression evidence photography offers its own set of challenges. As with all close-up forensic photography, photographs should be taken with and without scales and they should capture the length and width of the entire impression.

Capturing the impression’s detail is an experimental procedure, which means that there will be a trial-and-error period to determine the appropriate angle at which to hold the light source. The rule of thumb is that an attachable flash should be held at an angle of 10°. It may well be that the specific situation requires a different angle to obtain acceptable results. Before ALSs were readily available, flash was the recommended light source for impression evidence photography. Now, however, the different wavelength settings of the ALS, including white light, give equally good, if not better, results as flash. Also, the different wavelengths can be used to help enhance the texture and may give better results than white light.

Bodziak [13] recommends a minimum of four photographs of each impression: three photographs with scales with the flash held at the experimentally determined optimum angles of 90°, 180°, and 270° around the impression ensure that shadows from the tripod’s legs do not interfere; a fourth photograph is taken without scales. Figure 6.20 illustrates the positioning of the tripod and the light source. The small tripod diagram on the left of Figure 6.20 illustrates the vertical positioning of the light source—approximately 45°. The circle diagram to the right illustrates the positioning (broken arrows) of the light source in 100° increments around the impression. In order to capture the entire impression, it might be necessary to move the light source around the circle.
The idea is to capture the texture photographically, and capturing it properly might require photographs from other angles. Flash is recommended, but, as flash can create shadows, the scale should always be placed along the long and short edges of the impression.

Outdoor impression evidence photography can be difficult because sunlight can create shadows that obliterate details. Hilderbrand [18] recommends putting something in the path of the sunlight to create a shadow over the entire impression and then use flash to capture the detail. If the impression is deep in, say, mud, the light source may have to be held higher. The photographer will need to experiment to find the correct angle for the light source.

Digital cameras give the photographer the option of seeing the results of the photograph immediately, so that experimenting with different light source angles and locations make determining the best conditions relatively easy and quick. If there is significant glare, a UV filter or polarizing lens covers may be necessary.

For two-dimensional (2D) impressions, the flash or ALS should be held as close to the surface as possible so that the light can reflect off of whatever topography is present. The principle is the same as for deeper impressions, the difference between 2D and 3D impressions being only the depth of the impression.

For shallow impressions—dust prints, fingerprints, and tool marks, the same number of photographs are necessary as for 3D impressions. In both situations, an externally attached flash held at various angles can capture the appropriate detail. For example, the photograph of dust prints shown in Figure 6.12 in Section 6.5.4 illustrates the point. The worst exposure of the group of four photographs was taken using overhead, ambient lighting [17]. The best forensic photograph, the one with the most details for comparison, came from using a light source held at 10° from the vertical.

For 3D impressions, photography is particularly important as a backup to casting, and the following three aspects of the impression must be captured.

- An overview of the impression as found.
- Scales capturing the dimensions of the impressions on two sides.
- The detail of the impression.
Since most 3D impressions occur outdoors, other concerns also come into play, such as temperature and sunlight.

Much of the photographic technique necessary to capture 3D impressions has already been discussed. However, scene scientists/investigators use tricks to capture as much detail photographically as possible. One is to spray the impression with gray automotive primer paint, especially true for impressions in snow. A caveat with this technique concerns the dark color of the sprayed impression. Since dark colors absorb heat faster than lighter colors, sprayed impressions in sunlight may hasten melting of the snow in the impression. The team must work as quickly as possible.

6.8.3 Close-Up Photography

The principles discussed above apply equally to evidence items photographed close-up. The forensic relevance of close-up photographs is twofold: (1) establish measurements of the item and (2) preserve critical detail of the evidence as examined. Several commonly occurring types of evidence require close-up photographs. These include weapons (knives, guns, etc.) at the scene or received in the laboratory, fingerprints (developed latent prints and patent prints), other impression evidence (footwear impressions, cartridge cases, etc.), and blood. Some of the guiding principles discussed above, such as DOF, may not necessarily apply in close-up photography, which makes close-up photography easier than that used at the crime scene. The reason is the variables are fewer, although there are challenges. The following sections discuss those aspects of photography that the close-up photographer must consider.

6.8.3.1 Image in the Viewfinder

The image of the photograph in the viewfinder must take up as much of the viewing area as possible. Figures 6.21 and 6.22 illustrate the point. Figure 6.21 shows an example of a close-up photograph of an Amido black-developed bloody fingerprint on a hammer. This

Figure 6.21 Close-up photograph of Amido black-enhanced bloody fingerprint on hammer. (Photograph by Robert C. Shaler.)
is typical of the close-up photographs taken by students. The problem is that the camera was too far from the print. The fingerprint in Figure 6.22 is a cropped image of Figure 6.21. Although the cropped photograph captures the appropriate image, cropping is not the appropriate way to convert a badly thought-out photographic procedure into an acceptable photograph. The original photograph should have had the entire image in the viewfinder before taking the photograph. Something like the photograph in Figure 6.22 should fill the camera’s LCD.

### 6.8.3.2 The Close-Up Lens

An appropriate lens is critical. Close-up lenses are called macro lenses that typically have a minimum f/number between 1.4 and 3.5. A typical close-up lens is the Nikkor 60 mm f/1.4 macro lens. The smaller the f/number, the faster the lens. This means the photographer can work under minimal lighting conditions. Also, fast lenses mean that flash photography might not be necessary. Although zoom lenses are not recommended for close-up photography, especially those considered “kit lenses,” an acceptable example of an appropriate zoom lens is the Sigma 24–70 f/2.8 macro zoom. If a dedicated macro lens is not available, a way to use zoom lenses for close-up work is to focus on the item at the usual 55-mm setting and then zoom into the image until it fills the viewfinder.

### 6.8.3.3 Illumination

Illumination for close-up photography of objects must be even and must not produce glare or shadows. This means using light sources in creative ways. At the scene, available lighting and/or alternate lighting often proves the most important deterrent to obtaining the perfect forensic photograph. Capturing the evidence in situ is the photographer’s greatest challenge because the item cannot be moved to a more convenient location until the on-scene work is completed. This means taking advantage of whatever the scene offers while using experience to overcome obstacles.

Although flash is discouraged for on-scene photography except in special circumstances, it can be extremely helpful in creating a glare/shadow-free environment. Using attached but not mounted (i.e., not on top of the camera) flash held at various distances or

**Figure 6.22** Viewfinder-filled image of Figure 6.21. Photograph by Robert C. Shaler.
angles from the object, or bouncing light from various objects (paper, ceiling, etc.) onto the object can be helpful. The key words are experience and experimentation. There are no set guidelines for on-scene close-up photography other than knowing how to use the camera and understanding the specific situation (lighting/glare/shadows) under which the photograph must be taken. After that, it is the photographer’s experience and ability to create great photographs.

In-laboratory lighting is usually not an issue because laboratories have copy stands with lights and other ways to illuminate evidence evenly. Again, flash is generally discouraged because of the potential for washout. However, flash or other means of creating external lighting can be helpful. I can highlight details, especially in capturing detail on evidence in shadows.

Since the photograph on the left of Figure 6.12 was not taken using a UV filter or polarizing filters, the glare remains. Generally, this photograph does not meet appropriate forensic photographic standards.

6.8.3.4 Depth of Field

DOF is usually shallow, which means a wide open aperture setting to the minimum f/number permitted by the lens.

6.8.3.5 Focus

The most important reason for taking close-up photographs is to capture minute details of the evidence for comparison. This means that close-up focus in the photographs must be “tack sharp.” From a digital photography perspective, “tack-sharp” means the photograph in the viewfinder must be in focus to the maximum level the camera can zoom in on the image in the viewfinder.

Capturing focal detail to this extent means anchoring the camera to eliminate camera shake. Anyone who has attempted to hold a camera steady while taking close-up photographs understands how difficult this is. Certainly fast lenses help. At the scene, anchoring the camera means using a tripod. In the laboratory, this means using a tripod, a copy stand, or other means of steadying the camera.

One way to help focus is to use an electronic shutter-triggering mechanism. Most modern camera manufacturers offer ways to trip the shutter without touching the camera. Another method is to shut off the antishake mechanism. On a tripod, the anti-shake system is not necessary, and, if it is active, it will shake the camera very slightly causing blur.

6.8.3.6 Scales

Scales and their position are critical and must be included in close-up photographs. As mentioned earlier, close-up photographs are taken with and without scales.

References

2. PC Magazine online. Active archiving. Available at: http://www.pcmag.com/encyclopedia_term/0,2542,t=active+archiving&i=37447,00.asp# (accessed March 20, 2009).
Workshop I  Photography: Camera Basics

I.1 Introduction

The key to successful forensic photography is intimate familiarity with the modern digital SLR camera. Digital photography has become the de facto standard for archiving the scene. The reasons are obvious: color film and developing are no longer readily available and digital photography gives archivists the opportunity to “experiment” in order to obtain the perfect exposure and forensic perspective. Before beginning this workshop, readers should review Chapter 6. SLR cameras are necessary for quality forensic photography. The reason is that interchanging lenses is the key to capturing the perfect perspective offered by the scene. The following assumes that the student is using a Nikon D40 or better camera. Other cameras are certainly appropriate and, although the location of specific functions on the camera can differ, all modern cameras have at least those functions considered for this introduction to the camera.

I.2 Required Tools

- Camera: Digital (12 megapixel minimum)
- Lenses:
  - Wide angle (f/2.8 24–70)
  - Telephoto (f/2.8 80–200)
  - Close-up (f/2.8 6)
- Detachable flash
- Tripod with ball head
- Memory card of 8–32 gigabytes

I.3 Camera Basics

The following are the essential functions for successful forensic photography. These are the basics, but cameras can have many sophisticated functions that can increase the quality of the photographs.

I.3.1 File Formats

Most SLR cameras offer choices for storing photographs. Some cameras give choices: JPEG, RAW (NEF for Nikons), TIFF (tif). For most forensic photography, the RAW + JPEG setting is the best. This gives the photographer the ability to quickly review the photograph as a JPEG and to save it as a RAW, noncompressed file. The importance of saving the photograph in a file that is not compressed (RAW) is that compression (JPEG files) leads to automatic loss of information. The disadvantage is that the camera chooses what information to exclude from the file. In the RAW mode, no information is lost.

I.3.2 Camera Function Dials and Menu Options

- Menu: Most digital cameras have menus that can access the same functions as the
dials or buttons on the camera. The menus allow access to these same functions as well as to others (e.g., file formats) that are not included as dials or buttons on the camera body.

- On–off switch (self-explanatory).
- A: In the aperture (f/number) priority mode, the photographer sets the aperture (f/number) and the camera sets the shutter speed. The smaller the f/number, the larger the opening.
- S: In the shutter priority mode, the photographer sets the shutter speed (how long the aperture stays open) and the camera sets the aperture.
- M: In the manual mode, the photographer sets both the aperture and the shutter speed.
- P: In the program mode, the camera chooses what it believes is the correct exposure for the current lighting conditions. This is sometimes a good place, and the photographer can individually adjust the aperture and shutter speed.
- Auto: In this point-and-shoot mode, the camera decides on the exposure by setting the aperture, shutter speed, and the ISO setting. It is not recommended to use “auto” for forensic purposes. In this setting, some cameras do not allow the photographer to adjust other camera settings.
- ISO: This digital sensor sensitivity setting can be used to take photographs in dim light. The higher the ISO, the more sensitive the digital sensor. In “auto,” the ISO is set by the camera and cannot be adjusted by the photographer.
- WB: Digital cameras must be told how to interpret white balance. The camera does this by offering a menu of choices that reflect common photographic shooting situations. These menus can be simple or complex. Generally, they include settings for:
  - Auto
  - Custom
  - Flash
  - Shade
  - Cloudy
  - Direct sunlight
  - Incandescent lighting
  - Fluorescent lighting
- Format: This setting, accessed through the menu, allows the photographer to format (erase) the memory card. It is important that all photographs are downloaded to a hard drive immediately after photography is completed. After downloading, the memory card should be formatted.
- Metering: This setting allows the photographer to choose how the camera is to meter light. Choices can include among others matrix, spot, and averaging. These choices are usually accessed by using the menu, but, on some cameras, they are available as a dial or button on the camera body.
I.4 Exercise 1

For the following exercises, use a lens set between 50 and 60 mm. This is the setting that most approximates the human eye.

I.4.1 Aperture Priority

This is the most important setting for the forensic photographer because it is how the photographer selects the perspective of the resulting photograph. The aperture is also considered the DOF selector, that is, “what is in focus.” The larger the f/number, the smaller the opening and the greater the DOF.

In this exercise, the relative importance of the aperture will be demonstrated by taking photographs at different aperture (f/number) settings.

I.4.1.1 Procedure

- Select a location that allows your field of view to have several objects close up and others in the distance. This is easily done outdoors. If indoors, choose a hallway that is well lit. Choose the WB from the menu or the dial so that it reflects the type of light available (incandescent light bulbs or fluorescent lighting).
- In Table I.1, list the items/objects in your field of view, beginning with the closest and ending with the item furthest away.
- Stand approximately 5–8 feet from the first object (entry “1.” in Table I.1).
- Set the camera on “auto” and take a picture. Record the aperture and shutter speed chosen by the camera.
- Set the camera on “A,” aperture priority, at the lowest f/number the camera will allow; this is determined by the lens; for example, if the lens is rated at f/2.8, the lowest f/number the camera will allow is an “A” setting of 2.8; if the lens is rated at f/4.0, the lowest f/number available will be 4.
- Take photographs at the f/numbers listed in Table I.2. If the camera does not allow the f/2.8 setting, there is nothing to fill in.
- Circle the aperture/shutter speed combination that gave the greatest DOF.
- Circle the aperture/shutter speed combination that gave the shallowest DOF.
- Compare the two photographs with the one taken with the camera set on “auto.”

I.4.1.2 Questions

- In 500 words or less, explain the differences between the photograph taken on “auto” with those taken at maximum and shallowest DOF.

<table>
<thead>
<tr>
<th>Table I.1 Objects in Field of View</th>
</tr>
</thead>
<tbody>
<tr>
<td>Object in Field of View</td>
</tr>
<tr>
<td>1.</td>
</tr>
<tr>
<td>2.</td>
</tr>
<tr>
<td>3.</td>
</tr>
<tr>
<td>4.</td>
</tr>
<tr>
<td>5.</td>
</tr>
</tbody>
</table>
Table I.2 Aperture Priority Exercise

<table>
<thead>
<tr>
<th>Aperture Setting</th>
<th>Shutter Speed (Set by Camera)</th>
<th>List the Objects in Table I.1 that are in Focus</th>
<th>Describe Quality of Photograph (Over/Under Exposed, etc.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.8</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4.0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5.6</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8.0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11.0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>16.0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>22.0</td>
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</tr>
</tbody>
</table>

- Using the results from Exercise 1, in 500 words or less, discuss the concept of DOF. To illustrate your points, include examples (photographs) that were obtained. Use Chapter 6 as a guide.
- In 500 words or less, discuss aperture priority with respect to how f/numbers affect exposure. Use examples from Exercise 1.
- In the list of aperture settings in Table I.2, which of the following would be examples of one full stop?
  - A: f/8.0 to f/11.0
  - B: f/22 to f/16
  - C: f/2.8 to f/8.0
  - D: None of the above

I.4.2 Shutter Speed

I.4.2.1 Procedure
- Set the camera on “S.”
- Take a series of photographs of the objects in Table I.1 using the shutter speeds listed in Table I.3.
- Fill in the information in Table I.3.

I.4.2.2 Questions
- In 500 words or less, describe the effect shutter speed has on DOF, if any. Use examples from your data to illustrate the discussion.

Table I.3 Shutter Speed Priority Exercise

<table>
<thead>
<tr>
<th>Shutter Speed (seconds)</th>
<th>Aperture (Set by Camera)</th>
<th>List the Objects in Table I.1 that are in Focus</th>
<th>Describe Quality of Photograph (Over/Under Exposed, etc.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>10th</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>20th</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>40th</td>
<td></td>
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<td></td>
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<tr>
<td>100th</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>200th</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>400th</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>800th</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
From Table II.3, which of the following is known as moving a full stop?

- A: Shutter speed of 100th to 400th
- B: Shutter speed of 40th to 80th
- C: Shutter speed of 60th to 100th
- D: None of the above

- If you chose “None of the above” as your answer, explain why.
- If you chose one of the top 3 (A, B, C) as your answer, explain why.

### I.4.3 Manual Priority

#### I.4.3.1 Procedure

- Set the WB and ISO on “auto.”
- Set the camera on “A” and choose the f/stop (f/number) that gave the greatest DOF as listed in Table I.2.
- Set the camera on “M” and set the shutter speed corresponding to the aperture that you selected above (i.e., the shutter speed that gave the greatest DOF as listed in Table I.2).
- Keeping the aperture constant, take a series of photographs using shutter speeds that increase by one-third of a stop toward faster shutter speeds than the one selected from Table I.1.
- Keeping the aperture constant, take a second series of photographs using shutter speeds one-third of a stop slower than the one selected from Table I.3.
- Fill in Table I.4.
- Choose the best photograph.

#### I.4.3.2 Questions

- Does the best photograph have the same shutter speed as the one you selected from Table I.1 (Yes or No)?
- In 500 words or less, explain why?
- In 500 words or less, explain why the manual “M” setting on the camera gives more or less control of the photographic outcome than when choosing “A,” “S,” or “auto.”

### I.5 Dark Environment Photography

#### I.5.1 ISO

ISO refers to the sensitivity of the digital sensor, which means that in darkened environments, increasing the sensitivity makes it possible to obtain photographs in dark places.

<table>
<thead>
<tr>
<th>Table I.4 Manual Priority Exercise</th>
</tr>
</thead>
<tbody>
<tr>
<td>Manual Priority Shutter Speed (Seconds)</td>
</tr>
<tr>
<td>Shutter speed from Table I.1</td>
</tr>
</tbody>
</table>

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Workshop I
### Table I.5 ISO Exercise

<table>
<thead>
<tr>
<th>ISO</th>
<th>Aperture (Set by Photographer)</th>
<th>Shutter Speed (Set by Camera)</th>
<th>Describe Quality of Photograph (Over/Under Exposed, etc)</th>
<th>Place an “X” beside the Best Photograph</th>
</tr>
</thead>
<tbody>
<tr>
<td>“AUTO”</td>
<td>f/7.3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>100</td>
<td>f/7.3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>200</td>
<td>f/7.3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>400</td>
<td>f/7.3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>800</td>
<td>f/7.3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1600</td>
<td>f/7.3</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### I.5.1.1 Procedure

- Darken a room sufficiently so that there is very little light entering. The room should not be so dark that you can’t see anything.
- Set the camera to aperture priority and select f/5.6.
- Set the ISO to “auto.”
- Put the camera on a tripod and take a photograph. Describe the photograph in Table I.5.
- Using Table I.5 as a guide, take photographs at the ISO settings listed.
- Fill in Table I.5 after each photograph.

If all of the photographs appear too dark, reset the aperture to f/4.0 and retake the photographs. If the photographs are too light, reset the aperture to f/11 and retake the photographs. Describe the photographs in Table I.6.

### I.5.1.2 Questions

- Circle the photograph that gave the best result for aperture, ISO, and shutter speed. Does the photograph have sufficient DOF? If so, explain why. If not, explain why.
- If the DOF was too shallow, what would you do to deepen it?
- If all the photographs taken (at different ISOs) using an aperture of f/4.0 were too dark, what would you do to lighten them (assume f/4.0 is as low as the camera would allow)?

### I.5.2 Painting with Light or Using Slaves

At dark scenes where it is necessary to lighten areas with intense shadows, a technique called painting with light is sometimes useful. In this exercise, you will need a second

### Table I.6 Painting with Light and Slaves Exercise

<table>
<thead>
<tr>
<th>Shutter</th>
<th>Aperture (Set by Photographer)</th>
<th>Describe Quality of Photograph (Off-Camera Flash)</th>
<th>Describe Quality of Photograph (Slaves)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bulb</td>
<td>Wide open (smallest f/stop allowed)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bulb</td>
<td>f/7.3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bulb</td>
<td>f/7.3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bulb</td>
<td>f/7.3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bulb</td>
<td>f/7.3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bulb</td>
<td>f/7.3</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
person using an off-camera flash. On a tripod, the shutter is open. A second person takes a flash tethered to the camera (with a long cord) and begins triggering the flash manually to illuminate areas in shadow.

Another approach is to place slaves in strategic places. The flash from the camera will trigger the slaves to fire simultaneously to illuminate the area.

**I.5.2.1 Procedure**
- A dark street, alley, or patio can be used for this exercise. Set the camera on a tripod at a strategic location. Attach an off-camera flash unit and set the camera on bulb.
- Open the shutter.
- A second person (or the photographer) can walk to darkened areas and trigger the off-camera flash manually. After all the areas have been illuminated, shut the shutter.
- Repeat the exercise using slaves.
- Fill in Table I.6.

**I.5.2.2 Questions**
- Which technique gave the best results for the area you were photographing?
- In your opinion, which technique is the easiest to use and which gives the best and most consistent illumination in most circumstances?
- In 500 words or less, explain why.

**I.6 Close-Up Photography**

In close-up photography, there are three inviolate rules: (1) The image being photographed must take up the entire viewfinder on the back of the camera; (2) Scales of appropriate dimensions must be used; and (3) Photographs with and without scales must be taken.

**I.6.1 Procedure**
- Place a quarter on the floor.
- Set the camera on aperture priority and set the aperture to the lowest f/stop \( f/number \) the camera will allow; for close-up photographs, DOF is usually not a concern.
- Put the camera on a tripod and position it so that it is directly over the quarter and the quarter fills the viewfinder.
- Take the photograph. Examine the photograph for focus and exposure (lighting).
- If the photograph is too dark, reset the camera to manual priority “M” and set the shutter speed to allow in more light.
- Take the photograph and re-examine the result. Repeat the procedure until you have the perfect exposure. Record the \( f/stop \), shutter speed, and ISO in Table I.7.
- Repeat the exercise using scales vertically and horizontally along two sides of the quarter.

In those instances where an ALS is used to highlight fingerprints dusted with fluorescent powder or super-glued fingerprints stained with fluorescent stains or powder, the
Table I.7 Close-Up Photography Exercise

<table>
<thead>
<tr>
<th>Photographs</th>
<th>First Shutter</th>
<th>Second Shutter</th>
<th>ISO</th>
<th>Describe Quality of Photograph:</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Without Scales</em></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.</td>
<td>1st Shutter Speed</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td>Final Shutter</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>With Scales</em></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.</td>
<td>1st Shutter Speed</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td>Final Shutter Speed</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

procedure of obtaining the close-up photograph is essentially the same. The difference is that a barrier filter is placed over the lens so that the fluorescence reaches the digital sensor without being overwhelmed by reflected light. The photographic principles remain the same; the process for obtaining the perfect photograph does not change.

I.6.2 Questions

- In 1000 words or less, explain why you made the changes you did to obtain the perfect close-up photograph of the quarter.
- If there are differences in the camera settings between the photographs taken with and without scales, explain what they are and why they occurred.