FUNDAMENTALS OF DIGITAL PHOTOGRAPHY FOR FIRE INVESTIGATORS

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ABSTRACT

"A photograph is worth 1000 words" is a saying that is believed to have originated from the old Chinese Proverb "A photograph's meaning can express ten thousand words." Photographs are probably the most valuable form of documentation available to an investigator when documenting a fire scene. However, many photographs taken by investigators are of poor quality and some are completely useless. Often times, not enough photos are taken to completely document the fire scene. The author believes this is due to the investigator having a lack of knowledge regarding the basic fundamentals of photography, not knowing how to properly use his or her camera, and not being properly trained how to photograph a fire scene. This paper will educate the fire investigator in the fundamentals of photography and how to utilize those fundamentals to use a camera and properly document the fire scene.

DIGITAL CAMERAS: A COMPARISON

There are several types of digital cameras on the market today. For the purpose of this paper, only two types of cameras will be discussed, digital single lens reflex cameras (DSLR) and compact point and shoot cameras.

DSLR cameras are built in the same manner as a 35mm SLR film camera. They have a mirror that reflects light through the lens to the viewfinder. Once the shutter button is actuated, the mirror rotates allowing light through the lens onto the sensor that records the image. These cameras use interchangeable lenses and flashes that allow the photographer a more detailed representation of the current condition, and are typically what professional photographers use. These cameras have advantages and disadvantages for photographing fire scenes. Some advantages of a DSLR include the use of interchangeable lenses designed to control the amount of light that reaches the sensor as well as choosing different focal lengths for the distance, the ability to use a more powerful flash to provide a stronger light source or fill light, the ability to quickly take photographs without compromising detail and accuracy of the scene, and a larger and higher quality image sensor useful in lower light situations. Some disadvantages of a DSLR camera are they are heavier, require more interchangeable equipment to operate, require regular maintenance, and can be difficult to use in small spaces.

Point and shoot cameras are less complicated by design and more compact than DSLR cameras. The point and shoot cameras contain the flash and lens within the camera body itself. The image sensor is smaller so the information recorded is not as detailed and dynamic as the DSLR and there is no mirror to reflect the light to the sensor. Aside from cost, the main advantage to this style of camera for fire investigators is size. They can easily fit into a pocket and can be used to take photos in small spaces, where larger cameras may not fit. The disadvantages are they do not allow for much control. Some lack the ability to operate in very low light situations resulting in underexposure of the image or lack of detail. In many cases the flash is underpowered and cannot be adjusted making it difficult to adequately light the fire scene. Finally, many of these cameras have a lag or recycle time between taking photos that can be inconvenient and annoying.

Best Camera for Fire Investigations

For the majority of situations encountered by fire investigators, both a DSLR and a compact point and shoot camera are best to properly document the fire scene. The author prefers the use of a DSLR as a primary camera, but also carries a compact point and shoot. The compact point and shoot is carried as a backup camera to the DSLR, and is also useful to photograph those hard-to-reach places. The choice of camera type is up to the individual investigator and their personal preferences. In some aspects, the point and shoot will suffice, but in some situations an investigator will need the features provided by a DSLR to properly capture an image. Regardless of the type of camera an investigator chooses, it is more important that the investigator knows how to operate the critical functions of the selected camera. Understanding its limitations is equally important.

THE FUNDAMENTALS

Like anything else in life that you want to do well, you must know the basic fundamentals to be successful. Photographing a fire scene is no different. For the most part an investigator may get away with using an auto setting on a camera, but he or she will not get the best photos that are possible and in some situations, will not get usable photos at all.

A photograph, otherwise known as an exposure, is captured on a digital sensor in the camera using three main functions: shutter speed, aperture, and ISO.[1]

Shutter Speed

The shutter speed is the amount of time a camera's shutter is open. Along with controlling the amount of light that hits the sensor, it also determines how much movement is captured in the image. A faster shutter speed can stop movement and let in less light, while a slower one will create a blurred effect and allow in more light. Shutter speeds can range from around 1/8000 of a second to infinity on today's cameras. $1/60^{th}$ of a second is a good shutter speed to remember. This is the slowest shutter speed that should be used when holding a camera by hand, not using any other support such as a tripod. Shutter speeds slower than this will not result in a sharp, in focus photograph.[2]

Aperture

The aperture of a camera, which is a function of the lens, is the physical size of the diaphragm opening in the lens. These values are known as f/stops and each one has a number. Like shutter speeds, the lens aperture is adjustable. F/stops typically range from f/1.4 to f/32. These numbers are based on a mathematical formula, which is completely irrelevant for taking photographs. What must be understood is that f/1.4 is a large aperture, letting in the most amount of light, and f/32 is a small aperture, letting in a smaller amount of light.

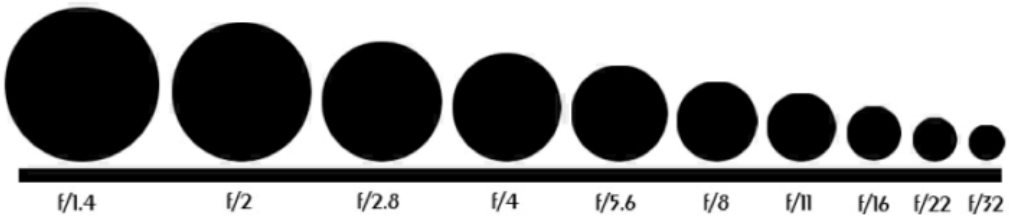
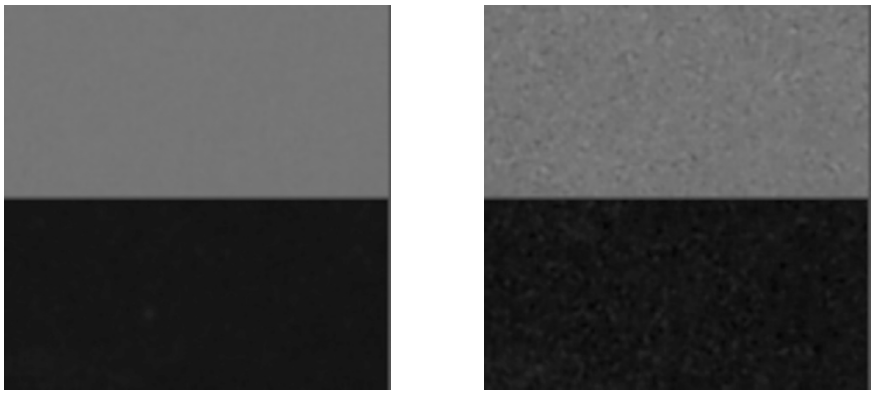


Figure 1 – Aperture Size Illustration[3]

The lens aperture also controls the depth of field of a photo. Simply put, the depth of field is the amount of the photo from the foreground to the background that is in focus. A large aperture such as f/1.4 will have a very shallow depth of field and f/32 will have a very large depth of field. If a photograph has objects in the foreground, middle, and background, only a limited area of that photo will be in focus with a large aperture. When using a smaller aperture given the same photograph, more areas of that photograph will be in focus.[2]

Film Speed/ISO

Film speed refers to how fast film (or digital sensor) can capture a properly exposed photograph. The term is also applied to digital photography, and like the two previous functions, is measured by a number referred to as the "ISO" number. ISO settings on today's digital cameras range from 50 to 6400 +. An ISO setting of 100 requires more light to create a properly exposed photo as compared to an ISO setting of 1600. Like the aperture, there is also a trade off with the ISO setting. The higher the ISO, the poorer quality the image will be. Photographs taken with high ISO values will be grainy, which is referred to as "noise" in the digital era. See figure 2.[2]



ISO 100 **ISO 1600**

Figure 2 – ISO Comparison

THE CAMERA AND ITS FUNCTIONS

The DSLR camera body has come a very long way in terms of technology since the first models became available on the market in the late 1990's. The camera body for the most part has all of the controls a photographer uses to take a photo.

Camera Shooting Mode

The mode button is used to select the mode of the camera ranging from auto, program, aperture priority, shutter priority, and manual. These titles vary by camera manufacturer, but serve the same purpose.

In the auto mode, the camera will do everything itself and allows for very little, if any, user inputs when using the camera. Using the program mode, the camera will allow the user some inputs, but will choose the aperture and shutter speed. In the aperture or shutter priority modes, the camera will allow the user to control those functions respectively. In the manual mode, the user has complete control of the shutter and aperture of the camera.

The Light Meter

Every digital camera has a light meter. The light meter tells the camera what shutter speed and aperture to use to get the proper exposure. The light metering can be changed in terms of the

area in which the meter takes a reading. Typically they are described as area, spot, and focal point metering.

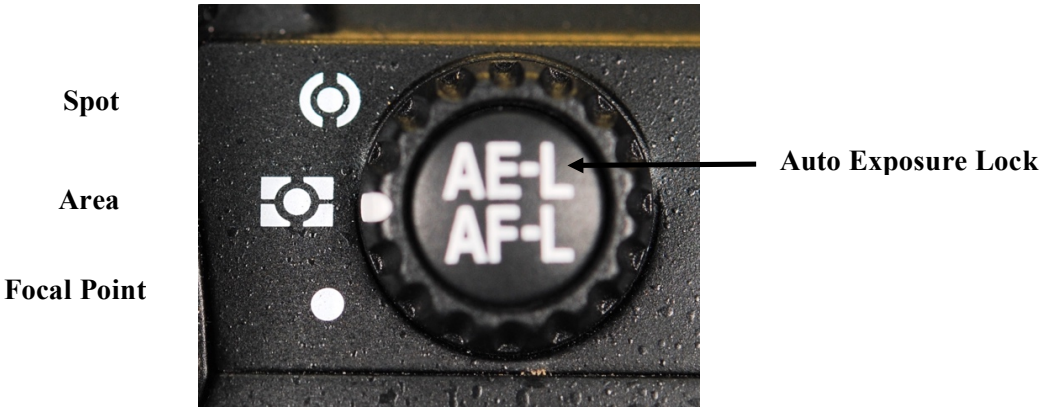


Figure 3 – Light Meter Selections

When using the area setting, the light meter will take into account the entire area of the photo in determining the proper exposure settings. The spot area will take a light reading from an area of reduced size, typically defined by the user, and the focal point setting will only read from the area of the single point of focus.

Changing the light meter setting will allow the photographer to properly expose a side of a burned building with the sun in the background. This comes in useful when the subject of the photo is very dark and the surrounding area is very bright, commonly found in a fire scene.

Exposure Compensation

The exposure compensation button is a very useful tool on the camera for fire scenes. This function allows the user to over expose or under expose the images by the given amount set. In program mode, the camera will determine the shutter speed and aperture for a given photo. Setting the exposure compensation to +1 or -1 stop will adjust the aperture 1 f-stop in the respective direction in addition to what the camera has determined to be the correct exposure. This can be used to capture more details of a dark subject with a bright background by setting the compensation to a positive value.

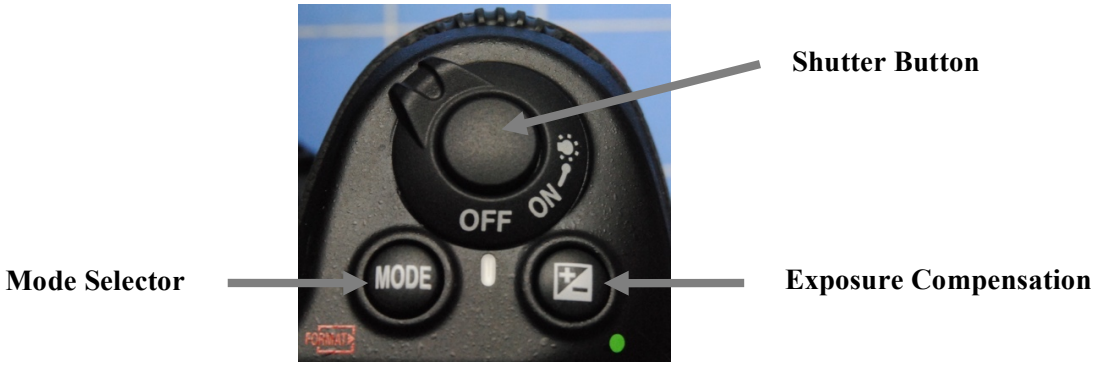


Figure 4 – Camera Controls

Exposure Lock

The exposure lock is a feature where the camera user can lock in an exposure setting in a non-manual mode and take a series of photos of the same exposure while holding the exposure lock

button down. This feature is useful when taking photos across a dark area with light coming through in some spaces. See Figure 4.

Focus Area

The focus area in most, if not all, cameras can be selected whether a single point, across a complete area, or the nearest or farthest objects. For purposes of photographing a fire scene, a single focus point will suffice.

White Balance

The white balance setting on a camera refers to the color temperature the camera is set at based on the surroundings to get a properly colored image. Different light sources produce different light temperatures, which are measured in Kelvin. The sun and clouds, fluorescent lights and halogen lights all produce different color temperatures and will affect the way the image is recorded by the camera. For the purposes of photographing a fire scene, the white balance should be set on auto or on the flash setting. The flash setting temperature is 5500K which is in the middle of the temperature range and will properly record an image when using the flash. This is also about the same temperature setting for sunlight.[4]

Sensor Crop Factor

With the exception of full frame sensor cameras, most digital cameras being used by fire investigators today do not have a sensor chip that is the same size as 35mm film. What this means is a photograph taken at a given focal length based on the lens, is truly not at that focal length. Most DLSR cameras currently on the market have a crop factor of 1.5 or 1.6 depending on the manufacturer. What this means is if you have a lens that is defined as 18-100mm, you truly have a lens that is 27-150mm. Why does this matter? For the most part it doesn't. However, when photographing a witness's viewpoint, the lens should be set at 50mm. This is similar to what the human eye sees. In the case of a DSLR with a smaller sensor, the lens should be set about 35mm with a 1.5 crop factor. This will provide a photo at about 50mm.

LENSES

Camera lenses are defined by two means, the lens aperture and focal length. An example of a typical zoom lens would be an 18-200mm f/3.5-5.6. 18-200mm defines the focal length of the lens. This is the length between the end of the camera lens and the digital sensor. 18 mm will show a wide field of view and 200 mm will show a telephoto view. The aperture range defines the maximum aperture a lens will have through its focal length. With the example given above, the lens will have a maximum aperture of 3.5 at 18mm and a maximum aperture of 5.6 at 200mm.[5]

"Professional" lenses will have a maximum aperture throughout the focal length. An example would be a 24-70mm f/2.8. Lenses with a single maximum aperture such as f/1.4 or f/2.8 through the entire focal length are very expensive, sometimes costing two to three times the amount of a variable maximum aperture lens, and are not needed for purposes of fire scene photography. Some lenses today also offer useful features such as vibration reduction, which helps reduce camera shake when photographing at long focal lengths.

FLASHES

Flashes for DSLR cameras have many features and are very sophisticated. Many of the features in flashes today are not needed for photographing fire scenes. Given that fire scenes are typically very dark areas, an investigator should use a large external flash to properly light the fire scene. Setting the camera's flash setting to "Through the Lens" (TTL) will accommodate most situations. This allows the camera to determine the proper amount of light needed from the flash based on readings from the camera's light meter detected through the lens. On some occasions, the

flash may need to be increased or decreased in power. This can be done through the controls on the flash or camera.

PHOTOGRAPHY TECHNIQUES

Different photography techniques should be used to properly document the fire scene. Although these techniques are not mandatory, they are recommended to ensure the scene is properly photographed.

Sequential Photographs

Taking numerous close-up photographs of a key piece of evidence, such as an outlet, can be very beneficial. However, three years later while preparing for deposition, trying to remember or determine where a key piece of evidence was located in the scene can be difficult if sequential photos were not taken prior to close up photos.

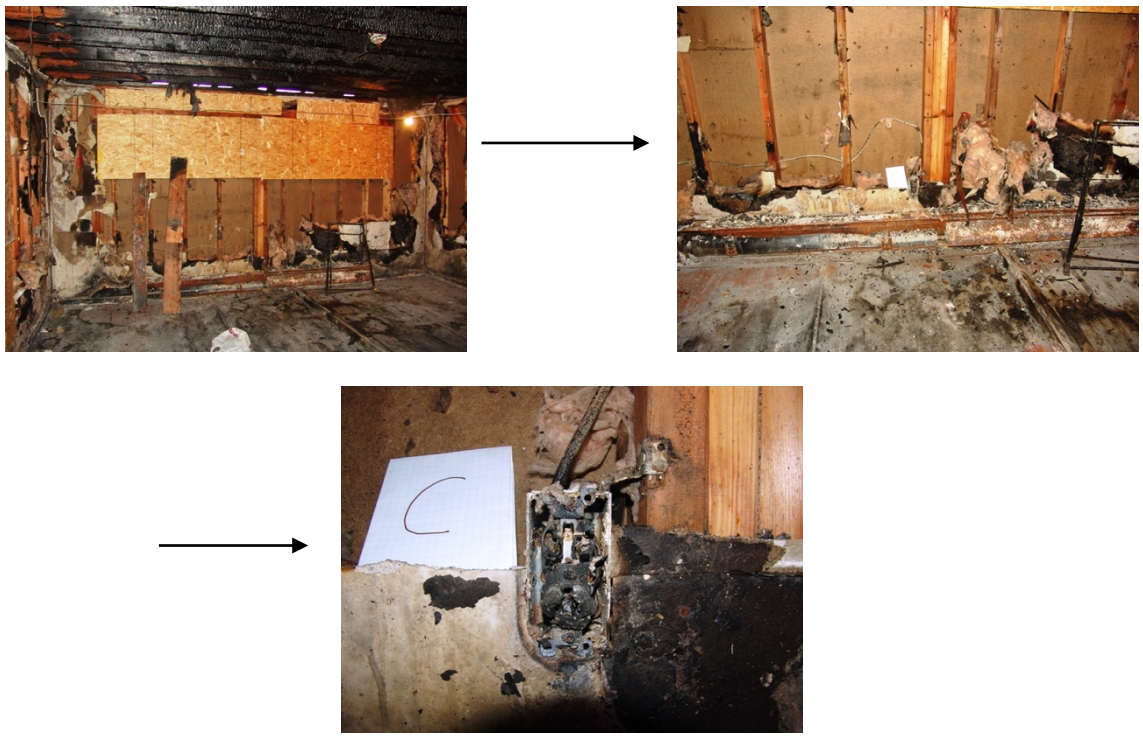


Figure 5 – Sequential Photos

Taking sequential photographs is a technique where an item of interest is first photographed from a distance, showing its location in an area of interest, and then taking more photos while moving closer to the item. Using this technique will help the investigator be able to recall locations of specific items that merit closer documentation.

Mosaics

Taking mosaic photos is a technique where a series of photos are taken across an area and assembled into one photograph. Some of today's cameras have a software feature built in that will do this.

Figure 6 – Photo Mosaics

This technique can be very useful to capture an entire area that cannot otherwise be captured in one photograph. Even if the photos are not assembled in a software program or by hand after printing, it is still a valuable technique to use. This will help ensure that complete areas are documented and are done so in a fashion that would be similar viewing a fire scene in person.

Fill Flash

Fill flash is not necessarily a technique, but a good way to properly light a fire scene. This requires a flash large enough to do so. This is where an external flash to the camera body is a very useful tool, and solves a majority of the lighting issues at a scene needed to get a properly exposed photograph.

PHOTOGRAPHING THE FIRE SCENE

Default Camera Settings for Fire Scenes

The author almost always uses the program mode when photographing a fire scene. This mode allows the user to determine necessary settings, while the camera's light meter determines the proper exposure. Those necessary settings include an ISO of 400, an exposure compensation of +1, and the white balance set on flash. With the flash operating, the typical exposure for the camera will be $1/60^{th}$ of a second for a shutter speed and an aperture of f/5.6.

The Systematic Process

As discussed in the appropriate texts and fire investigation standards, a systematic process should be used when photographing a fire scene. Typically, this involves photographing the exterior of a building first and then photographing the interior. There may be exceptions to this rule.[7]

It is up to the individual investigator to determine how much of the structure should be photographed. Each fire scene should be photographed in a fashion to completely document fire spread, fire origin, fire cause, and witness statements. Typically, the entire structure of a common single-family dwelling will be photographed. However, it may not be necessary to photograph a large office building with multiple suites when the fire is contained to one office suite or room.

Exterior Photographs

It is recommended that every time a scene is photographed, it should be started in the same location or fashion. Whether it is to always photograph the front of a building, the north side of a building, or some other fashion, this process should be used at every scene. Once a side of a structure is documented overall, the investigator should determine if anything on that side requires more photo documentation. This could include, but is not limited to fire patterns, utilities, and conditions of doors and windows. Sequential photographs should be used to better document these items. Once this is completed the investigator should proceed to the next side of the structure, documenting corners in between. Photographing the corners helps provide orientation. Once the exterior of the building is sufficiently documented, the investigator should photograph the interior of the building.

Interior Photographs

Prior to entering the structure, the point of entry should be photographed for orientation. Once inside, sufficient photographs should be taken to document the conditions of each area or room. If the area has no fire damage or any evidence of value, one or two photographs of that area may suffice. Interior photos should be taken in a similar systematic fashion. Start in the area of entry and document that area prior to moving to the next area. In each area overall photos should be taken followed by more specific photos of fire spread, fire patterns, utilities, and anything else that may be of value to the investigation. Sequential photos should be utilized for orientation and to document the progress throughout the building.

Mosaic photographs should be taken to ensure entire areas of walls, ceilings, floors, fire patterns, or damages, are documented. Even if there is no intention in assembling these photographs into one photo, it is still a good technique to use to ensure all surfaces are documented.

As the fire scene investigation progresses, efforts should be made to photograph the progress of the work, new discoveries, and evidence as it is uncovered. Keep in mind it is important to use the sequential technique to ensure close up photos of specific items can be properly identified and located at later times.

PROBLEMS WITH PHOTOGRAPHING A FIRE SCENE

The following discussions cover some typical problems encountered while photographing a fire scene and how to force the camera to properly expose the area or subject that is being photographed. To address these problems successfully, the investigator must have an understanding of the basic fundamentals of photography and know how to properly use their camera equipment. There may be other ways to remedy these problems other than discussed.

Dark Surfaces, Bright Windows

This situation is encountered in most fire scenes. When photographing an interior wall with a window that is allowing light in, the camera's light meter will typically use the light coming in through the window to determine the aperture and shutter speed. This will give you a great photo of whatever is outside the window, but will underexpose the main purpose of the photo, the damage and patterns on the wall's surface. Figure 7 shows a properly exposed wall and an improperly exposed wall.

Figure 7

To fix this situation and get the proper exposure for the wall, point the camera towards the wall away from the window. Press the shutter button half way down, focusing the camera and setting the shutter speed and the aperture. Hold down on the exposure lock. Reposition the camera to photograph the wall while holding the exposure lock button and take the photo. This should properly expose the wall and over expose the window. Other ways to fix this situation include using the focal point light meter versus the area selection and adjusting the ISO and exposure compensation values.

Large Voluminous Areas

These situations are typically encountered in warehouse type properties. This is where it is necessary to have a large external flash.

Figure 8 - Large Voluminous Spaces

Do not be afraid to put the camera in manual mode to get properly exposed photographs. This may be necessary to get the best exposure in a warehouse setting. Set the shutter speed at 1/60 of a second. Set the aperture as large as the lens will allow (f/1.4-f/3.5). Increase the exposure compensation to +2 or higher. Increase the power of the flash. Increase the ISO from 400 to 500+. Using these rules, you should be able to force the camera to capture more detail in such a dark area. Trial, error, and experience will make the investigator more comfortable knowing how and when to use the camera in manual mode.

Flash Position

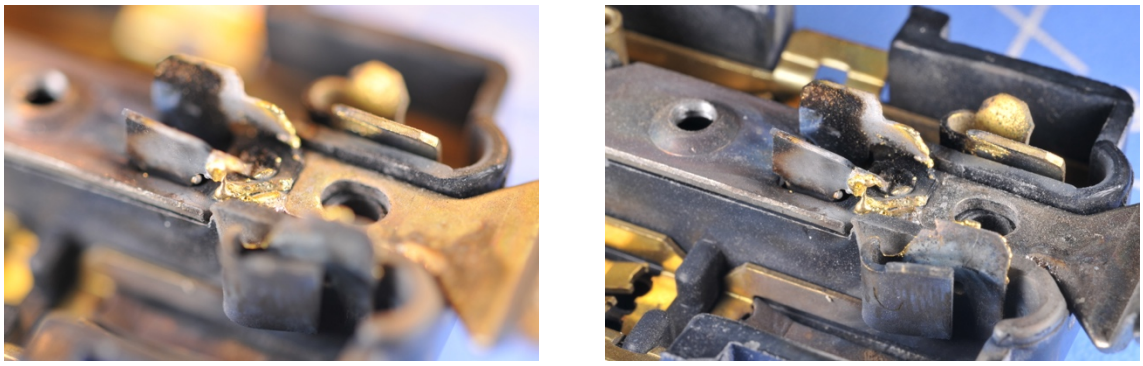
A large flash attached to the top of a camera can be a problem in some instances. This occurs when an object is in between the flash and the subject of the photos. The object will keep the light from properly reaching the subject of the photo, either casting a shadow or causing an underexposed subject (See Figure 9). The solution for this may be as simple as repositioning the camera or turning the camera upside down to light the entire area. Some DSLR cameras and flashes allow for the flash to be fired by the camera remotely through a flash or radio signal. This will allow for the flash to be removed and held by hand in a proper position. It is important for the investigator to be aware when these situations occur to ensure that the subject of the photos is properly captured.

Figure 9 – Shadow Problem

MACRO PHOTOGRAPHY

Shooting macro photography in the forensic field is most commonly done during evidence inspections. Macro photography involves photographing subjects close up. Most cameras today have macro settings. When using a DSLR camera, a macro lens is needed that is designed specifically for close up photography.

When shooting macro photos, the aperture priority setting should be used. When taking close up photos, the depth of field will be very small.[6] Therefore a small aperture should be used to ensure a wide range of focus in the photo. Choosing the appropriate aperture can be trial and error. Compare the two photos in Figure 10. The focus area is limited using an aperture of f/3.8 when compared to the smaller aperture of f/22, which has a greater area that is in focus.



F/3.8 **F/22**

Figure 10 - Focus Area Comparison

The downside of using small apertures is lighting. To overcome this, a ring strobe flash should be used. These flash devices are specifically designed for macro work. The flash is typically positioned on the end of the lens, allowing the subject of the photo to be properly lighted when the lens is positioned very close.

CONCLUSION

Photographs are arguably the most widely used and important form of fire scene documentation utilized today. It is important for the fire investigator to thoroughly capture the fire scene in properly exposed photographs. Understanding the basic fundamentals of photography, knowing how to properly use camera equipment, and practice and experience will help the fire investigator properly record the fire scene.

RECOMMENDED CLASSES

Readers of this paper wishing to further their study in the fundamentals of photography should visit www.betterphoto.com. A recommended course on this website is “Fundamentals of Photography Made Easy” by Jim Zuckerman.

ABOUT THE AUTHOR

Ryan M. Cox has been working full time as a fire investigator for Kodiak Fire & Safety Consulting since January 2003. Prior to this, he interned at Kodiak while he obtained his Bachelor of Science Degree in Fire Protection and Safety Engineering Technology at Oklahoma State University. Ryan has investigated fires all over the United States and in other countries. His investigation experiences range from small fires in single family dwellings to multi-million dollar losses in private and commercial properties. Ryan has testified as an expert witness in both state and federal courts. Ryan started in the volunteer fire service in 1995 and is currently a Fire Captain with the Aboite Township Fire Department in Ft. Wayne, IN.

ENDNOTES

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