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Law Enforcement
Equipment Technology

Selection and Application Guide to

POLICE PHOTOGRAPHIC EQUIPMENT

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This guide was prepared by the Law Enforcement Standards Laboratory of the National Bureau of Standards under the direction of Lawrence K. Eliason, Manager, Security Systems Program, and Jacob J. Diamond, Chief of LESL. Its preparation was sponsored by the National Institute of Law Enforcement and Criminal Justice, Lester D. Shubin, Standards Program Manager.

Selection and Application Guide to POLICE PHOTOGRAPHIC EQUIPMENT

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FOREWORD

The Law Enforcement Standards Laboratory (LESL) of the National Bureau of Standards (NBS) furnishes technical support to the National Institute of Law Enforcement and Criminal Justice (NILECJ) program to strengthen law enforcement and criminal justice in the United States. LESL's function is to conduct research that will assist law enforcement and criminal justice agencies in the selection and procurement of quality equipment.

LESL is: (1) Subjecting existing equipment to laboratory testing and evaluation and (2) conducting research leading to the development of several series of documents, including national voluntary equipment standards, user guides, and technical reports.

This document is a law enforcement equipment guide developed by LESL under the sponsorship of NILECJ. Additional guides as well as other documents are being issued under the LESL program in the areas of protective equipment, communications equipment, security systems, weapons, emergency equipment, investigative aids, vehicles and clothing.

Technical comments and suggestions concerning this guide are invited from all interested parties. They may be addressed to the author or to the Law Enforcement Standards Laboratory, National Bureau of Standards, Washington, D.C. 20234.

Jacob J. Diamond
Chief, Law Enforcement Standards Laboratory

INTRODUCTION

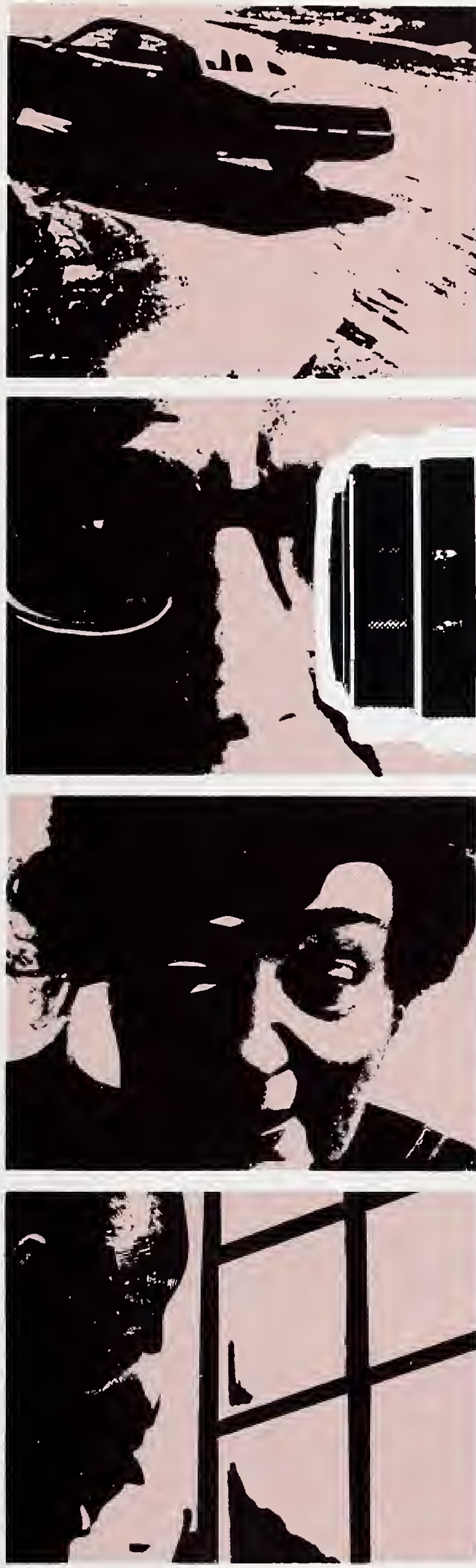
Virtually every segment of the law enforcement community makes extensive use of photography on a daily basis, preparing documentation, evidence, or visual aids for training and public education. Law enforcement photography, as a specialty, probably encompasses a broader range of specialized photographic skills than any other recognized branch of the photographic profession. This guide briefly discusses the typical assignments that are encountered on a routine basis and reviews the types of pictures that the photographer must obtain in each instance. Those problems that are unique to specific assignments are identified, and some useful photographic techniques are described. Cameras, lenses, film, exposure meters, lighting equipment, and accessories are also discussed, with emphasis on the characteristics that are important to law enforcement applications.

The upsurge in popularity of photography among the general public has resulted in a flood of new equipment, particularly in the 35 mm field. The professional photographer has benefited greatly from the availability of this sophisticated equipment. On the other hand, the demand for specialized law enforcement equipment is relatively small, and some of the popularly advertised equipment is not suitable for law enforcement use. The individual making the selection must choose from the large variety which is commercially available. The final choice is often a compromise.

The purpose of this guide is to assist those law enforcement and procurement officials who are not technically trained in photography in the selection and application of photographic equipment which will meet their needs. The basic operating principles of cameras, lenses and other equipment are described in order to make it easier to discuss the considerations which affect their application to different photographic assignments. Emphasis is placed upon picture quality, acquisition and operating costs, and equipment reliability, factors that must all be taken into account when selecting equipment. Matching equipment characteristics to specific assignments will help in the selection of the type that will produce the highest picture quality. Judgment will have to be exercised and compromises may have to be made, based upon the relative frequency of use of each type of equipment, personnel skills, and personal preference. Only the individual who knows the requirements of the user can judge these points properly.

In a field such as law enforcement photography, where widely diverse subjects are normal, the skill of the individual photographer is of maximum importance, and equipment cannot be substituted for professional competency. The greatest portion of the annual cost of photographic services goes for labor rather than for equipment or materials. It would be sheer folly, therefore, to handicap the photographer by forcing him to use inferior equipment which wastes his time and talent. It is hoped that this guide will assist in the logical selection of photographic equipment which is best suited to the job to be done.

The major manufacturers maintain technical staffs to answer questions and assist in the application of their products to specific uses. They have published a number of handbooks, manuals, and technical bulletins that discuss specific law enforcement applications, such as forensic and evidential photography, in depth. In addition, the monthly photographic magazines contain a great variety of photographic information and can enable a police department to become aware of new products as they are introduced. The importance of keeping current with photographic technology cannot be over emphasized. A month never goes by without the introduction of a new camera, film, or accessory; which may often be ideally suited to law enforcement application.



TYPICAL PHOTOGRAPHIC ASSIGNMENTS

Basic law enforcement photographic assignments are traditionally classified according to the crime or the object photographed: homicide, burglary, breaking and entering, arson, sex crimes, etc.; mug shots, fingerprints, physical evidence, documents, etc.

TYPICAL PHOTOGRAPHIC ASSIGNMENTS

Crime Scene and Physical Evidence Photography

Photographs taken at the scene of a crime are essential to the investigation and for later prosecution of those charged with the offense. The purpose of crime scene pictures is to show in detail the objects, conditions, and relations present at the time the investigating officers arrived.

The normal crime scene assignment involves a number of different pictures with widely different requirements. Overall views are needed to positively identify the location, showing the general and immediate surroundings and their relations to the crime scene. Close-up pictures must be taken at progressively decreasing distances and from different views. The general photographic sequence might go from street scenes to the dwelling, to the entry, to the room, the overall conditions of the room, and to any victim involved. Crime scene photography, in general, involves relatively large areas and the pictures must have good detail and perspective. Many of the pictures can be taken with existing light; however, interior photography will most often require additional light. Another type of crime scene photography is the recording of a re-enactment of a crime. This requires a somewhat different approach. The pictures should be relatable and compatible with those taken at the time of the initial investigation of the crime.

With the exception of those pictures taken to fix the location of the investigation, all pictures made at the scene of a crime are potentially evidence photographs. It is particularly important to obtain photographs of evidence that may be transitory in nature, such as footprints, tire marks, or fingerprints.

When investigating a burglary or breaking and entering, the pictures should include evidence of the point of entry, tool marks, trace evidence such as cigarette butts, articles left at the scene such as tools, the condition of various rooms and areas from which articles were taken, fingerprints or footprints and the articles or area where found, and the known or possible paths of exit.

Photographs taken at the scene of a crime involving a victim, including drowning, are often critical to determining whether the investigation concerns homicide, an accident, or suicide. Pictures must be taken from all sides of the body, and all wounds must be shown in detail. Any weapons present must also be photo-

graphed in detail. Coverage must be sufficiently thorough to leave no possibility for later requirements which were not anticipated at the time. After a full set of pictures has been made of the victim as found, it will often be necessary to take additional pictures of the body, wounds, blood stains under the body, or other additional evidence once the body has been moved. As with an investigation of breaking and entering, points of entry and exit are important.

The photographic conditions encountered in crime scene assignments involve a wide range, from large exterior objects under good illumination (such as a broken store window) to very small objects under poor illumination and in inaccessible locations (such as a bullet hole, at the scene of a shooting).

In many instances, the crime scene photograph will be the only record of physical evidence for later use, such as damage to a large wall safe that cannot be removed from the property; in other cases, it will be possible to take items to the laboratory for further examination and photography. Weapons and tools can be studied and photographed to display fingerprints, or unique characteristics that will aid in the investi-

gation. Items can be examined and photographed under other types of illumination such as infrared or ultraviolet light, which may enable the detection of such things as the alteration of an original check signature. The photography studio will also be used to make records of property, such as a stolen radio picked up during a pawn shop investigation.

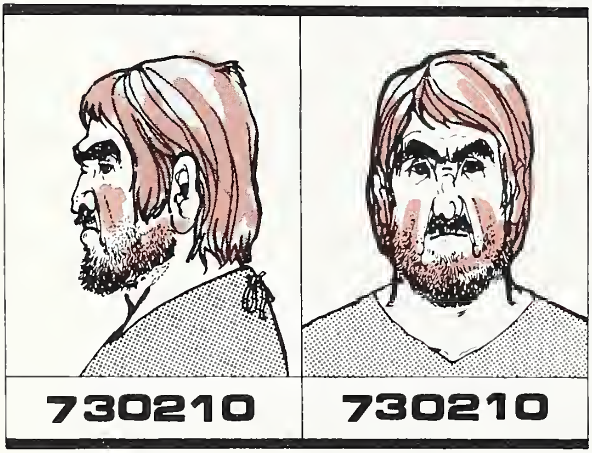
Photographs of sex crime victims are still another type of evidential photography, and require the full cooperation of the victim. Pictures may be necessary to substantiate the fact that sexual assault was committed. Evidence of resistance to the attack in the form of wounds, bruises, scratches, etc., are of special importance.

Traffic accident pictures form a complete documentation of an automobile accident involving a traffic fatality or injury. General views are required to show the scene and to identify the locality. It will be necessary to show as nearly as possible each driver's view of his surroundings prior to the accident, particularly his possible view of the approach of the other vehicle; what view each driver had of the other at the point of impact; general views of the vehicles involved in relation to their surroundings; a close-up of the damaged vehicles, and the locations of those injured or killed; views of dirt dislodged from the underside of vehicles, indicating location of collision; views of tire or skid marks or other evidence of preventive measures or lack of them. Any record that would indicate a mechanical failure of either vehicle is also important.

Tire or skid marks require two views: one looking in the direction of travel from as high an

elevation as feasible, to indicate evasive maneuvers made by the driver; the second view at right angles to the direction of travel, enabling the length of the tire marks to be determined. Such marks must also be measured.

Arson photography represents one of the more difficult assignments. It requires careful coverage from several viewpoints, which are not compatible. An overall general view of the scene of the fire, showing smoke formation, color of smoke and flame, location of initial flames and direction and speed of spreading is important. At the same time, pictures of the crowd of spectators should be obtained for the possible identification of arson "repeaters" who may be present. The first set of pictures can best be taken from a considerable distance, choosing the camera viewpoint carefully to show what is wanted. A long focus or telephoto lens should be used. Crowd views require working in close, at the scene of the action, making it a difficult job for one person to cover. After the fire, a complete record of the point where the fire started, its direction of travel, the damage, and any evidence of items that were used in starting or spreading the flames must be obtained. The required photographic techniques are familiar to the experienced photographer. In the photography of fire-blackened areas, both lighting and exposure must be modified to meet the conditions found. Normal exposure, using flat lighting of fire-blackened walls, produces very poor picture quality. Lighting to emphasize the texture of the burned surfaces should be used. Exposure should be increased as required to get black objects dense enough on the negative to provide good detailed reproduction. Evidence of multiple starting points should be photographed in any fire; this is often a sign of arson. In all cases, evidence should be photographed from a distance great enough to show its relation to the surroundings, as well as close enough to show the details.



Identification Photographs

Identification or "mug" shots are an important part of any criminal file. They are the only method of reliably showing facial characteristics, and a good one will enable an investigator or witness to recognize a suspect on sight. At least two views of each subject are required for an identification series to be complete: a front view and a side view. The identification photograph is most often a close-up of the head and shoulders, extending down to the chest only far enough to show the identification or file number. The side view is most important for absolute identification; it provides many more elements for positive identification than any other view. To the untrained eye, however, the front view is more recognizable; it is widely used for display to witnesses. Some police departments also photograph a full length front view of the standing suspect and occasionally a three-quarter view from each side. In all cases, the pictures should be lighted for maximum detail. The picture should include any unique features, such as scars, birthmarks, etc., that would aid in identification. Black and white pictures are more common, but color shots are being increasingly used.

Identification photos traditionally have been made in pairs on a 12.5 x 18 cm (5 x 7 in) negative, producing two 9 x 12.5 cm (3 1/2 x 5 in) prints, and there is a tendency to standardize on prints of about this size. Some special identification cameras put three shots on a single 10 x 12.5 cm (4 x 5 in) negative, although two is more common.

"Mug" shots are essentially portraits and the same rules of good perspective govern. Use a long enough focal length that it is not necessary to bring the camera too close to the subject.

Fingerprints

Fingerprint photography is a specialty, and the fingerprint expert will have a special set of techniques. The general law enforcement photographer will have more limited contact with fingerprints: prints found at the scene of a crime that must be photographed immediately, and photographs of lifted prints that are being prepared for presentation to a hearing or court.

Fingerprints are made visible by four major methods: (a) dusting with various colored powders that stick to the prints, increasing their contrast against the surfaces on which they are found; (b) "lifting" the powdered prints with an adhesive-backed plastic tape and transferring them to a more suitable background; (c) illuminating the prints with ultraviolet light to make them fluoresce; (d) fuming the prints with chemical vapors, such as iodine.

Fingerprints may be photographed with (a) a special fingerprint camera, which is a self-contained unit providing fixed magnification and integral lighting; (b) with a press-type camera adapted for fingerprint photography by means of special attachments; or (c) with any other type of camera which is suitable for close-up photography.

In printing fingerprints for court presentation, they should always be printed so that the ridges are dark and the grooves are light. This may necessitate printing from a positive transparency made from the negative, instead of directly from the negative.

Surveillance Photography

Surveillance photography is directed toward the preparation of a photographic record of suspect actions. The surveillance may center around an individual or around a location. In the case of an individual, there is interest in everything he does and everywhere he goes. The surveillance operator must be sufficiently close to the suspect to record his location and his actions. This requires a maximum of ingenuity, the careful selection of equipment, adequate manpower, and much experience (and luck). In many cases, the task is impossible or impractical, and even if pictures are obtained, they may not be of direct use as evidence.

In the case of a location surveillance, there is interest not only in what happens at the location, but in the identity of all persons entering or leaving the premises. With luck, the surveillance camera can be set up in a concealed location, such as an adjoining building, which is close enough that a lens of moderate focal length such as 135 or 200 mm can be used, and oriented so that the light comes from behind the photographer. In practice, ideal conditions are the exception and one must make the best of whatever conditions are found, and select equipment to suit the conditions.

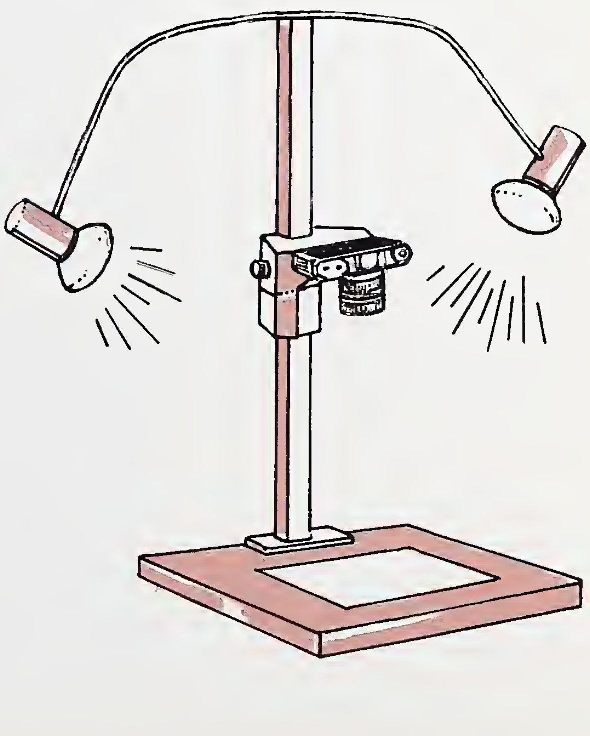
The items most often looked for in surveillance photos are recognizable or identifiable faces. The subject distance is generally large compared to the subject size. Under these conditions, negative size is of much less importance than in other photographic work. What is of importance is image size, and this is determined by lens focal length and subject distance rather than negative size.

Document Photography

Document photography, from a photographic standpoint, is the simplest of all assignments. All of the work is contained in two relatively well defined photographic areas: copying and macro-photography. While all document work will fall into one or the other of these two categories, not all macro-photography in the law enforcement field is document photography.

A major document assignment may be the simple copying of personnel identification photographs so that prints are available to all the investigators. Departments with a large volume of investigation will require a standardized copy set-up which can reproduce, rapidly and efficiently, documents, photographs and other paper originals with sizes of 28 x 36 cm (11 x 14 in) and larger. The proper copying camera will provide reduced, same size or enlarged copies, from one-fifth or one-tenth actual size up to five or more times actual size. Negative sizes for such cameras tend to be much larger than normal, frequently 20 x 25 cm (8 x 10 in) and larger. A large amount of document work will be at a one-to-one ratio.

For the smaller department, where a process camera cannot be justified, copy stands are available for use with press or other type cameras, and greatly speed up the making of reduced size negatives from any flat original.



Normally, document work is done on a slow, fine-grained, high-contrast film. Panchromatic film is normally used, but a color-blind emulsion may be required for some subjects. Filters are commonly used as required.

Documents may be photographed in their entirety, for presentation as evidence. Small sections may be enlarged to show evidence of alteration, erasures or forgery. Documents are commonly photographed for fingerprints, to determine whether a suspect handled them; fuming and other techniques may be required to make the latent prints visible. Fluorescent photography may also be required, to show tampering or alteration. Where enlarged sections are necessary, the standard macro techniques and equipment may be used or the copy camera itself may be adequate. Under these conditions, the medium format camera 6 x 6 cm (2 1/4 x 2 1/4 in) or 10 x 12.5 cm (4 x 5 in) is little more trouble to use than a small format camera. The photographs made with the larger format camera will often be of better quality, particularly if a blow-up of a small portion of a negative is required.

Motion Picture Photography

Motion picture photography has probably been used in surveillance and arson investigations more than in other law enforcement activities. Much detail can be seen in a motion picture, such as a surveillance photograph of a suspect. However, a still picture made from a single frame may be useless for identification. In part, this is because the subject is moving and the individual frames have too long an exposure to stop the subject's motion. It isn't necessary to stop motion for a motion picture. In part, the better apparent quality of the motion picture is due to the inherent ability of the eye to take a detail out of one frame and add details from each of the other frames projected so the perceived motion picture apparently has much more detail than any one of the individual pictures from which it is created. This adding-up process, known as integration, contributes much to the ability of the motion picture to convey information to the viewer.

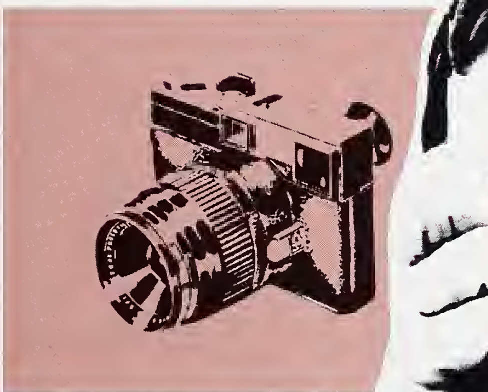
Documentation or Record Photography

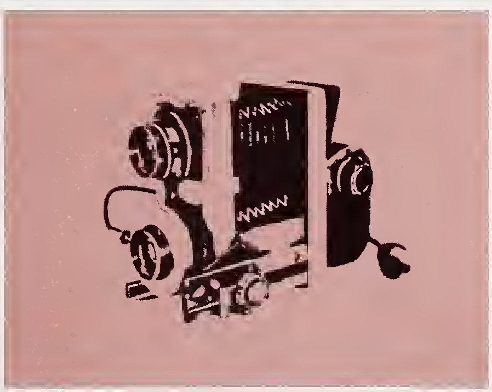
A less-traditional use of photography in law enforcement is documentation (as opposed to document or documentary) or record photography.

Documentation is the general use of simple, non-professional cameras by rank and file officers to provide photographic information where normally only notes and interviews would be used. This is the area where automatic and instant processing cameras (Polaroid and the new Kodak equipment) have their greatest utility.

The purpose of a documentation picture is to add to the information which the investigator records to pin down details that might be remembered imperfectly and to preserve information which is difficult or very time consuming to record properly by other means. These photos are not intended as evidence or as substitutes for formal photography; they may be of relatively low quality and have insufficient detail to allow enlargement. They are intended to supplement the normal photographs and investigator's notes. They are particularly valuable in situations in which it is impossible, impractical, or too costly to assign a regular photographer to make a thorough photographic record. The instant-process photograph is of particular value as an interim record that the first officer on the scene can get and use to convey information until the lab prints can be made and distributed.

CAMERAS





There is such a wide range of camera types available that the police photographer must define the needs of his assignment in order to choose the camera that would be most helpful.

CAMERAS

General Considerations

The convenience and efficiency with which any type of photographic assignment can be accomplished is largely dictated by the camera that is used. With the exception of pictures taken by an officer for informal documentation purposes, the objective of nearly all photographic assignments is to obtain professional quality prints suitable for formal court presentation. This requires a camera that can be used under all types of lighting conditions, and one which can produce sharp images over a broad range of subject distances. In many cases, it is also essential to have the capability of using different lenses. The simplest of currently available cameras, with slow lenses and fixed or zone focusing, have little application to law enforcement photography.

The early cameras had lenses with very small apertures, and used glass plates for negatives. Focusing was done on a ground glass screen, and the plate was then inserted and exposed. Since long exposures were required, only a stationary subject could be photographed. All present-day cameras have evolved from these simple direct-view cameras, incorporating a variety of features to increase their utility and take full advantage of improved film and lenses.

The development of roll film and better lenses resulted in the design of a variety of view finders, the simplest of which is simply a wire frame which outlines the field of view. While view finders enable one to aim the camera, even in the case of a moving subject, almost all suffer from a common problem—parallax. This is a consequence of the fact that the view finder must in general be located above or to the side of the lens, and the camera lens and view finder see different aspects of the subject. The effect of this displacement of the view-finder image from that of the camera lens becomes significant at subject-to-camera distances of less than approximately 3 m (10 ft), and at very long distances when a telephoto lens is used. While a number of camera designs have incorporated adjustments to minimize the problem of view finder parallax, only the single-lens reflex has completely eliminated it.

Two types of shutters are used in modern cameras. Most medium and large format cameras [6 x 6 cm (2 1/4 x 2 1/4 in) and larger film sizes], and cameras that do not allow lenses to be interchanged, use a between-the-lens shutter. The exposure is controlled by leaves which are located in the barrel of the lens between the optical elements and which open for the required period of time. The speed of a between-the-lens shutter is normally limited to a minimum duration of 1/500 second. The majority of cameras that permit lenses to be interchanged use a focal-plane shutter. The exposure is controlled, at fast shutter speeds, by moving a small slit-opening in a metal or fabric curtain across the surface of the film in a plane located immediately in front of film. The focal-plane shutter permits fast shutter speeds, generally 1/1000 second or less.

It is generally possible to synchronize between-the-lens shutters to permit the use of a flash lamp or electronic flash unit at all shutter speeds. The focal-plane shutter, however, requires that a flash lamp or electronic flash be used at the slow shutter speeds (generally 1/60 second or longer), during which the entire picture area is exposed simultaneously.

Since most negatives will be used to produce an enlarged print, film size must enter into the selection of a camera. A 35 mm negative must be enlarged eight times to produce the 20 x 25 cm (8 x 10 in) print that is normally used for court presentation. The 6 x 6 cm (2 1/4 x 2 1/4 in) negative need be enlarged only five times to produce such a print. As the negative size decreases, the skill of the photographer must increase, and the processing of the film becomes more critical. It is apparent, then, that the camera must be considered as one part of the total photographic system. The trade-off factors relative to film size include 1) the ideal size, from the standpoint of picture quality, for the particular task, 2) the lowest material cost, obtained by the use of a small negative size and only one size for all tasks and 3) efficiency in manpower use, which suggests the smallest possible number of different types and a film size that requires the least time and lowest level of skill in both the taking and processing of pictures.

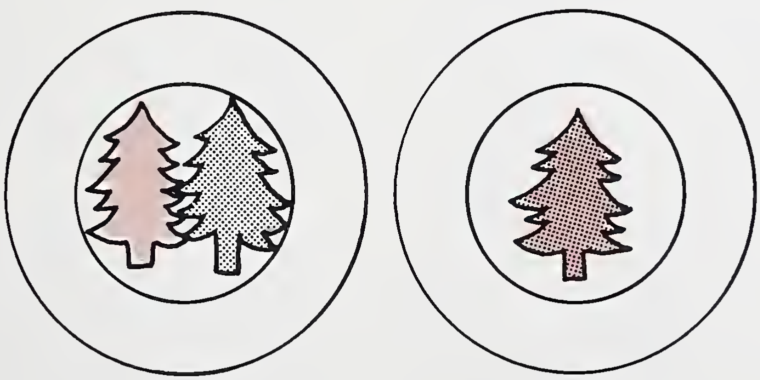
Based on the variety of assignments that is encountered, and the general considerations concerning cameras that have been discussed, it is evident that the selection of photographic equipment is not a simple task. The general characteristics of different camera types that are suitable for use in law enforcement photography are discussed in the paragraphs that follow.

Coupled Rangefinder Cameras

Since the law enforcement photographer must frequently take pictures at high lens speeds (low f-numbers) and/or short distances, and thus at shallow depths-of-field, accurate focusing is essential. The coupled rangefinder camera was devised to accomplish rapid, accurate focusing, particularly with moving subjects. In the superimposed image type, the operator sees two separate images of the subject in a single eyepiece. The rangefinder is adjusted until they coincide and become one. At this point, the subject distance can be read off a scale, if desired, but the camera lens has simultaneously been adjusted to the proper focus. In the split-image type of rangefinder, adjacent areas of the image are moved with respect to each other until a line which is continuous in the subject becomes continuous across the image dividing line in the eyepiece. The choice between rangefinder types is primarily a matter of personal preference.

Rangefinder cameras come in all film sizes from 35 mm to 10 x 12.5 cm (4 x 5 in). The largest number of available models feature automatic exposure control and non-interchangeable lenses. Much smaller numbers have interchangeable lenses. The top quality 35 mm rangefinder cameras are designed as complete systems, with literally hundreds of accessories. Some professional photographers prefer these cameras and use no others.

Rangefinder cameras, with few exceptions, are simple to load and adjust. Focusing is positive, giving a clear-cut in-or-out of focus indication which requires less judgment than a ground glass. Rangefinder cameras commonly use a small optical viewfinder-rangefinder combination, requiring considerably more skill to visualize the finished picture than is required with the larger matte screen image used in most single lens reflex or press cameras. However, this is largely a personal matter. Individuals wearing glasses will probably have more diffi-



culty with this type of viewfinder than those who do not.

The rangefinder camera is most suitable where a small, quiet camera is required. In the 35 mm size, where the choice is between the rangefinder and the single lens reflex types, the rangefinder's major advantage is its ability to determine focus under poor light conditions more easily than the single lens reflex. It also has a much lower noise level than an equivalent single lens reflex and, in general, is a lighter and significantly smaller camera. Thus it lends itself to situations where the camera should be as inconspicuous as possible for a given film size. Parallax is a problem with the rangefinder camera and it is not the best choice for any task involving subjects at distances closer than 2.5 to 3.5 m (8 to 12 ft), or for use with long focus or telephoto lenses. With extremely wide angle lenses, the parallax effect becomes very small and may not be noticeable (such lenses generally require accessory view finders).

The initial cost of a rangefinder camera, assuming comparable picture size, lens speed, lens quality and optional features, will be significantly less than that of other cameras such as the single lens reflex or twin lens reflex. There is one major exception to this generality—the top quality cameras are provided with a great many features which are not found in the great majority of rangefinder cameras; their prices are comparable to those of the better quality single lens reflex cameras.

Press Cameras

The press camera, coupled with photoflash or electronic flash supplementary lighting equipment, has been the starting camera and "workhorse" of the photographic units of many law enforcement agencies. It uses sheet film rather than roll film, although film pack adapters, rollfilm holders (and Polaroid adapters) are readily available. The size range is from 6 x 8 cm (2 1/4 x 3 1/4 in) up to 10 x 12.5 cm (4 x 5 in), the most common size. The increasing popularity of the smaller format cameras prompted all manufacturers to discontinue making the press camera several years ago. Consequently, only used press cameras are currently available; however, it now appears that at least one manufacturer will start to make the press camera in the near future.

The press camera is essentially a simple, direct view camera with a few added features, many of which may be separately purchased options. Press cameras provide for direct viewing of the subject image on a ground glass, in addition to providing an optical viewer. For general police use, the coupled rangefinder is the most important option. It should be noted that many of the older press cameras did not couple the rangefinder to the focusing system of the camera. Some press cameras also provide interchangeable cams to enable the rangefinder to automatically focus lenses of different focal lengths.

Slide and swing adjustments are the second most important option. These adjustments, built into the front and/or back of the camera, allow the position of the lens with respect to the film to be changed for distortion control. When the ground glass screen is used, a tripod or other camera stand is mandatory. This enables the press camera to be used for many of the functions of a studio view camera. Recognize, however, that the greater the number of adjustments that are provided, the more the accuracy and reliability of the coupled rangefinder is jeopardized. For the law enforcement department with only occasional need for a studio view camera, the press camera with full adjustment capability is an excellent choice.

Some press cameras are also provided with a revolving or reversible back, which allows either horizontal or vertical pictures to be taken without turning the camera on its side. A revolving back allows the film to be rotated through any desired angle, while the reversible back has two fixed positions: vertical and horizontal. Either is convenient, and both increase the utility of swings, tilts, and other adjustments.

Almost all press cameras provide one viewfinder in addition to a ground glass. The separate optical finder can be adjusted to match a full range of lens focal lengths, or a few specific lenses. Some cameras combine the viewfinder with the coupled rangefinder. This combined viewfinder/rangefinder can be adjusted for various focal length lenses. Remember, no viewfinder will enable the photographer to observe the effects of view camera adjustments upon the image.

Press cameras have been used for every type of law enforcement photography and are an ideal choice for many assignments, providing maximum versatility with a miminum amount of special equipment. The level of skill required to realize the ultimate potential of the press camera is relatively high. The basic methods of operating the press cameras tend to encourage the operator to utilize more care in setting up than is usual with an automatic camera. The result is fewer but more carefully planned pictures. The skilled photographer can use the press camera on almost any assignment.

The press camera is much simpler mechanically than many other cameras, resulting in higher reliability and easier repair. It is versatile, and the large negative provides a safety factor in all operations from exposure to final printing. However, it is large, weighs considerably more than smaller cameras and is slow to operate. Since it lacks a built-in exposure meter, the photographer must use a separate one. While its size and operating procedures make it unsuitable for some assignments, such as surveillance, the press camera is an excellent camera for all-around use.

The press camera is strictly a professional camera. Because of its limited market, the initial cost of the basic camera with one lens is high compared to either the single lens reflex or the rangefinder camera, as is the cost of accessories. This cost, however, will tend to be offset by long operating life and overall reliability. Similarly, the large negative size will result in a relatively high cost per picture taken; however, this will tend to be offset by the greater percentage of good and usable pictures that will be produced.

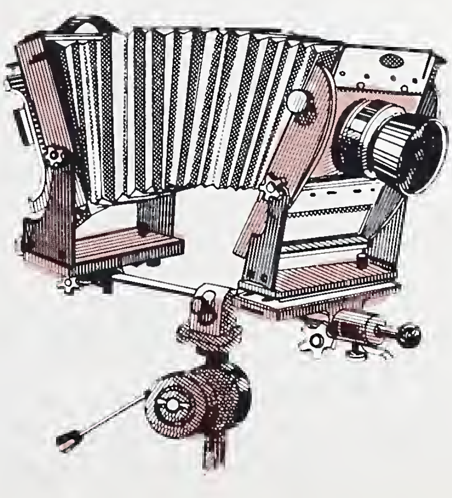
Studio View Cameras

The studio view camera, normally referred to as simply a "view camera," is the traditional camera by which the commercial photographer is known. All focusing and composition is accomplished using only the ground glass screen. For inside studio work, it is essential, and it can be used in the field as well. The view camera provides a wide range of adjustments for changing the relative location and angular position of the lens with respect to the film. The distance between the lens and the film can be adjusted over a wide range, from a small fraction to three times the focal length of the normal lens. View cameras are essentially large-negative cameras; 20 x 25 cm (8 x 10 in) is the standard size. Recently, a negative size of 10 x 12.5 cm (4 x 5 in) has gained popularity, and view cameras using a negative size of 6 x 8 cm (2 1/4 x 3 1/4 in) are available.

Because of its large negative and ground glass viewing screen, the view camera requires the least skill to visualize the finished print; however, of all cameras used for law enforcement photography, it requires the highest level of skill to set up and adjust.

The view camera is the only camera that has been specifically designed to eliminate the shape distortion that is present in most photographs. It also provides highly detailed ultracloseup pictures; for example, a ten-times magnification of a thumbprint requires an image size of 20 x 25 cm (8 x 10 in). It is likewise adaptable for use in the photography of tool marks, morgue shots and forcible entry records.

The major features of all view cameras are quite similar in principle, differing mainly in their precision of construction, the care with which joints are fitted (this determines the overall



rigidity of the camera, particularly in larger sizes), the ease with which adjustments can be made, and the independence of adjustments from each other.

View camera adjustments are basically swings (rotation about a vertical axis), tilts (rotation about a horizontal axis), and slides (horizontal or vertical displacement). Adjustments are more easily and quickly made if the back (film holder) swings and tilts are on pivot lines that intersect at the center of the viewing screen surface. This produces the minimum lateral, longitudinal, or focus shift of the film with respect to the lens when the back is adjusted, and minimizes the amount of compensating lens adjustment that must be made. In some cameras, the back pivots about its bottom edge instead of at the center of the film, causing a very large change in focus as the back is tilted. Similarly, the lens tilts and swings should be about axes that intersect the lens axis at about the surface of the lensboard. This minimizes change in camera direction to maintain the same view as the lens is adjusted.

A good view camera will have "click stops" or some other means of positively setting all the adjustments at the zero or centered position.

Sliding and rising-falling fronts and backs should be designed so that their adjustments and locks are completely separate from the swings and tilts, to prevent a change in one adjustment from affecting others.

In a standard camera, the "plane of sharp focus" is always parallel to the film, at right angles to the optical axis of the camera, and at the distance from the lens for which the lens is focused. In the view camera, the plane of sharp focus can be tilted at an angle with respect to the camera's axis and rotated around this axis as desired. As a general rule, the swings and tilts of the film holder of the view camera are for the purpose of correcting distortion and those on the lens holder are for the purpose of keeping the desired part of the subject in sharp focus. They may be used together or independently.

A modern view camera will have a tension release on the spring back so that film holders can be easily removed and replaced without danger of moving the camera while trying to change a holder against a heavy tension spring.

Other available features include "fresnel" type field lenses behind the viewing screens to brighten up the viewed image in the corners of the screen; sectional bellows to increase the total lens extension for extreme enlargements of fingerprints and small objects; revolving backs allowing the film to be set at any angle (all view cameras have a reversible back for horizontal or vertical pictures); reducing backs on the larger cameras to take smaller size negatives; reflex viewers for convenience in using the camera on a vertical copy stand for the routine copying of documents and for macrophotography; and a wide variety of accessory film holders for both sheet and roll film and for instant-processing film.

Two basic types of view camera construction are found. The monorail has all parts mounted on a single tubular metal rail, which may be rectangular, triangular or of other non-circular cross section, to prevent rotation of the front or back standards around the bed. Traditional view cameras, which were largely of wooden construction, used a flat bed with two parallel metal tracks to guide the back and the front standard. Both types of construction are still found. The camera should be carefully checked to see if the total assembly rigidly locates the lens with respect to the film when the camera is locked. This is particularly important in the larger size cameras. All view cameras should have a sliding base for attachment to the tripod, so that the complete camera can be balanced over the center of the support.

The view camera has several major disadvantages for some law enforcement assignments. It must be used on a tripod, since the camera must be fixed during adjustment. Setting-up to take a picture requires more time than with most other types of camera. It does not lend itself to situations requiring rapid changes of location or viewpoint. It most often uses individual film holders which must be loaded in a darkroom or light-proof changing bag. The total number of pictures that can be made without returning to the darkroom for re-loading is limited by the number of holders carried unless a changing bag is used. The camera is large in size and heavy compared to smaller film size cameras. Its ability to make short exposures is greatly limited by the long focal length lenses used (which require stopping down for reasonable depth of field) and by the large shutters they require (which generally limit the shortest exposure to 1/50 of a second or longer). Any operation in which a large volume of diversified work is being done will require at least one view camera to be available for the accurate portrayal of crime scenes, accidents and some physical evidence.

As with the press camera, the initial cost of a modern precision view camera is higher than the cost of precision 35 mm cameras. View camera lenses are always sold independently of the camera. View cameras have extended service lives, with 30 years of use not uncommon. The cost of operation will be higher per shot than for any other type of camera; however, this is offset by the quality of the pictures that are produced.

Single Lens Reflex Cameras

The major characteristic of the single lens reflex camera (SLR) is a design that eliminates viewfinder parallax. An internal mirror reflects the image from the camera lens to a viewing screen which enables the operator to focus and compose the image exactly as it will appear on the film. When the exposure button is pressed, the mirror swings out of the way so that the image is formed on the plane of the film. In older cameras, and in a few current models with film sizes larger than 35 mm, once the mirror is tripped for exposure, viewing is "blacked-out" until the camera mechanism is wound to advance the film for the next exposure. The majority of SLR cameras incorporate an instant-return mirror which automatically returns to the viewing position as soon as the shutter has completed the exposure.

Virtually all SLR cameras incorporate lenses whose apertures can be preset. The camera is focused at maximum aperture, and during exposure the lens aperture is automatically stopped down to that preset for correct exposure. It is possible, however, to set the aperture to the exposure setting to observe the depth of field. Most SLR cameras of current manufacture also incorporate some type of built-in exposure control, permit the use of interchangeable lenses, and all provide either plug sockets or "hot-shoes," or both, for attaching either photoflash or electronic flash units.

The film size of SLR cameras is basically limited to 35 mm, with more than 50 models available, and 120 roll film, with approximately 10 models to choose from. Most of the 120 roll film cameras produce a 6 x 6 cm (2 1/4 x 2 1/4 in) negative; however, a negative size of 6 x 8 cm (2 1/4 x 3 1/4 in) is available, and two manufacturers recently introduced cameras that produce a negative size of 4.5 x 6 cm (1 5/8 x 2 1/4 in).

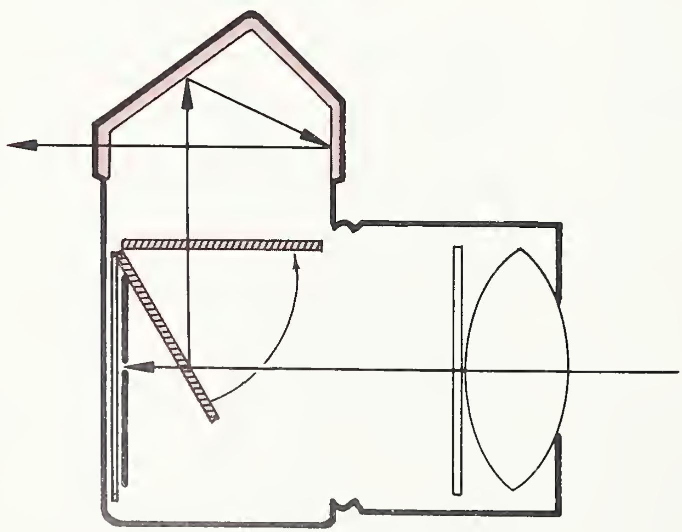
Some older SLR cameras have exposure meters that are integral to the camera but not coupled, requiring that the shutter speed and aperture be set manually after the correct exposure has been computed from the meter reading. Most cameras of current manufacture use through-the-lens meter systems that are coupled to the shutter and aperture. SLR systems measure the light from the scene in several different ways. Some systems measure all of the light entering the lens, some average all of the light with emphasis on the central area of the image, others use a spot meter, and a few offer a choice of meter operation. While the majority of exposure systems require that the operator adjust either the aperture or shutter speed to set the correct exposure, there are cameras which provide fully automatic exposure. All of these systems do a good job, but the operator must recognize that the SLR may indicate incorrect exposures under certain lighting conditions, such as a small dark object that is back-lighted, or a small brightly lighted object silhouetted against a dark background. The operator aware of the problem can easily correct for such lighting conditions. It should also be noted that many SLR camera exposure systems are very sensitive to light entering through the viewing eyepiece. Photographers who wear eye-glasses must be constantly alert to prevent inaccurate exposure readings.

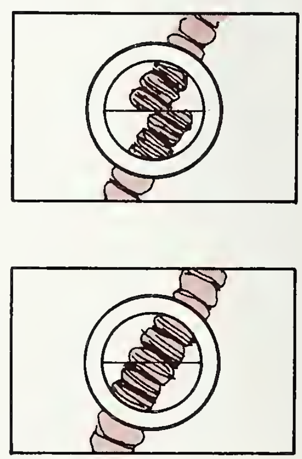
Rubber eye cups with correcting lenses are available to remedy this problem.

Many, but not all, of the SLR cameras offer interchangeable viewing screens and eyepieces. Often, the camera can be ordered with a nonstandard screen if desired. The available types range from the plain ground glass (commonly called matte), through various types of microprisms designed for specific focal length ranges, to clear screens for aerial image focusing. Some are available with a split prism in the center of the field. The standard matte ground glass is probably the best choice for all-round use and for the best visualization of the final picture. The micro-prism is a pebbled surface on which the image appears to break up and disappear unless sharply focused. When focused, the image is seen; when the image is not sharp, the pebbles or prisms are seen. This screen is good for use in poor lighting conditions. The split prism is also good for very precise focusing and for focusing in poor light. The viewing screens normally have field lenses to provide a bright picture from corner to corner; this is standard in most SLR cameras.

The ability to use a variety of different lenses is a major advantage of the SLR camera. Both bayonet and screw-in mounts are used to attach the lens to the camera, with most of the higher quality cameras using the bayonet mount. When selecting accessory lenses or extension tubes, be sure to determine whether the automatic aperture features of the lens couple directly to the camera exposure control. Some of the 120 roll film size SLR cameras use a between-the-lens shutter, and each accessory lens must also have its own shutter. In general, the range of accessories for the large format SLR camera is more limited than that of the 35 mm camera.

The SLR camera requires a minimum of operator skill to produce high quality pictures. These cameras are necessarily complex in both mechanical and electrical construction, however, and are more prone to malfunction than are the simpler cameras. Similarly, when they do malfunction, repair can be expected to be more expensive than with a rangefinder or press camera. Also, mirror vibration is a problem that is peculiar to the SLR camera. If the camera is not firmly supported, the vibration when the mirror moves from the viewing position may be sufficient to blur the picture. The extent of the problem varies depending upon the design of the camera. High quality SLR cameras have a control to manually lock the mirror in the "up" position when the camera is used with an unusually long focal length lens, with a microscope, or for very long exposures. In this position, the camera is "blind" and the image cannot be seen. If the camera must be used on a light tripod, use either a very short exposure (1/250 second or less) or a very long ex-



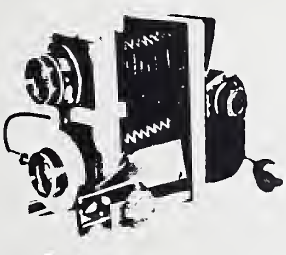


posure (1 second or more) to minimize the effect of mirror vibration on the picture. Mirror vibration may be more evident on a light tripod with some cameras at shutter speeds between 1/250 and 1/15 second than if the camera is hand-held. The noise produced by the focal-plane shutter and mirror of a SLR is much louder than that produced by a between-the-lens shutter. The noise may be a serious disadvantage in covert surveillance photography.

Quality 35 mm SLR cameras can be purchased for $300, with an automatic lens of normal focal length and built-in exposure control. The 120 SLR camera, however, is much more expensive. In general, the prices of SLR cameras are exceeded only by the price of top quality view cameras.

Twin Lens Reflex Cameras

The twin lens reflex camera (TLR) had widespread popularity, particularly in the period before a large selection of SLR cameras became available. The TLR has two objective lenses mounted one above the other. The top lens, by means of a fixed front-surface mirror, reflects the image to a horizontal ground glass viewing and focusing screen at the top of the camera. The image is right side up, but reversed from left to right. The lower lens is the picture taking lens and has a between-the-lens shutter and iris diaphragm. The twin lenses are carefully matched for focal length. They are mounted on a common plate and are focused by moving them together as a unit. The viewing lens has no adjustable aperture or shutter, and is normally supplied with a larger aperture to increase focusing accuracy and image brightness. Unlike the SLR, the operator can see the image at all times, even during exposures.



Most TLR cameras are manufactured in the 120 roll film size. The TLR camera is widely used in making personal identification photos. An electrically operated TLR, using 70 mm film in 100-foot rolls, has proven very useful in departments where a large volume of such work is done. Using machine processing methods (Kodak Versamat), consistently high quality negatives can be obtained in large numbers with a minimum of labor.

Several TLR cameras incorporate built-in exposure meters that are coupled to the shutter and aperture, and adapters are available which allow the use of 35 mm film or sheet film. Only a limited number of attachments or interchangeable lenses is available. Eye-level finders are also manufactured; these allow the direction of sight to be parallel to the camera axis rather than at right angles to it, and some choice of viewing screen style is provided.

The level of skill required to operate a TLR is on a par with that of the rangefinder camera. The large viewfinder is an advantage to many operators. The TLR camera does, however, suffer from parallax. Since the TLR camera is not complex mechanically, it is a reliable camera and repair costs are relatively low.

The initial cost of a TLR camera with a single set of lenses will be about the same as for the SLR of the same film size. While there are individuals who prefer to use a TLR camera, it is not normally considered to be a top choice for law enforcement photography.

Motion Picture Cameras

The motion picture camera is essentially a motor driven still picture camera. The mechanism automatically takes pictures and advances the film at the rate of sixteen or more pictures per second. Most cameras operate on a cycle where one picture is taken for every revolution of the motor drive shaft. During half of this revolution, the film is stationary and exposed to light; during the other half revolution, the shutter is closed and the film is transported out of the picture aperture and replaced with a fresh section.

Four sizes of film are commonly used for motion picture work: 35, 16, 8, and Super-8 mm. Thirty-five millimeter (the same size as used in 35 mm still cameras), is used exclusively for commercial movies for theatre showing. Sixteen millimeters has been the standard size for all documentary, educational, industrial, television, commercial, and law enforcement movies for many years. Eight millimeter, once the standard size for amateur use, is obsolete, replaced by the Super-8, with a 31 percent greater picture area on the same film width (4.1 x 5.8 mm frame size compared to 3.7 x 4.9 mm). The choice for law enforcement purposes will be either the 16 mm or the Super-8 size.

The big advantage of 16 mm motion pictures is in the quality of the picture. The variety of equipment available for taking and projecting 16 mm pictures, while not large compared with the variety available in the Super-8 mm amateur market, is adequate. They can be classified as of high and very high quality. Sixteen millimeter movie projection equipment is to be found all over the country in schools, institutions, clubs and government agencies, and is also used by private concerns for educational, training and information purposes.

As far as picture quality is concerned, the situation is simple. Both 16 mm and Super-8 use the same film width. The lenses of both sizes of cameras, if of standard quality, can image much more information than the film is capable of recording. The 16 mm camera can provide pictures that cover almost three times as much area with the same detail as the Super-8 or a picture of the same area as the Super-8, but with almost twice as much detail, enabling objects to be detected in the 16 mm picture that are half as large as the smallest detectable object in the Super-8. A single frame of 16 mm film can be enlarged to make a print up to 7.5 x 10 cm (3 x 4 in), as compared to 3.8 x 5 cm (1 1/2 x 2 in) for the Super-8, before the detail begins to fall off so rapidly that further enlargement is useless.

Sixteen millimeter equipment lacks some of the convenience features that are taken for granted in Super-8. Almost all Super-8 cameras are designed around a variable focal length or "zoom" lens and automatic exposure control, rather than interchangeable lenses. Sixteen millimeter cameras are invariably built around interchangeable lenses, requiring a minimum of three or four separate lenses. Variable focal length lenses are available as accessories for all 16 mm cameras. They are very high quality lenses with a normal focal length range of 10:1 and are correspondingly expensive.

In most cases, good motion pictures will require a higher order of skill on the part of the operator than will good still pictures of the same subject. In making motion pictures, it is common practice to assign all of the processing to a motion picture processing lab having the required special equipment and expertise to assure a high quality job. This simplifies the operator's task. Movies are dynamic and constantly changing. The operator must be able to keep abreast of such changes and anticipate them, or the quality of the movies will be greatly degraded. The operator must be alert and perceptive over much longer time periods and to many more things than is normally required in taking still pictures.

Two major uses for movies in law enforcement photography are surveillance photography and in recording tests and behavior in "driving while under the influence of alcohol" (DWUTIA) arrests. Where surveillance is from a fixed location and the larger size of the 16 mm equipment is not a critical item, jeopardizing the large expenditure in labor and time by the use of the lower quality Super-8 would not seem justifiable. For recording a large number of DWUTIA tests, the lower operating cost plus the conditions under which the movies are made would make Super-8 the logical choice.

All 16 mm equipment will be relatively high in initial cost, although in general the quality will be high. There is a good supply of used 16 mm equipment, and high quality rental equipment is available for the infrequent user. The relative operating cost will be about 6 times as high for 16 mm as for Super-8, based upon film price and processing cost for a single original in color, using the same type of emulsion, and for the same running time in both sizes. Local conditions with respect to processing facilities and film discounts will cause this figure to vary from department to department.

Instant Process Cameras

There are several instant process systems of photography. Prior to 1976, there was only one, manufactured by the Polaroid Corporation. Eastman Kodak introduced an instant process film and camera system in the spring of 1976. In one process, a paper negative is exposed in a special camera or adapter. It is then automatically coated with a viscous developing agent and rolled into contact with the paper positive as the "sandwich" is removed from the camera. Printing proceeds to completion by a chemical diffusion process (rather than exposure to light) between the sandwiched emulsions until they are separated in normal light. This requires approximately 10 seconds for black and white film (hence the instant process designation). It is a little longer for color film. After separation, the black and white positive requires a surface cleansing and coating with a preservative, applied with a swab. In the color Polaroid process, this step has been eliminated. Both Polaroid and Eastman Kodak manufacture color films that do not use a separate paper negative. Pictures taken with those films require several minutes to fully develop the image.

At the present time, the Polaroid Corporation manufactures a full line of cameras and one "Sixty-Second" camera is available from an independent manufacturer. The complexity of these cameras varies from a simple scale focusing unit to a completely automatic, motor drive, folding, single lens reflex (the only folding SLR available). All of these cameras, including the simplest, utilize electronically controlled shutter speeds to automatically control the exposure within the range of conditions that a particular camera has been designed to cover. The Polaroid Corporation has also introduced cameras with automatic focusing. These cameras are simple to operate, requiring minimal operator skill. The picture sizes of the Polaroid cameras are limited to 6.5 x 8 cm (2 1/2 x 3 1/4 in), 8 x 11 cm (3 1/4 x 4 1/4 in) and 8 x 8 cm (3 1/8 x 3 1/8 in) in the case of the SLR.

Eastman Kodak introduced two models of its camera during 1976, and plans to expand the line to include more sophisticated cameras. The Kodak cameras also incorporate automatic exposure control. Their picture size is 6.5 x 9 cm (2 1/2 x 3 1/2 in).

Adapters are available which allow instant process film to be used with view cameras, press cameras, and 35 mm SLR cameras. Polaroid film is available for use in the 10 x 12.5 cm (4 x 5 in) size, and a black and white film is manufactured which produces both a positive print and a negative. The negative must be fixed in a special hypo solution immediately after exposure. The resolution of this film, unlike that of most instant process film, is comparable to that of conventional photographic film.

The big advantage of the instant process camera is the ability to see the picture immediately. This is important to the beginner or infrequent user, for it allows errors in framing, focus or exposure to be corrected at the time the pictures are being taken. With the conventional photographic process, such errors are rarely detected in time to allow corrective action. Instant process cameras are therefore excellent for use in photographic training. From a law enforcement standpoint, however, the ability to use the picture as soon as it is taken may be more important than the ability to correct mistakes.

There are two methods of obtaining multiple prints from the instant camera process (unless the picture is taken with a positive-negative film): taking as many pictures as required at the time of photography, or copying the original print using conventional photographic processes to make a negative. Taking duplicate pictures is impractical for any subject involving motion, living subjects, facial expressions, or position of moving vehicles. In outdoor scenes, even the lighting changes. Multiple picture taking can only be used under special circumstances. The use of conventional photographic processes to copy an instant process print produces good duplicates, but it also neutralizes almost every advantage of instant process photography. The end result is that more labor must be put into every print than if it had been made by conventional methods initially. In addition, the instant process pictures lack the detail of conventional prints, picture quality is necessarily degraded by the process of copying, and an enlargement cannot be made without significant loss of detail. It may not be possible to make an enlargement to show minute detail that may be desired long after the original picture has been made.

The instant process camera system is not an inexpensive system to use, particularly if a substantial number of pictures are to be made. Initial equipment cost will be less than for the 35 mm automatic camera. For situations where widely varying numbers of pictures are needed at infrequent and irregular intervals, it is ideal. However, there is no way to use production-line methods to reduce the cost per picture as the total number of pictures increases. A roll or pack of film, which costs many times the cost of equivalent materials for the same number and size of conventional photographs, costs the user the same whether or not it produces pictures. However, the costs are relatively fixed and predetermined.

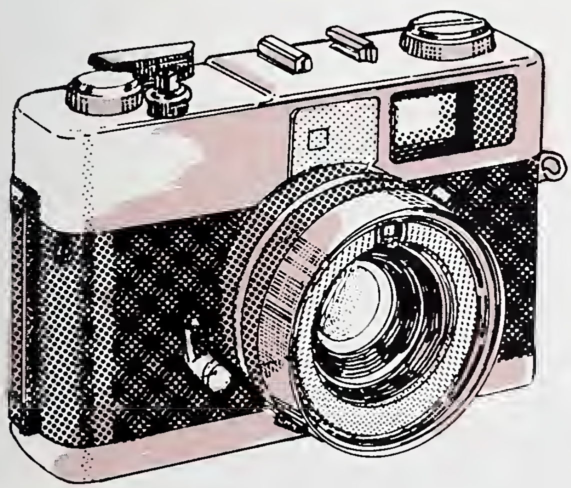
There are a variety of special purpose cameras and accessories available, and the instant process camera can be an outstanding tool for the law enforcement official. Like other tools, it should be used where its characteristics fit the job: informal documentation, supplementary aid on smaller cases that do not require formal photographic evidential coverage, mug shots, internal security badges and similar uses. Instant process photography is a supplement to, and not a substitute for, conventional photography in the law enforcement field.

Automatic Cameras

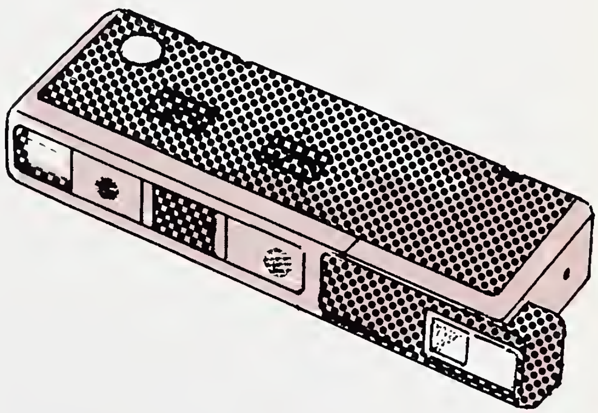
An automatic camera is one in which the normal picture-taking actions of threading the camera and choosing the aperture and shutter speed have been so simplified that the user need have no knowledge of their principles in order to perform the operations properly and obtain a usable picture. The automatic camera senses the exposure the subject requires and, if it cannot adjust to these requirements, either signals the photographer that a mistake is about to be made or prevents the exposure.

The automatic camera has two features that most single lens reflex cameras do not have. First, it uses an already threaded roll of film in a plastic cartridge that can only be placed in the camera in one position, the right one. The cartridge is notched to set the camera properly for the speed of the film in the cartridge, rather than requiring the operator to set the film speed. Secondly, the exposure control system senses the light coming from the subject and automatically adjusts the camera to meet those conditions, rather than indicating the condition in some manner and requiring the operator to do the adjusting. If the light is insufficient for the needs of the camera and film, a warning signal tells the operator to use a flashbulb. Putting in the flashlamp automatically programs the camera to properly expose for the flashlamp and subject, either from the distance for which the camera is focused in the simpler automatics, or by closing the shutter when the proper amount of light has been reflected from the subject in the more sophisticated ones. At least one manufacturer has announced the availability of an auto-focusing 35 mm camera.

These cameras (the highly popular Kodak Instamatic is a typical example) have met a definite need in the law enforcement field. It should not be forgotten, however, that an automatic camera cannot select for an investigator those elements which are important to be recorded in a picture. Directions for camera operation are in the instruction manual that comes with every camera. Directions for making good pictures are much more difficult to communicate. Photographers devote a good part of their professional careers to perfecting this technique. The automatic camera's usefulness will be determined by the operator's judgment in selecting what he photographs, as much as by the camera's technical features.



In addition to the cartridge-loading automatics, there are a number of automatic cameras that use standard 35 mm film magazines. Loading, in these cameras, has been simplified to placing the film in the camera, inserting the end of the film in a slot and closing the camera. In addition, the film speed must be set into the camera by the operator. This type of camera is often provided with greater capabilities than the average automatic camera, in the form of faster and higher quality lenses, higher maximum shutter speeds and, in some cases, interchangeable lenses or front lens elements, giving some choice of focal length. They find considerable use in covert surveillance where a small inconspicuous camera is required but something larger than the sub-miniature negative is necessary.



Sub-Miniature Cameras

A sub-miniature camera is any still camera that uses film which is smaller than 35 mm in width. The classic example of the sub-miniature camera (the Minox, which has been around since pre-World War II) uses 9.5 mm film to produce 50 pictures approximately 8 x 11 mm. Most of the current sub-miniatures, however, are based on a film width of 16 mm and produce pictures from 10 x 14 mm to 13 x 17 mm. Anyone who has tried to get good identification pictures from

16 mm motion picture records will appreciate some of the difficulties to be expected in the use of the sub-miniature camera.

If a camera has a lens of good quality, the film is always the limiting factor in the camera's performance. The theoretical maximum resolution that can be obtained from any f/2 lens is approximately 700 line pairs per millimeter; many available lenses are almost that good. There are very few films that approach that figure, however. Mostly these are extremely slow, very high contrast films that are completely unsuited to the purposes for which we would like to use them. If effective use of sub-miniature cameras is required, it is suggested that comparative tests be made of as many different types of film as possible. From this, identify film with the desired characteristics. Since packaging of film for sub-miniatures is not standardized, it is common practice to obtain a store of cartridges to fit the camera and load one's own film. Obviously, processing is critical to the quality of pictures taken with sub-miniature cameras.

Cameras using the instant loading 110 size film cartridge which produces a 13 x 17 mm picture should also be considered sub-miniature. These cameras, made by all of the major manufacturers, follow the general automatic operation of the Instamatic system except for camera size and picture format. The Pocket Instamatic is not just a camera but a coordinated system of cartridge color film, camera and projector, designed for producing transparencies of color negatives and prints. It may be of particular use in some covert surveillance, since it is an amateur type of camera, rather than a professional type, and may attract less attention for this reason.

Fingerprint Cameras

The need to conveniently record fingerprints, at a period when cameras specifically designed for close-up, small object photography were not available, led to the development of the traditional "shoe-box" fingerprint camera. This was a complete unit of camera, lens, film, lights and batteries, built in the form of an open-ended box. The open end of the box was placed against the surface on which the print was located, the lights were turned on, the shutter was released, and a same-size negative of the print resulted. In spite of all the progress that has been made in other areas of photography, the same fingerprint camera is being used today.

A fingerprint camera is a simple camera, designed to do one job: make full-size records of fingerprints, single or whole hand (or similar marks, such as ear-prints). It is a special-purpose camera which requires basically no operating adjustments by the operator, and has its greatest use as a tool for non-photographic personnel. If its reliability is good and its operation foolproof, it could be a useful piece of equipment. Too often, the available types of fingerprint cameras, while simple to operate, are not automatic in the sense that they warn when things are going wrong. A weak set of batteries would probably not be detected until the operator received his underexposed negatives.

Instant fingerprint records can now be obtained by an instant process camera kit which utilizes a framing guide fastened to the front of the camera. When this is placed against a flat surface, it steadies the camera, keeps it the proper distance from the surface to assure a sharply focused picture, and outlines the area of the subject that will be covered. Lighting must be separately supplied. Also, close-up attachments are obtainable for use on the 10 x 12.5 cm (4 x 5 in) press camera specifically for taking fingerprints. Fingerprints would seem to be an assignment made to order for the single lens reflex camera with macro lens and one of the automatic electronic flash units. Either a tripod or one of the many macro or close-up attachments similar to that provided on the instant process kit would enable most fingerprint assignments to be handled with comparative ease.

Although at first glance the fingerprint problem would seem to be one that could well be handled by an automatic type of camera modified for the purpose, the wide diversity of surfaces on which prints are found and the different techniques required to make them visible make the problem more complex than a cursory examination would indicate. For this reason, the experienced photographer with his more versatile equipment will probably still be required to assure good photographs.

Camera Selection

The great popularity of the 35 mm single lens reflex camera for amateur use has made available a large selection of equipment of high quality and reasonable price. Most of it has been designed to appeal to the inherent tendency of photographers to equate excellence of equipment with excellence of pictures. Excellence of equipment in this context normally is taken to mean the degree of automatic operation built into the camera rather than the degree of reliability, adaptability, resistance to normal field abuse, and a long normal life without maintenance. The law enforcement official choosing photographic equipment should keep this and the following points in mind.

A. When one particular type of subject only must be recorded, and it can be closely controlled, automatic equipment can do a much better job with less operator skill than manual equipment.

B. Automatic equipment is also useful for the production of relatively good and consistently exposed negatives by completely untrained operators under a variety of unfamiliar conditions.

C. Where overall picture quality is the main criterion, there is no substitute for large negative size. No matter how good a small negative can be, a large one of the same quality will always produce a better print. Large negatives require less magnification, and any imperfections will be less noticeable.

The size of the subject that is to be photographed is one of the first concerns when selecting a camera, for it is a limiting factor in the size of the image that will be recorded. Table 1 presents a general classification of subject size.

Table 1. CLASSIFICATION OF SUBJECT SIZES

Size Classification	Subject Dimensions	Examples of Typical Subjects
Large Area	Over 17m (50 feet)	General area, large building, general fire scene, mob scene, general street view, inside of large hall or arena, scene of accident or crime.
Medium Area	3 to 17m (10 to 50 feet)	Large room view, wrecked car, skid marks on road, interior vandalism, crime location, location of bodies, interior accident.
Small Area	60cm to 3m (2 to 10 feet)	Portion of room, general view of very small room, position of body, print of entry, tire or footprint, large weapons, large articles of evidence, documents.
Very Small Area	15 to 60cm (1/2 to 2 feet)	Documents, handprints, wounds, small articles of evidence, tools, weapons, cigarette and cigar butts, damage at point of entry.
Macro*	Less than 15cm (1/2 foot)	Fingerprints, jimmy or tool marks, paint chips, bullet holes, cartridge cases and bullets, hair and skin fragments, signatures.

* Macro is a prefix indicating that the image must be larger, compared to the subject, than is usual in photography. This is done by using special photographic lenses as opposed to the use of a microscope.

Obviously, large format cameras offer a distinct advantage when photographing large or medium size subjects, if small detail is critical to the usefulness of the photograph. Image size is discussed in more detail in the section of this guide that follows.

The selection of a camera will also be influenced by the manner in which the subject is illuminated (either by existing light or supplemental lighting), or if the subject is moving or stationary.

While this guide places emphasis on the selection of equipment to obtain the highest quality photograph possible, not all choices can or should be based solely upon negative quality. Rather, the person making the camera selection must use careful judgment based upon a multitude of factors such as size, weight, level of operator skill, adaptability to many assignments, or the ability to handle fast action. A checklist of camera characteristics that should be considered when selecting a camera is at the end of this section. One special characteristic is conspicuous by its absence: personal preference or known skills of your photographers with specific types of equipment. In using the checklist, you can set your own requirement for each characteristic based upon what you would consider to be ideal for your application and rate the various cameras that you are considering accordingly.

CAMERA SELECTION CHECKLIST

1. Overall size
2. Total weight
3. Time to set up
4. Operating skill
5. Available accessories
6. Initial cost (camera & one lens)
7. Relative cost/picture
8. Maximum lens aperture
9. Maximum magnification
10. Maximum negative area
11. Versatility
12. Distortion control
13. Types of film used
14. Maximum shutter speed
15. Instant process available
16. Follow fast action
17. Ultra wide angle lens
18. Automatic exposure control
19. Conspicuousness
20. Interchange lenses
21. Number of lenses available

LENSES

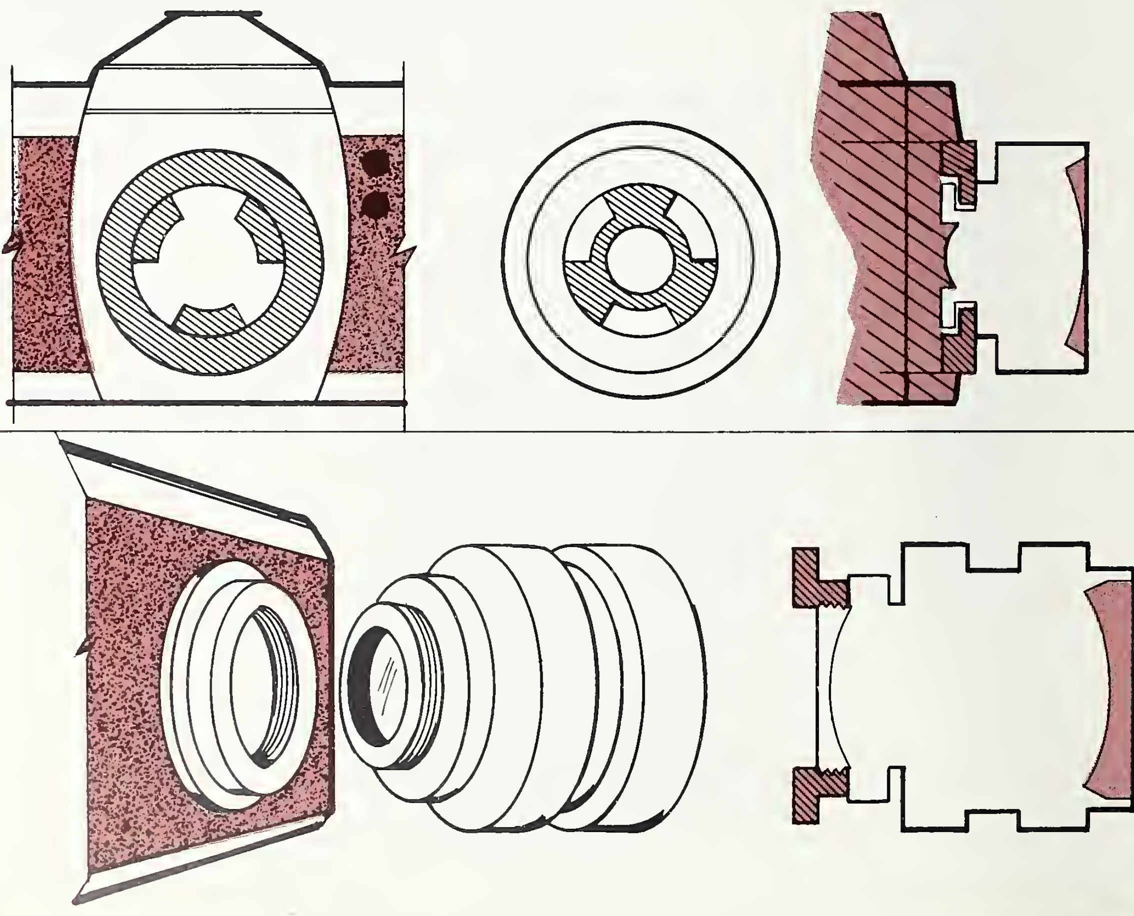
Lenses extend the police photographer's ability to gather evidence by making it possible to obtain photographs under a wide range of conditions.

LENSES

Depending upon the assignment, the photographer will need a wide-angle, normal, or long-focus lens to record the subject of interest. Aside from the obvious requirement that the lens must fit the camera that it will be used with, the selection will boil down to focal length (which determines the size of the image) and f-number (which determines how bright the image is). Naturally, one is also interested in the limits of use of a specific lens, such as general purpose, macro, or process.

In most cases, one will select a lens that is provided by the camera manufacturer and designed for use on that particular camera. The lens mounts will fit properly and assure that the lens is in the proper position for focusing. It also assures that the automatic or preset diaphragm used on so many single lens reflex cameras will be properly mated mechanically to the mechanism that is a part of the lens. The manufacturers of most cameras with interchangeable lenses provide some selection of lenses of varying characteristics for use on their cameras. Some 35 mm single lens reflex cameras provide a choice of 20 or more lenses of various focal lengths, speeds, angles of view and special use characteristics.

Why look elsewhere than to the original manufacturer of the camera for an additional lens? Two reasons. Not all camera manufacturers are lens manufacturers, although a great many are. You may be forced to buy a Brand-X lens if an



accessory lens is wanted. In the professional field, particularly with press and view cameras, it is common practice for the photographer to make his own selection of lenses and have them fitted to the camera of his choice. Some lenses that eminently fill special needs are available from one or two manufacturers only, and such manufacturers are normally lens specialists and not camera manufacturers.

The great variety of 35 mm single lens reflex cameras has brought into the market a large selection of "universal" Brand-X lenses, designed to fit many makes and models of single lens reflex, rangefinder and other 35 mm cameras. All of these lenses are made by independent lens manufacturers and they supply adapters to fit the lenses to most popular cameras. Why use Brand-X lenses for professional work? In general, they are of high quality, as good as those furnished by the camera manufacturer. Many times, they provide an in-between selection of focal length, speed or some other characteristic desired by the professional, that is not available in the camera manufacturer's line of lenses. Because of larger production in some popular models, prices may be lower than for the equivalent lenses as available from the camera manufacturer. The user of good quality "universal" accessory lenses will normally be satisfied with them, but he must assure himself that the desired lens is properly adapted to the particular camera on which it is to be used.

Image Size

The size of the image that a lens forms is determined by three things: the size of the subject, the distance from the camera to the subject, and the focal length of the camera lens. The ratio between the size of the image and the focal length of the lens, for subjects which are at least 10 focal lengths from the camera, will be the same as the ratio between the size of the subject and its distance from the lens.

Focal length is an inherent "designed-in" property of every lens. For a simple thin lens made of a single piece of glass, it is the distance from the center of the lens to the film when a very distant object is sharply focused on the film. Photographic lenses are thick lenses (combinations of a number of simple lenses), however, and methods of measuring the lens to film distance are complicated. There is no readily identifiable point, in a lens which may be two or more inches thick, from which to measure; so we speak of the "equivalent focal length" of a photographic lens, referring to the focal length of the simple lens that would give the same image size. All photographic lenses are marked with a focal length. This is a nominal value and is normally within 5 percent of the actual focal length.

For the rapid calculation of image size, it is convenient for the photographer working in the field to know the "coverage" ratio of each lens-camera combination which he uses. This figure will quickly give him, with only a rough mental calculation, the total field of the camera. The maximum dimension (height or width) of the negative divided by the focal length of the lens is the coverage ratio. For any object at any distance, the distance times the coverage ratio for that lens-camera combination will give the maximum field of the camera.

For example, a 35 mm camera (36 mm maximum negative dimension) and a 50 mm lens have a coverage ratio of 36/50, which equals 0.72 or approximately 7/10. If the subject of interest is 100 feet from the camera, the total field of view is 7/10 of 100, or 70 feet. A 6-foot man is a very small portion (somewhat less than 10%) of the field of view, so his image is going to be an equally small percent of the total length of the picture (less than 35 mm). Notice that it does not matter in what units the lens focal length is marked, as long as you figure the coverage ratio using the same units for the length of the negative. Similarly, the calculated figure for the camera field of view will be in the same units you use to measure the distance: meters, feet, yards, etc.

As another example, consider two cameras, a 16 mm movie camera and a 35 mm single lens reflex, both with 50 mm lenses. For the 16 mm camera, the coverage ratio is 10.3/50 or approximately 2/10. For the 35 mm camera, the coverage ratio is 36/50 or approximately 7/10. At 20 feet, the field of view of the 16 mm camera is 2/10 times 20 or 4 feet. The picture will include only 2/3 of a 6-foot subject. For the 35 mm camera at 20 feet, the field of view is 7/10 times 20 or 14 feet. The 6-foot subject will cover about half the negative. Table 2 gives the coverage ratios for some commonly used image sizes and lenses.

Lens Speed

Lens speed is a subject of interest and confusion to beginning photographers and to those not well versed in optics. A camera is like a closed room with a window in the center of one end wall, and the film on the center of the opposite wall. The light reaching the film through a large window will be quite bright, while much less light will reach the film through a small window. Similarly, for a given window size, the amount of light on the film will decrease if the room becomes longer. The amount of light reaching the film, then, is a function of the length of the room (the focal length of the lens) and the size of the window (the diameter of the aperture or diaphragm of the lens). Specifically, the amount of light reaching the film is determined by the ratio of the focal length to the diameter of the aperture. This ratio is called the relative aperture of the lens. The amount of light reaching the film will be the same for any specific relative aperture, regardless of the focal length of the lens. The relative aperture is the f-number or stop of the lens; if the focal length is twice the diameter of the aperture, the ratio is 2/1, or 2 and it is written as f/2. Similarly, if the focal length is four times the diameter of the aperture, the ratio is 4 and the f-number is f/4. Note that the size of the aperture for a given focal length decreases as the f-number increases. Thus, the brightness of the image on the film decreases with increasing f-number.

It is convenient in photography to vary the length of time that light is allowed to act on film by factors of two to one. So lens diaphragms are marked with a series of relative aperture numbers that have a two to one exposure factor between adjacent stop numbers. The opening in the lens diaphragm is circular, and it is the area of the aperture that determines how bright the film image is. Doubling the diameter of a circle makes its area four times as great; thus, our f-numbers will have an inverse-square relationship with the required exposure. If we

Table 2. FIELD COVERAGE RATIOS

Lens Focal Length (mm)	Picture Size				
	24 x 36mm	7.5 x 10.3mm	6 x 6cm	6 x 7cm	10 x 12.5cm
15	2.4	.69			
25	1.4	.41	2.4	2.8	
35	1.0	.29	1.7	2.0	3.6
50	.72	.21	1.2	1.4	2.5
58	.62	.18	1.0	1.2	2.2
75	.48	.14	.80	.93	1.7
80	.45	.13	.75	.88	1.6
90	.40	.11	.67	.78	1.4
100	.36	.10	.60	.70	1.25
135	.27	.076	.44	.52	.93
150	.24	.069	.40	.47	.83
165	.22	.062	.36	.42	.76
180	.20	.057	.33	.39	.69
270	.13	.038	.22	.26	.46
375	.096	.027	.16	.19	.33

multiply the f-number by two, the diaphragm area will be decreased by two squared or four (requiring an exposure duration four times as long as the original to produce the same effect on the film). Since it takes two multiples of two for the new exposure, it is spoken of as an exposure increase of two stops.

Table 3 will make this a little clearer. It compares, starting with a relative aperture of f/1.4, the standard f-numbers which are normally used for marking relative apertures, the total number of stops of exposure change which they represent, and the relative brightness of the image on the film with respect to the image at f/1.4. In going from f/1.4 to f/22 (a normal range for a lens of this speed) the exposure is increased by eight stops and the image on the film is 1/256 or 0.0039 times as bright as the original image.

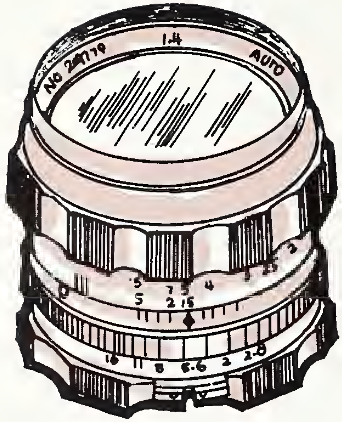
Most lenses have the maximum relative aperture (smallest f-number) marked on the lens and as the first stop on the aperture control. The next stop marked on the aperture control will be the next larger one of the above series of standard stops. For instance, on an f/1.7 lens, the next marked stop would be f/2. This does not represent a change of a full stop but only seven-tenths of a stop from maximum aperture. This must not be forgotten since the change for the first aperture stop is not always a full stop on a great many lenses.

Speed in a lens, as determined by the relative aperture, lets us know how long we have to expose the film. Using table 2, we find that with an f/1.4 lens, the light can be one-eighth as bright as with an f/4 and still allow the same length exposure. For the same brightness of light on the subject, the shutter speed can be shortened by a factor of eight. For the law enforcement photographer, lens speed is of the greatest value in a covert surveillance situation where supplementary illumination cannot be used and the difference between an f/1.2 and an f/1.4 lens may mean not getting a picture with the f/1.4.

Depth of field is another important factor. The nearest object of interest and the most distant one must both be sharply focused at the same time. Whether or not they will be is dependent on several factors, all of which must be balanced against each other. A large depth of field is particularly important when the amount

Table 3. LIST OF STANDARD f-NUMBERS

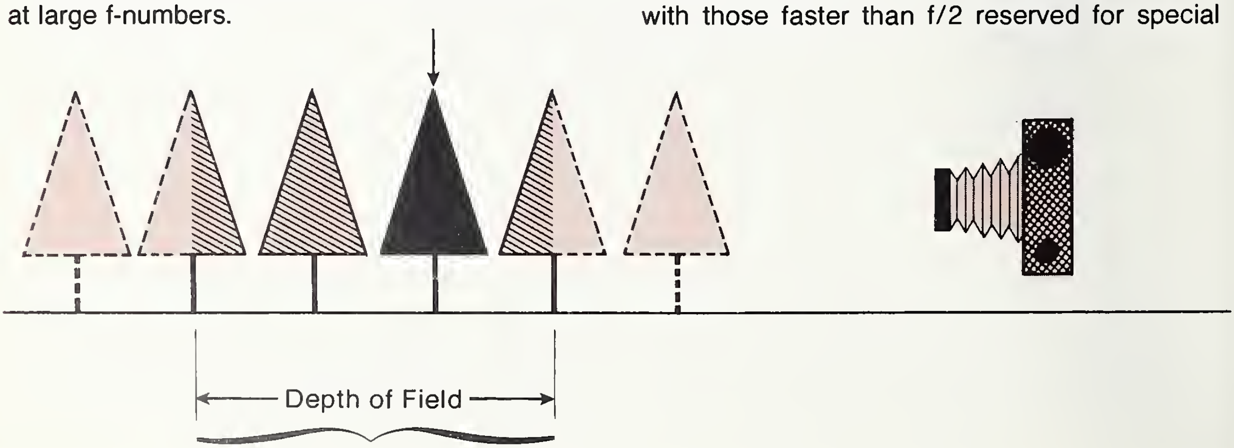
Stops	—	1	2	3	4	5	6	7	8
f-Number	1.4	2.0	2.8	4.0	5.6	8.0	11	16	22
Relative Brightness	1.0	1/2	1/4	1/8	1/16	1/32	1/64	1/128	1/256



of enlargement to be given the negative is great. A large depth of field is obtained when the f-number of the lens is large, the focal length is short, and the nearest object distance is large. Conversely, a very shallow usable depth of field is obtained when the lens f-number is small, the lens focal length is large, and the near object is very close to the camera. These requirements are obviously conflicting, and the lens aperture or f-number is normally the one which can be most easily adjusted to get the desired depth of field. Focal length must be chosen based on required image size; the near and far objects are where we find them; and the negative size determines the amount of enlargement. The working photographer quickly finds that his sharpest pictures tend to be shot at large f-numbers.

Still other factors are pertinent to the subject of lens speed; speed is obtainable only by the sacrifice of other qualities. The sacrifices required for extreme speed in lenses used primarily for general law enforcement photography do not produce corresponding benefits. Covering power must be sacrificed for speed; in general, even moderately wide angle lenses will be one or two stops slower than lenses with smaller angular coverages. As speed is increased, size and weight go up rapidly. A two-stop increase in speed automatically doubles the diameter of the lens. In addition, the internal construction must be made more complex, requiring 8, 10 or even more optical elements where 4, 5, or 6 were sufficient on the slower lens. The more complex lens will be physically longer than the simpler one, and this in turn requires still larger diameter front and rear elements to prevent light cut-off or vignetting. The weight and size are thus increased still more.

Focusing range, in general, is also sacrificed for speed. The more complex lens designs are much more sensitive to changes in object distance than the simpler designs. An f/1.2 lens may show a definite fall-off in sharpness when used at 3 feet while a corresponding f/2.8 lens may give sharp pictures down to 12 inches. Such problems are generally only discovered by actual experience with the lens, at which point it is too late to correct the problem. Many ultra-fast lenses cannot be stopped down beyond about f/11 or f/16, and neutral density filters must be added for bright light conditions. For general purpose work, lenses with apertures in the range of f/2 to f/4 will be found adequate, with those faster than f/2 reserved for special



situations where the maximum obtainable lens speed is the only way to get a picture.

Lens coatings, too, must be considered. Whenever light strikes the surface of a glass lens, about 4 to 5 percent of it is reflected back from the surface, a much smaller amount is absorbed in passing through the glass and the balance is transmitted through the glass to the opposite surface, where again about 4 percent is reflected back to the first surface. Thus, about 8 percent of the light is lost for every element in the lens which is bounded by air on both sides. For a 6-element uncoated lens, the total light leaving the lens is about half of that entering it. With a complex zoom lens with 15 to 20 elements, the light leaving the lens would be only a small part of that entering.

By coating each lens surface with a layer of magnesium fluoride or similar material, the reflection losses can be reduced. The layer must have a uniform thickness of exactly 1/4 of a wavelength of light. With this technique, the light reflected at each surface for one particular wavelength can be reduced to about 1/2 percent, with an overall reflection for all wavelengths of 1 to 2 percent per surface instead of the normal 4 percent or more. By using more complex coatings with 7 or 8 layers and different materials, the reflectance per surface can be brought down to an overall figure of 1/2 percent. These multi-layer high-efficiency coatings are being increasingly applied to newly designed lenses. The resulting increased light transmission is of great value in complex zoom and extreme wide angle lenses of many elements. What is of equal importance is that the light from internal reflections in an uncoated lens may be reflected back to the film in the form of stray light that fogs the film and decreases the image contrast, degrading image resolution. The multi-layer coating prevents this degradation, which is particularly noticeable in a back-lighted subject.

Angular Coverage

As previously discussed, the size of the image formed by a lens depends solely upon the distance to the subject and the focal length of the lens. The field of view of the lens can be visualized as a cone which extends forward from the center of the lens, spreading out around its optical axis to infinity. The angle between the sides of this cone is the angular coverage of the lens. Similarly, a second cone extends from the lens on the image side of the lens to the film; the angle of this cone is the same as the viewing angle. Whether the image completely covers the negative depends upon the focal length, the angular coverage, and the size of the negative. The image that is formed is circular, while the negative is square or rectangular. The dimension of concern, then, is the diagonal measurement of the negative.

It is readily apparent that if the area of the image circle just covers a 35 mm negative, it will only partially cover the area of a 6 x 6 cm negative. Thus, if the same focal length lens is to be used on a larger film size camera, the angular coverage of the lens must be increased to provide an image at least as large as the film. In the case of a view camera, which has distortion control adjustments, the angular coverage must result in an image area even larger than the film size. The lens manufacturer will state angular coverage either in degrees or in terms of the maximum film size that will be covered by the lens when it is focused at infinity.

The normal lenses for any camera will have an angular coverage of 45 to 50 degrees when used on the film size for which they were designed. Their coverage ratio will be approximately 0.7 to 1.0. They produce a pleasing perspective in the negative and will lead to natural appearances and convenient viewing distances. In movie cameras, the tendency is to use a normal lens with a considerably smaller angular coverage, generally about 30 to 35 degrees. This is partly for convenience in filming; the subject is further from the camera and so does not go out of focus so easily, as it moves around. Table 4 lists the length of the film diagonal, the normal lens focal length (which is approximately equal to the diagonal) and the minimum angular coverage for several picture sizes.

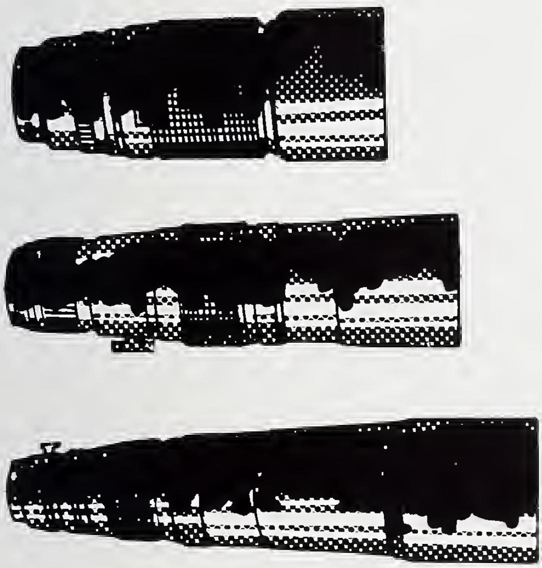
The law enforcement photographer will have frequent need for other than normal focal length lenses. These too are tabulated in table 4. Wide angle lenses are defined as lenses that are designed to provide a much greater than normal angular coverage when used with the picture size for which they were designed. They are always of shorter focal length than the normal lenses for a given picture size. This has lead to the misconception that all short focal length lenses are wide angle, which is incorrect. All lenses with angular coverages exceeding 50 to 60 degrees are wide angle lenses. Their coverage ratios will be much greater than 1. Even a wide angle lens can become a normal lens if it is used on a sufficiently smaller film size than it was intended for, because of the reduced angular field of the image that is recorded. Lenses with coverage angles of 100 or more degrees are generally considered to be extreme wide angle lenses, although there are no hard and fast limits. Fish-eye wide angle lenses covering 180 degrees to 220 degrees are available for many picture sizes and camera models. These extreme coverages are obtained only at the expense of great distortion. Straight lines a short distance from the lens axis are greatly bowed and appear in the picture as though curved. Such lenses have little application to law enforcement use.

The opposite of the wide angle lens is the narrow angle or long-focus lens, commonly mis-called the "telephoto" lens. The term telephoto, although commonly used, may be incorrect; optically, a telephoto lens has a special design. It is composed of two combinations of elements, a negative or diverging combination nearer the film, with a positive or converging combination ahead of it. Its distinguishing char-

Table 4. ANGULAR COVERAGE FOR DIFFERENT PICTURE SIZES

Film Size	Picture Area		Angular Coverage					
			normal		wide angle		narrow angle	
	length and width	diagonal (mm)	focal length (mm)	angle (degrees)	focal length (mm)	angle (degrees)	focal length (mm)	angle (degrees)
Super-8	4.1 x 5.8mm	7.1	13	31	09	43	23	18
9.5mm	8 x 11mm	14	15	50	NA	NA	NA	NA
110 Cartridge	13 x 17mm	21	23	50	NA	NA	NA	NA
16mm	7.5 x 10.3mm	12.7	25	29	15	46	100	7
35mm	24 x 36	43	50	47	28	75	180	14
126 Cartridge	28 x 29mm	40	50	44	28	71	180	13
120 Roll	6 x 6cm (2-1/4 x 2-1/4 in.)	85	75	59	47	84	270	18
120 Roll	6 x 7cm (2-1/4 x 2-3/4 in.)	92	90	54	58	77	180	29
120 Roll	5.4 x 7.9cm (2-1/8 x 3-1/8 in.)	96	100	51	47	91	180	30
Polaroid Pack	9 x 10.8cm (3-1/4 x 4-1/4 in.)	140	135	55	NA	NA	NA	NA
4 x 5 Sheet	9.5 x 12cm (3-3/4 x 4-3/4 in.)	153	165	50	90	81	375	23
8 x 10 Sheet	19.7 x 25.8cm (7.3/4 x 9-3/4 in.)	325	300	57	240	68	480	37

acteristic is that the distance from the front of the lens to the film is much less than the focal length of the lens; that is, it gives a long focal length in a short lens. The term telephoto should be restricted to lenses of this type, and the term "tele-lens" or long-focus lens used as the general term for lenses used to provide large images of distant subjects. Coverage ratios for tele-lenses will be small, from about 0.5 to 0.05 or less.



Long focus lenses are normally listed by focal length, but are selected on the basis of the relative magnification they provide. Relative magnification is computed with respect to the normal focal length lens for a particular picture size. A 50 mm lens is normal for a 35 mm single lens reflex camera. If we replace the normal lens by a 300 mm lens, the magnification is 300/50 or 6 times. A 16 mm camera has a normal lens of 25 mm focal length. The same 300 mm lens on the 16 mm camera provides a magnification of 300/25 or 12 times. A lens of this focal length might well be a telephoto type.

There is a very wide selection of long-focus lenses available today. These are very useful in surveillance photography, in which image size is of crucial importance. However, while all 300 mm lenses, for example, provide the same image size regardless of the camera with which they are used, they may not be equally suitable because of the large magnification to which surveillance negatives are normally subjected. A 300 mm lens for a 20 x 25 cm (8 x 10 in) view camera is designed to have a wide angular coverage, and this may involve a sacrifice of picture sharpness near the center of the field. Such a lens would produce results inferior to those of a 300 mm lens designed for use on a single lens reflex with maximum center resolution. The only simple way to tell whether the large format lens is usable is to test the two lenses on the same subject. In general, the lens designed for the smaller negative size will provide the higher quality picture, in lenses of equal focal length and aperture.

Lens design and manufacture is a series of compromises. Invariably, many of the characteristics which are desired in a lens have conflicting requirements: one can only be obtained by sacrificing another. Speed is obtained at the sacrifice of angular coverage and overall image quality. The ability to work in both visual and infrared light without refocusing the lens is obtained at the expense of simplicity of design, by using many elements of more expensive glass and by reducing maximum lens aperture. Maximum resolution, as required for microfilming, is obtained by designing lenses that work well for only a very limited range of subject distances. Therefore, most lenses are designed with some specific and limited type of use in mind.

The normal camera lens is designed to work at distances from infinity to about 10 focal lengths from the subject, in daylight. Its performance is invariably improved by stopping down to a smaller than maximum aperture. Many general purpose lenses suffer noticeable deterioration when used in infrared light (which is important to the law enforcement photographer) and most lenses must be refocused in infrared. A special focus mark is provided on many lenses for infrared illumination. If it is not present, increase the lens to film distance, after visual focusing, by about 5 percent of the focal length of the lens and make tests about this point to determine the position giving the sharpest image.

Within its limits, a high quality general purpose photographic lens will provide more detail in its image than the average film can record. For certain special subjects, however, special lenses should be used. These are listed below in the order of their importance.

Enlarging Lenses

A general purpose lens produces an image which is not flat when the subject is flat; the edge of the image curves in toward the lens. In enlarging, we have a flat negative as a subject, and the image is on a flat paper surface. Both subject and image are also very close to the lens. Both conditions cause a deterioration of the final image. The remedy is to use an enlarging lens, which is designed to have a very flat field and to work at distances from the paper of 2 to 10 focal lengths. A high quality enlarging lens will also be color corrected to work with tungsten light, which has much more red than daylight.

Macro Lenses

The law enforcement photographer frequently needs to get large images of small objects: fingerprints, handwriting, tool marks, etc. His subject distance will be very much less than 10 focal lengths. While some general purpose lenses work well under these conditions, many are completely useless; only careful tests will tell how well a given general purpose lens can form an image of a very close subject. A macro lens is specifically designed to provide sharp images of subjects at distances that approach one focal length. When used with bellows or extension tube, macro lenses can produce images that are several times the size of the subject.

Macro lenses have other unusual properties; as the image size approaches that of the subject, a dividing line is approached where the normal photographic rules change. As long as the image is smaller than the subject, long-focus lenses provide larger images of the subject, and short-focus lenses have more depth of field than long-focus lenses.

When the image that is formed becomes larger than the subject, however, the rules reverse. For larger than actual size images, short-focus lenses produce larger images for a given lens-to-film distance than long-focus lenses, and long-focus lenses have more depth of field than short-focus lenses. There is no sudden reversal of the rules; rather, the trends that have governed image behavior when the image is smaller than the subject become less well defined, then start increasing in the opposite direction.

The use of a copy camera is a good example. For images of less than actual size, the normal procedure is to keep the film and subject fixed and move the lens to focus the image. This becomes more and more difficult as the one-to-one ratio is approached. At one-to-one, moving the lens merely changes the image size with little change of focus; focusing must be done by moving the subject or the film instead of the lens. For images much larger than actual size, it becomes necessary to keep the lens and film stationary and move the subject to focus, since under these conditions a change in lens to film distance changes the focus slowly and the image size rapidly.

Process and Copy Lenses

The process lens has much in common with the enlarging lens, although it is intended for use in a camera as opposed to an enlarger. It might be considered a superior enlarging lens. It is designed specifically for use at a one-to-one magnification and normally performs well at magnifications of from ten-to-one to one-to-ten. It is a much slower lens than an enlarging lens, the usual speed being f/8, and is generally of much longer focal length, 500 mm to 1000 mm being common. In the process lens, speed and angular coverage have been sacrificed in order to gain maximum resolution over the full field of the lens, and over a large wavelength range. The process lens is the basic lens for all color separation work; it must be capable of making negatives through three different color filters (red, blue and green) and producing three separate black and white images of exactly the same size. This requires better color correction than is necessary for any other photographic purpose. Where a fixed copy camera is set up for document reproduction of all types, the process lens is the best choice for producing the highest quality work.

Zoom or Variable Focus Lenses

This type of lens is a relative newcomer to the photographic field. The modern zoom lens has been made possible by two developments: the electronic computer, which made practical the design of complex systems with the 12 to 20 or more elements required for the zoom lens, and the lens coating, which made it possible for lens designs with large numbers of elements to produce crisp, high-contrast images. From this combination came, first, heavy and cumbersome zoom lenses for television cameras. The technique was then extended to 16 mm and 8 mm movie camera lenses. Today, the zoom lens is the standard and only lens on most of the Super-8 movie cameras for non-professional use. In the 35 mm single lens reflex field, the zoom lens has become a standard accessory lens for a large proportion of all the camera systems available. While zoom lenses are common in the three fields of television, motion pictures and still photography, the requirements in each field are quite different.

Still pictures require the maximum resolution and sharpness. While slight variations in focus with change in focal length can be tolerated, since focusing can always be done after focal length is selected, the resulting negative must be comparable in contrast, sharpness and resolution with those produced by the best of the fixed focal length lenses. In addition, the lens speed must be high; the 35 mm zoom lens must have an aperture of at least f/3.5 for the lens to be competitive. Size and weight must be kept to a minimum.

In the motion picture field, the overall picture quality requirements are as high as for the 35 mm single lens reflex, but this problem is somewhat simplified because of the shorter focal lengths involved. For motion picture and TV work, however, it is essential that the lens remain in perfect focus as the focal length is changed; without this, the zoom shot becomes impossible. It was the zoom shot, with many of the attributes of the dolly shot and none of the difficulty in performing it, that inspired the development of the modern zoom lens. In the TV zoom lens, resolution is not as important as in still and movie lenses, since the TV system has a very limited resolution compared to film. Light transmission and contrast are more important for TV use.

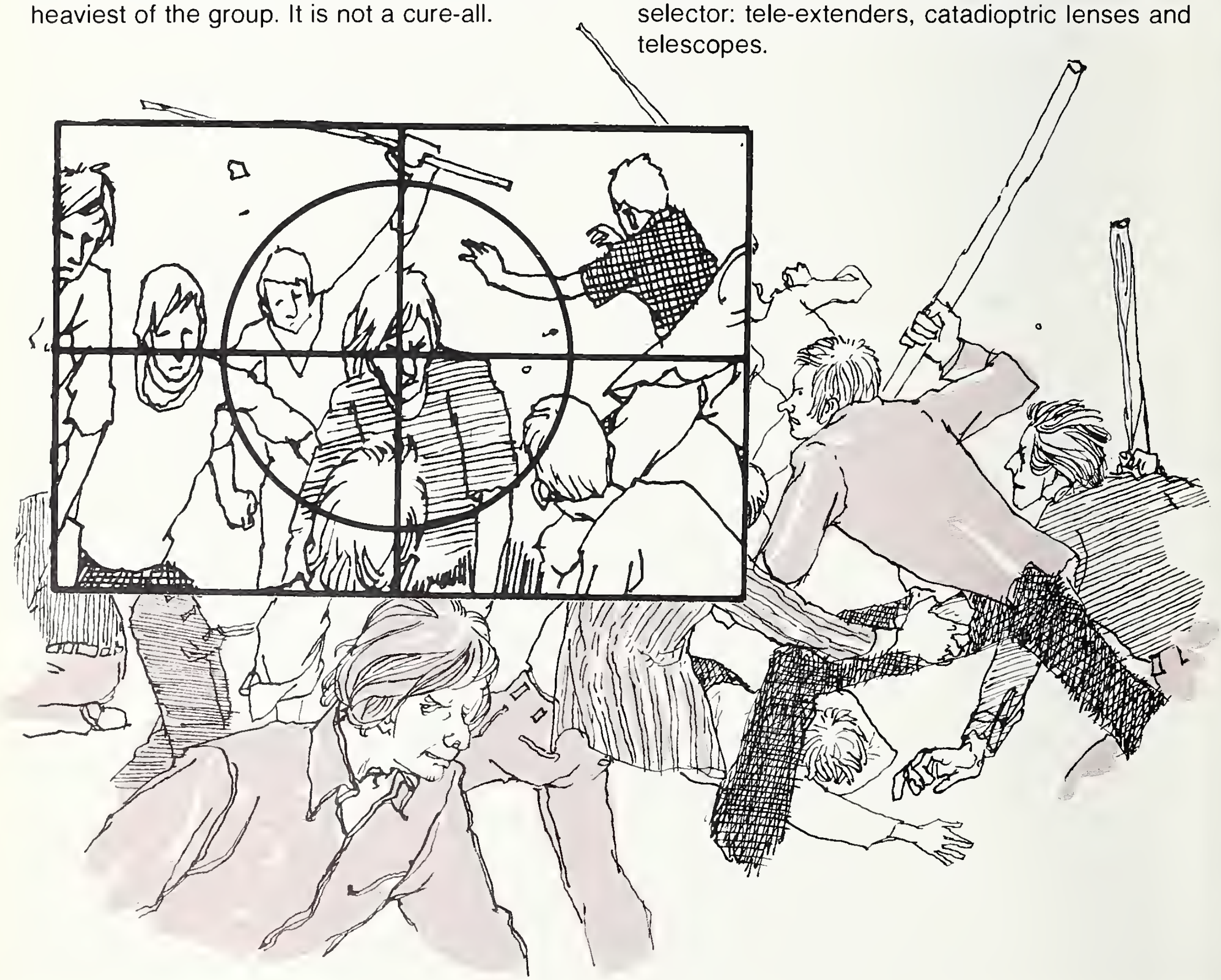
For the law enforcement photographer, the zoom lens has several advantages. It enables him to choose his perspective and image size independently. He can set up his camera where he has to, or wants to, in order to obtain the required perspective. A quick shift of the zoom control, and the image size is adjusted to the available film area. This should result in faster, more efficient picture taking, as well as pictures that show just what is wanted, no more and no less

A second advantage is found in those zoom lenses that combine the variable focal length zoom with the short distance performance of the macro lens. With only one lens, a much wider range of assignments can be handled, from accident scene, to long distance identification of a suspect, to full size images of wounds and tool marks. The macro-zoom lens is constructed so that, in the zoom mode, a set of moving elements controls the lens focal length. When shifted to the macro position, the focal length is fixed (generally at the short end of the focal length range) and the same moving elements now do the focusing and control the lens aberrations so that the image is sharp even though the subject is much closer than normal.

Since focal length range is the major attribute of the zoom lens, it is pertinent to mention some of the available ranges. In the 16 mm movie and TV field, a 10-to-1 focal length range has become almost standard for professional work. This is normally from 12 to 120 mm. Thus, one lens covers the full range from extreme wide angle to full telephoto.

In the 35 mm single lens reflex field, such extreme ranges have not as yet been produced. Those available start at 35 mm and go to approximately 300 mm with a three-to-one overall range. One or two manufacturers supply lenses for their own cameras with a six-to-one range of 50 mm to 300 mm (the greatest focal length range available) and 200 to 600 mm (the longest focal lengths). The 50 to 135 mm range is a very good combination for the law enforcement photographer, particularly in conjunction with a separate 24 to 35 mm wide angle lens. One manufacturer combines a 50 to 125 mm zoom lens with a 2X extender, which converts it to a 100 to 250 mm lens. The lens also performs as a macro lens, providing images up to one-to-one. This is a very practical combination. However, it must be noted that the zoom lens will be larger and heavier than the equivalent fixed focal length lens of the same maximum focal length and aperture. Though the zoom lens on a 35 mm single lens reflex is equivalent to a whole battery of single lenses, it also results in always carrying the largest and heaviest of the group. It is not a cure-all.

When it comes to surveillance jobs, the zoom lens will generally not be of long enough focal length for the really tough assignments, and a truly long fixed focal length lens (500 mm or more) will probably be required. A good criterion is to use at least one millimeter of focal length for every foot between the subject and the camera in order to get a recognizable identification shot. Two millimeters per foot will guarantee results, from the focal length standpoint. For lenses of such extreme focal length, every other requirement, except lens speed, is subordinated to image size. A few manufacturers have concentrated on this field, but the selection is meager compared to that available below 500 mm. The laws of optics prevent any lens with a focal length of more than 500 mm and a reasonable aperture from being anything but large, heavy and expensive. For problems of this type, there are three aids for the equipment selector: tele-extenders, catadioptric lenses and telescopes.



Tele-Extenders

A tele-extender is a type of auxiliary lens that is produced by many manufacturers. It is used between a regular lens and the camera to increase the focal length of the regular lens by a factor of two or three. Where there is an occasional need for an extra-long focal length lens, this is probably the best solution. All extenders degrade the quality of the image to some extent. They also increase the f-number of the lens by the same factor by which they increase the focal length: an f/4 lens becomes an f/8 when used with a 2X extender. Some extenders are specifically designed for use with particular lenses and, in general, these can be expected to give the best quality images. Since the results with different extenders differ greatly, and cannot be predicted, the only remedy is to take test pictures with your own equipment before buying one.

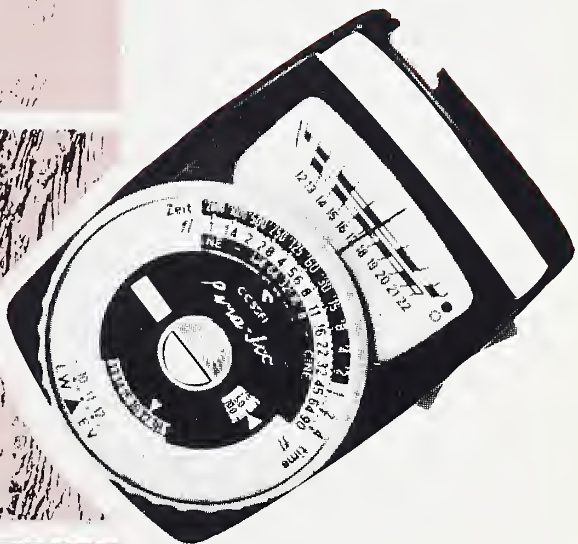
Reflecting or Catadioptric Lenses

There is a fairly good selection of special long-focus lenses of the catadioptric type. These are combinations of lenses and mirrors, used to produce effects that cannot be obtained by lenses alone. Their focal lengths are normally 500 mm or more. These lenses are noted for their extremely small size as compared to their focal length. As focal lengths increase, catadioptric lenses in general are capable of producing sharper and higher quality pictures than the equivalent conventional lenses. A 1000 mm catadioptric lens may be no longer than a 200 mm conventional lens resulting in a relatively small and compact long focus camera system. Such lenses, however, do not have the conventional adjustable aperture, and the available f-stops are limited.

Telescopes

A useful alternative, where a focal length of more than 1000 mm is required, is to use some form of telescope or spotting scope in place of the photographic lens. Each type of scope has its own problems and will have to be considered on its own special merits. One greatly respected astronomical telescope (the Questar) is available in a model which has been modified for use with a single lens reflex 35 mm camera for strictly photographic use. The telescope and camera combined are less than 16 inches long, and provide a focal length of 1400 mm or more, depending on the extension tubes used. The total system is very convenient to use.

EXPOSURE METERS



Use of exposure meters can insure the photographer of consistent proper exposure under many conditions.

EXPOSURE METERS

An exposure meter of some type is an essential part of the working kit of every law enforcement photographer. With it, the photographer measures the illumination coming from the subject and entering the camera lens. For every lens aperture and film speed, there is a unique product of illumination and time in seconds that represents the total amount of light required to produce the optimum density in the developed film. The exposure meter measures the illumination, and the calculator into which the ASA film speed has been entered is used to compute the length of time the light from each lens aperture must be allowed to act.

Exposure meters as separate units are not as important as they once were because of the widespread use of cameras with built-in meters and automatic exposure controls. The essential principles of operation and use are, however, the same for separate meters and built-in meters.

Separate exposure meters are of two general types: incident light and reflected light. Built-in exposure meters of the types normally used in single lens reflex cameras are almost universally of the reflected-light type. A third type of meter, which is found less frequently, is the spot meter. It too is found as both a separate and a built-in meter. The integrating or flash meter is another type.

The reflected-light meter, which was the first of the electric exposure meters to be used and is still the most commonly encountered, is simple in principle. A photoelectric cell (photocell) is placed in a position near the camera lens and arranged to receive light from about the same angle as an "average" camera lens. Two types of photocells may be used with all types of exposure meters. One type, the photovoltaic, (barrier layer) directly converts the light into an electrical current which is measured by a sensitive ammeter. The amount of the current is directly proportional to the brightness of the light. This type of cell has the advantage of not requiring any battery, but its ability to measure weak or dim light is limited. The second type, the photoconductive photocell, has a resistance that is inversely proportional to the illumination falling on it. A miniature battery is used to provide the source of electric current. The photocell controls the current, which is measured on a sensitive ammeter. This type of photocell has the advantage of being very much smaller than the barrier layer cell and very much more sensitive to dim light. The most commonly used photocell of this type is the cadmium sulphide, or CdS, cell. Silicon photodiodes, which provide a greater sensitivity to changing light levels, are replacing the CdS cell, and more recently, some manufacturers have started to use gallium arsenide-phosphide (GAsP) cells, which are the most sensitive of the photocells presently available.

The reflected-light meter has the following advantages: it is small, rugged, relatively inexpensive, and requires no upkeep if of the barrier layer type; can be used from the camera position; can be filtered to see colors in about the same relations as the film sees them; and has a reasonably long life.

Its disadvantages are: its field of view should match that of the camera lens but is generally larger; it is influenced too much by small areas of bright illumination in the subject, tending to expose for the brightest area and underexpose much darker ones; it is unduly influenced by the overall lightness or darkness of the subject, tending to expose so as to offset these differences; while it looks at a subject from the same position as the camera lens, it does not respond to light in the same fashion as the lens-film combination. Some type of shield or baffle is essential in order to limit the light reaching the cell to that coming from the same direction as that reaching the film through the camera lens. Because of the way in which the cell responds to light, this is difficult to do regardless of whether the barrier layer or the CdS cell is used.

The incident-light meter uses a different approach. It looks at the light which is reaching the subject from all directions. The meter faces toward the light source and infers the proper exposure from this light. It too, uses either type of photocell.

The advantages of the incident-light meter are: it tends to record all parts of the subject at density levels which correspond to their relative brightnesses; it is not affected by the proportion of light to dark areas in the subject, but only the brightness of the light falling on the subject; it is more useful in very dim illumination, since it measures the total incident illumination, which is always more than the reflected illumination.

The disadvantages of the incident-light meter are: it should be used from the subject position, with the meter facing toward the camera; it is not generally usable for subjects which are themselves luminous, but only with those that are luminous because they reflect light which is falling on them from an external source.

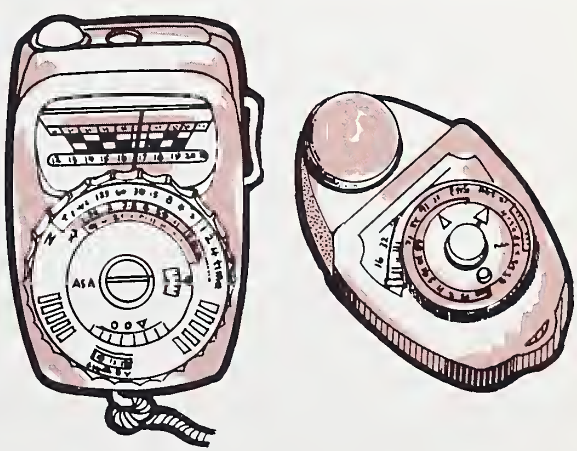
Many of the available professional meters are designed for use with either reflected light or incident light. This is the ideal system, since it provides maximum flexibility for use under unusual conditions: the consistency of the incident-light meter and the ability of the reflected-light meter to deal with self-luminous subjects.

A third type of exposure meter is the spot meter. It is basically a reflected-light meter which has been placed behind a telescope so that the sensing photocell sees only a very tiny area of the subject. Each small element of the subject can have its brightness measured directly by the meter from the camera position.

The advantages of the spot meter are: it sees and responds to each spot in the subject in the same way that the corresponding area of the film in the camera does; it can be used from the camera position to measure exposure on inaccessible subjects; and it is ideal for measuring exposure for extreme long-focus lenses, since it sees only what the lens sees.

The disadvantages of the spot meter are: it is time consuming to use, since many points on the subject must be read and the exposure is computed from the brightest and darkest elements of major importance; it is larger and more expensive than either the incident or reflected-light meters; and it requires more judgment on the part of the user.

There is a fourth type of exposure meter, originally used in photomicrography but currently found in a modified form in most single lens reflex cameras with built-in exposure control. This meter has the high sensitivity to dim light provided by the photoconductor, the small area reading capabilities of the spot meter, and much of the tolerance of the incident type meter for bright subject areas. In photomicrography, a probe-type of exposure meter with a very small photocell is used to measure the brightness of the image directly in the film plane of the camera. The same principle is used in the single lens reflex camera having a through-the-lens metering system. This uses one or more photocells, placed in the optical system so that they measure the brightness of the image on the viewing screen. Two types of adjusting system are used. In the stop-down manual system, there is no connection between the lens diaphragm and the exposure meter. The lens is stopped down manually until the meter indicator is centered. The image is then the right brightness on the viewing screen and the lens is at the proper ap-



erture for taking the picture. This system can be used with any lens on the camera, since diaphragm coupling is unnecessary. However, it forces the photographer to always work with a stopped-down image on the viewing screen, which may give problems in poor light.

The alternate system, which requires mechanical coupling between the lens diaphragm control and the meter, is the one more commonly used. As the diaphragm control on the lens is operated to adjust the exposure meter indicator, the lens is not actually stopped down, but the corresponding stop is preset into the system. The meter is adjusted simultaneously with the diaphragm control and so reflects the preset stop in its reading. When the exposure release is operated, the lens is automatically stopped down to the preset point before the exposure is actually made. Many single lens reflex cameras are arranged so that either method can be used.

Either method has the advantage that it compensates for bellows extension on close-up shots; for variations in diaphragm calibration from lens to lens; for variations in lens transmittance; and for filters placed over the lens. Either method eliminates the hypersensitivity to bright light sources just outside the field-of-view of the lens, which is characteristic of photocells external to the main lens. Both through-the-lens systems are quite sensitive to feed-back of stray light through the eyepiece of the viewing system. The stop-down method is more prone to trouble since it is always working with a lower light level at the sensor.

The through-the-lens exposure system normally uses two or more photocells, which are so positioned that each views a limited area of the scene. Their relative effects on the camera exposure are balanced for the best overall result. Generally, the center portion of the picture area has more effect on exposure than the outer borders have.

Another type of through-the-lens system in use has a single photocell positioned on the lens axis, a small distance away from the film plane. This gives a center-weighted exposure determination. The cell is retracted from its position as the shutter release is operated.

Exposure meters using CdS detectors are accurate over a broad range of illumination levels; however, they suffer a loss of sensitivity at low light levels immediately following use under conditions of bright illumination. The CdS detector will slowly recover full low light level sensitivity over a period of many minutes, but may not provide correct exposures if one takes pictures outdoors and immediately attempts to use the detector in a dimly lighted interior. Several manufacturers have introduced cameras that replace the CdS detectors with silicon photodiodes or gallium arsenide-phosphide cells, both of which are much more sensitive than the CdS detector and retain low light level sensitivity even after use in bright light.

A relatively new development in the exposure meter field is the integrating or flash exposure meter. These were made practical for normal use by the miniaturization and low power requirements of solid-state electronic modules, which reduced the size of the unit from a laboratory instrument to a pocket meter.

The unit senses any sudden increase in light and measures both brightness and duration, even when the latter is only a few microseconds. The product of the two, which is the total exposure, is then displayed on a meter. With this type of meter, the photographer can make a flash lighting setup containing several different sources fired by slave units from a master flash lamp and predetermine whether his exposure is correct or not, something that had not previously been practical. Meters of this type measure the reflected light received at the camera from the full subject for the full duration of the flash.

Some other types of exposure sensing systems are in use, such as photocells around, but external to the lens, and photocells built into the reflex mirror as part of the coating which reflects the light to the viewing screen. While there are some advantages and disadvantages to each different system, all are capable of providing good results. Some are more forgiving of one type of error and some of another. A little experience with any one of them will allow the photographer to learn their individual idiosyncrasies and obtain consistent exposures under many conditions.

FILM

Size, speed, color sensitivity, grain, contrast, singular packaging and processing are all factors to be considered in film selection.

FILM

Film available for the use of the law enforcement photographer varies widely in size, speed, color sensitivity, grain, resolution, contrast, maximum density and sensitivity to handling, as well as in how it is packaged for different types of cameras, and whether it is processed by conventional photographic methods or is of the instant process type.

For this guide, we have basically considered both equipment and film as being in three general size categories: small, medium and large. Film sizes 35 mm wide and under fall in the small category. Films from 35 mm to 90 mm fall in the medium size category. Any film larger than 90 mm has arbitrarily been placed in the large category. In the small size are found sub-miniature cameras and 35 mm cameras with picture sizes of 24 x 36 mm. In the medium size category are found a collection of cameras taking pictures 6 x 4.5 cm (2 1/4 x 1 5/8), 6 x 6 cm (2 1/4 x 2 1/4 in), 6 x 7 cm (2 1/4 x 2 3/4 in) and 6 x 8 cm (2 1/4 x 3 1/4 in), plus a few odd sizes (mostly instant process). In the large size are found 8 x 10.8 cm (3 1/4 x 4 1/4 in) (mostly instant process), 10 x 12.5 cm (4 x 5 in) and 20 x 25 cm (8 x 10 in) pictures.

The 20 x 25 cm (8 x 10 in) print will be considered the standard picture size toward which all law enforcement photography is aimed. This will be true for the majority of pictures intended for formal court presentation and it is the preferred size for many other purposes. It will not be true, however, for pictures from specialized systems used for making personnel identification photos, for some fingerprint photos, and for some surveillance pictures where picture size may be determined by how much enlargment the negative can stand.

With reference to their classification as large, medium and small, negatives will require the following amounts of linear enlargement to make 20 x 25 cm (8 x 10 in) prints: large size negatives, from zero to three times; medium size negatives, from three to eight times; and small size negatives, more than eight times. The division between medium and small negatives falls at a critical point in the recording capability of photographic material. The result is the requirement for a major change in total photographic technique when the shift is made from medium to small size negatives. The dividing line between the two techniques is not abrupt or rigid, but the personnel responsible for selecting equipment that will determine the picture size used for various purposes should be aware that the decision is not to simply "make the print larger." Small negatives can and do produce excellent prints even larger than 20 x 25 cm (8 x 10 in). They do not do so as consistently or with the same lack of care and attention to detail at every stage in lighting, exposing, processing and printing the final picture, as can be done with medium or large negatives. This is a fact of life due to the basic nature of the photographic process.

Experience and tests have shown that a photographic print will appear crisp and sharp to the observer only under certain conditions. One of these conditions is the fineness of the detail it contains. Detail finer than about 1/20 of a millimeter (that is, 10 line pairs per millimeter) will not contribute to its apparent quality. If the finest detail is coarser than this, the observer can tell that the quality has been lowered. Slow and medium speed films can record well over 100 line pairs per millimeter when used with ordinary lenses, and at apertures several stops smaller than maximum. High speed films have lower capabilities; even under ideal conditions, 80 line pairs per millimeter is seldom reached. Dividing the line pairs per millimeter in the negative by the required line pairs per millimeter in the print gives us the maximum number of times the negative can be enlarged before the deterioration in print quality, due to lack of detail in the negative, becomes noticeable. With the fast or medium speed films, under any condition other than ideal, a 50-line pair per millimeter resolution is a reasonable expectation. This sets the maximum enlargement at five times, which means a 12.5 x 18 cm (5 x 7 in) print from a 35 mm negative, before quality starts to drop. A 6 x 6 cm (2 1/4 x 2 1/4 in) negative, under identical conditions will give a 28 x 28 cm (11 x 11 in) print, which means we can crop off part of the negative and still get a 20 x 25 cm (8 x 10 in) print with good detail.

The guidelines given above must not be taken as hard and fast numbers. A seven times enlargement from one negative may look good, while the duplicate shot next to it on the roll may look very bad. Obviously, something happened to make the two different, but determining what it was and preventing it from happening again may be impossible tasks. The generalities drawn will be found valid in practice. They should be given proper consideration in determining the film size that will form the foundation for photography in any law enforcement operation.

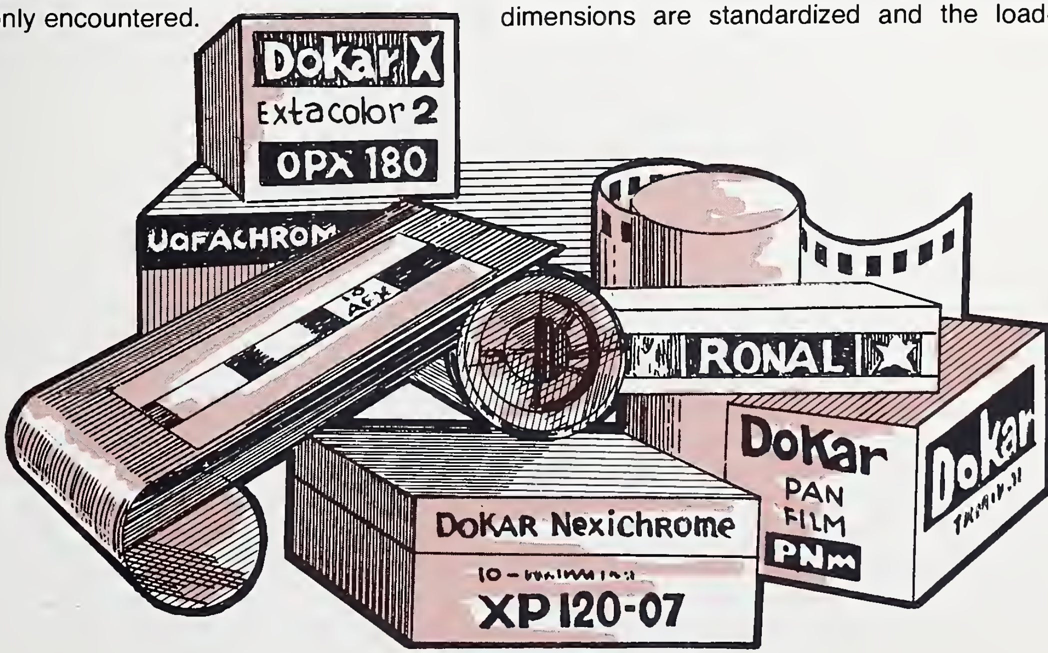
Packaging

Film is packaged differently for use with different cameras. Six different types of packaging are commonly encountered.

Roll Film. This consists of long strips of film, normally for eight to twelve exposures, backed by a slightly wider strip of light-proof paper, marked with exposure numbers to provide the proper spacing between frames, and rolled onto a light-tight spool which can be loaded into a camera in daylight.

Bulk Film. This consists of carefully slit widths of film of various dimensions, similar to roll film but minus the backing paper. Generally supplied in lengths of 100 feet or more in light-proof wrappings. It must be manually loaded into the camera or some form of cartridge or magazine, in total darkness, before it can be used. Bulk film includes motion picture film, which is normally on a flanged spool which is proof against subdued light and is provided with sufficient extra film on the roll (generally about 10 feet) to serve as a leader and trailer to protect the main portion of the film from being fogged during the process of loading into a 16 mm camera.

Film Cartridge. This is the standard packaging for film for 35 mm still cameras. A length of 35 mm wide, perforated motion picture film, sufficiently long for 20 or 36 exposures of 24 x 36 mm size, is wound on a standard size spool, and inserted in a metal magazine provided with a velvet lined slit through which the end of the film is extended. The magazine dimensions are standardized and the loaded



magazine is light-tight in direct sunlight. The protruding end of the film strip is fastened to the camera take-up spool, and the film transferred to this spool during picture taking. After exposure, the film must be manually rewound back into the magazine before the camera can be opened and the film removed.

Instant Load Cartridge. This consists of two film magazines (one for unexposed, one for exposed film), connected by a film gate or aperture which guides and locates the film. Since the film is already attached to the take-up spool, there is no film threading or rewinding involved in using the instant load cartridge. The cartridge is shaped so that it can only be inserted in the camera in one way. Inserting it automatically adjusts the camera exposure mechanism to the proper speed setting for the type of film contained in the cartridge. When the last exposure is made and the film advanced to the end, the camera can be immediately opened and the film removed without rewinding. Instant load cartridges are available in three sizes: 126 size cartridges for 29 x 32 mm picture size instant load cameras; 110 size cartridges for sub-miniature instant-load cameras; and Super-8 mm motion picture camera cartridges of 50 feet.

Sheet Film. This is packaged in light-proof packages containing a specified number of accurately cut sheets of heavy base film, notch coded in the upper right hand corner of the sheet (when facing the emulsion side and the film is vertical) for easy identification of film type and emulsion orientation. Individual sheets are manually removed from the packing in total darkness, and loaded into individual sheet film holders containing two sheets of film, back to back, separated by a divider. The holders are closed with opaque slides, after which they can be handled in full daylight, inserted individually into view or press type cameras and one slide removed for exposure. The slide is replaced in the reverse position to indicate exposure and the holder either reversed for exposure of the second film or returned to the darkroom for processing. Sheet film is commonly found only in sizes 6 x 8 cm (2 1/4 x 3 1/4 in), 8 x 10.8 cm (3 1/4 x 4 1/4 in), 10 x 12.5 cm (4 x 5 in), 12.5 x 18 cm (5 x 7 in), and 20 x 25 cm (8 x 10 in).

Film Pack. This is used instead of sheet film when many pictures have to be made in rapid succession. A film pack consists of a stack of thin-base sheet films loaded in a metal frame with opaque black paper over the top sheet and between films. A long paper tab is fastened to the bottom of each sheet. When the first tab is pulled, the front safety cover is removed from the stack. After the front film of the stack is exposed, its paper tab is pulled, transporting the film from the position in the front of the stack, emulsion facing the lens, around the bottom end of the stack and into the back with the emulsion facing away from the lens. A flat spring divider, originally pushing the entire stack to the front of the film pack frame, is now between the exposed and unexposed sections, pressing the unexposed sheets forward to register with the front of the pack frame. The films are then exposed in sequence. Film packs are highly convenient in the small sizes and provide a large exposure capacity in a very small space. Both fully exposed and unexposed packs can be placed in a film pack adapter in daylight. The adapter is placed in the camera and used exactly like a sheet film holder. Pack film must be made on a thin base, to allow for the sharp bend in the reversing operation when the tab is pulled. This makes pack film, in the 10 x 12.5 cm (4 x 5 in) and larger sizes, highly subject to film buckling, sometimes causing local out-of-focus patches in the negative. Increased cost per exposure (as compared to sheet film) is another disadvantage that must be considered.

Film Speed

An important characteristic of film is film speed. This is a measure of how much light must be allowed to act on the film in order to record a picture. For a given level of illumination on the subject and a given lens aperture, the higher the film speed, the shorter the exposure required. However, high speed in film can only be obtained at a price: a very significant loss in the film's ability to record fine detail and a great increase in the grain size. Grain is a characteristic, overall mottled appearance in the emulsion forming the photographic image. A fine-grain film can have its image enlarged many times before grain becomes apparent to the eye, while a high-speed film may have its grain apparent to the eye with no enlargement. The coarse-grain film has to be used only in large negatives or serious limitations on maximum acceptable enlargement must be accepted. It is not likely to produce a good print from a 35 mm camera, whose negative must be enlarged eight or more times to get a 20 x 25 cm (8 x 10 in) picture.

Grain is a function of exposure and development as well as of film type. In general, overexposure and underdevelopment tend to decrease grain size. Fine grain developers reduce grain size, sometimes at some sacrifice of film speed. Excess soaking in processing solutions, and higher temperature processing solutions, contribute to increased graininess.

Since films are available in a wide range of speeds, a medium-speed film is generally the best choice for all around use. High-speed films are best reserved for those jobs where any picture is better than none and tests have shown that medium-speed films produce no picture. The smaller the area of the negative to be used for the print, the more careful one must be to minimize grain. Speed ratings range from ASA 8 for slow process films, to ASA 4000 for extremely fast surveillance films.

It should be noted that the effective film speed which can be obtained on any emulsion is subject to some control by the amount of development given and the type of developer used. This variation, for a given emulsion, is normally less than the variation between a medium speed film and high speed film.

Color Sensitivity

A characteristic of all black and white films is their varying sensitivity to light of different colors. Film is available in three major types of color sensitivity: color blind or blue sensitive film; orthochromatic or blue and green sensitive film; and panchromatic or blue-green-red (all-color) sensitive film. Blue sensitive films will show objects that are bright red to the eye as black in the print. Orthochromatic films will show blue and green objects in shades of gray that are similar to their visual appearance, but red objects will still be much too dark. Panchromatic films tend to show all colors in relative shades of gray that match their relative brightness to the eye. The majority of black and white film used in law enforcement today is panchromatic and it is best for general use. However, where large amounts of one type of work are being done, the use of one of the other types of film may offer advantages.

All manufacturers issue specification sheets for each of the films which they manufacture. These sheets list the film characteristics, give correct processing times and formulas, and list the type of subject for which the film is specially suited.

COLOR FILMS

The films so far considered have been the normal black and white negative type. Color films must also be considered.

Packaging. All color films are packaged in exactly the same manner as are black and white films. The selection of sizes is more limited and not all types of color film are available in all of the common sizes. Some color negative materials are available in a very limited size range.

Film Speed. Color films in general are much slower in speed than black and white films. Like black and white films, however, the fastest color films provide the poorest resolution and the grainiest pictures. The rated speed of color films will vary from about ASA 25 to about ASA 400. Fidelity of color reproduction tends to decrease as film speed goes up and is always sacrificed when any color film is pushed. Pushing (normally applied to reversal or positive color film only) involves changes in processing procedures which result in higher effective film speed ratings, at the expense of more grain (often much more), poorer color rendition and loss of overall quality in the transparency. It has value when film is known to have been underexposed one or at most two stops. It should be used as an emergency tool and not used consistently.

Types of Color Emulsions. Color films come in the form of positive or reversal emulsions and color negative emulsions. All color films are very complex, multiple layer emulsions, as compared to the simple one to three layers found in black and white films (anti-halation sub-coating, silver halide emulsion, plain gelatin over-coating). Some black and white films have only the essential silver halide emulsion layer.

Positive Color Films. All currently used color films are multilayer films with a minimum of three separate light sensitive emulsions (plus necessary filter and separation layers), each of which records one of the three primary colors (for most emulsions red, green and blue). In any emulsion, the image starts at the surface and extends downward through the layer in proportion to the illumination at that point. Development converts the image into a varying thickness of metallic silver, like a relief map upside down, backed by a complementary layer having the same contour of undeveloped and still light-sensitive silver emulsion under it, the whole making up the thickness of the original emulsion layer. In all reversal emulsions, this metallic silver negative image layer is chemically bleached or removed. The remaining complementary positive image is then re-exposed to light and developed to a positive image. In a black and white reversal film, the positive image is made insensitive to light and washed. In color film, it is necessary to convert the positive silver image into a color image formed of colored dyes. And, in the color reversal process, each of the three layers of the film must be treated individually and converted separately into differently colored dye images. The complexity of the process and necessity for strict control are evident.

In positive color films, variations in the compositions of the dyes and the compounds used to produce them cause variations in the "grain" size of the dye and in the sharpness and resolution of the resultant dye images. Higher speed emulsions still tend to produce coarser grained images. These are some of the elements that determine the varying characteristics between color films of different types.

Color Negative Films. Color negative films are similar in many respects to positive color films: they are multilayer in construction, start with metallic silver images and end with color dye images. The development process is carried only to the point where the negative image layer is obtained. Conversion from silver image to color image occurs at this point, but the colors in the conversion are different. They are complementary to the actual colors of the image at that point. A blue object becomes a negative blue or yellow image. A green object becomes a negative green or red image. There are several advantages to the color negative. Film speeds tend to be higher for a given graininess and resolution. The negative process is more forgiving of minor errors in exposure than is the reversal process required for positives. Paper positive prints are made from color negatives by direct printing on negative color printing paper and the processing procedure is simpler than the reversal processing procedure that must be followed when making prints on positive color paper. Color negatives also make excellent black and white prints, on a special panchromatic printing or enlarging paper. This is exposed and processed in a manner identical to that for normal black and white printing paper. Color negative material would seem to have the best of both worlds. Unfortunately, the color rendition in general has been inferior to that obtained with the reversal processes.

As the process improves in overall quality, there is certain to be a growing application in law enforcement photography for the color negative with its built-in capability for good black and white prints without the need for a copy negative.

Instant Process Film

The Polaroid instant process black and white film takes a picture, develops it, prints it and develops the print, in a single operation taking about 15 seconds. Instant process film is packaged for use only in instant process cameras, in rolls, film packs, and single exposure packets that fit a special developing holder that can be used with any 10 x 12.5 cm (4 x 5 in) press or view camera which takes standard size film holders. Instant process film is available in rolls, producing a picture size of 8 x 11 cm (3 1/4 x 4 1/4 in), with ratings of ASA 200 (Type 42), ASA 3000 (Type 47), ASA 10,000 (Type 410), and high contrast (oscilloscope recording). Film packs producing a picture size of 8 x 11 cm (3 1/4 x 4 1/4 in) are available with ratings of ASA 75 (Type 105) and ASA 3000 (Type 107). Single exposure packets are available in the 10 x 12.5 cm (4 x 5 in) size with film speeds of ASA 50 (Type 55 P/N), ASA 200 (Type 51), ASA 400 (Type 52), and ASA 3000 (Type 57). Types 105 and 55 P/N are a positive-negative variety which produce a conventional black and white negative, plus a positive paper print. The negative may be discarded or cleared, washed and dried by conventional processing methods, after which it can be enlarged or printed like any other negative. Lantern slide transparency film is supplied in rolls, ASA 200 (Type 146L) to make 8 x 10 cm (3 1/4 x 4 in) lantern slides, and ASA 800 (Type 46L) to make 8 x 11 cm (3 1/4 x 4 1/4 in) lantern slides.

Polaroid instant process film is also available in color positive or "Polacolor" form, each exposure producing one positive paper print. This film has an ASA rating of 75. It is available in rolls (Type 48) producing an image size of 8 x 11 cm (3 1/4 x 4 1/4 in); in film packs (Type 88) size 8 x 8.5 cm (3 1/4 x 3 3/8 in) and (Type 108) size 8 x 11 cm (3 1/4 x 4 1/4 in); in single exposure packets (Type 58) size 10 x 12.5 cm (4 x 5 in); and SX-70 which produces an image of 8 x 8 cm (3 1/8 x 3 1/8 in). The instant process color film is not quite as "instant" as the black and white. The color requires 60 seconds for developing, but does not require cleaning and coating after development, as does the black and white.

At the present time, Eastman Kodak manufactures a single instant process film, available only in color, type PR 10. The picture area of this film is 6 x 9 cm (2 1/2 x 3 1/2 in). The film speed is ASA 150.

Storage

Photographic materials—film, paper and processing solutions—deteriorate with age. The expiration dates given on film and paper apply for storage at room temperature (not over 75 °F) Deterioration is greatly slowed by storage at low temperature (40 to 50 °F), as in a normal refrigerator. Film so stored will show but slight deterioration after several years of storage. Film that has been refrigerated, however, should be allowed to remain at room temperature in the sealed container for about three hours before use. Exposure to high temperatures will cause rapid deterioration, particularly at temperature above 90 °F.

Film and cameras should never be left in a car parked in the hot sun, particularly in the glove compartment or the trunk. Exposed film may deteriorate more rapidly than unexposed film, and color film may be more sensitive to high temperatures than black and white film.

Summary

It is rather obvious at this point that no single type of film will be best for all law enforcement tasks. In most small departments two or three types should be adequate. A medium speed panchromatic, general purpose film which is available in all of the sizes that are used should be standardized as the major film and used whenever possible. This gives the individual photographer the maximum amount of experience with one emulsion, and is the best way for him to learn what his film will and will not do. A panchromatic process-type film will be of great value where the material to be photographed has very low contrast, such as faded photographs and printed matter, or primary monochrome, like some fingerprints. Many other uses for the process type of emulsion will be found. Proper choice of developer formulas greatly broadens the contrast range that can be covered, particularly in the direction of reduced contrast by using soft working developers.

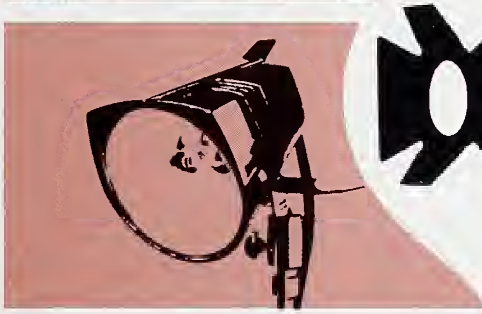
There will also be requirements for an extremely high speed emulsion for surveillance and stakeouts. It would be worthwhile to make comparative tests on a typical subject with at least two "ultra-speed" emulsions to determine just how short an exposure can be used while still getting usable prints. Practical, comparative experiments of this type with different films and developers will provide the best information to the photographer. When the technique is needed, it is at hand and proven.

The problem of color films versus black and white and conventional versus instant process films is complex. Easy answers may not be readily available.

Color versus black and white should be decided on the requirements of the application. Color photography is much more complex than black and white. For many departments, use of color means that all color processing will be contracted out. This means that processing quality will probably be held to a more uniform standard than when done in-house (in any but the largest departments where a major effort can be justified to achieve processing control). While quality can become more uniform under these conditions, flexibility to cope with unusual situations will be correspondingly lessened. It would appear that for many years to come black and white photography will be a necessity in some form in almost all police departments.

Instant process versus conventional materials is relatively simple to answer. If professional photographic services are needed, both types of materials will be used, because there are places where each excels. If photography is a secondary effort, to supplement other in-house information, exclusive use of instant process materials can be the right answer.

LIGHTING EQUIPMENT



Supplementary lighting problems can usually be solved by the informed application of either an electronic flash, a photo flash or flood lights.

LIGHTING EQUIPMENT

The problem of providing supplementary lighting for taking law enforcement photographs has always been a difficult one to solve. With equipment available today, the solution is getting much simpler. Three basic types of supplementary lighting are available: electronic flash, photoflash, and floodlights. What they will and will not do, and where they are of greatest use, will be considered.

The electronic flash lamp is the most convenient method, and it will solve most lighting problems for still picture taking. The electronic or repeating flash gun is a relatively simple device which has been available but not widely used in photography for almost 40 years. One of the many unglamorous beneficiaries of the space program, it has developed into a compact, inexpensive, light-weight, and very powerful light source which now "tells itself what to do photographically."

In the electronic flash, a small battery provides low voltage direct current electrical power, which is fed into a storage tank or capacitor over a time period of 10 to 30 seconds, until the capacitor is fully charged. This power is converted into light energy by discharging the capacitor through a Xenon flash tube at the instant the camera shutter is open. The Xenon tube has the ability to very efficiently convert the electrical energy stored by the capacitor into an extremely intense pulse of light (radiant energy), and compress the conversion into an extremely short time period.

The flash of light from the Xenon tube has many desirable characteristics. It approximates the color of daylight, so it works equally well with black and white and with color film. The duration of the light is so short (about 1/500 of a second at the very longest, to as short as 1/100,000 of a second) that there is little danger of any subject or camera motion showing during the time the exposure is made. Because of the small size of the Xenon tube, it is simple to design very efficient reflectors to concentrate all of the light where it is needed in the field of the camera.

Electronic flash lamps are rated for the amount of light they put out in several ways: in beam candlepower-seconds, a direct measure of the integrated output in light units; by the electrical input to the flash lamp in watt-seconds; by the guide number of the system when used with film of a stated ASA speed rating; or by total light output in lumen-seconds. The guide number, provided in a table accompanying the unit, is the most meaningful to the photographer. Dividing the guide number by the distance (in feet) from the flash lamp to the subject gives the f-number required for correct exposure with a film of the stated ASA rating. Typical guide numbers will be in the range from 25 to 50 or more for color film with an ASA rating of 25. At a 3 m (10 ft) distance, lens apertures will be from f/2.5 to f/5.0. Convenient calculators are often integral with the flash unit.

Electronic flash sources are compact, some smaller than 35 mm cameras. They are light in weight, typically less than one pound, and have a life of thousands of flashes. Three types of power sources are found: (1) Dry batteries of the standard flashlight type in the AA or A size. Typically, a set of batteries will give 100 flashes in the higher powered units; more in the lower. (2) Rechargeable nickel-cadmium (Ni-Cad) battery packs of about the same size as the flashlight battery pack. The Ni-Cad pack normally gives fewer flashes per charge but can be recharged hundreds of times. A charger recharges the batteries when it is plugged into the 115 Volt ac line. (3) Converters that allow operation directly from the ac power supply, thus saving batteries where line power is available. In some flash units, the battery charger serves also as a converter.

Two different types of electronic flash lamps are now in use. The first, or manual, type takes a fixed amount of charge from the batteries for every flash and uses it all. If more light is put out than is needed, the photographer has to stop down the lens to obtain the correct exposure. The second, or automatic, type varies the duration of the flash to suit the needs of the situation.

The first automatic electronic flash lamps used a quenching circuit, controlled by a photocell sensor that measured the reflected light from the subject. This type of circuit turns off the flash lamp as soon as the correct amount of light has been put on the subject, but continues to drain the energy from the storage capacitor until it is completely discharged.

The latest type is the thyristor-controlled electronic flash lamp. This is preset for the lens aperture to be used, in most cases with a choice of two or more apertures. The flash unit is provided with a photocell sensor which measures the amount of light reflected back to the camera from the subject. It starts measuring as soon as the flash comes on and, as soon as the light has totaled up to the correct exposure for the stop selected, the thyristor turns the flash off, saving the balance of the energy that was stored in the capacitor. When the capacitor recharges, only the actual amount of energy used to take the picture is replaced, rather than the whole amount needed to completely recharge the capacitor. This makes for a great saving in battery energy, so that many more flashes per set of batteries (or per charge on the rechargeable ones) are obtained. Pictures can be taken more rapidly, since it takes less time to charge the capacitor fully when it starts with a partial charge.

The major advantage of the automatic unit is that it greatly simplifies the problem of taking pictures with flash illumination; exposure is automatically determined. This will be found especially helpful when the photographer is using both flash and existing illumination. Balancing the two for a pleasing overall effect is simply a matter of selecting the desired aperture setting of the flash lamp, choosing a lens aperture 1 or 1-1/2 stops smaller than this (to prevent the flash from completely overriding the existing light) and setting the camera shutter speed in the normal manner for the bright areas of the picture. Other possibilities will suggest themselves.

The traditional source of supplementary illumination is the photoflash lamp: a glass bulb, similar to an incandescent lamp bulb, filled with a measured amount of metal wire or shredded metal foil in an atmosphere of pure oxygen. A primer, which is fired by an electrical fuse, ignites the wire or foil on command when the shutter is operated. The foil burns with a brilliant

flash of light lasting about 1/25 of a second. Photoflash lamps are often fired from "flash guns." These are flashlight-type cases which contain the battery for igniting the lamp, an efficient reflector for controlling and directing the light and a wire connecting the flash-lamp to the synchronizing circuit in the camera so that the flash goes off when the camera shutter is fully open.

Electronic flash lamps fire instantly (within a few microseconds) when their firing circuit is closed. Photoflash lamps require an appreciable length of time after the firing circuit is closed before the illumination reaches its maximum value. The delay varies with the type of bulb, ranging from 5 to 20 milliseconds. With photoflash lamps, the firing circuit must be closed before the shutter starts to open. Most camera synchronizing circuits have two settings for this purpose: "X" for electronic flash where the firing circuit is closed after the camera shutter is fully open; "M" where the firing circuit is closed about 15 to 20 milliseconds before the shutter is fully open. The correct setting must be made for the type of illumination being used.

The big advantage of the photoflash bulb for the photographer who only occasionally needs a few bulbs, but wants them ready to go without prior preparation, is that the bulb has an unlimited shelf life, and is a convenient, ever-ready source. For the high volume flash user, the main advantage is that the photoflash bulb is a compact source of much more light than can be obtained from the electronic flash lamp. In a small amount of space, enough lighting can be stored to properly illuminate fairly large outdoor areas, such as accident and crime scenes. The guide numbers for photoflash bulbs used with ASA 25 color film are typically 40 to 50 for even small bulbs, such as the AG-1B, and exceed 100 for the large "press" bulbs.

Those who use instant process or other cameras that are designed to use the smaller photoflash bulbs will quickly find that it is not possible to fully illuminate a large area, such as the scene of a night time traffic accident, for in order to get all of the area of interest into the field of view, it is necessary to stand so far away from the subject that insufficient light reaches the scene. Adaptors are available to allow the use of other "flash guns" designed for larger photoflash bulbs, or electronic flash lamp units. Even with flash equipment that provides more illumination, it may still not be possible to illuminate the entire scene. When necessary, two people working together can cover quite large areas, "painting" the entire scene with light. One person operates the camera on a tripod, shutter set on bulb, opening the shutter momentarily on command. The other, using the battery-powered "flashgun" unit and a supply of the larger size bulbs, or an electronic flashlamp, systematically covers the entire scene, breaking it up into areas and firing a properly directed light in each area, being careful to keep the illumination away from himself. The technique is simple, easily mastered, and very adaptable. A dozen bulbs or flashes from an electronic flashlamp can illuminate a large area.

Most press-type cameras are provided with some form of photoflash lighting unit. Separate photoflash "guns" are available in both press and miniature types and can be adapted to any camera provided with synchronizer contacts. All currently available cameras are so provided.

A number of years ago, the photoflood lamp came on the photographic scene and "cast light" on many of the problems of both still and motion picture photographers. This was a simple low voltage incandescent lamp which was over-volted to produce a very large amount of light. It traded lamp life for light and lasted about two hours in continuous operation. The tungsten-halogen (also known as quartz-iodine) lamp has performed a similar revolution. It has provided even more light from the same amount of electrical power than the photoflood, at a color temperature that more nearly approaches daylight, and with a constant color temperature and light output over the full life of the lamp. The photoflood bulb is large and requires much ventilation and large reflectors. The tungsten-halogen lamp is very small and its filament temperature is higher than that of other lamps.

Since more of its electrical input goes to produce light, it actually produces less total heat than the photoflood. Its small size makes it easier to cool and lends itself to the design of very efficient reflectors. Less of the bulb's light gets lost and more gets on the subject where it is wanted. The average life of quartz-halogen bulbs is much greater than that of photoflood bulbs, on the order of 50 hours rather than two hours. Because of the limited life of both photoflood and tungsten-halogen lamps, provision is generally made to operate the lamps at a reduced voltage during the time required to set up and focus the camera. The voltage is then increased to the operating value for the actual exposure. Lamp life is greatly increased in this manner.

Where any volume of photography is done which demands continuous light for setting up, posing, or photographing subjects, either still or movie, the law enforcement photographer will need tungsten-halogen or photoflood lamps as light sources. They are the most compact, efficient and portable continuous light sources available. They provide the largest amount of light per watt of electrical input or per cubic inch of total size, of any continuous light source available. Fluorescent lamps are more efficient but bulkier, and may change the color balance.

The tungsten-halogen bulb works well at low voltages. This has made possible continuous light sources that provide a number of hours of illumination from portable battery packs. These can be used for lighting small areas in locations where no electrical power is available, particularly if movies are required.

The law enforcement photographer will require a standardized set-up of lights for personnel identification photographs, preferably in a fixed location where lighting and camera can be left ready to use at a moment's notice.

If much physical evidence photography is to be done, other than at the scene of the crime, a much more complete lighting set-up with lights selected from the standard units widely used by commercial photographers may be desirable. This includes flood lights for providing an overall level of illumination, spotlights for emphasizing texture or lighting deep recesses, ring lights which fit around a lens and provide shadowless illumination, and reflectors for softening shadows. Since lighting requirements are determined directly by the object to be photographed, it is probably best to start with a minimum selection and add to it as required. For many law enforcement photographers, an electronic or photoflash lighting unit on the main camera with a second similar unit for side lighting, a slave-switch to fire both of the flashes together, plus two or three small tungsten-halogen or photofloods in diffuse reflectors will cover all of the lighting requirements for many assignments.

FILTERS AND OTHER ACCESSORIES

In addition to filters there are many photographic accessories available. They vary in size and importance and are designed to solve the problems that different situations can present.

FILTERS AND OTHER ACCESSORIES

The line of accessories available to the law enforcement photographer is nearly endless. The most important (filters, tripods, and copy stands) will be described in some detail. Other, less important accessories will be listed to remind the reader that such equipment is available.

Filters are relatively simple but very necessary tools. Every law enforcement photographer will need a reasonable selection of them.

Filters are of two constructions: solid glass, ground and polished, into which the necessary color was incorporated when the glass was originally fused; and thin sheets of gelatin colored with dyes and cemented between sheets of protective glass. Gelatin filters are not as commonly used as formerly because of the greater variety of solid glass filters which is now available. There are, however, many useful filters that are obtainable only in gelatin. The photographer should be familiar with both varieties, and also with the fact that plain gelatin films, in 2, 3 or 4 inch square sheets, can be obtained very inexpensively and in more than 100 types. Because of their extreme thinness, a gelatin filter can be used in front of or behind most lenses without correction in focus. With solid glass filters, the lens focus must be readjusted when working at close distances with the filter in front of the lens and will always need adjustment if it is necessary to use the filter behind the lens. Always focus the camera with the filter in place, or test for accuracy of focus if the filter is too dark for visual focusing.

Five different types of filters will be found useful in law enforcement work: contrast filters, color correction filters (commonly called CC filters), polarizing filters, haze filters and neutral density filters. Each has specific uses.

The underlying principle of the optical filter is relatively simple. Visible light is made up of energy of all wavelengths between about 400 and 780 nanometers. While this is the range of wavelengths visible to the human eye, both shorter and longer ones are of importance in photography, particularly those in the infrared region between 780 and 900 nanometers. All filters pass light of some wavelengths and absorb or reflect light of other wavelengths. Filters are designated by what they absorb or transmit. A high-pass filter transmits all wavelengths longer than a certain value. A low-pass filter transmits all wavelengths below a given value. A neutral density filter transmits all wavelengths equally. A minus filter (minus blue, for instance) absorbs the wavelengths corresponding to the indicated color (blue). All filters reflect or absorb some of the light that reaches them, even at the wavelengths they pass, but they absorb a lot more of the incident energy in the wavelengths they do not pass.

Filters are normally supplied in special screw-in mounts that are designed to fit specific lenses. "Series" size filters are circular, metal rimmed filters designed for general use. The standard sizes are series IV, V, VI, VII, and VIII. Adapter rings are available that allow one set of filters to be used on a number of different size lenses. Adapter rings are held in place on the lens by friction and are simply pushed onto the lens. Step-up rings are available to fit small lens adapter rings to allow the use of larger filter sizes, further increasing the interchangeability.

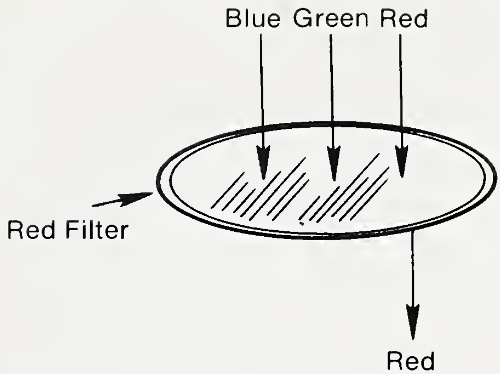
Contrast Filters

Contrast filters, which are the type most frequently needed in law enforcement work, are used to increase the apparent contrast in a subject. An example of this use is the copying of a badly yellowed document written in sepia ink that has faded. With normal films, the document is reproduced with very little contrast between the writing and the paper, and it may be illegible. By taking the picture through a filter with the same color as the background (yellow), we can increase the contrast. A deep yellow or a minus blue filter will normally lighten the yellowed paper, making it photograph like a clean white, and increase the contrast in the final picture. Or we can go the opposite way and use a filter that will hold back the parts of the picture which should be dark. For the sepia ink, which is reddish, we use a minus red filter, which appears green. This will make the ink appear blacker, again increasing the contrast of the copy.

Every photographer doing document photography should have a selection of several densities of filters in each of the major colors, red, yellow, green and blue (see table 5). Filter selection can sometimes be made by visual inspection, but actual test exposures will be necessary to tell for certain what the overall effect is.

Color Compensating Filters

Color compensating filters are used in color photography. They are used with color film which has been designed for use with one type of illumination, when it is desired to use it with a different type of illumination. A commonly encountered example is the salmon-colored filter number 85A, used to allow tungsten light balanced color film to be used in daylight. Each



different type of color film has its own filter requirements for conversion; filters for the same general light conversion cannot necessarily be used with different makes of film.

A special series of CC filters is available to correct for small variations between the illumination for which a film was designed and that which must be used. These filters can, for example, be used to remove the excess blue light present in daylight on a hazy day. The filters are bluish or reddish in tint and very transparent, come in a wide variety of densities and are also used in color printing and transparency copying to achieve color fidelity in the final copy.

Table 5.

GUIDE FOR SELECTING FILTERS FOR MAXIMUM CONTRAST

Subject Color	Choose filter color listed to render subject: lighter	darker
Red	Red	Blue or Dark Green
Yellow	Yellow	Dark Red or Blue
Green	Green	Red or Dark Blue
Blue	Blue	Red or Dark Yellow

Neutral Density Filters

The neutral density filter and the polarizing filter are two types of filter which have an important property in common. They both affect all colors approximately the same, and therefore have no pronounced color. Neutral density filters are used to reduce the intensity of all wavelengths of light by equal amounts. They are marked in terms of optical density units. An 0.3 neutral density (ND) filter transmits 50 percent of the light reaching it; a 1.0 ND filter transmits 10 percent of the incident light; and a 2.0 ND filter transmits 1 percent. The densities of two filters used together must be added in order to get the overall density of the combination. Thus, two 0.3 filters have an ND of 0.6 and transmit 25 percent of the incident light. ND filters are of value for use with the faster lenses which can only be stopped down to f/11 or f/16. When a fast lens must be used with a fast film in bright light and the camera shutter speed cannot prevent overexposure, adding an 0.3 ND filter reduces the light by one stop, 0.6 ND by two stops, 0.9 ND by three stops and so on.

Neutral density filters are of two types: solid glass, in which light is absorbed in the glass, and evaporated metal film, in which most of the light that is not transmitted is reflected. Two evaporated metal film neutral density filters should not be used together, because the densities do not add linearly. Multiple reflections between the filters will cause the density of the combination to be less than the sum of the two densities, and can produce undesirable interference effects.

Polarizing Filters

The polarizing filter is quite different in its effect than the ND filter. It, too, absorbs all colors of light equally. But light has another property, which is not directly visible to the eye: polarization. Light is partially polarized whenever it is reflected from a shiny surface such as window glass. A normal photograph of a window may show only the reflection, and nothing behind the glass. Place a polarizing filter over the camera lens and rotate it. In most instances, one position of the filter can be found where the glass reflection will be greatly reduced or eliminated entirely, depending on how strongly polarized the light is. The use of large polarizing filters placed over light sources in conjunction with a filter at the lens gives almost complete control of reflections. A polarizing filter always requires at least a one stop exposure increase, since it cuts out at least half the light it receives.

Haze Filters

The haze filter is especially valuable in law enforcement work. It is a clear glass filter which has no effect except to hold back the ultraviolet wavelengths. In all except extreme distance views, the effect of the filter on the picture is nil. It does serve as an excellent mechanical protector and "transparent lens cap" for the lens. Dust, dirt, scratches, and fingermarks get on the inexpensive, easily replaced haze filter, instead of the front lens element. Haze filters are available, anti-reflection coated, to prevent ghosts when used facing strong light sources.

Tripods

No law enforcement photographer can work without a tripod or some other form of camera support. The tripod is the traditional, most readily available, and probably most convenient support. A tripod should be tall enough to hold the camera comfortably at eye level, and should fold small enough that it is not too cumbersome in the camera kit or squad car. An adjustable "elevator" post in the center will save a tremendous amount of time setting up for the required perspective. A quick-release plate for the camera is a great convenience when the camera is attached and removed frequently. Tripods that vibrate excessively are of little value. Many do so, but can easily be identified. Put a camera with a very long focal length lens on the tripod. Outside at night, point the lens at a street light a few blocks away. Take a picture of the light at each shutter speed on the camera, plus some time exposures, say 3, 5 and 20 seconds. Try not to overexpose, and use neutral density filters if necessary for the long exposures. Focused sharply, the street light should be no more than a speck, like a star, on the negative. Examine the street light image

critically with a 10 power magnifier. If the tripod is vibrating on any of the exposures, a characteristic pattern will show as the image of the light moves on the film. This will be different than the increased image size caused by overexposure. Many times it is a figure-eight type pattern, but any sign of a snake-like path indicates excessive vibration at that shutter speed. Thereafter, use much higher or lower speeds. The good tripod will be firm enough for the longest focus lens normally used, easy to adjust, not too heavy, and will not pinch fingers. Make sure the tripod is adaptable to both horizontal and vertical positions with all cameras and lenses.

A pan tilt head is a very necessary accessory for use with a tripod. It permits the camera to be pointed in any direction and then locked in position.

Copy Stands

This is one of the most useful accessories for the smaller department which cannot justify a separate copy camera. A popular type is built very much like a 10 x 12.5 cm (4 x 5 in) vertical enlarger with no lamphouse. External lights are provided to evenly illuminate the full baseboard of the stand. The "enlarger" part is really a 10 x 12.5 cm (4 x 5 in) camera with a long bellows, ground glass, and a reflex focusing hood so the operator can look horizontally into the ground glass, instead of having to climb a ladder or put the stand on the floor. Similar units are available to which a press, single lens reflex or other type of camera can be attached. Adapter backs will make sheet film, roll film, 35 mm color film, and instant process film available for use on the copier. For reproducing identification photos, fingerprint cards or documents of any kind with a wide range of sizes, or for any type of small object (macro) photography, the copy stand is both convenient and time saving compared to improvised set-ups. Process type lenses are available for the complete assembly. These are corrected for giving images up to 20 times actual size.

Miscellaneous

The list of other accessories is endless. Special mention is made of slave units which can be attached to individual electronic or photoflash lamp units. When areas must be photographed with supplementary light, any number of flash units can be located at strategic points. When the main flash at the camera is fired, all the slave units fire too, without any wire connections to the camera. With electronic flash at each unit, the firing is simultaneous with the main flash. With photoflash lamp units, the slaves will all fire together, but all will be delayed from the main flash by about 20 milliseconds and the shutter speed must be lengthened accordingly.

Focusing magnifiers and angle viewers have occasional value. They are available for many cameras. Many times, a long cable release or a remote camera tripping device will be essential. A cable release should always be used with a camera on a tripod to prevent hand vibration. If you do not use haze filters on all your lenses, the use of a lens brush or ear syringe "blower" to remove dust before attempting to clean a lens will protect the lens against scratches.