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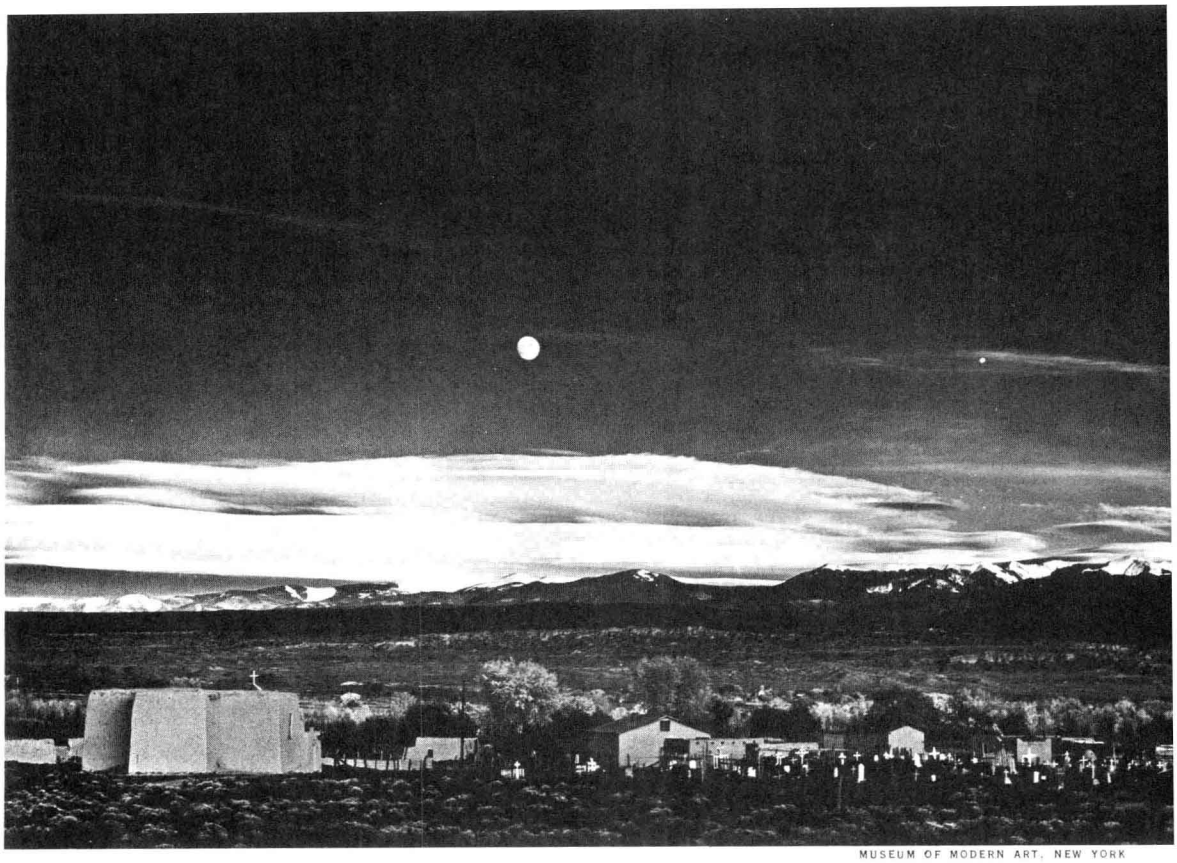


MUSEUM OF MODERN ART, NEW YORK

A sweeping vista of land and sky is recorded in all its rich detail with a view camera; a print is developed with care in the darkroom; and an enduring work of art is created by the master photographer Ansel Adams.

PHOTOGRAPHY is the production of visible images by the action of light. Millions of photographs are taken each year, the vast majority for the purpose of getting souvenirs of family and friends, occasions of personal significance, and places of interest. Because they result from the desire simply to obtain a recognizable image, informal pictures usually involve only the most casual concern with technique and require only simple equipment.

Most other photographs fall into two broad groups: illustrative, reportive, and artistic photographs, on the one hand; and scientific and technical photographs, on the other. The first group consists mainly of editorial and advertising illustrations for newspapers, magazines, and books. Artistic photographs, however, are often acquired by individual collectors and art museums, like other works of art. For all these photographs the choice of equipment is based on the qualities desired in the final image, the degree of mobility needed by the photographer, and the photographer's personal preferences. Similarly, photographic techniques are selected for their contribution to the expressiveness of the picture.

Photographs of the second group, intended to provide accurate scientific or technical records of their subjects, often demand the greatest degree of control over all aspects of the photographic situation. They may require equipment of sophisticated design, materials of the highest quality, and techniques of great precision.

This general survey article on PHOTOGRAPHY is divided into three major sections: 1. *Techniques of Photography* (pages 2–8), which covers the taking of photographs and darkroom processing; 2. *The Art of Photography* (pages 9–24), which describes the historical development of photography; and 3. *Technology of Photography* (pages 25–32), which explains how photographic materials and processes work.

For further information on special applications of photography, consult the articles AERIAL PHOTOGRAPHY, ASTROPHOTOGRAPHY, MOTION PICTURES, and X-RAYS. Photographic equipment and materials are described in further detail in CAMERA, FILM, and LENS. The theoretical basis of photography is discussed further in the article PHOTOCHEMISTRY. Articles on historical and modern photographic processes include CALOTYPE, DAGUERREOTYPE, and HOLOGRAPHY. Separate biographies are provided on outstanding photographers.

The term photography, from Greek words meaning "to draw with light," is used in this article primarily to refer to image-making processes that are based on photochemical reactions such as those that take place in the making of conventional prints and slides.

Several other image-making processes rely primarily on electronic, electrostatic, or other nonchemical responses to light. These processes, including television, xerography, and thermoplastic recording, are described in separate articles appearing under those headings.

1. Techniques of Photography

TAKING A PHOTOGRAPH

The photographer needs only four things to take a picture: a camera, film, a subject, and light. As he (or she) gains experience and feels the need for greater technical flexibility, the photographer may wish to expand the range of his picture-taking capabilities with additional items of photographic equipment, including special lenses, an exposure meter, filters, and an electronic flash. Such additional equipment is not essential, however, and many great photographers have worked with only the most basic equipment.

Choosing a Camera. The photographer's choice of a camera depends on the kind of picture he intends to take, the degree of mobility he needs, and the degree of control over exposure and composition he requires. The simplest cameras use small (110, 126, or 35mm) films or self-processing materials and are quite suitable for most informal pictures. Compact and lightweight, with a fixed lens, they provide automatic exposure control and simplified or fixed (nonadjustable) focusing. While they offer maximum mobility and complete freedom from technical concerns, such cameras give the photographer no control of the image-recording process except that of aiming at the subject and pressing the shutter release.

When the photographer uses a simple, fixed-lens camera, the choice of lens is made once-and-for-all with the choice of a camera. There is considerable variation in the speed and sharpness (ability to reproduce detail) of lenses on fixed-lens cameras, and these characteristics should be important factors in selecting a camera for purchase. The vast majority of such cameras are designed for photographing a normal, or slightly wider than normal, field of view.

Many cameras that use 35mm or 120/220 film are sufficiently small and lightweight for great mobility, but offer a wide variety of controls. Most cameras in this group can be fitted with interchangeable lenses providing many combinations of focal length, speed, size, and convenience of operation. Most of them also give the photographer control over focusing and composition by providing a direct through-the-lens preview of the image that will be recorded on the film. Other features typical of this group of cameras include built-in light meters with optional automatic or manual exposure control, a wide range of shutter speeds, delayed shutter release, and provision for intentional double or multiple exposure. By far the most common of such cameras is the 35mm single-lens reflex.

To obtain illustrative, artistic, or technical photographs of the highest quality, technical or view cameras using sheet film in 4x5- or 8x10-inch (or even larger) sizes are the first choice. Such cameras provide maximum sharpness of detail, subtlety of tone or color, and accuracy of subject appearance. See also CAMERA.

Choosing a Lens. Among the factors to be considered in choosing a lens for a particular purpose are the speed required of the lens, the image magnification and subject coverage sought, the perspective desired, and the distance between subject and object.

Lens speed is the light-transmitting power of the lens at its maximum aperture, or f-stop setting. Each higher f-number represents a setting that cuts light transmission in half. Thus, at maximum aperture, an f/2 lens transmits twice as much light as an f/2.8 lens. However, when any two lenses are adjusted to the same aperture, say f/8, they transmit equal amounts of light. A fast lens, with a maximum aperture of about f/2, is desirable for hand-held cameras and for photography in dim light, because it permits the use of fast shutter speeds to reduce the chance of blurring images by camera movement. Lens speed is less important with tripod-mounted cameras, and a slower lens may be chosen to take advantage of other features—such as extreme correction of aberrations—that are not usually found in fast lenses.

Desired image size and subject coverage both affect the choice of focal length in a lens. Compared with the image produced by a *normal* lens—one with a focal length about equal to the diagonal of the film area it covers—a shorter focal length, *wide-angle* lens takes in a wider view of the scene in front of the camera. However, the images of individual objects in the scene are smaller and the apparent depth perspective is exaggerated, so that background objects seem farther away than they really are. A short focal-length lens is used for a wider view when the camera cannot be moved back from the subject.

A longer-than-normal focal length, or *telephoto*, lens takes in less of the scene, making the images of individual objects larger. It also compresses the apparent depth of the scene, so that background objects seem nearer than they really are. A long lens is often chosen to get a large image when the camera cannot be moved closer to the subject, or to provide a normal-size image when a greater camera-to-subject working distance is required—for example, to allow the proper positioning of lighting units. For portraits, a focal length about twice normal is often chosen to produce a large undistorted head-and-shoulders image that fills the negative. If a normal or wide-angle lens is used close-up to produce a large image, the subject's features may appear distorted. See also CAMERA—*Lens*.

Special Lenses. *Macro lenses* are designed for use at distances close enough to produce very large images, on the order of 1:1 (image size equal to object size). The original macro lenses were used on long bellows or extension tubes, but many modern macro lenses for 35mm cameras have extension tubes built in to permit focusing very close up.

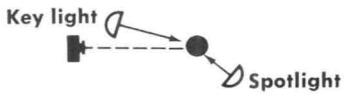
Lens *extenders* fit between a lens and the camera body to provide a 2X or 3X increase in the focal length of the lens. They are much less expensive than telephoto lenses, but they reduce the speed of the lens at all f-stops, and exposures must be increased accordingly. For example, a given f-stop actually functions as two stops smaller with a 2X extender, or as three stops smaller with a 3X extender. Thus, a lens stop of f/2 becomes f/4 with a 2X extender, or f/5.6 with a 3X extender.

Zoom and *varifocal* lenses can be set to any of a continuous range of focal lengths, providing the photographer with the picture-taking capabilities of several lenses, while eliminating the need to change lenses.

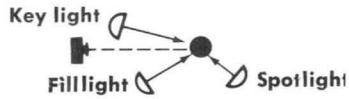
Simple *supplementary* lenses used in front of a camera lens change the effective focal length without affecting f-stop ratings. They are most often used to get closer to a subject for a larger film image, but when used for portraits they pro-

STANDARD LIGHTING FOR PORTRAITS

Key light only. Using only the basic key light gives somewhat harsh illumination, lifeless hair.

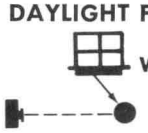


Key light and spotlight. Spotlight behind subject livens hair, but lighting remains a bit harsh.

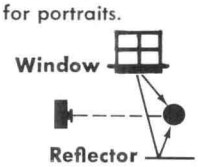


Key light, spotlight, and fill light. Fill softens overall lighting and brings out shadow detail.

DAYLIGHT FROM A WINDOW

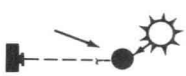


Window light only. A north window gives good but somewhat dramatic lighting for portraits.

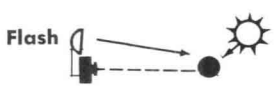


Window light plus reflector. A reflector acts as a fill light to add detail in shadow areas.

SUNLIGHT



Sunlight plus skylight. To avoid harsh shadows, skylight is used as key light, sun as spotlight.



Skylight, sunlight, and flash. Fill light from camera flash adds sparkle without high contrast.

Photographed with a slow shutter speed of 1/60 of a second, the picture of the cyclist is blurred.

Here the cyclist's motion is stopped by taking the picture with a high shutter speed, 1/500 of a second.

Using the same slow shutter speed as in the top photo, motion is stopped here by a frontal camera angle.

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duce some distortion of the subject's features. See also LENS.

Choosing a Film. There are three main types of films, designed to produce the three major kinds of photographs: black-and-white prints, color prints, and color slides (or transparencies). The chief factors to be considered in choosing a film of any one of these types include film speed, contrast, graininess, and color balance (for color films).

High-speed films (rated above ASA 250) permit the use of shutter speeds fast enough to take pictures with a hand-held camera even under dim light. Their contrast, or degree of distinction between light and dark areas of the subject, is comparatively low, and they may produce images with visible graininess. Slow films (ASA 10-64) have the finest grain and produce negatives of the highest contrast, but they may require shutter speeds so slow that a tripod is necessary to prevent blurring of photographs. For most photographic situations, medium-speed films (ASA 100-250) offer an excellent combination of characteristics; including adequate speed, good contrast, and fine grain.

A color film that gives accurate reproduction of colors when used in daylight would give poor results when used in artificial light. For accurate results, the *color balance* of the film must match the wavelength composition of the light on the subject. Color balance is designated in degrees Kelvin, and most types of color film are available in three different color balances: Daylight (5500K), for use with daylight, electronic flash, and blue flashbulbs; Type A (3400K), for use with photoflood lights; and Type B (3200K), for use with other common photo lamps. When the color balance of a film and a light source do not match, a conversion filter may be used to adjust the balance. See also FILM.

Filters. A filter placed in front of the lens changes the color of light that reaches the film. Although not essential, *correction* filters provide the most accurate translation of subject colors into shades of gray on panchromatic black-and-white film. A No. 8 (yellow) filter is used with daylight, a No. 11 (yellow-green) with tungsten light. *Contrast* filters make major gray-shade changes in the final image, because they lighten objects of their own color and darken opposite or complementary colors. For example, a red filter darkens blue sky and green foliage considerably, and lightens red objects.

Color conversion and *light balancing* filters for color photography change the overall color balance of light in order to match it to the film's response. For example, an 85B filter permits using a Type B (3200K) film with daylight (5500K). Color compensating (CC) filters make only slight changes. They are used chiefly in the darkroom to adjust color balance in color printing. However, a blue CC filter will remove excess reddishness in color pictures taken soon after sunrise or just before sunset. *Haze* and *skylight* filters remove excess bluishness from distant views outdoors. *Neutral density* (gray) filters provide exposure control by reducing light intensity without affecting color balance. A *polarizer* reduces reflections from some surfaces and increases color saturation by reducing glare and scattered light.

Filters act by absorbing some of the light that would normally reach the film. To compensate for this absorption a wider lens opening or slower

The four photos shown here were taken from the same position but with different lenses. *(Above left)* A wide-angle lens gives a panoramic view with exaggerated sense of depth. *(Above right)* A normal lens gives a typical snapshot view with normal sense of depth. *(Below left)* A short telephoto narrows the view to the building facade and fountain. *(Bottom right)* A medium-long telephoto concentrates the view with little sense of depth.

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shutter speed should be used with most filters. The amount of compensation is given by a factor assigned to each filter. For example, a factor of 4 means that four times as much exposure is required. The f-stop setting or the shutter speed, or both, may be changed to make the adjustment.

Lighting. While a great deal of photography uses existing light with great success, it is often necessary to add light to a scene for proper exposure or a different lighting effect. Photographic light sources include incandescent and tungsten-halogen lamps, flashbulbs, and electronic flash tubes. Fluorescent lamps are seldom used because it is difficult to vary their intensity and because complex filtration is needed to balance their light for color photography. Aside from flashcubes and flashstrips used on simple cameras, the most popular light sources are electronic flash units. Many are inexpensive, small, and lightweight, and all have a lifetime of many thousands of high-intensity flashes of daylight-color light. Many units provide automatic exposure control, so that—within certain limits—the photographer can change his working distance from the subject without adjusting the exposure controls of the camera.

The intensity of illumination can be controlled by moving the light source closer to or farther from the subject, by using a different light source, or by placing light-absorbing material between source and subject. But good lighting technique involves much more than providing enough light for proper exposure. It calls also for controlling the light to enhance certain qualities and characteristics of the subject and to deemphasize others. A common lighting problem, for example, is to control the lighting contrast, or degree of difference between the light reflected from light parts of the subject and that reflected from dark parts of the subject. Too much contrast gives a harsh appearance, with loss of color or detail in very bright and very dark areas. Too little contrast makes the subject look drab and two-dimensional.

IMPROVING COMPOSITION

Move the subject.

(Left) The car in the background spoils the picture of the boy by providing a distracting background. *(Right)* If a better background is near at hand, a simple solution is to move the subject away from the distracting background.

Change your lens opening.

(Left) Again, a car in the background spoils the picture of the boy. *(Right)* In the absence of a better background, the photographer minimized the distracting effect of the car by using a wide lens opening to throw the car out of focus while keeping a sharp image of the boy.

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In controlling lighting contrast, the photographer generally uses more than one source of light. Usually he begins by placing the *key* (main) light on the subject, and then he adds sufficient *fill* (supplementary) light to raise the shadows and dark areas to a suitable brightness. A key-to-fill lighting-intensity ratio of 2:1 or 3:1 is usually suitable for color and portraits. A ratio of 5:1 or 7:1 is common for general black-and-white pictures. Key-to-fill ratios can be measured easily with an exposure meter.

To avoid excessive contrast in outdoor portraits on sunny days, the use of the sun as the key light and flash as the fill is effective. Another good way to avoid excessive contrast—especially in color photography—is to place the subject of the picture in open shade—that is, an area lighted by the bright sky but not by direct sunlight.

Exposure. Control of exposure is the basis of all photography. The intensity of the light on the scene must be accurately estimated or measured and the measurement then must be translated into f-stop and shutter-speed settings, which adjust the light intensity to the sensitivity of the film.

Light intensity is measured by exposure meters. There are many models of hand-held meters, but most small cameras today have their own built-in meter/exposure systems. Some built-in systems provide entirely automatic control of all settings; others allow the photographer to select either an f-stop (in *aperture-preferred* systems) or a shutter speed (in *shutter-preferred* systems), while the meter system adjusts the other control automatically.

Metering technique depends on the design of the meter and on the photographic situation, but all meters must be set to the speed (ASA rating) of the film in use.

Reflected-light meters, which include all in-camera meters, are aimed at the subject to measure the light reflected toward the camera. With hand-held meters or manually controlled in-camera meters a reading can be taken at close range to avoid the effects of extraneous light from behind the subject. This technique can be used with automatic in-camera meters only if the close-up exposure settings can be locked in so they will not change as the photographer moves to take the picture. With reflected-light meters it is essential to prevent the light source from

IMPROVING COMPOSITION

Move the camera closer.

(Left) A hedge and steps in the background and bicycle handlebars in the foreground clutter the composition and spoil the picture. *(Right)* Moving the camera in close to the subject eliminates the clutter and improves the picture.

Move the camera down.

(Left) When young children or sitting adults are photographed from adult eye level, the camera distorts the subject's proportions and creates a sense of distance between subject and viewer. *(Right)* Taking the picture from a kneeling position eliminates both distortion aad sense of distance.

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shining directly on the face of the meter or on the lens of a camera that has a through-the-lens meter.

Incident-light meters are held at the subject position and aimed at the intended camera position. The meter "sees" all light falling on the subject that could be reflected to the camera. Many hand meters can be adjusted to make an incident- or a reflected-light reading. An incident-light reading, or a reflected-light reading from the most important area of the scene, is preferred for color photography. See also LIGHT METER.

With nonautomatic flash light sources, exposures are calculated on the basis of a guide number for each film-flash combination. Dividing the guide number by the flash-to-subject distance gives the lens f-stop required for use with a specified shutter speed.

Composition. The arrangement of subject elements within the picture is called composition. Sometimes the photographer, like the painter, can select the elements one by one and arrange them to create an image planned in advance. Far more often, the photographer selects a view of some part of an arrangement that already exists. In either case the essential factor is seeing and judging the effectiveness of the total arrangement within the scene.

The basis of effective photographic picture construction is first to see or visualize the subject clearly and identify its visual characteristics. Then examine the subject through the camera to find the viewpoint that most strongly reveals those visual characteristics.

Photographic composition is adjusted by three basic techniques: (1) moving the camera nearer to or farther from the subject or changing lenses in order to make the subject larger or smaller, to include more or less of the scene, or to change apparent depth relationships; (2) moving the camera left, right, up, or down in order to clarify relationships between parts of the scene, to shift confusing elements away from the main subject, or to reveal a more expressive aspect of the subject; and (3) adjusting focus to make all elements sharp or to make only the most important part of the scene sharp, leaving unimportant or distracting areas blurred.

Other, generally more subtle, changes may be accomplished by altering the lighting, using filters, and similar techniques. As each compositional adjustment is made, the entire image area

—not just the central subject—must be examined in the camera viewfinder to ensure that all parts of the picture contribute effectively to the overall effect. The final composition has been achieved when the scene in the viewfinder conveys the same feeling or visual message as the subject does when viewed directly.

DARKROOM WORK

The image recorded on conventional film must be chemically processed to become visible. If it is a negative image, a print must be made to obtain a positive picture. Almost all photo materials may be processed by an amateur photographer in a simple home darkroom at modest cost. Home processing not only ensures personal attention to every step of the work, but it also permits experimentation and the use of special techniques not offered by most commercial processors to modify the photographic image. In addition, a great many photographers find it a genuine pleasure to be responsible for every aspect of their own work.

Film Processing. The basic equipment required for film developing includes film holders, a tank for solutions, a thermometer, a clock or timer, and a supply of film-processing chemicals. The most important aspects of film-processing technique are to follow time-and-temperature requirements strictly and to agitate the film in the solutions sufficiently to ensure thorough and even development.

Roll films are commonly loaded onto spiral reels for processing in a small plastic or stainless steel cylindrical tank fitted with a lid that is light-tight but permits solutions to be poured in and out. After the tank has been loaded in total darkness, the film can be processed in a lighted room. Sheet films are loaded into individual holders in total darkness, and they are processed in the dark if the tank does not have a light-tight cover.

Printing. Basic darkroom printing equipment includes an enlarger or printing device, a safelight, and trays or a tube or drum for processing, in addition to a thermometer and timer. The essential aspects of printing technique include precise focusing of the enlarged image, exact timing of exposures, and uniform processing procedures from print to print.

Prints are made by shining light through a negative onto a light-sensitive paper-base material. Contact printing with the negative placed directly against the paper emulsion produces a same-size image. Projecting the image from an enlarger onto the paper produces bigger pictures. In addition to standard materials for making black-and-white and color prints from negatives, there are panchromatic papers for making accurate black-and-white prints from color negatives and reversal materials for making color prints from slides and transparencies.

Black-and-white print papers are available in several contrast grades, to produce various scales of gray steps between black and white. A high-contrast paper is used to obtain a normal range of grays from a low-contrast negative, and a low-contrast paper is used with a high-contrast negative. Multi- or variable-contrast papers produce different contrast grades on a single paper by means of special printing filters. Many amateurs prefer to use these papers because they eliminate the need to keep a supply of several grades of paper.

Color print materials are generally available in a single contrast grade. The contrast and color balance of the image is adjusted by filters, which selectively change the color composition of the printing light.

Most print materials other than color reversal papers may be handled under a safelight, which gives a subdued illumination of a color to which the emulsion is relatively insensitive. Safelight colors for conventional black-and-white materials are red and orange, or light amber (for variable-contrast papers). Panchromatic and color print materials can be briefly handled under a dark amber safelight.

Special Techniques. The character of a print image can be altered in the darkroom by a number of methods.

High contrast images of black and white but few middle shades of gray result from negatives given less than normal exposure and extra development. The effect can be increased by printing on high-contrast paper.

Multiple printing creates combined images. Two or more negatives may be sandwiched together to make a single exposure, negatives may be changed to superimpose exposures on the same sheet of printing paper, or the position of the paper or negative may be shifted between repeated exposures from a single negative.

A *mask*—an opaque sheet with a hole for the projected image to pass through—creates shapes with sharply defined edges when placed directly against the paper and blurred edges when held away from the paper during exposure.

Distortions are produced by curving or tilting the paper, reflecting the image from an uneven surface, or otherwise changing the path of the light to the paper.

Toning solutions, used after normal processing, add a single color to middle and light tones of a black-and-white print. Sepia, brown, red, and blue are the most common toning colors.

Tone reversal (the Sabattier effect, or so-called darkroom solarization) results when a partly developed image is briefly exposed to white light and then returned to the developer. Some tones will change from negative to positive or positive to negative, depending on whether a negative or a print is being processed. The effect varies according to the original tone of an area, how much of the first stage of development is completed, and the intensity of the re-exposing light.

Color shifts are produced by exposing color materials through strong filters or other materials that significantly affect the color composition of the printing light. Combinations of techniques, purposeful mismatching of chemicals and materials, and many other methods are also used to produce special effects in the darkroom.

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Editor of "Current 35mm Practice"

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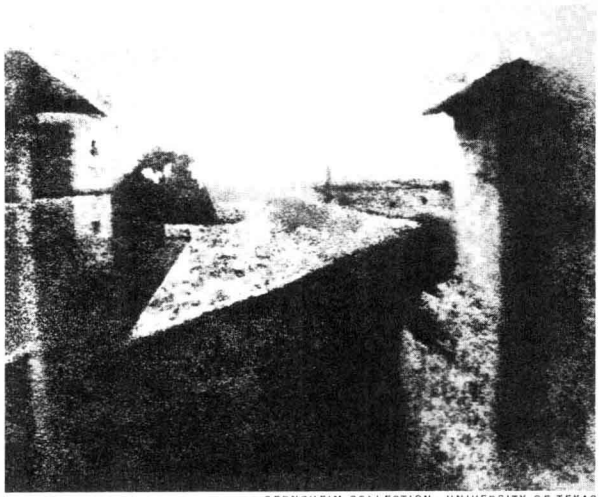


GERNSHEIM COLLECTION, UNIVERSITY OF TEXAS

INTERNATIONAL MUSEUM OF PHOTOGRAPHY, GEORGE EASTMAN HOUSE

Photography was born when Joseph Niepce preserved an image on a pewter plate in a primitive camera. *(Above)* His oldest surviving photograph (1826), a view of his estate at Gras, France, required an exposure of several hours. *(Right)* Portraits became possible when Niepce's partner, Louis Daguerre, created a process that cut exposure time.

2. The Art of Photography

The history of photography spans only about a century and a half, yet photography has greatly affected the way we perceive the world, the manner in which we conceive art, and the degree to which we acquire knowledge. Photography has its own history, but its development is also linked with technological advances, ideas and styles in art, and general cultural activities.

THE INITIAL IDEA

Although photography was first made public in 1839, the theory behind the principles of the medium begins with Aristotle's description of how light waves behave when projected through a small aperture. This is fundamentally the description of how a lens or camera's aperture operates when it projects an image onto the film at the back of a camera. In the Middle Ages, Alhazen and Francis Bacon extended this principle to include a large, darkened room with a small opening in one wall. In the 15th to 18th centuries this *camera obscura*, as it came to be called, was reduced in size and made convenient for artists to use in tracing scenic designs and architectural perspective. See CAMERA OBSCURA.

The chemical principles basic to photography were also described well before photography was "invented." Johann Schulze, in 1727, demonstrated that silver salts turned dark when exposed to light. Carl W. Scheele, in 1777, showed that ammonia retarded the effects of light on these salts after they had been altered by light, and he indicated a possible way of stabilizing the photochemical process. By the end of the 18th century, the necessary equipment (the camera obscura) and the requisite photochemistry (silver salts as photosensitive material and ammonia as stabilizer) were available, at least to produce semipermanent photographic images.

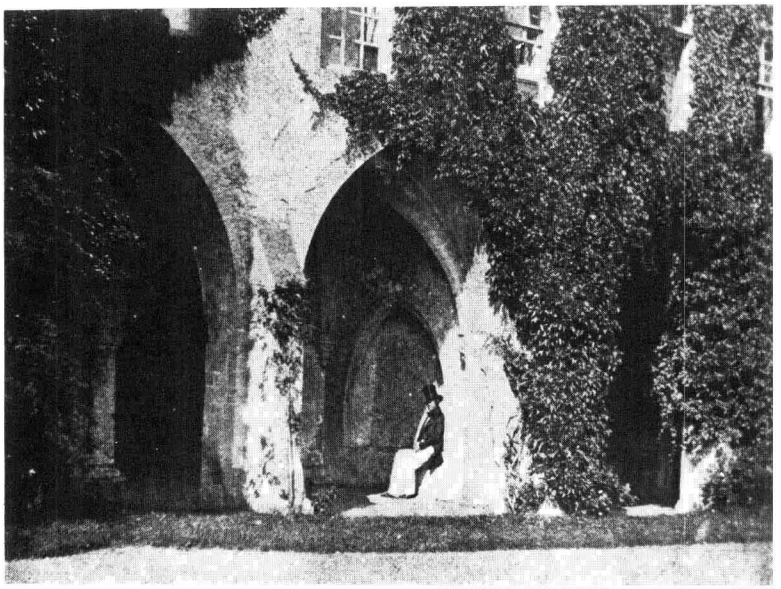
The artistic style and aesthetics of Renaissance and post-Renaissance Europe placed a high value on a naturalistic rendering of nature and thus legitimatized the use of machines like the camera obscura by artists. By the mid-18th century, a public demand had made itself felt for realistic portraits, which was partially satisfied by other machines for recording human likenesses. Beginning in the 1790's, Jacques Charles conducted experiments in the automatic, if impermanent, recording of portrait silhouettes on photosensitive paper. Two imperatives—the need for perspectively accurate landscape and architectural scenes and for objectively truthful portraits—created a climate for certain types and styles of pictures that, after 1839, would be achieved easily by photography.

Thomas Wedgwood correctly thought that light-sensitive materials would be of use in the mass production of painted designs on chinaware. In 1802, Wedgwood and Sir Humphry Davy published the first report in English of an attempt to produce a photographic image. Their attempt was unsuccessful because they could not make their images permanent. Similarly, but with more success, Joseph Nicéphore Niepce, in 1816 near Chalon-sur-Saône, France, experimented with combining photosensitive materials with lithography in order to facilitate his endeavors in printmaking.

THE BIRTH OF PHOTOGRAPHY

It was also in 1816 that Niepce had the idea of trying to reproduce nature by transferring the image projected by a camera obscura onto some sort of alterable surface. By 1822 he could claim some success in achieving what he called "points de vue," small images made by the camera obscura with more than eight hours of exposure. Between 1822 and 1827 he had perfected his process, based on the principle that bitumen of Judea turns insoluble when exposed to light. Also, he could fabricate photographically generated photo-etchings (similar to modern photogravure). His earliest extant picture is about 1826.

In 1829, Niepce entered a partnership with the Parisian painter and theater designer Louis Jacques Mandé Daguerre, who had also been trying to make the camera's images permanent.



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William Henry Fox Talbot, in England, invented a paper-based negative from which any number of prints could be produced. His view of Lacock Abbey appeared in *The Pencil of Nature* (1844), the first major publication containing photographs.

Niepce died in 1833. Daguerre continued his efforts to perfect a photographic process until, in 1839, he was successful enough to have his invention purchased by the French government and made public.

The Daguerreotype. Daguerre's process, called after him the daguerreotype, is an image formed on a copperplate that has been silver-plated, polished to a mirrorlike surface, and exposed to iodine vapors to create a photosensitive layer of silver iodide. The plate is then placed in a camera obscura, exposed to light entering from a lens, and "developed" by mercury fumes that adhere only to those areas of the plate that have received a quantity of light. The resulting mercury-silver amalgam, whitish in tone, represents the light areas of the scene or portrait; the darker areas remain as polished silver after fixing with hypo. The polished silver, when held in such a way as to reflect a dark surface, represents the dark areas. The daguerreotype was a perfect jewel of an image: no grain, perfect focus and clarity, and an incredible range of tonal variations. Unfortunately, only one image could be made at a time, and there was no provision for duplicates because there was no negative; the surface was likely to tarnish and wear away; and because the daguerreotype directly rendered the image as it entered the camera via the lens, the picture was laterally reversed, as in a mirror.

The daguerreotype caused a pictorial revolution. Within months the long exposure times, measured in minutes, were reduced, and portraits were made. Within months expeditionary photographers were daguerreotyping in Russia, Egypt and the Middle East, North America, and in most countries of western Europe. Many artists criticized the new invention and denied that it was another art. Others, like Paul Delaroche, called it an immense service to art. Many painters gave up their palettes for a camera and became capable photographers. The photographic portrait business grew rapidly during the early 1840's. In the United States the daguerreotype captured the public imagination and remained the most popular form of photography until the mid-1850's. It was in the United States, also, that the daguerreotype found its highest achievements in the work of Mathew Brady, Abraham Bogardus, John Plumbe, and in the firm of Albert Sands Southworth and Josiah Johnson Hawes. Distinguished European daguerreotypists included John Mayall (English), Sabatier-Blot (French), and Carl F. Stelzner (German). See also DAGUERREOTYPE.

PAPER PHOTOGRAPHY

By the mid-1840's a new and very different process had produced a more convenient and useful type of photography. Invented by William Henry Fox Talbot in Wiltshire, England, the calotype allowed for paper-based negatives from which any number of positive, paper prints could be produced. Starting his experiments in 1832, Talbot worked until he had refined the calotype to its definite form in 1841. The fact that the calotype used a negative-positive process —in principle exactly like modern photographic techniques—was most important. The calotype's negative was soaked in silver nitrate, chemically developed and fixed, and then used to contact-print a second calotype sheet, which in turn was printed out in sunlight, fixed, and dried. Prints could be mass-produced by large firms like Talbot's in Reading, England, or Louis Désiré Blanquart-Evrard's in Lille, France. They could then be pasted in family albums and scrapbooks and, most importantly, included in books and periodicals. Now a public could see what foreign lands and notable personalities looked like or examine the most famous art works without having to depend on the "interpretations" of engravers.

The calotype substituted a luminous, grainy, and somewhat romantically soft image for the daguerreotype's hard, sharp, and classically precise representation. And if U. S. photographers were responsible for the most consistently artistic daguerreotypes, Europeans brought the calotype to its most sensitive and exquisite resolution. Talbot's own calotypes in *The Pencil of Nature* (1844)—the first major publication containing original photographic illustrations—offered the viewer a nearly complete range of photography's applications from simple documentation to the most interpretive art work. In the opinion of later generations, the calotype portraits by the

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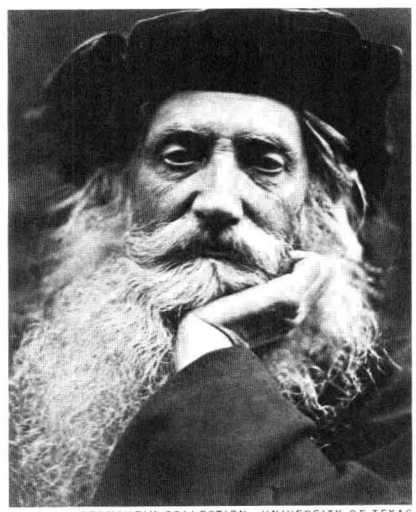
David Octavius Hill, a Scottish painter, and his partner, Robert Adamson, used Talbot's process in the 1840's to create photographs that elevated the medium to a form of art. Their portraits, such as this sensitive study of the McCandlish sisters, reflected the contemporary style in painting.

Scottish team of David Octavius Hill and Robert Adamson have never been superseded as perhaps the finest photographic portraits ever made. The mid-19th century landscape views of Roger Fenton (British), Henri Le Secq (French), and Maxime Du Camp (the French author of *Egypte, Nubie, Palestine et Syrie*, 1852) and cityscapes of Hippolyte Bayard (French) are some of the most delicately rendered and artistically perfect pictures made by the photographic medium.

THE GOLDEN AGE OF PHOTOGRAPHY

The period 1851–1854 was significant for bringing photography fully into the modern era. Photographic prints were first shown at a major world's exhibition, The Crystal Palace in London, in 1851. The first major photographic society, Société Héliographique, was formed in Paris the same year. And the British chemist Frederick Scott Archer discovered that collodion—a viscous mixture of guncotton and ether—was suitable for making photosensitive chemicals adhere to glass plates. From then on photographers could have the near-perfect sharpness of detail of the daguerreotype with the economy and ease of replication of the calotype's negative-positive process. But the photographer had to carry a supply of fragile, heavy glass into the field and, once ready to photograph, had to sensitize the plate, expose it in the camera, and develop it before the wet collodion dried. If a fairly large format print was required, the negative had to be the same size because it was contact-printed. Consequently, the camera had to be large enough to accommodate such a negative. In spite of these restrictions, many photographers from the mid-1850's to about 1870 produced startlingly clear and tonally brilliant landscape views.

Collodion provided the perfect glass negative. It also made possible two other types of photography fairly popular in the mid-19th century: the ambrotype and the tintype. Both of these variations, one on glass and the other on a sheet of iron, were small, unique images based on the principle that a thin enough collodion negative could be backed with a black substance to give the appearance of a positive. Paper prints, however, were responsible for most of the more important



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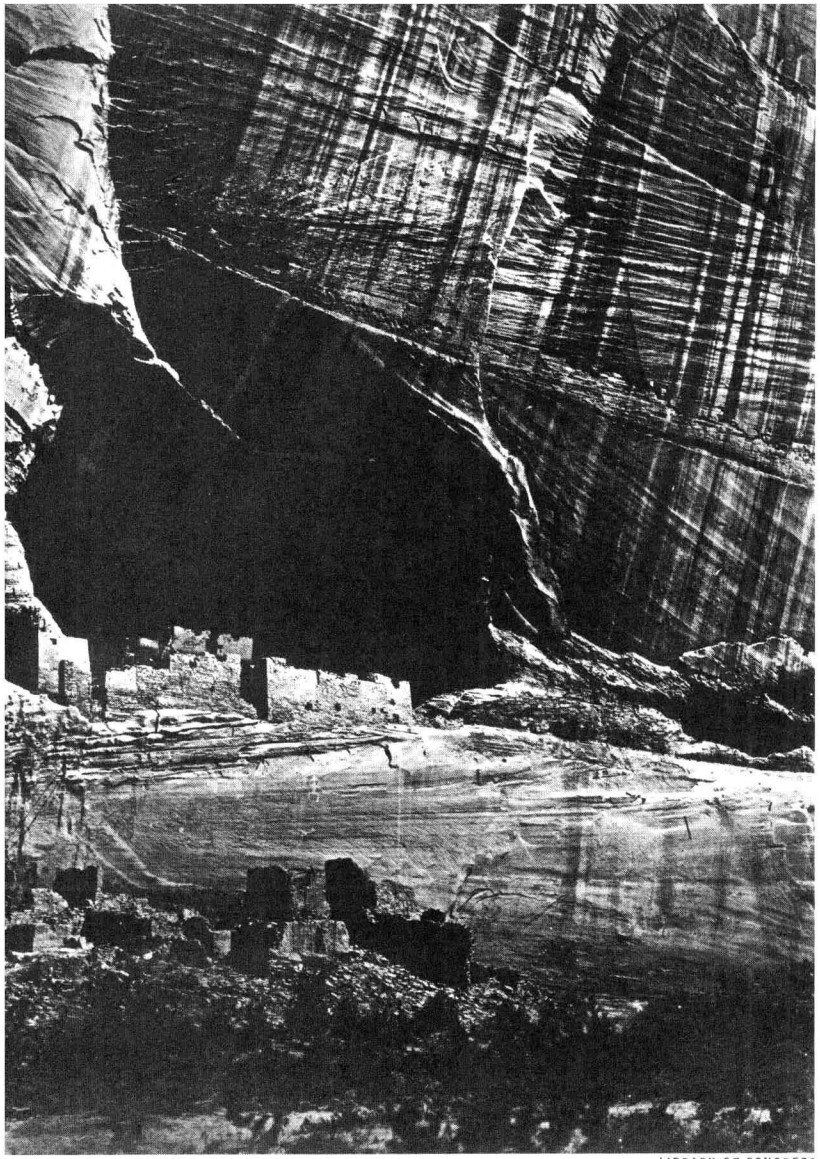
In portraits of the poet Henry Taylor and others in the 1860's, Julia Cameron tried to show "the greatness of the inner man."

images made at this time, especially since beginning about 1852 photographers could print their images on albumenized paper—paper whose emulsion or coating was made from egg whites, its surface smooth and clear. Albumen paper and the collodion negative were the principal means of making photographs during the third quarter of the 19th century.

When the Crimean War began in 1854 the essentially modern species of photographer, the war correspondent, was created. The clumsiness of the equipment and certain propagandistic curtailments prevented Charles Pap. Szathmari (Hungarian), James Robertson (British), Colonel Langlois (French), and Roger Fenton (British) and others from taking any shots of action or human suffering. This had to wait until Felice Beato (Italian-British) documented the second Opium War in northern China in 1860, and,



LIBRARY OF CONGRESS

For many years, Americans had doubted the "tall tales" about the beauty and mystery of the Far West. Photographers, carrying heavy equipment over difficult trails, turned rumor into reality. Timothy O'Sullivan photographed these ancient Indian ruins in Canyon de Chelly, Arizona, in 1873.

much more influentially, when Timothy O'Sullivan, Alexander Gardner, and Mathew Brady recorded the devastations of the U. S. Civil War.

From the 1850's to the 1870's, splendid landscape photographs were made on large albumen prints from collodion negatives by Robert MacPherson (British in Rome), Francis Frith (British in Egypt), Édouard-Denis Baldus (French), and the photographers of the American West like Carleton Watkins, William Henry Jackson, Timothy O'Sullivan, and Edward Muybridge.

The most notable examples of portraiture are the works of Nadar and Carjat (French), Alexander Hesler (American), Lewis Carroll and Oscar Gustave Rejlander (British), all of whom attempted to depict the sitter's personality and inner character as well as appearance. More popular and cheaper was the portrait called the *carte-de-visite*, a small, palm-sized image on a card, as many as eight of which were produced per exposure. It was patented by the Frenchman Adolphe-Eugène Disdéri in 1854. The cartes were avidly collected and traded.

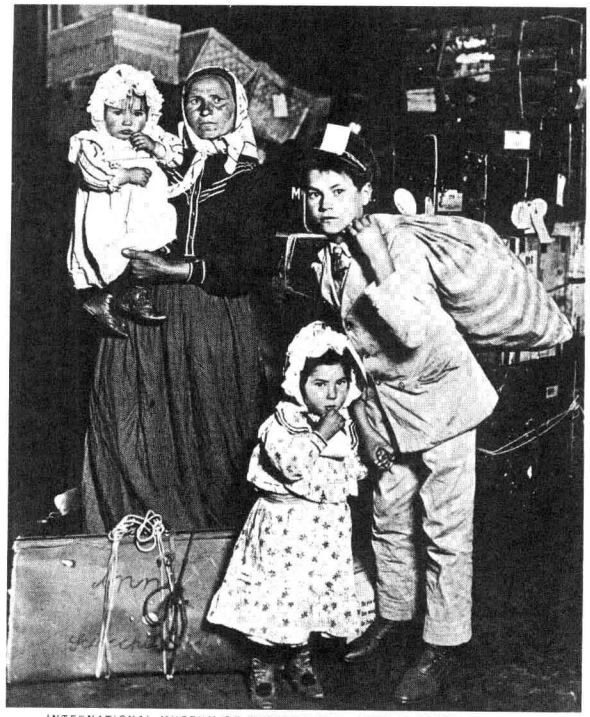
The collecting mania during the 19th century reached its apex with the stereographic card and with the carte-de-visite. First described in 1832 by Sir Charles Wheatstone, the principles of stereography were applied to photography by Sir David Brewster in the mid-1840's and popularized by him in the early 1850's. Two slightly dissimilar photographic images could be recombined into a single image through the use of two lenses mounted in a viewer. This device, called the stereoscope or stereopticon, gave the spectator the semblance of three-dimensionality and depth. Throughout the late 19th century and well into the 20th, stereographs were produced in the millions.

"High Art" photography—which attempted to emphasize "lofty" subjects rather than everyday scenes—was also popular during this era and into the 1890's. Henry Peach Robinson (British), and Rejlander were perhaps most involved in the development of the Victorian allegorical or narrative photograph, often illustrative of contemporary literature. Julia Margaret Cameron (British) one of the greatest 19th century artist-photographers, sought in her romantic, soft-focused portraits to capture the "souls" of her subjects.

DEMOCRATIC PHOTOGRAPHY AND PICTORIALISM

Technological developments involving new kinds of photographic emulsions and the continual miniaturization of camera sizes, begun during the 1870's, changed the complexion of photography in the 1880's. In 1871, the British physician Richard Leach Maddox discussed the possibility of using gelatin instead of collodion as the adherent of the photochemistry onto the glass plate negative. This breakthrough meant that photographers no longer had to prepare their negatives in the field but could exercise greater freedom and mobility in taking pictures. Combined with various dyes in the emulsions, the gelatin negative was more sensitive to colors of the spectrum than was collodion. The photographer could now achieve more naturalism than before. Gelatin negatives meant greater freedom in taking pictures. Gelatin-based papers (instead of albumen) meant the possibility of developing out rather than printing out papers, in turn leading to the potential for enlarging prints in the darkroom instead of printing them under sunlight for hours.

The Small Cameras and Their Impact. If enlarging was possible, then both the negative size and the camera could be reduced. In the 1880's a great number of small, "hand" cameras were developed. In 1888, George Eastman, in Rochester, N. Y., began distributing a hand camera already loaded with a gelatin-based, flexible roll film on paper, which he improved in 1889 by coating a flexible roll of clear plastic with gelatin



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The early 1900's saw more versatile cameras. *(Above)* Lewis Hine photographed immigrants at Ellis Island. *(Below)* Alfred Stieglitz explored New York streets.

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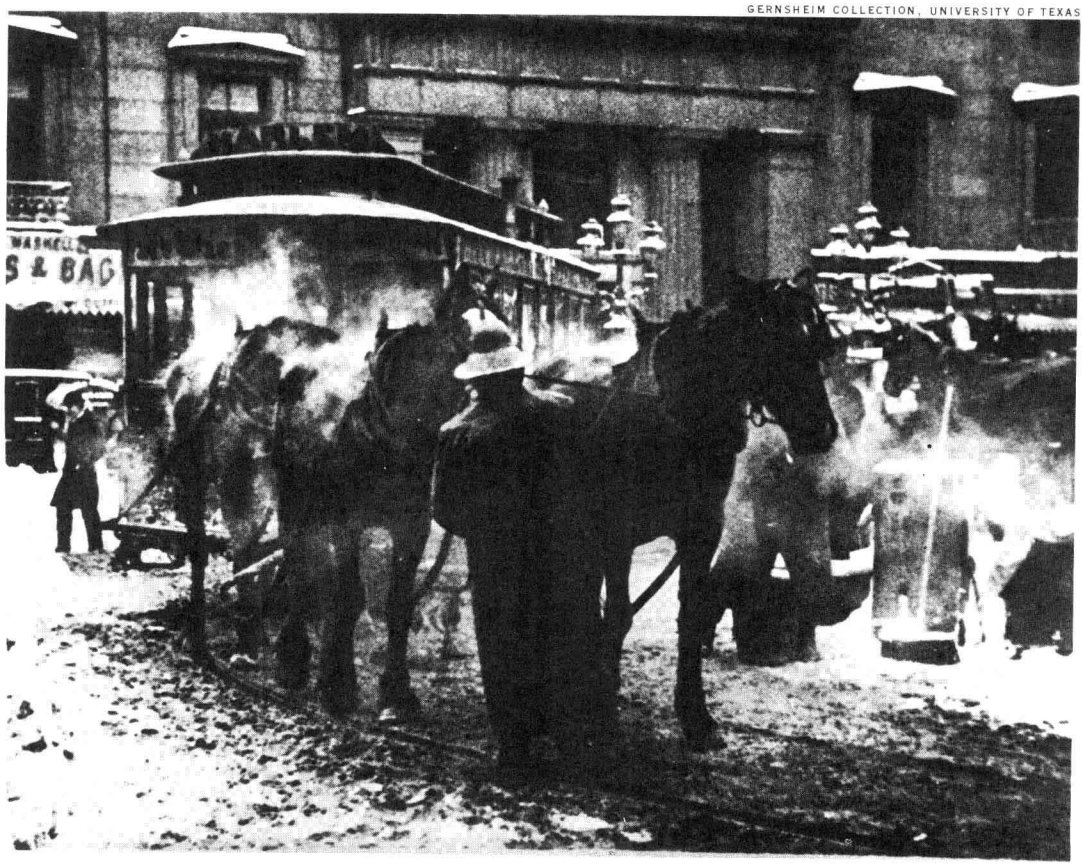
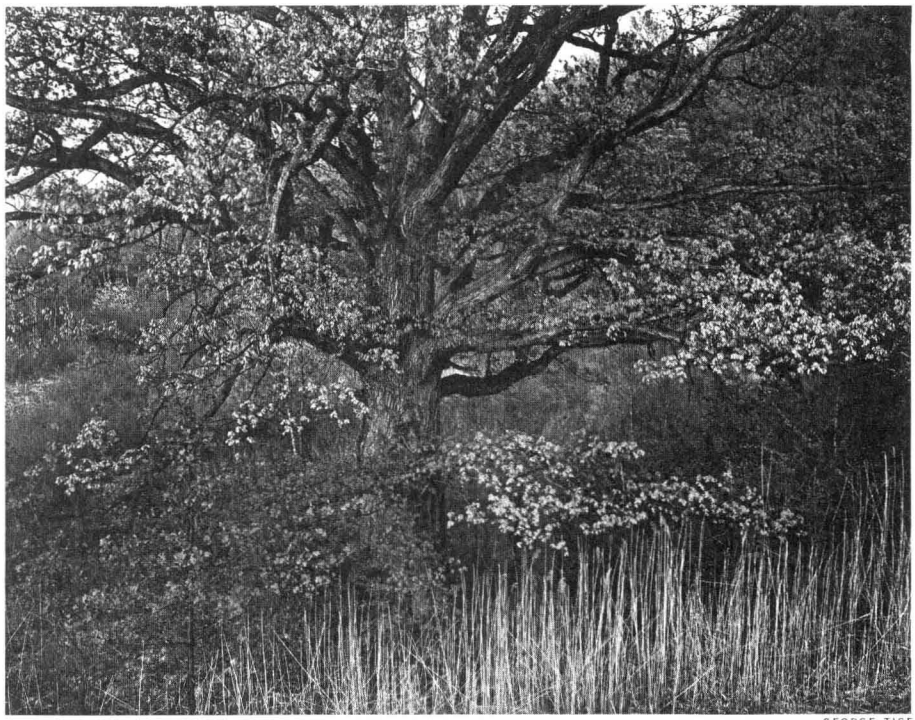
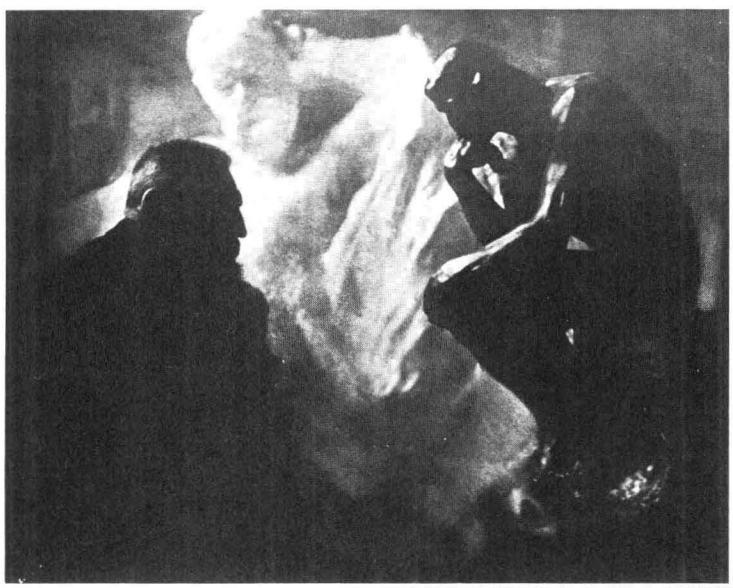




GEORGE TICE

George Tice, a contemporary American photographer, has used a large format view camera and a tripod to preserve details in a venerable oak trunk and in young leaves. To preserve the great range of gray tones, he took the photo at dusk to eliminate strong shadows and harsh highlights.



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Through his creative techniques during a long career, Edward Steichen (1879–1973) helped to win acceptance of photography as a fine art. When quite young, he photographed the sculptor Auguste Rodin in 1902.

emulsion. The photographer—professional or amateur—could now take pictures, send the roll off to be processed, and receive the prints by mail. The Eastman Kodak Company's motto, "You press the button, we do the rest," announced the start of modern, democratic photography.

The development of new emulsions and cameras and new and faster lenses made photography more spontaneous and the cameraman less conspicuous. Needing less time for exposure, photographers explored new avenues. In the 1870's and 1880's, Edward Muybridge (American), Étienne Jules Marey (French), and the painter-photographer Thomas Eakins (American) investigated the visual appearance of time-motion relationships. Their images, called chronophotographs, of animals and humans moving through time and space broke the temporal continuum into photographic segments and presented these instantaneous images either in sequence (Muybridge) or overlapping on a single photograph (Marey and Eakins). For the first time, it was possible to analyze how bodies position themselves when moving.

In the 1890's the new gelatin plates, along with flash powder (used as early as 1861 by Nadar in Paris), allowed Jacob Riis (American) to examine the seamier aspects of the slums of New York. Sociological photography was not new, but it was never before treated with such