2 The Camera

Large-format cameras are categorized by two important features: their format, or nominal film size, and their design. The film size in a camera's designation is usually the largest conventional rectangle the camera can accommodate. These dimensions are given in inches for the U.S. and U.K. and in centimeters for countries that use the metric system. All large-format cameras can be adapted to the use of smaller film, so the nominal film size indicates only the upper limit. A 4x5 camera (called 5x4 in Britain and 10x12 in Germany) can use any size film up to 4-inch by 5-inch film sheets. Other common formats are 5x7 and 8x10.

Two designs dominate today's view camera market: the *flatbed* (in its modern incarnations as *field* (p. 100), *technical* (p. 106), and *press* (p. 105) cameras) and the *monorail* (p. 99). The 4x5 monorail has become the archetypal view camera, and forms the basis for modular camera systems that can be adapted to smaller film as well as modified to become larger-format cameras. Because the individual features of a monorail camera are more obvious than those of any other design, it will be used in this book to exemplify the structure of the generic view camera.

The Monorail View Camera

Named for the supporting shaft at its base, the monorail view camera is the most common of today's large-format cameras. A major characteristic of any view camera is that it provides the physical means to adjust the lens and film positions independently. These adjustments may be made with more freedom and greater ease on a monorail than on a camera of any other design. Inexpensive or student-grade monorail cameras make lens and film position adjustments and provide for interchangeable lenses, but a professional-quality monorail view camera has additional features that make it much more useful.

The versatile, but more expensive, professional monorail cameras are all modular. That is, they comprise a system of interchangeable and interlocking parts and accessories that can be used to assemble a camera tailored to a specific photographic challenge.

The rail clamp attaches to the tripod and provides a solid foundation for the rest of the camera.

Every interlocking module is an elemental camera part that can be moved, extended, or replaced. These elements, common to all view cameras, are described below and illustrated with a modular camera. Familiarize yourself with these parts of the camera and their terminology before trying to set up or use your camera.

Rail

The *rail* provides a rigid base of support for the rest of the camera. Although some rails are round in cross section, some square, and some triangular, the design goal is the same: to provide a light, strong, inflexible shaft along which the adjustable front and back of the camera can slide independently. For most modular cameras the rail can be extended by adding sections. Such extensions would be needed for extreme close-ups and for the use of long-focus lenses. A very short rail for use with short-focus (wide-angle) lenses is also available.

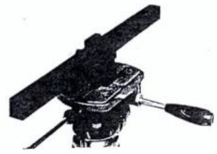
A *rail clamp* holds the rail in place on a tripod and allows you to adjust the position of the rail for balance. The clamp has a threaded hole in its base that matches the corresponding mounting screw on the tripod head (p. 136). The rail slides through the clamp, which may be fixed at any point along the length of the rail. When packing up after a shoot you may choose, if your camera allows it, to remove the camera from its tripod by releasing the clamp from the rail, leaving the clamp attached to the tripod until the next use. This is sometimes easier than removing the clamp from the tripod.

Front and Rear Standards

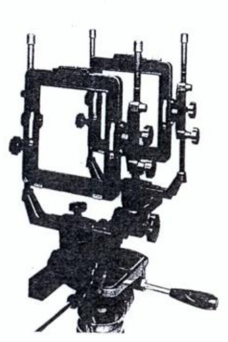
A *standard* is one of two upright frames attached to the monorail by a sliding geared or spring clamp. Each standard fulfills several functions. The front standard holds the lensboard mounted with lens and shutter at the front of the camera. The rear standard holds the camera's back with its spring back and ground-glass focusing screen, the devices that hold film and determine focus. The bellows is suspended between the two standards. These parts are described in detail later in this chapter. Both standards contain the mechanisms for adjusting independent rotation and movement of the lens or film they hold, and both may be moved longitudinally along the rail. This front-to-back movement is used to vary the distance between the standards and bring an image into focus.

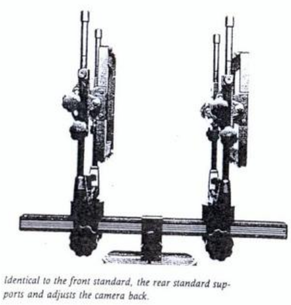
In modular 4x5 cameras the front and rear standards are identical. A monorail camera designed for film larger than 4x5 has a proportionately larger rear standard; its design and function are the same as the front standard's, but the two are not interchange-

The monorail, for which the camera is named, is a rigid tube along which the rest of the camera can slide while maintaining alignment.



The front standard can move along the rail, and contains the mechanisms for adjusting the position of the lens it is designed to support.





Identical to the front standard, the rear standard supports and adjusts the camera back.

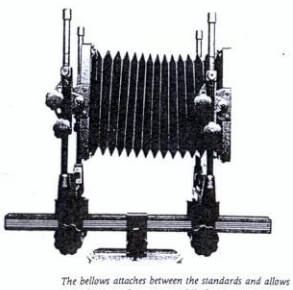
able. The spring back of a modular camera is a separate piece, attached with clips to the back of the rear standard. The bellows, also a separate piece, is held to the front of the rear standard with similar or identical clips. The other end of the bellows clips to the back of the front standard, and the front of the front standard holds a separate lensboard. If the attachment mechanisms on both sides of each standard are identical, the standards can be reversed on the rail so the controls are more convenient for a left-handed photographer.

Bellows

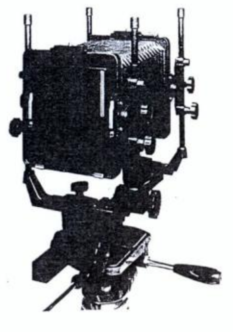
The *bellows* is a hollow tube of flexible material held in place between the front and rear standards. With the lensboard and spring back in place, the bellows completes a chamber forming the body of the camera. The *standard* or *square* bellows is made from pleated folds of opaque cloth, leather, or a similar synthetic material, and serves to keep the enclosed volume lighttight without restricting movement of the attached standards for adjustment or focus. The interior surface of the bellows is made nonreflective to assist its accordionlike folds in suppressing contrast-reducing stray light. Unwanted light inside the camera body can come from the lens projecting an image larger than the film (see *coverage*, p. 74), or from reflections off the film itself. The standard bellows collapses compactly for storage and can be extended enough for all but the most extreme long-focus lens or close-up work.

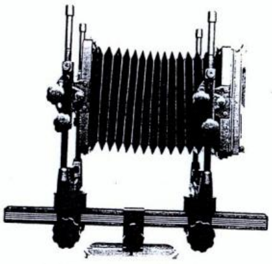
Spring Back

The back of a view camera is formed by the *spring back*, a pair of nesting frames on the rear standard. It holds the ground glass in place for focusing and viewing, and it accepts a film holder for exposure. The ground glass is held in the inner frame, which in turn is held to the outer frame by springs. As the film holder slides into place between the two frames, it forces the ground-glass frame away from the rest of the camera back. The holder is pressed securely into place against the inner frame by the springs, forming a lightproof seal. The spring back's dual role — holding both ground glass and film — is important because it enables the position of the film during exposure to correspond exactly to the position of the ground glass during viewing. The image can then be recorded exactly as viewed.



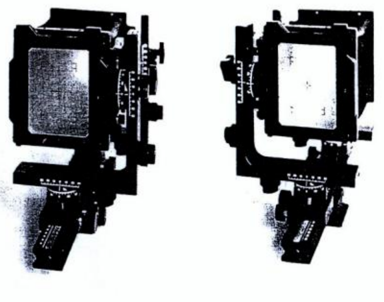
The bellows attaches between the standards and allows them freedom of movement while forming an opaque and lighttight shell.



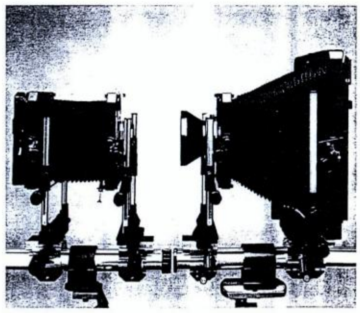


The camera back clips into the rear standard and contains the spring back to hold the film and the ground glass to allow focusing.

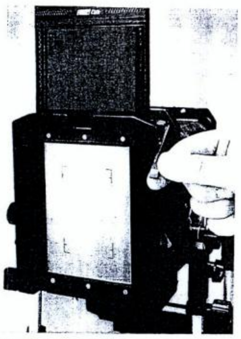
The lensboard, with its attached lens and shutter, is held in place in the front standard.



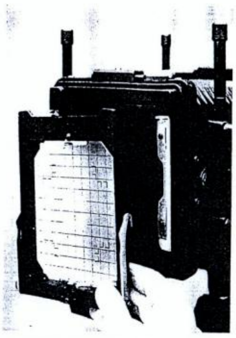
Like many modular view cameras, this Horseman 450 allows its standards to be reversed on the rail for the convenience of a left-handed photographer.



A modular, system view camera like this Toyo allows the use of several different-sized film backs with the same rail and front standard. To change formats, the bellows, rear standard, and back must be replaced.



A bail lever is sometimes incorporated into the spring back to facilitate the insertion of film holders.

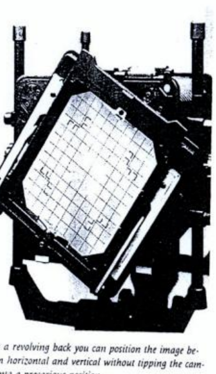


Removing the spring back from this universal (or Graflok) back allows other accessory backs to be clipped into place.

Some view cameras have a *bail lever* around the ground-glass frame to force the springs apart and open a path for the film holder. This prevents the unnecessary wear on your film holders that occurs if they are forced into place by using them to pry the ground-glass frame away from the camera back.

On many 4x5 cameras, the spring back is held with clips in yet another frame and can be removed to allow the use of various accessory backs and film holders. Graflex introduced this modular design in 1949 as the *Graflok* back on Speed Graphic cameras. Although camera backs bearing the Graflok brand name are no longer manufactured, current *universal* or *international* backs are interchangeable with them and Graflok-style accessories will fit them all.

A *revolving* back allows you to rotate the spring back and ground glass to any desired position in its outer frame. This feature enables you to avoid having to rotate a large camera to frame a photograph exactly as you want. A *reversing* back fits into the rear standard either horizontally or vertically, but adjustments of the film's orientation for angles in between must be made by rotating the entire camera, using the tripod head. Revolving backs are rare on cameras larger than 4x5; these most often use the lighter and more compact reversing back to save considerable bulk.



With a revolving back you can position the image between horizontal and vertical without tipping the camera into a precarious position.

Ground Glass

The frame of the spring back holds in place a sheet of *ground glass* on which you view, compose, and focus the image projected by the lens. Ground glass is sheet glass made translucent by grinding, etching, or sanding one surface. The ground side of the glass faces the lens to receive the image, inverted by the lens, and the glass sheet should be the exact size and shape of the film. The position the front surface of the ground glass holds during viewing and focusing should be the exact position held by the film's emulsion when the ground glass is moved away by a film holder in place for exposure. See Chapter 8 for more information on the ground glass.

Lensboard

A *lensboard* is the rigid, opaque plate that holds the lens to the front standard. Most lensboards are flat, square panels of metal or wood drilled with a single mounting hole for the lens. The back or interior side of the lensboard should be nonreflective black so that it can absorb light reflected from the film during exposure.

Many wooden cameras use wooden lensboards, and you can fabricate and drill a substitute yourself with hand tools to save money. The more modern, modular monorail cameras have metal lensboards with formed edges that are difficult to duplicate in a home shop. These metal lensboards are rarely interchangeable from one brand of camera to another. And although you will need one for each lens you wish to use on your view camera, lensboards are sold separately from the lenses.

Lens and Shutter

A *lens* gathers the light in front of it and converges that light to a focus behind it to form an image. The lens for a view camera is recognizable as a lens to anyone familiar with other cameras. It is larger than most other lenses, however, and is usually mounted in a *shutter*. As in other cameras, the shutter opens and closes to admit light to the film for a metered amount of time. Before you can use your camera, the shutter and lens must be mounted to the lensboard in a round mounting hole and the lensboard must be affixed to the front standard. Lens mounting is a job usually left to a specialist in a camera repair or machine shop. If you want more information about lenses at this point, read Chapters 5 and 7.

3 Using Your Camera

Now that you are familiar with the structure of your camera, you can begin to put it to use. Establishing a familiar pattern of use with your camera will enable you to set it up and adjust it while concentrating on the image you wish to make. Initially, setting up the camera will demand your undivided attention, so before you take it out into traffic, practice setting up and adjusting your camera in a place where you can work comfortably and without distraction.

This chapter is designed to get you working with your camera as soon as possible. First we will move through the making of a simple exposure and the sequence of actions you must follow for every photograph. Using the camera this way will be very much like using a bigger version of a camera you already know, and you will soon become comfortable with the essentials of view camera use. The latter part of the chapter will introduce you to the way the camera movements influence and control perspective and focus. Mastering the camera movements is difficult and should be left until you are comfortable with the basics of using the camera.

Many of the camera parts and accessories mentioned here are explained in detail later, so you can read through this sequence of steps rapidly, without digression. If you want more complete information, refer to the page numbers indicated.

Mounting the Camera

Before mounting the camera on your *tripod* (p. 134), extend the tripod's legs so that its platform is at chest height. This positioning places the tripod's feet far apart to give you a steady platform for attaching the camera. It also places the ground-glass viewing screen at a comfortable height just below eye level. Save lower camera positions for a time when you are proficient and can set up and work quickly — prolonged viewing in low positions can strain your lower back. After a little experience, you will know in advance how much to extend the tripod's legs for the vantage point you desire. Remember that the height of the platform is much easier to adjust before you have the weight of the camera on it.

Locate the threaded mounting bolt projecting through the platform of your *tripod head* (p. 136) and the corresponding threaded hole in your camera's rail clamp or baseplate. With one hand hold the camera as close to its top as possible while aligning and threading the mounting screw into the hole in the baseplate with your other hand. Make sure the rail, or lens axis, is aligned with the axis of the tripod head before you tighten the mounting screw securely. Many cameras have a carrying handle at the top of the rear standard, which makes the mounting operation much easier. Never hold a view camera in one hand by its monorail — this is an invitation for the camera to invert and crash into the tripod or worse, onto the ground.

Before you release your grip on the camera and rely upon the tripod for safe support, be sure all the adjustment levers on the tripod head are secure. If just one lever works loose, the camera may tip and capsize the entire tripod. Check also to make sure the lens and lensboard are securely attached before you move or tilt the camera. The most convenient way to move the camera more than a few steps is to lean it over your shoulder, but this rifle-carry position places considerable strain on the mount. If the camera comes loose, a fall from shoulder height could irreparably damage both camera and lens.

Positioning the Camera

Swivel the tripod head to align the axis of the monorail and lens with one leg of the tripod. This position, with one tripod leg pointed forward, will give you room to move around behind the camera between the other two legs without continually kicking or tripping over one tripod leg. It will also provide a more stable platform should you tilt the camera downward.

It is not practical to take frequent casual glances through a view camera the way you might with a 35mm, to decide on the correct camera position for the image you desire. Instead you will need to train your eye to see what the camera sees. With time you will be able to place the tripod in its final position the first time you set it down. For now, place the tripod approximately and point the camera in the general direction for the photograph you plan to make.

The lens projects an image upside down onto the ground-glass viewing screen. To see it well, your eye should be about the same distance from it as a comfortable reading distance from a book page the same size.

Zero Position

Zero position for a view camera means that all of its adjustments are set as though it were a rigid-bodied camera: front and rear standards are parallel to one another and at right angles to the monorail, and the rear of the lens is pointed straight at the center of the ground glass. This neutral setting is sometimes called the *normal* position.

Once your camera is mounted on its tripod, set all the movements to zero position and extend the bellows by setting the standards approximately one focal length apart, that is, 150mm (6 inches) apart with a 150mm lens. This setting, called the *infinity focus*, is a good place to start for general work. The bellows will need to be extended further for close-ups. Make sure the camera's movements, standards, clamps, and revolving back are securely locked.

Framing and Focusing

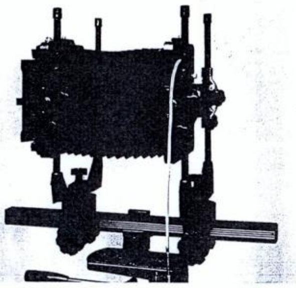
To view through your camera, open the shutter using the *press-focus lever* (p. 88) and set the aperture to its widest setting. Then, facing your subject, stand behind the ground glass. Cover your head and the rear standard with the *darkcloth* (p. 139) and look at the image that appears upside-down on the ground glass. All lenses invert the image they form but other cameras are designed to reinvert the image (*reflex* cameras) or else provide an alternate upright image (such as a *viewfinder* image) for you to look at. Remember, in a view camera you are looking *at* the ground glass, not through it, so your eyes will need to be reading-distance away from it. In time, you will find it as easy to work with an image upside-down as with one right-side-up.

After you open the shutter, disengage the focus lock on the rear standard and focus on the scene by moving the rear standard along the rail. Your camera will probably have a focus knob to move the standard by very small amounts. Focus by rocking the knob back and forth past the point you think is the best focus a few times, rocking it less and less each time until you settle on the position for best focus. If you have a fast lens, that is, one with a large maximum aperture, it will admit enough light for you to focus unassisted in bright light, but at smaller apertures and for very precise focusing, hold a magnifying *loupe*

(p. 157) against the ground glass to enlarge a part of the image. Make certain the front of the monorail is not visible in the image at the top of the ground glass. If it is, move the front standard forward on the rail, then refocus. If after viewing the image you decide to change it by moving the camera (or, later, if you change the camera movements), you will also need to refocus.

Although under most circumstances you can adjust the focus equally well with either the front or rear standard, get in the habit of focusing with the rear standard. It is especially difficult to focus close up with the front standard because it changes the magnification and makes the image larger or smaller as you focus. This change results from altering the distance from lens to subject — the *object distance*. Using the rear standard to focus allows you to find the appropriate focus for an object in a fixed relation to the lens. With a very short object distance it is often easier to move the entire camera or even the subject to bring the image into precise focus.

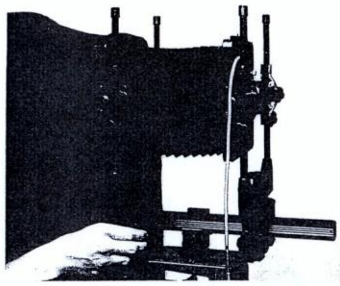
Lock the focus knob in place after final focusing. Select your working aperture by stopping down until adequate depth of field is visible in the ground glass. These adjustments are judged strictly by eye, so you will need to manipulate the controls from the rear of the camera, while under the darkcloth. When the camera is adjusted and focused, and the lens is stopped down to the working aperture, close the shutter. After taking your exposure reading, set and wind the shutter. You may wish at this point to check exposure, lighting, framing, and focus with a sheet of Polaroid film (p. 145).



To begin using your camera, set it securely on its tripod, and make sure all the adjustments are locked in zero position and the shutter is opened for viewing.

Making the Exposure

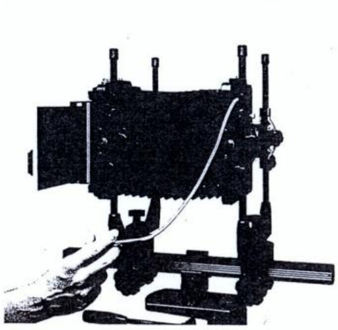
Once you are certain the camera and tripod have been properly adjusted and all of the parts have been locked in place, open the spring back. If your camera has one, use the bail lever. If not, pry back the ground-glass frame a bit with your fingers and insert a loaded *film holder* (p. 60.) against the spring pressure. Hold the camera steady to avoid moving it out of position. With some cameras it may be easier to remove the entire back, insert the holder, then replace the back. If you are using the bail lever, release it gently to prevent the back from snapping shut and cracking the ground glass. The film holder must make a good lighttight seal to avoid unwanted streaks on the film or fogging (*fog* is an even, overall exposure to unfocused light that lowers contrast and degrades the image quality). If you are unfamiliar with your camera, you may have trouble at first finding this proper, seated position. Practice inserting and removing the film holder a few times to make sure you know where the holder is supposed to seat.



With the darkcloth covering your head and the camera's back, focus the image on the ground glass by moving the rear standard along the rail.

Double-check the shutter to see that it is closed and then gently withdraw the *darkslide* (p. 61) from the side of the film holder facing the lens. In dry climates, a too-rapid movement of the darkslide may generate enough static electricity to mark the film. If the sun is shining on the camera back, or if there will be a long delay between removing the darkslide and making the exposure, drape the darkcloth over the camera back to protect against possible light leaks.

Look carefully at the camera for vibration. If you have just taken your hands away from it, give it time to stop moving. If there is a breeze against the bellows, try to wait for a lull. Hold the end of the *cable release* (p. 138) in your hand, leaving enough slack in the cable to prevent motion being transmitted from you to the camera. Make the exposure by pressing the cable release to trigger the shutter. After the exposure is made, insert the darkslide back into the holder with the black rim of its handle facing the outside (a safeguard signifying exposed film) and remove the film holder from the camera.



After closing the shutter, insert a film holder and withdraw its darkslide. Make sure the camera is motionless before gently pressing the cable release to make the exposure.

Advanced Camera Control

Your view camera's unique appearance is in part the result of its separately adjustable front and rear standards. *Camera movements*, the adjustments of these standards, make the view camera unique in function as well as appearance. The importance of adjustable standards is that we can use them to independently alter and control the positions of the lens plane and film plane.

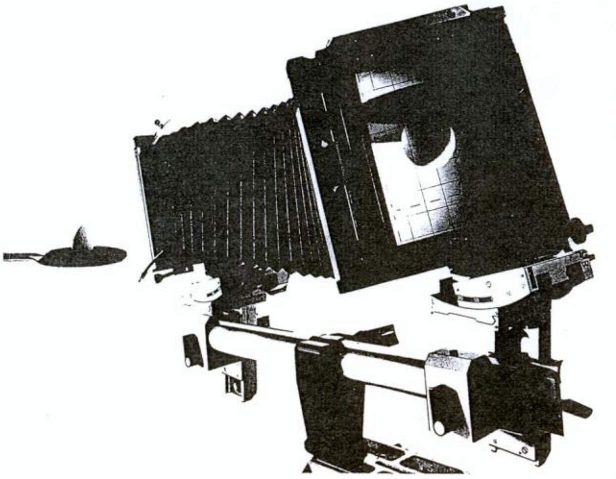
The *film plane* is the position of the film during exposure, or of the front surface of the ground glass without the film holder in place. With a movable rear standard, the film plane can be angled away from its normal position perpendicular to the rail and to the *optical axis*, the path of a ray of light passing unrefracted through the center of the lens.

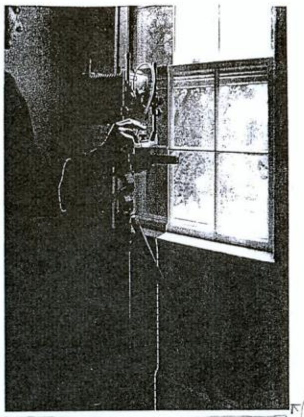
The *lens plane* is always perpendicular to the optical axis, and corresponds roughly to the position of the lensboard (it may in fact be slightly in front of or behind the board depending on the kind of lens and the thickness of the board and lens mount). With the front standard's movements, the lens plane may be moved away from its normal position perpendicular to the rail. The optical axis moves with the lens.

Moving the lens and film planes away from their normal positions parallel to each other changes the rendering on film of both perspective and focus. Once you are in control of the effects of these movements, you can create images that would otherwise be impossible. Because the idea of camera movements may be new to you, it may seem intimidating at first. Finish reading this chapter entirely before trying to apply the concepts it introduces. You will need to understand how the camera movements change an image before you can successfully apply that knowledge. Then put your camera through its paces while rereading this chapter. In a short time you will be able to concentrate on the ground-glass image while setting the movements, using no more conscious thought than you need to adjust the focus.

Always begin with your camera set up in zero (or normal) position with the monorail or camera base horizontal and the lensboard and camera back vertical. The lens plane (lensboard) and film plane (camera back) should be parallel, so that the optical axis will run parallel to the monorail through the center of the lens and the center of the ground glass. Get into the habit of returning the camera to the zero position after each photograph.

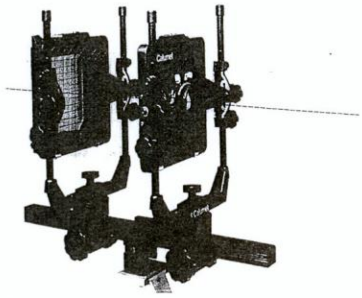
Adding the camera movements to your photographic repertoire will give you pictorial control otherwise impossible, as shown in this photograph by Switzerland's Fred Waldvogel made for Sinar on their 5x7 Model P camera.





The film plane extends in all directions, continuing outward from the edges of the film, or the front surface of the ground glass.

The lens plane extends the surface of the lensboard. It is always perpendicular to the optical axis.



The optical axis is an imaginary line through the center of the lens, perpendicular to the lens plane.

Swings and Tilts

Adjusting the front and rear standards to control the image requires some combination of three motions: shift, swing, and tilt. These camera movements are adjustments of the plane and position of the lens and film and are sometimes referred to as swings and tilts.

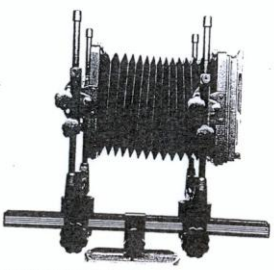
A *tilt* is a movement of the lens plane or film plane around a horizontal axis perpendicular to the optical axis. Nodding your head as if to answer yes would be a tilt of your face.

A *swing* is a movement of the lens or film plane around a vertical axis perpendicular to the optical axis. Shaking your head to say no is a face swing. Swings and tilts are both inclining movements and produce an angular change in the position of the lens or film plane.

A movement of the lens or ground glass that leaves it in the same plane is called a *shift*. For example, in a lens shift you would slide the lens to the side or up or down and produce a lateral or vertical displacement of the optical axis. Opening a sliding door is a shift movement. A vertical shift is often called a *rise* or *fall*.

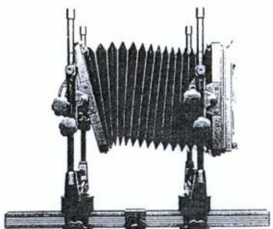
What the Movements Do

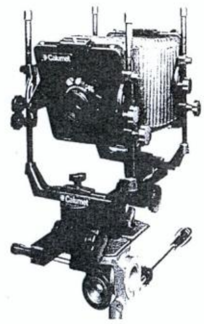
The camera movements increase your ability to control two important aspects of a photograph: the rendering of perspective and the position of the plane of focus through the image. *Perspective* means the relative sizes of objects in the image, and the *plane of focus* is that plane in front of the lens in which all points are in focus, independent of depth of field. Although the effects of front and back movements can overlap (shifting the front up gives almost exactly the same results as shifting the back down), and although a single movement of one standard can affect both plane of focus and perspective, the swings and tilts are best understood if you mentally separate the functions of the front and back. As a rule of thumb, *use the position of the lens plane to control plane of focus and the position of the back to control perspective.*



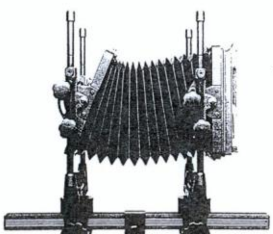
The camera in zero (or normal) position.

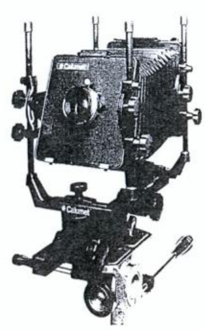
The illustrations on the next few pages show the camera movements — swing, tilt, and shift — shown in extreme positions for clarity. In normal use, you will rarely need to adjust your camera so far from zero position.

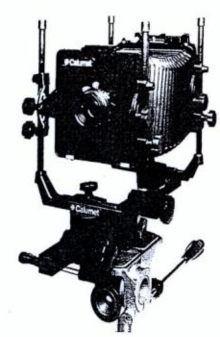


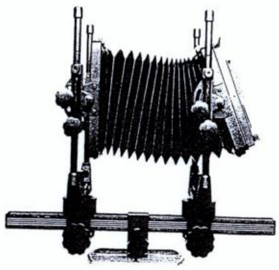


Front tilt, sometimes called lens tilt.

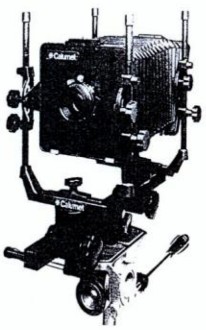


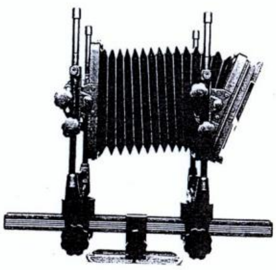


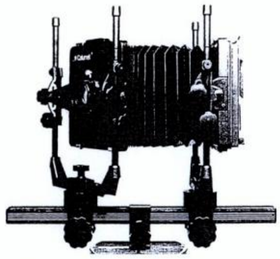




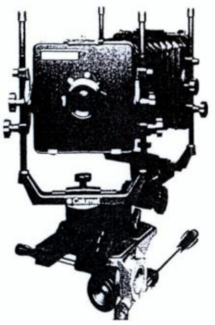
Back tilt.

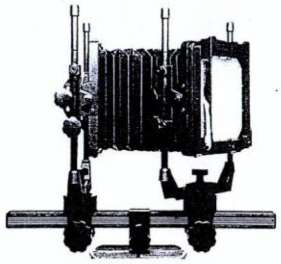




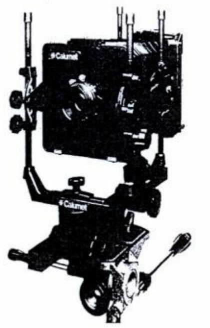


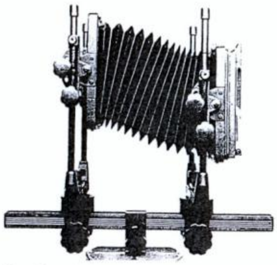
Front or lens swing.



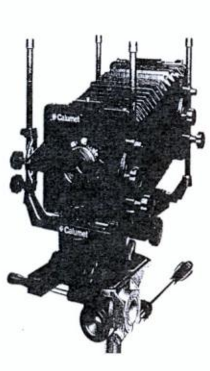


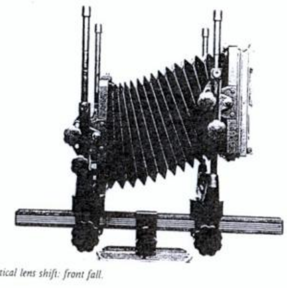
Back swing.





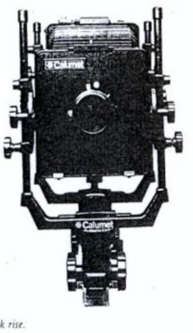
Vertical lens shift, nearly always called front rise



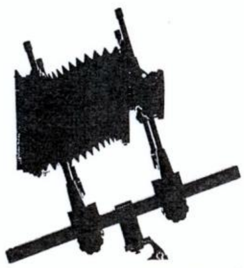


Vertical lens shift: front fall.

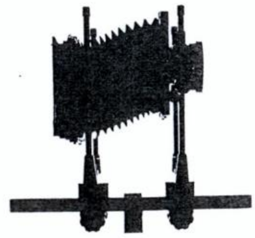
Front or lens shift.



Back rise.



The actual positions of the lens and film will affect your photograph, not how you got them into those positions. The effect on your photograph of a front and back tilt on an inclined rail . . .



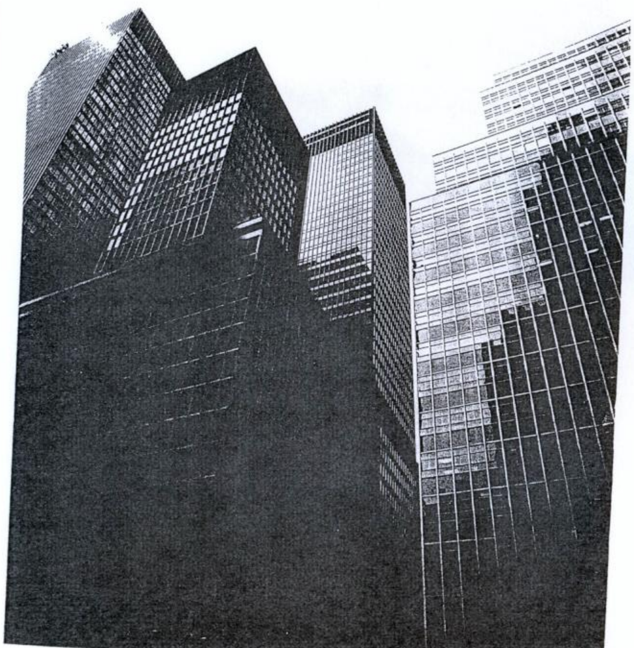
. . . is exactly the same as the effect from a front rise on a horizontal rail.

Controlling Perspective: Back Movements

In your past experience as a photographer, you have probably found that one of the most important controls at your disposal is camera placement. This may seem obvious; if you put the camera in the forest, you will make a different photograph than you would in the city. And a photograph made from above your head will be different from one made at knee level. These considerations of *vantage point* are extremely important to the making of photographs with any camera.

Vantage point is the position of the lens in space and determines *perspective*, that is, the relative sizes of near and far objects in your image. Perspective is also the relative sizes of near and far parts of the same object so, as a direct consequence, perspective controls the appearance of the shape of objects. The perspective in your photograph will ordinarily be the same as what you would see with one eye if it were viewing the scene from the same position as the lens. If you can alter the position of the back of a camera, and therefore the position of the film relative to the optical axis, you can alter this apparent perspective in your photographs. Once you have placed your lens for the desired vantage point, your view camera allows you to control the appearance of the image further by altering the position of the back.

In this 1969 photograph of New York City buildings, Harry Callahan made intentional use of the keystone effect, the convergence of vertical lines that is a natural consequence of tilting the camera up.

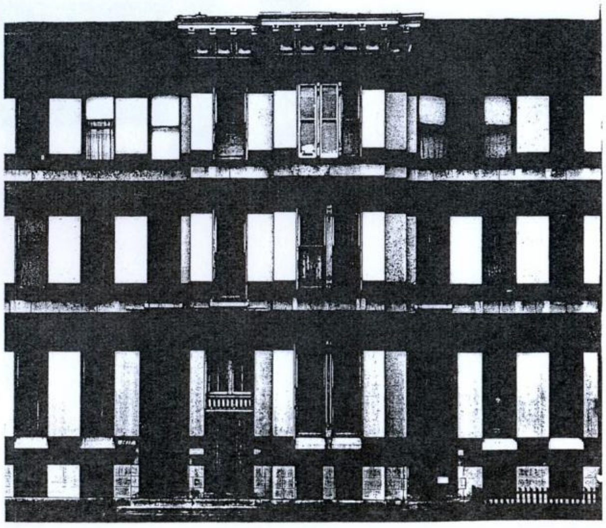


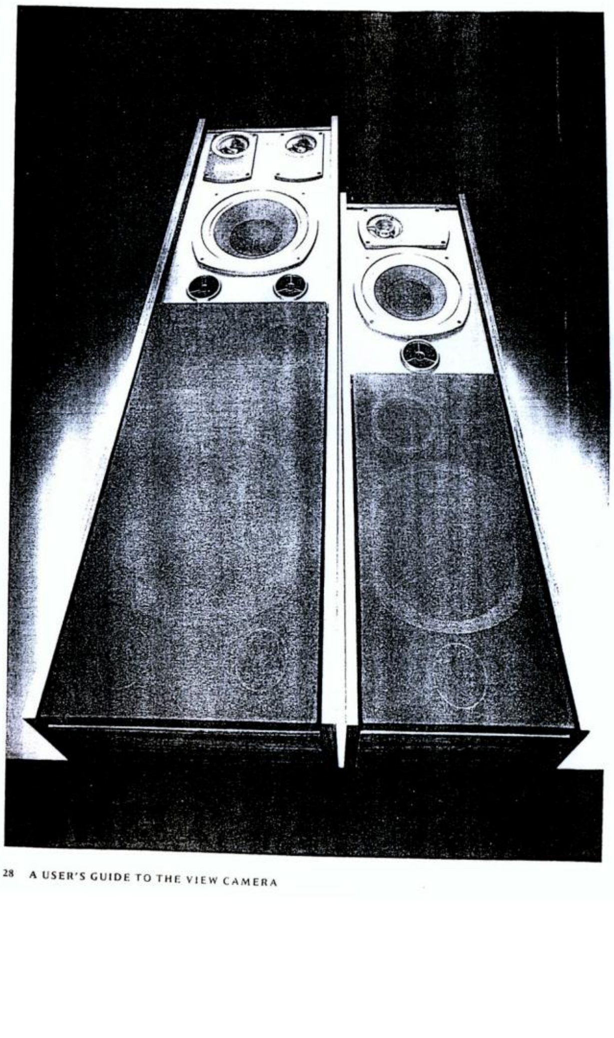
Back Tilt

As an example of the kind of perspective control a view camera can give you, use a 35mm camera (or any camera having back and lens in fixed positions) at ground level to photograph all of a tall building. The building, having vertical, parallel sides, will appear in the photograph to be narrower at the top. This effect, called the *keystone effect*, is the result of tilting the camera up to include the top of the building. The top of the building appears smaller than the bottom because it is farther from the lens and the parallel sides of the building appear to converge toward the top.

To avoid the keystone effect with your view camera, you can tilt, or incline, the back independently of the rest of the camera. When you do, one end or edge of the film ends up closer to the lens than the other. The cone of light projected rearward by the lens (p. 31) gets larger as it moves away from the lens. When you incline the film plane, the image on the part of the film farther from the lens becomes larger than that part closer to the lens. This tilt will diminish the appearance of convergence toward that side of the image.

An earlier photograph by Callahan, from Dearborn Street in Chicago, 1948, exhibits vertical lines of the building carefully made to appear exactly vertical in the photograph. Callahan's mastery of the camera allows him to select and control convergence to his own aesthetic advantage.





Opposite: Vertical convergence was exaggerated with back tilt for dramatic emphasis in this advertising photograph made for the loudspeaker manufacturer by Geoff Stein.

Because the lens inverts the image, the top of the building in the example above appears at the bottom of the ground glass. Tilting the back, now leaning with its top away from the building, toward a vertical position moves the image of the top of the building (seen at the bottom of the ground glass) away from the lens, making it larger or wider, and the image of its bottom (at the top of the ground glass) toward the lens, making it smaller or narrower. If the back is adjusted this way until the top and bottom of the building appear to be the same width in the image, its sides will appear both vertical and parallel.

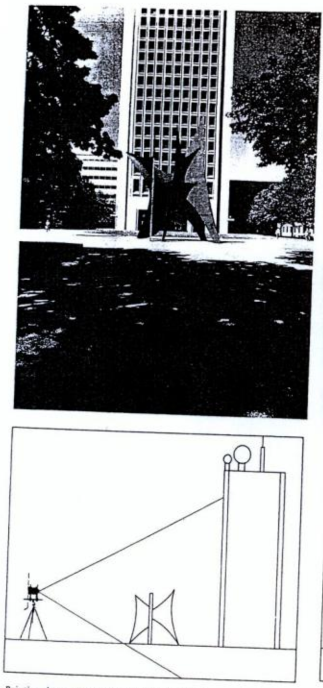
This tilting procedure alters the normal perspective of the image. Your eye, like a fixed-back camera, actually forms an image of the building with its top narrower. Your brain usually ignores that data, however, because you *know* the sides of the building are parallel. Some photographers refer to this kind of perspective alteration in a photograph as "correcting," because it makes the image appear as we *perceive* the building, not as we *see* it.

Photographs of buildings are the most obvious examples of the need for this kind of perspective control. When architects and builders carefully design and construct buildings having parallel sides they like to see their efforts clearly demonstrated in photographs of their buildings. They exhibit a particularly strong preference when they are paying for the photographs.

The Vanishing Point and Convergence. When you make photographs, remember first that the relative sizes of near and far objects (and of near and far parts of the same object) are determined by where you place your lens. The *vanishing point* is the point at which parallel lines or surfaces receding from the camera position appear to converge. Because tilting the back increases or diminishes convergence, it also moves the vanishing point closer to or farther away from the center of the image. Once you have selected a specific vantage point, you may further modify the perspective by altering the location of the apparent vanishing point with the position of the camera's back.

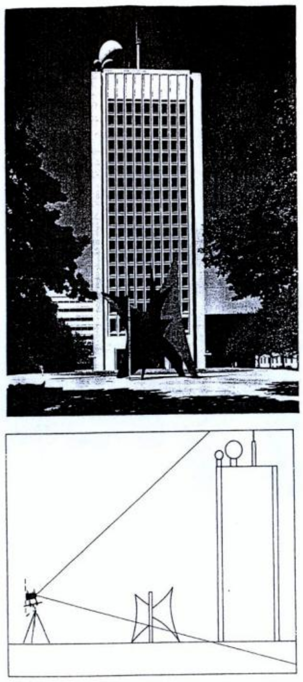
Tilting the back controls vertical convergence. When the camera back is vertical, all vertical lines in the scene appear as parallel vertical lines in the photograph. If the back is tilted away from vertical, as in the previous example with the tall building, vertical lines in the scene will converge in the photograph. If convergence is desired, as in the photograph of the loudspeakers on the opposite page, it can be exaggerated; the farther from vertical the back is tilted, the greater the convergence.

Note that increased convergence means that the vanishing point moves closer to the center of the image. The results of tilting the back are easiest to understand by looking at vertical lines, such as building sides in an architectural photograph. But even in an image containing no straight lines, such as a landscape, moving the vanishing point profoundly affects the appearance of the photograph.

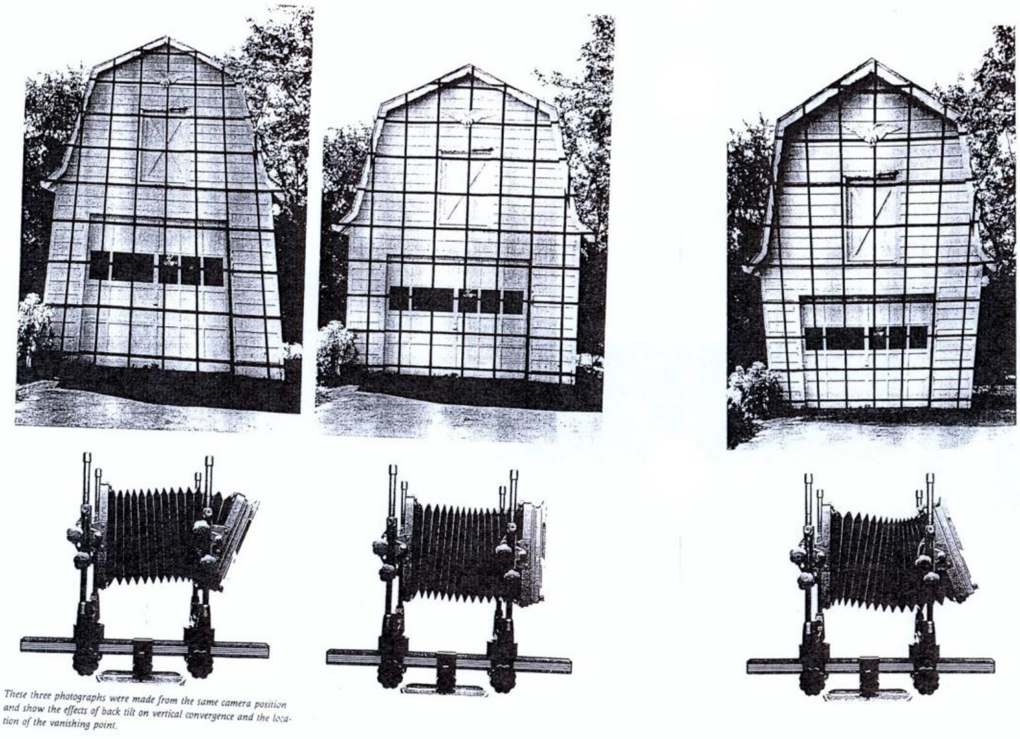


Pointing the camera straight at a tall building from eye level will result in a photograph that includes a great deal of foreground but lacks the top of the building.

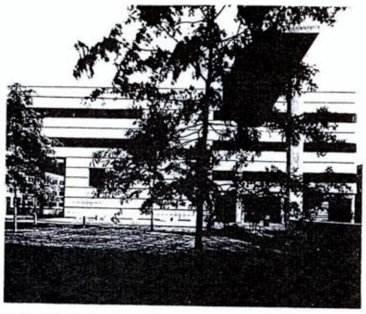
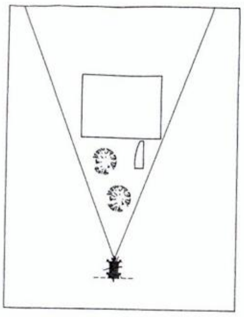
Pointing the camera up to center the building in the frame results in a photograph that shows the sides of the building as converging lines. The bottom of the building is closer to the camera than the top, and is represented in normal perspective by appearing larger.



Tilting the back of the camera moves the bottom of the camera, with the image of the top of the building, farther from the lens than the top of the camera with the image of the bottom of the building. The image formed by the lens grows larger as it moves back away from the lens in the projected cone of light, so the image of the building's top is made larger to appear the same width as the image of the bottom of the building.



These three photographs were made from the same camera position and show the effects of back tilt on vertical convergence and the location of the vanishing point.

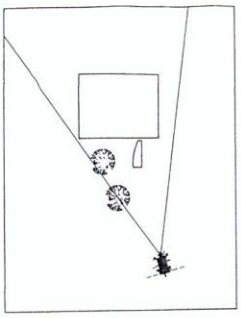
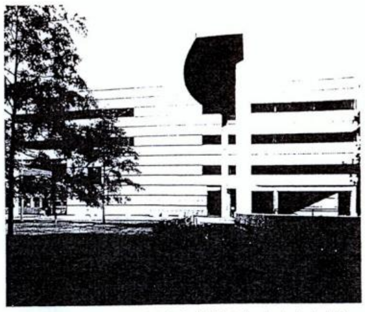
The front of this building shows its horizontal lines parallel (without horizontal convergence) because it was made from a position exactly in front of the building's center. Unfortunately, there is also a tree in a position exactly in front of the building, making the value of this vantage point questionable.

Back Swing

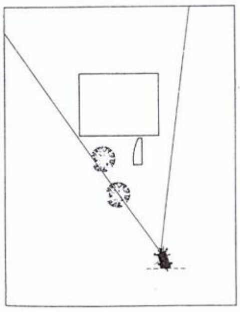
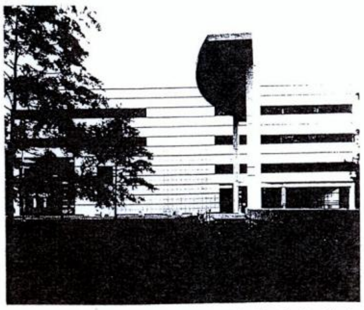
While back tilt controls vertical convergence, back swing affects convergence (the position of the vanishing point) for horizontal lines. When a horizontal line on the back of the camera is parallel to horizontal lines in your subject, as in a head-on photograph of a house, the horizontal lines in the image will all be parallel and horizontal. Pointing the camera at the same house from a position on either side of head-on, with the camera back at an oblique angle to the front of the house, the horizontal lines will converge away from the camera. Swinging the back from this position to be more parallel with the front of the house will reduce this convergence; swinging it farther away from parallel will exaggerate it.

In the two series of photos on the following pages, placing the camera in position for a head-on photograph eliminates convergence as easily as using the back swing. The swing movement is most useful when your access to a desired vantage point is limited, for example by a tree or car in front of the house. This is why the back tilt is more often used than the swing; a vantage point head-on to a horizontal surface is easier to achieve (say, by walking around a building) than one head-on to a vertical surface (which might require a very tall ladder). Your own mobility is often much greater horizontally than vertically.

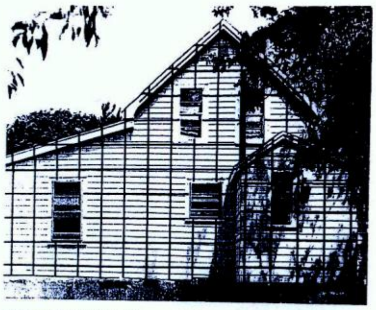
The advantages of swing and tilt control are most evident when you are photographing man-made objects because their regular shapes make convergence more noticeable. This is why the view camera is indispensable when photographing architecture or for advertising. Remember that nature's forms are no less affected by moving the vanishing point, however, and creative control is at your fingertips when using a view camera for landscapes.

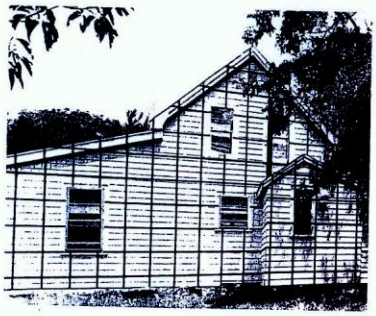
From a vantage point slightly to the side, the building's elevation is clearly visible, the tree is on the left edge of the frame, but the horizontal lines converge to the left.

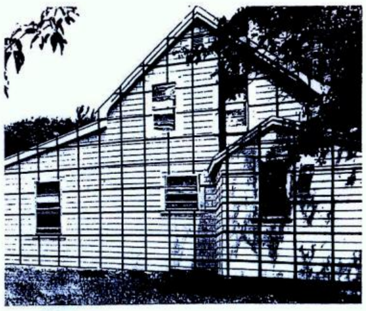
By using a back swing, making the back parallel to the building's facade, the horizontal lines are made parallel in the photograph made from this vantage point.

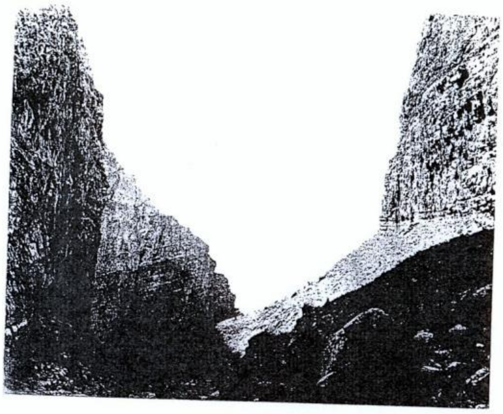



These three photographs made from exactly the same camera position show that back swing can be used to introduce and control horizontal convergence, without altering the vantage point.

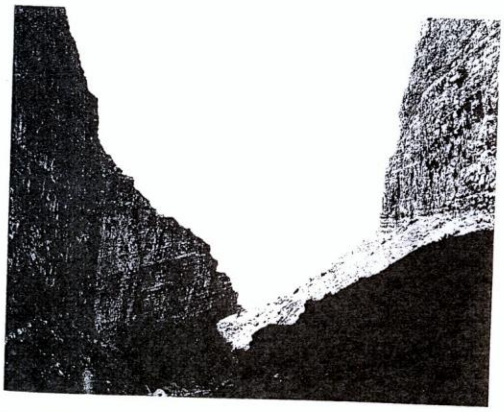




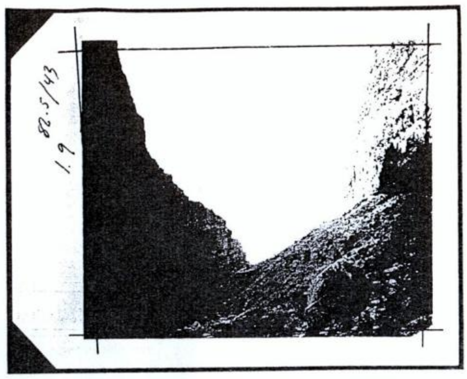




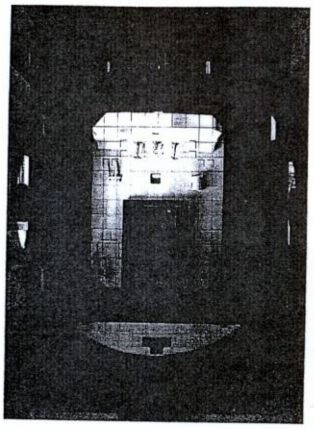
Timothy O'Sullivan made this photograph of Colorado's Vermillion Creek Canyon in 1872 for the United States Geological Survey.



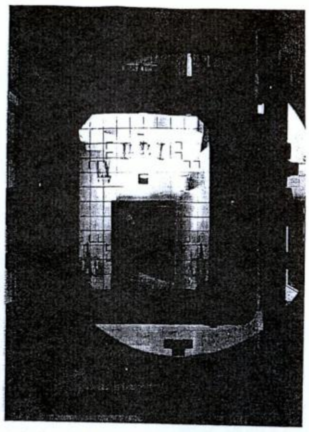
For the Rephotographic Survey Project, Mark Klett made this photograph in 1979 from O'Sullivan's original vantage point showing this particular section of our western landscape to be virtually unchanged in over a century.



Klett's precise methodology reveals O'Sullivan's use of camera movements for perspective alteration. This Polaroid field check of camera position made without camera movements has the borders of O'Sullivan's photograph drawn in. Their trapezoidal shape indicates that an angular displacement of the camera back is necessary to recreate the perspective shown in the 1872 photograph.



Without camera movements, a head-on photograph of this environment reveals the camera's reflection in the mirror.

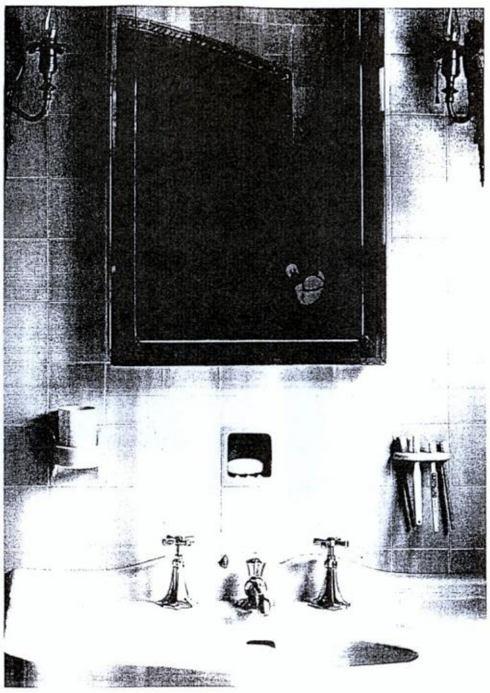


Moving the camera to the side removes the reflection in the mirror, and the image circle from the lens is large enough to allow a back shift to adjust the framing of the image.

Back Shift

Back shift movements — rising, falling, and lateral shifts — do not alter the perspective of the image, but they do alter the image in other ways. Think of the image projected by your view camera lens onto the film as the one projected by a slide projector onto a screen. If the slide projector is too far from the screen, the image you see on the screen is only part of the image on the slide — the extra spills over the edges of the screen. By moving the screen from side to side and up and down, you can make different pictures appear on the screen, each a different section of the whole slide.

In a similar manner, most view camera lenses project an image somewhat larger than the film (see *coverage*, p. 74), and you can shift the back of your camera side to side and up and down to select the desired part of that larger image. In this way you can make adjustments to the framing of an image without moving the entire camera and with no change in perspective or vantage point.



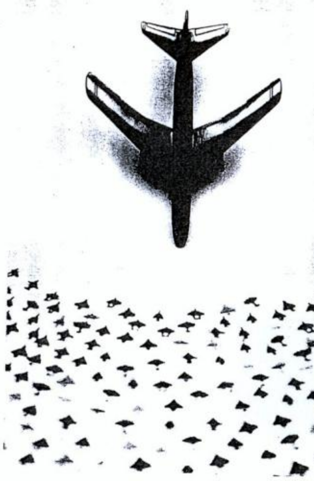
The resulting image avoids the camera's reflection in the mirror yet still allows the pattern of tiles to be reproduced without convergence.

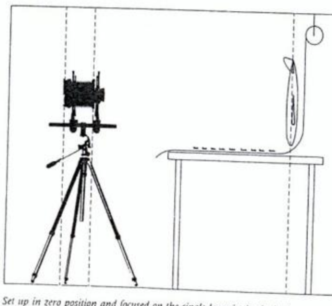
Controlling Plane of Focus: Lens Movements

With a rigid-bodied camera such as a 35mm, the lens plane and film plane are parallel and fixed in relation to each other. The only relative movement allowed is changing the distance between the two to focus. When this distance is adjusted so that a point 2 meters from the lens is in focus, an entire plane through that point, parallel to the lens and film planes, is in focus as well. Adjusting the focus to 3 meters moves this *plane of focus* 1 meter farther away. This plane of focus is always a two-dimensional surface slicing through a three-dimensional world.

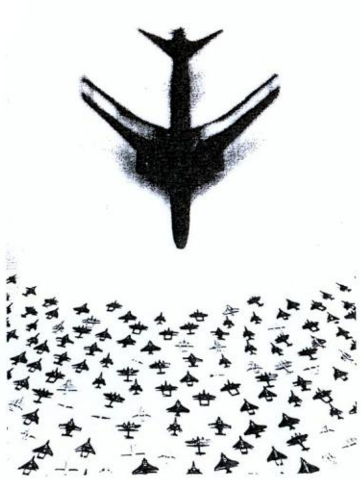
When your view camera's lens plane and film plane are parallel, the plane of focus behaves in exactly the same way as that of any rigid-bodied camera. You have the option, however, to adjust the lens and film planes away from their normal parallel position. A swing or tilt of either lens or back will move the plane of focus to a new position parallel to neither lens nor film plane. Understanding and applying this control will make it possible for you to make great photographs in otherwise impossible situations. If, for example, you were photographing across a tilled field, with your camera aimed at the horizon, tilting the lens plane by moving the top of the lensboard forward would move the plane of focus to cut horizontally across the surface of the entire field. In this way you would have the entire field in focus, foreground to background, without having to use a very small aperture to get great depth of field. The larger working aperture would allow the use of a faster shutter speed, perhaps to stop the action of workers moving in the field. In addition, the wider apertures (but not the widest) of any lens will usually produce an image with greater sharpness than the smaller apertures on the same lens.

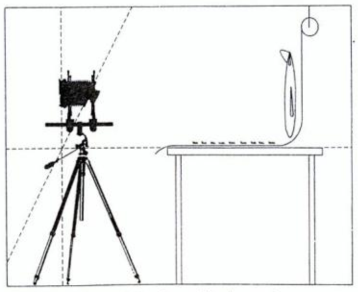
In the following section, you will learn how the angle between the lens plane and film plane determines the position of the plane of focus. When you change that angle by moving either lens or film plane, you will change the plane of focus. In the previous section we found that perspective depends on vantage point and can be altered by the position of the film plane. Perspective is not altered by angular movements (swing or tilt) of the lens plane. Because of this, your chosen perspective will be unaffected by your adjusting the plane of focus if you make that adjustment with the lens plane and not with the back. To save steps, select your vantage point first, then adjust convergence with the back, and finally alter the lens plane if you wish to move the position of the plane of focus.





Set up in zero position and focused on the single large jet in the back, the plane of focus is vertical; the limited depth of field throws the foreground out of focus. The appearance and position of the plane of focus are the same as they would be using any hand camera.





With the lens tilted so that the lens plane and film plane meet in a line with the horizontal plane of the tabletop, the plane of focus is now horizontal, leaving the vertical jet out of focus. The position of the back of the camera and therefore the rendering of perspective remains unchanged.

The Scheimpflug Principle

When the lens and film planes are *not* parallel to each other (a situation usually possible only with a view camera), an unusual set of optical conditions exists in which the plane of focus cuts at an angle through the image. The rule governing this peculiar situation was named after a Prussian army officer of the nineteenth century who was presumably the first to quantify the results. The *Scheimpflug* (shīm'-floog) *Principle* states that when the lens plane and film plane are not parallel, neither will be parallel to the plane of focus. Fortunately, the Scheimpflug Principle also tells us where the plane of focus will be: it will meet the lens plane and film plane in a line.

Front Tilt

To visualize the effects of the Scheimpflug Principle, imagine your camera set up in zero position. If you stand close to the camera back, the film plane passes through your toes (remember the film *plane* doesn't stop at the edges of the film). If you tilt the lensboard forward so that its extended surface (the lens plane) also passes through your toes, and you adjust the focus properly, then the plane of focus will be the floor. In other words, with the back vertical and the lens tilted forward, the surface of the floor will be entirely in focus — the plane of focus will be horizontal. The planes of the lens, film, and floor meet in a horizontal line, perpendicular to the rail, at your toes.

Front Swing

If you set your camera at an oblique angle to a long wall, you can swing the front standard so that the lens plane meets the vertical line where the film plane cuts the wall. The surface of the wall will then be the plane of focus. In this way, the plane of focus may be made to lie along any vertical, flat surface.

Once you get used to the notion that the plane of focus needn't be parallel to the film, and can visualize the positions of the film plane and lens plane beyond the edges of the ground glass and lensboard, it will be easy for you to use the Scheimpflug Principle to your advantage.

Front Shift

Shifting the front in one direction has almost exactly the same effect as shifting the back in the opposite direction. A lens shift, however, introduces a change in vantage point. For a distant scene, moving the vantage point only a few centimeters will not produce a noticeable change in the image, so you can often use a front rise interchangeably with a back fall. In situations where small adjustments of vantage point are needed, such as close-up work, use the lens shift for exact placement of the vantage point, then use the back shift to adjust the exact framing of the desired image.

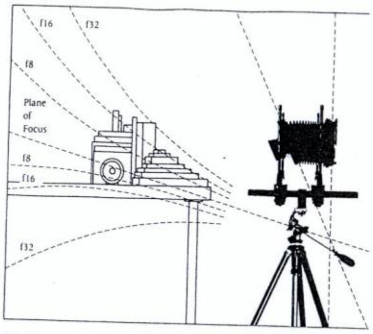
Depth of Field

Theoretically, a lens can only focus sharply on a flat, two-dimensional surface, the plane of focus. In practice, however, your eye is unable to distinguish between the sharpness in the image formed of a point in the plane of focus and that of one slightly closer or farther which is only slightly unfocused. The distance between the near and far limits of what we see in the image to be in focus is the *depth of field* and it is always measured perpendicular to the plane of focus. Depth of field affects the appearance of your photographs profoundly by determining what appears to be in focus; it therefore deserves careful attention during the making of any photograph.

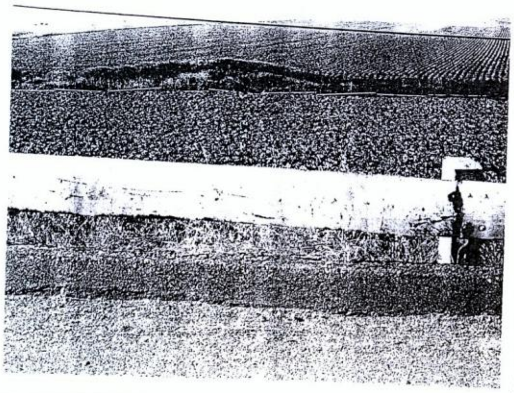
With your view camera in zero position, the behavior of the depth of field conforms to the same rules it obeys in any rigid-bodied camera. The lens and film planes are parallel, and the near and far limits of the depth of field are planes parallel to the lens plane, the film plane, and the plane of focus. For a given object distance (from the lens to the plane of focus), the distance included in the depth of field will increase with smaller apertures. For a given aperture, depth of field will increase for greater object distances. For very short object distances, the plane of focus is near the center of the depth of field. There is an old adage about the plane of focus having one-third of the depth of field in front of it (toward the camera) and two-thirds behind it; this is generally accurate at middle distances (say, across the room or across the street). At greater distances, the depth of field increases to a much greater extent behind the plane of focus than in front of it.

The behavior of the depth of field is altered by the Scheimpflug Principle, though not beyond recognition. Depth of field still is increased by smaller apertures and greater object distances, and still surrounds the plane of focus. Since all parts of the plane of focus are not at the same distance from the lens, however, the depth of field is not the same in all parts of the image. Depth of field increases as the plane of focus recedes from the camera. At smaller apertures, it increases more rapidly with distance.

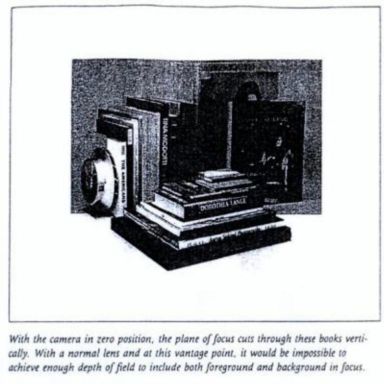
Depth of field is affected by aperture, object distance, and lens plane adjustments, but it depends especially upon what is considered acceptable sharpness for your use. Judgment of acceptable sharpness is subjective, and hinges on such factors as viewing distance and degree of enlargement for the final print. To supplement experience for increasing your ability to make judgments about depth of field, there are standard tables and scales based on average values of the factors affecting depth of field. This information may be found explained in detail in a standard text on photographic optics.



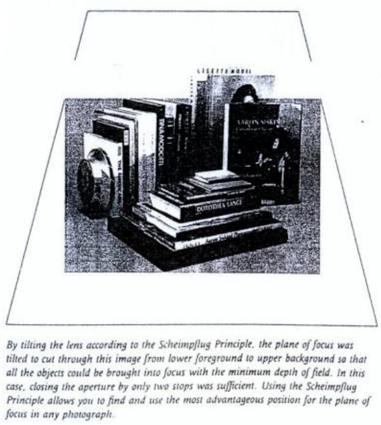
This diagram shows the limits of the depth of field at several aperture settings, around a plane of focus repositioned using the Scheimpflug Principle. Though the plane of focus has been repositioned by a lens shift, as it is here, and this diagram looks quite different from what you might be used to, the behavior of the depth of field is essentially unchanged by the Scheimpflug Principle.



In this 1981 photograph, Charles Roitz tilted the lens of his 8x10 view camera to make the plane of focus run along the surface of the ground. With intentionally limited depth of field, the focused area slips under the roadside fence, leaving it suspended in a slight blur.

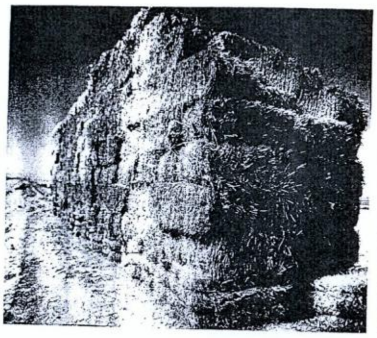


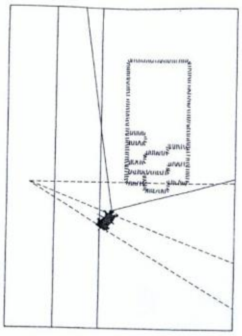
With the camera in zero position, the plane of focus cuts through these books vertically. With a normal lens and at this vantage point, it would be impossible to achieve enough depth of field to include both foreground and background in focus.

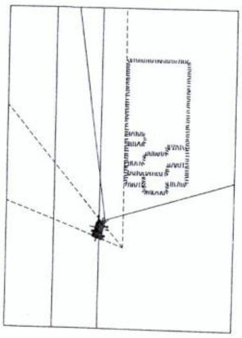


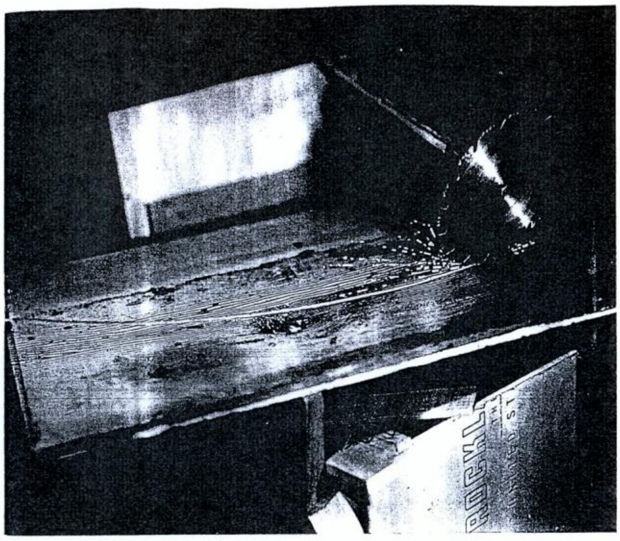
By tilting the lens according to the Scheimpflug Principle, the plane of focus was tilted to cut through this image from lower foreground to upper background so that all the objects could be brought into focus with the minimum depth of field. In this case, closing the aperture by only two stops was sufficient. Using the Scheimpflug Principle allows you to find and use the most advantageous position for the plane of focus in any photograph.

The lens swing was used to line up the plane of focus with one face of this pile of hay bales, and then with the other face from the same camera position. A wide aperture limited the depth of field so that the positions of the plane of focus are easily visible.







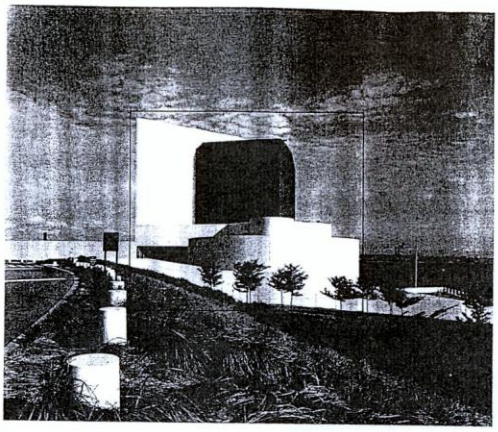


Robert Cumming used lens swing to angle the plane of focus along the saw blade in the whimsical Circular saw cuts 36" radius *(1974). The limited depth of field allows you to easily trace the position of the plane of focus.*

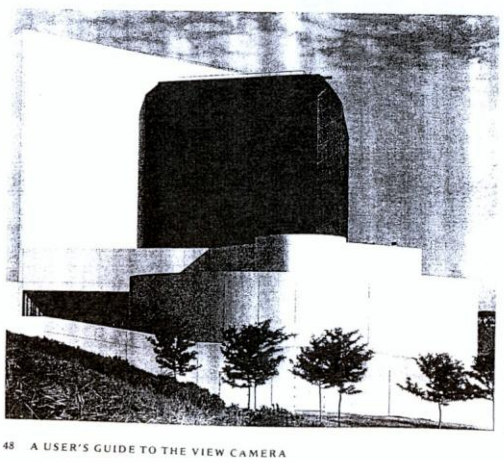
More About Perspective

As in a painting or any other two-dimensional pictorial representation, the illusion of depth in a photograph depends upon four factors: 1. *Atmospheric effect* is the softening of detail with distance, as though the scene were viewed in a haze. In a photograph it is controlled by your selection of film and filters, time of day, and focus. 2. *Lighting* can be controlled in the studio or selected outdoors to give the illusion of compressed or expanded distance. Soft, nondirectional light, for example, compresses distance. 3. *Interposition of objects*, the way a foreground object hides what is behind it, is primary information for the eye in judging relative distances. An object with its contour interrupted by that of another object appears to be behind the object interrupting it. 4. *Linear perspective*, the relative sizes of objects in the image, causes objects in the foreground to appear larger than objects of similar size in the distance.

Linear perspective is wholly the result of vantage point (lens position). The closer you position your lens to an object, the larger it will appear in relation to objects behind it. The effects of linear perspective are independent of lens focal length (p. 79), even though you might assume that a wide-angle lens will render a different perspective from that of a long-focus lens. This misconception results from the fact that a wide-angle lens must be much closer to an object to make the image of that object the same size on a negative. The closer position changes the perspective by making other, distant objects relatively smaller, hence the assumption that shorter lenses exaggerate perspective. From the same camera position, however, all lenses will represent objects in the same relative sizes.

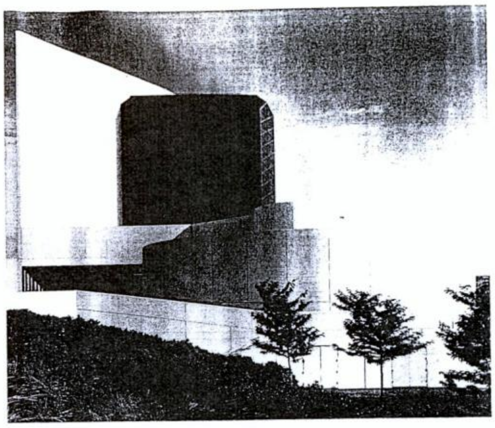


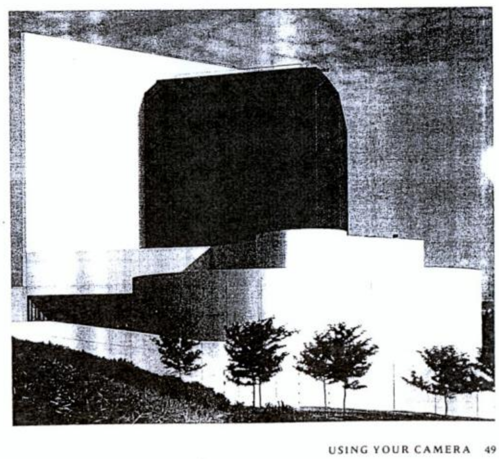
This photograph of the John F. Kennedy Memorial Library was made with a wide-angle lens, in this case a 90mm lens on a 4x5 camera.



Made with a 180mm lens from exactly the same camera position, therefore an identical vantage point, this photograph shows every part of the image to be exactly twice as large as the one made with a lens having half the focal length.

Making a photograph with the 90mm lens to include the same boundaries as one with the 180mm lens requires a much closer camera position (vantage point); therefore the perspective appears completely different. This rendering of perspective is not the result of using a wide-angle lens, but is because of the close position.





Enlarging the center section of the first wide-angle photograph (upper left) gives exactly the same perspective as that rendered by the longer lens from the same position. Perspective depends entirely upon vantage point and not at all upon focal length.

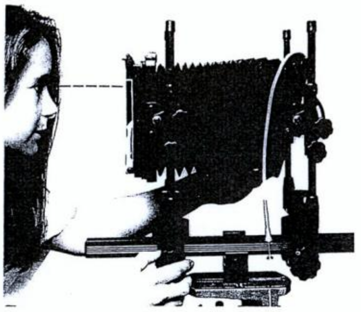
Setting Up a Photograph: A Complete Sequence

After you have read the section on lenses (Chapter 5), and if you are fortunate enough to have a selection of lenses from which to choose, a simple sequence of steps can lead you to exactly the photograph you want. You will eventually integrate these steps into your procedure for setting up the camera, and your mind will be free to concentrate on the desired image.

1. Select a vantage point for the desired perspective. Where you put the lens and when you make the exposure are the most important decisions you must make for each photograph. Remember that the selection of a lens is not a factor in the control of perspective; if you close one eye you will see objects in the same relative size — with the same linear perspective — as with any lens you choose. The vantage point is determined entirely by the position of the lens; use the placement of the camera as a rough control and the lens shift for fine-tuning.

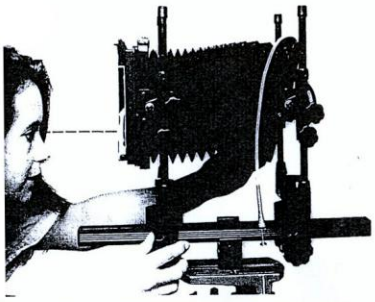
2. Select the focal length of the lens for the *angle of view* (p. 80), the section of the scene in front of the lens you wish to include. If you don't have the exact lens you need, you can use a shorter focal-length lens (one having a wider angle of view) and plan to crop out the unwanted part of the image later. If you substitute a longer lens (one with a smaller angle of view) it will leave out part of the desired image, or force you to move the camera farther back. If you move the camera you will change the size relationships you determined in selecting your vantage point.

3. Once you have selected a lens and established a perspective based upon a specific vantage point, adjust the back to contour the perspective to your needs. By combining tilt and swing movements you can adjust convergence (move the vanishing point) not only horizontally and vertically but to any angle in between. More often than not you will want the back vertical. This is such a common working position that many cameras provide a small bubble level — often two — on the rear standard to aid in determining a precisely vertical position. If your camera is not so equipped, bubble levels are available as an accessory.



To determine exactly how much to tilt the lens for your selected plane of focus, you should approach the correct setting gradually, in steps. Pick a point in the foreground and one in the background that you would like to include in the plane of focus. Select these points from the scene beforehand, not from the ground-glass image. Keep one hand on the focus adjustment of the rear standard and the other on the tilt adjustment of the front standard. Bring the foreground point into focus and then refocus for the background point. Make a mental note of the amount you had to turn the knob to refocus between them.

4. Select a plane of focus. Make a judgment based on the parts of the scene you would like to appear in focus, and imagine the plane slicing through the scene in a position that will give you that focus with the least possible depth of field. As with the adjustments of the back, lens swing and tilt can be combined so the plane of focus can cut through the subject at any angle. Select the placement of the plane of focus carefully so you can achieve the depth of field you need without having to stop down the lens beyond its sharpest apertures (see *diffraction*, p. 118). Pick three points in your image to define the desired plane of focus. These points will form a triangle to help you visualize the surface of the invisible plane cutting through the image. The farther apart the three points are, the more accurate you can be in isolating that particular plane when you adjust the lens plane. If your image allows it, one of your selected points should be in the extreme background and the other two on the extreme left and right of the foreground.



Tilt the lens a few degrees in the direction indicated by the Scheimpflug Principle; for a tabletop plane below camera level, you will need to tilt the top of the lensboard forward. Focus again on the two points, first one then the other. The amount of refocusing needed should diminish. Tilt a little more and then refocus again. As you proceed, the distance between correct focus for the two points will get smaller and smaller until they are both in focus at once. If you find you need to move the focus farther each time, you have passed the correct tilt and are moving away from it.

5. Adjust the lens tilt to bring two of your selected points, one near and one far, into focus simultaneously. While you are under the darkcloth viewing the ground-glass image, use one hand to tilt the lens and the other to focus with the rear standard. Before you tilt the front away from zero position, focus on one, then the other, of your selected points. Notice how far you have to move the back to focus from one to the other. Change the angle of the lens slightly in the direction indicated by the Scheimpflug Principle. Adjusting the lens tilt moves the plane of focus away from the vertical around a horizontal axis at right angles to the monorail. Remember, the plane of focus and the lens and film planes will meet in a line. Once more, focus on one point, then the other again, back and forth, and check to see whether the distance you have had to move the back to focus from one to the other has decreased. If so, the two points are closer to being in focus simultaneously, that is, closer to being in the plane of focus.

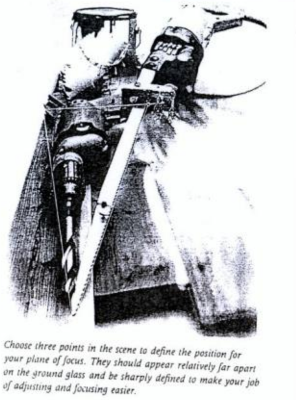
Continue to adjust the lens tilt by very small amounts. Focus both points after each adjustment to check that the distance between their focused positions continues to decrease. If it has decreased, you are approaching the lens angle at which the focus position is the same for both points, meaning that both points will lie in the plane of focus.

If you adjust the lens tilt by a small amount and find that you must increase the distance you move the focus adjustment between the two points, you have moved the lens past the correct position, or in the wrong direction. For most photographs, the amount you will have to tilt the lens away from normal position will probably be quite small, so use very tiny adjustments of the angle.

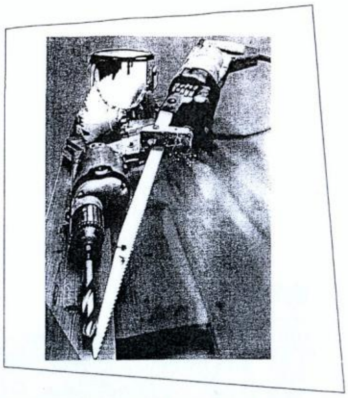
6. Use the lens swing to tip the plane of focus left and right. If your two foreground points require a focus plane slanted from side to side, use the same procedure as above to adjust the lens swing until both points are simultaneously in focus. When you have found the correct position of the lens and they are both in focus, check the near and far points again. Unless your lens has been rotated (with the swing) exactly around its rear nodal point (p. 113), you will probably have to readjust the tilt very slightly. The thickness of your lensboard and lens mount will affect the position of the nodal point, and the design geometry of your particular camera (see the next section) decides the exact axis around which the lens swings.

7. Select the working aperture. Once the plane of focus has been properly positioned, close the diaphragm until you see the desired depth of field in the ground-glass image.

Focusing on the ring in this setup, with the camera in normal position, results in a plane of focus cutting through the image in this position. It is not possible to bring the entire scene into focus by closing down the aperture for depth of field.



Choose three points in the scene to define the position for your plane of focus. They should appear relatively far apart on the ground glass and be sharply defined to make your job of adjusting and focusing easier.



This plane of focus was selected to allow all of the image to be brought into focus with the largest aperture (the minimum depth of field) possible. It required both a tilt and swing of the lens plane. Here, with the lens wide open, it shows the plane of focus cutting through the image.

Closing down the lens to a middle aperture created enough depth of field for convincing sharpness in the final image.

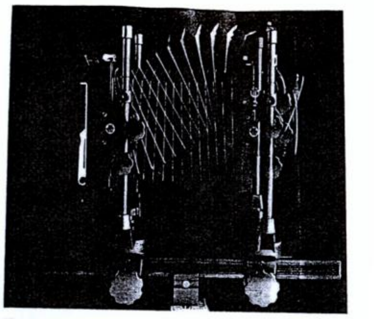
Base vs. Axis Tilts

Not all cameras are designed to have the tilt pivot in the same position. Most monorail cameras offer *axis* tilts, meaning the lens and ground-glass tilt around their own centers on a horizontal axis. Some use *base* tilts, in which the front and rear tilts pivot around a horizontal axis at the base of the standard. Current flatbed designs — field, press, and technical cameras — have backs that tilt from the base. Although you can make exactly the same photograph using a camera with either base or axis tilts, this design difference can make some unexpected differences in the operational steps needed to achieve that image.

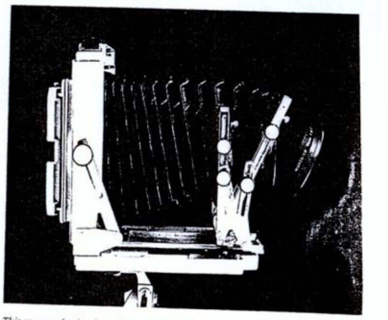
In cameras having either axis or base tilts, a rise or fall is a movement of the lensboard or back along the upright member of the standard. With axis tilts, the standards themselves are always perpendicular to the rail, but the standards on a base-tilt camera tilt along with the lens or back.

Tilting the lens on a base-tilt camera will move it farther from the film, changing the image distance, and once tilted, a vertical shift will change the image distance once again. Also, tilting the lens at the base moves the lens away from the swing axis. In other words, adding a swing to a base-tilted lens moves the whole lens in a circular path rather than rotating it around the vertical swing axis. Swinging the lens in an arc moves the nodal point of the lens, thereby requiring considerable readjustments of focus and tilt. Axis tilts have the advantage of requiring less refocusing of the image after each movement, but have the disadvantage that an extreme back tilt can block insertion of the film holder.

At least two monorail cameras, Arca and Rajah, include both axis and base tilts. The Sinar P offers a unique system that tilts back and lens around an axis between base and center, using a very sophisticated geometry to simplify the focusing and adjustment process. Although many photographers express strong preferences for one system or camera, the technique of adjusting any of the available cameras will rapidly become second nature with practice.



These two photographs show the results of adding a front rise to a tilted lens with two different cameras. This camera uses axis tilts.



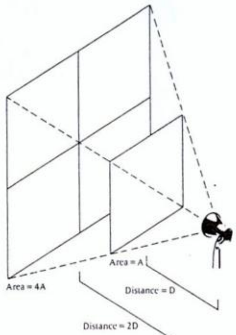
This camera, having base tilts, requires more refocusing after adding one camera movement to another.

Exposure Compensations

Bellows Extension Factor

The only limitation to focusing on close objects with your view camera is the length of your bellows, and you can remove even that limitation by adding an additional standard and another bellows. This freedom to focus on nearby objects is one of the great virtues of the camera, but exercising it introduces you to another important photographic principle. This principle, the *Inverse Square Law*, is ordinarily hidden from users of small cameras by the designers of those cameras.

The illumination available from a light source depends upon the distance from it. Imagine a long, windowless corridor with only one light bulb at one end. The farther from that light bulb you stand, the darker it is where you are and, for example, the harder it would be to read by that light. The film in a view camera is also in a long, windowless corridor, the bellows, and the lens is the light source. *Bellows extension* is the length of that corridor. The more closely you focus, the longer the corridor you make for your film — the greater the bellows extension — and the farther the light is from the film. This means that by decreasing the object distance, the intensity of the light reaching the film is diminished.



The illumination from this lamp that falls on the close card would have to cover a card four times the area if it were twice the distance away. The area for the same illumination increases as the square of the distance.

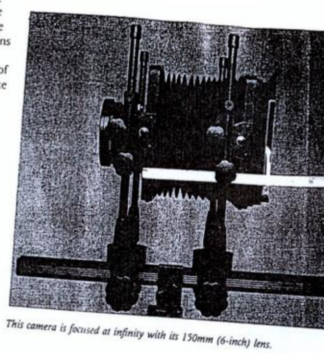
Most photographers whose experience is limited to small cameras assume the light intensity reaching the film is only affected by the light level of the scene and by the selected aperture. Within certain limits, this is not a damaging misconception. With any camera, a normal exposure is based upon an infinity focus, at which the lens and film are one focal length apart. Focusing on a closer object moves the film farther from the lens, diminishing the light intensity. In order for the light intensity to be diminished by a noticeable amount, however, the object distance has to be less than about seven times the focal length. Since the focusing mounts for most small camera lenses are intentionally designed to prevent their use at object distances less than seven times their focal length, users of these lenses can produce satisfactory work within the limits of their equipment and in ignorance of bellows extension effects.

Your view camera has no built-in barrier to keep you from focusing more closely than seven times the focal length. If you do, you will reduce the illumination reaching the film plane enough to need to compensate for the light loss. The *bellows extension factor* is the measure of this necessary exposure compensation.

You can calculate the bellows extension factor and multiply the measured (uncompensated) exposure by it, or you can make an educated guess at the needed exposure increase. But in order to do either it is important to know how far the film is from the lens. All your normal exposure calculations are based on an object distance of infinity, the shortest bellows extension possible with a given lens. This is your starting point. At infinity focus, the lens and film are separated by one focal length. With a 300mm lens at infinity focus, the lens and film are about 12 inches apart (remember that 25mm is approximately 1 inch). With this lens, which you might choose for general use on an 8x10 camera, you will need to calculate a bellows extension factor when you focus more closely

than about 2 meters, or almost 7 feet. Once you have focused inside this range, measure (or estimate) the actual distance between lens and film.

The Inverse Square Law is the principle of physics governing bellows extension and, like other laws of nature, it cannot be ignored without consequence. It tells us that the intensity of a light source diminishes with the square of the distance from it. In our long corridor, if you move twice as far from the bulb, you are illuminated one-fourth as much. At three times the distance, you are illuminated with one-ninth the light. Similarly, if you are using a 150mm lens, and want to make a photograph with the bellows extended to 300mm (12 inches), you will need four times the normal exposure. With the film twice as far from the lens as the infinity focus on which a normal exposure is based, the illumination is diminished to one-fourth normal and the exposure must be increased by a factor of four, or two extra stops.



This camera is focused at infinity with its 150mm (6-inch) lens.

There are several methods and formulas for calculating the bellows extension factor, and they will all result in the same compensation. The simplest formula is this: the bellows extension factor is equal to the extended bellows length squared, divided by the focal length squared. The indicated exposure (the one determined by metering) should be multiplied (increased) by this factor. You can increase exposure by using a larger aperture or a slower shutter speed.

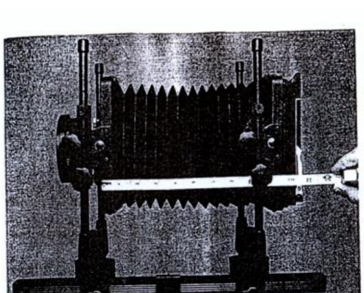
With most black-and-white work, a careful estimate of the exposure compensation will be sufficient. With color materials, especially reversal film, measurement and calculation will be necessary. Copy work almost always demands compensation for bellows extension because short object distances are common.

Reciprocity Failure

The *Law of Reciprocity* tells us that the correct exposure for a given film in a given lighting situation may equally well be any of several equivalent combinations of aperture (illumination) and shutter speed (time). If we increase the illumination, we may decrease the time by the same amount (and vice versa) without affecting the exposure. Another way of stating this is to say that the film's speed, or *exposure index*, is constant.

Your work with the view camera will eventually introduce you to a characteristic of film rarely noticed by users of small cameras. That is, the Law of Reciprocity is valid only within a limited range of exposure times. *Reciprocity failure*, or the failure of the reciprocity law, is a diminished film speed and increased contrast due to very long or very short exposure times. Most films obey the reciprocity law and have a consistent exposure index only for exposures shorter than 1 second and longer than 1/1000 second. A hand camera is rarely used outside that range. However, because your large-format camera with its longer focal length lenses requires smaller apertures to achieve sufficient depth of field, you will often find yourself making very long exposures. And you will often find yourself having to compensate for the reciprocity failure by making those long exposures even longer.

Compensating for Reciprocity Failure. Accurate compensation tables for each different film's reciprocity characteristics are available from the manufacturer, and are sometimes packaged with the film. Since the degree of reciprocity failure depends on how much light actually gets to the film, you must consider light losses such as filter factors and bellows extension *before* figuring reciprocity compensation. Calculating bellows extension, for example, after reciprocity failure compensation will result in underexposure.



When the camera is focused on a close object, the bellows extension is 10 inches. The formula for bellows extension factor (BEF) is:

$$\frac{(BE)^2}{(FL)^2} = BEF, \text{ where } \begin{array}{l} BE = \text{bellows extension} \\ FL = \text{focal length} \end{array}$$

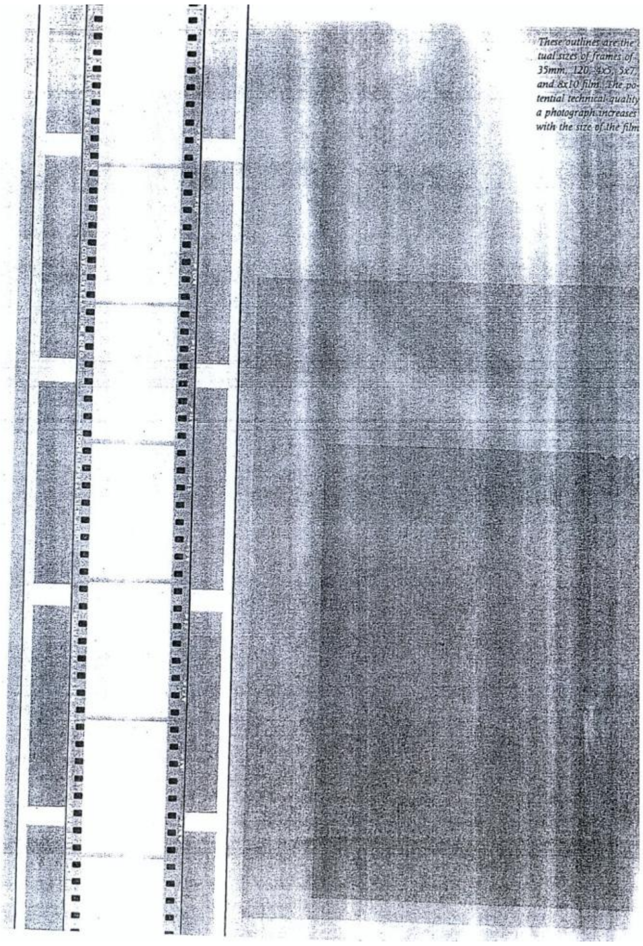
The factor is 100/36, or about 3. The compensation should be made either by multiplying the exposure time by 3 or by increasing the aperture by about 1½ stops.

In the absence of reciprocity tables, use the following as a rough guide for exposures on black-and-white film. With a metered exposure near 1 second, your film loses half its speed from reciprocity failure and needs one stop more exposure. At an exposure of about 10 seconds, it loses half its speed once again, needing two extra stops. At 100 seconds, film speed is one-eighth normal and needs three extra stops. These exposure compensations *must* be added to your measured exposures or your film will be underexposed. To compensate for the increased contrast that also results from such long exposures, reduce your development time by 10 percent, 20 percent, and 30 percent respectively for the three examples above. These exposure compensations are accurate when increasing the aperture. Giving the film extra exposure time will require slightly more compensation because the film's speed continues to diminish with extended exposure. Three extra stops for a 100-second exposure, which with a constant exposure index would total 800 seconds, should actually be 1200 seconds.

Color film is affected by reciprocity failure more severely than black-and-white film. Not only does the film speed change for long and very short exposures, but it changes a different amount for each of the three color-sensitive layers comprising color film. So reciprocity failure brings a color shift that in many cases cannot be corrected by filtration. Knowing this, film manufacturers make professional color films for different exposure ranges: Kodak's Type S is for short exposures, and Type L is for long.

Exposures shorter than 1/1000 second occur so infrequently for the large-format photographer that you probably needn't be concerned with reciprocity failure in that exposure range. Large, professional strobe lighting equipment usually produces light bursts of longer duration, and the leaf shutters commonly used with large-format lenses rarely have speeds exceeding 1/500 second. If you do encounter very short duration exposures, take the time to test for reciprocity failure with the materials you plan to use before making any important photographs.

You can test your final calculations for exposure, including bellows extension and reciprocity failure, with a sheet of Polaroid film (p. 145). But it is a good practice, and an economical one as well, to avoid using Polaroid tests in place of calculation.



These outlines are the actual sizes of frames of 35mm, 120, 4x5, 5x7, and 8x10 film. The potential technical quality of a photograph increases with the size of the film

4 Film and Development

One of the major virtues of the view camera is its unique film system. Large-format cameras use film in flat sheets, with dimensions that correspond to the nominal size of the camera. For example, 4-inch by 5-inch sheets are used in a 4x5 camera. Each sheet is loaded, exposed, and processed individually so you will have more steps to follow than with roll film, but you will find that the advantages more than make up for this minor inconvenience.

The Advantages of the Film System

Film in Sheets

The single-sheet film system used for view cameras gives you more freedom than any other system to shift from one kind of film to another. Once set up, many commercial shots are photographed first on Polaroid, then successively on black-and-white, color negative, and color reversal film. Each use for the photograph can then be satisfied with no sacrifice in quality: color transparency to the printer for a brochure, black-and-white prints from a negative for a press release, and color prints from a negative for the office walls.

A Variety of Film

Kodak lists dozens of different emulsions available in sheet-film sizes, more different types of film than are available in rolls. These include special-purpose films for scientific, graphic arts, and aerial photography. Many of the available films are not only useful to their intended fields but also provide raw material for the experiments of inventive artists.

Large Film

Another advantage of large-format film, obvious to anyone who has ever seen a print made from a large negative, is the sheer visual quality that results from the great expanse of film. Sharpness, resolution, and graininess, common indicators of image quality in a photograph, are all related to the degree of enlargement from negative to print. A 35mm negative has less than 9 cm^2 of image area and a 6x6cm negative from 120 film has 36 cm^2. A 4x5 negative (10 by 12cm), however, yields 120 cm^2 of image. These figures mean that, all other things being equal, a print having the same fineness of detail can be made more than thirteen times larger from a 4x5 negative than a 35mm negative. Or, if the same size print is made from both, the resolution, sharpness, and granularity will be many times better from the larger negative. Larger film sizes, such as 8x10, are most often printed by contact for the highest possible image quality. Many artists have elected to work solely with 8x10 for this reason alone.

For the advertising photographer, sheet film is often necessary when a client's needs include retouching. Concepts impossible to express by photographic means are made visible at the hands of an experienced retoucher, who asks only to be supplied with a transparency large enough to work on directly.

Separate Development

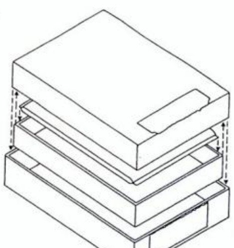
The Zone System, an advanced technique for black-and-white photography, uses controlled exposure and development as a way of adjusting the contrast of a negative, and can be used effectively only if development can be varied from one negative to the next. Once you are comfortable with the camera and can begin to explore its expressive uses, study the Zone System to introduce complete tonal control to your black-and-white picture-making. Several good texts are available on the subject.

Sheet Film Storage

Sheet film, sometimes called *cut film*, may be purchased in boxes that ordinarily contain either 25 or 100 sheets (for black-and-white; color film comes in 10- or 50-sheet boxes). Start with a small box: you will find the box itself useful to store and transport small quantities of film after you have exposed all the film in it. The film is contained in a sealed foil package of 25 sheets; 100-sheet boxes contain four foil packs.

Unless you expect to use all the film soon after you purchase it, keep large boxes refrigerated or frozen to preserve the film and transfer one pack at a time to a smaller box as you need it. To avoid condensation on the film's surface, allow the cold film to reach room temperature before opening the packet. Give refrigerated film at least 1 hour, and frozen film 4 hours, to reach room temperature. Sealed foil packs are airtight. If you wish to refrigerate an opened pack, reseal the box in a plastic bag first, preferably on a dry day.

The film is packed inside a box made of three nested lids to prevent light leaks. Store your empty boxes (*only* your empty boxes) with the outer two lids nested in the same direction (see illustration). This keeps out dust, and a glance at the bottom of the box will allow you to tell by the visible edges of the center lid around the bottom of the inner lid that the box is empty.



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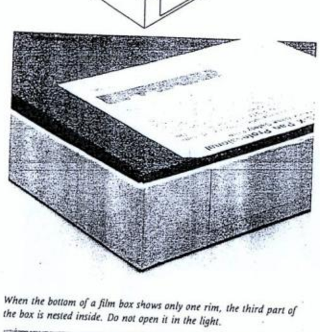
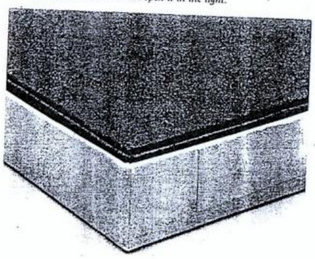


When the bottom of a film box shows only one rim, the third part of the box is nested inside. Do not open it in the light.



If you store empty film boxes nested this way, the dust will be kept out and you can tell them apart from the boxes containing film.

Loading the Film

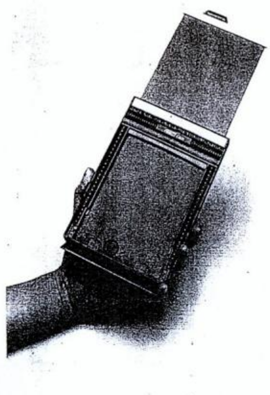
The Film Holder

Sheet film is sold as raw stock. Before you can expose the film in your camera, you must load it into a reusable lighttight *film holder*, which is inserted for the exposure into the camera's spring back. To develop the exposed film, you must remove it from the holder. Since the film you are most likely to use is either color or panchromatic black-and-white, you will be loading and unloading film holders in complete darkness.

The standard film holder for sheet film is a *double* sheet-film holder. This holder provides space for two sheets of film, and has two identical faces each with a shallow compartment to hold the film. Each face has a hinged flap at the bottom to facilitate film insertion and has its own separate *darkslide*, a flat, opaque plastic sheet that slides through a felt-lined slot at the top of the holder and down in tracks along the sides of the film compartment to seat into the flap and cover the film. When the shallow film compartment is covered by the darkslide, the film inside is protected from the light.

After the film holder has been inserted properly into the camera's spring back, the darkslide must be withdrawn before the exposure is made. The black felt in the slot acts as a light trap to block light from fogging the film when the darkslide is withdrawn. Other styles of film holders that may better suit

your purposes are described on p. 141, along with more detail on this standard holder.



This is a standard double sheet-film holder for 4x5 film. One of its two supplied darkslides is withdrawn, revealing the compartment for one sheet of film.

The Darkslide

When you are photographing you will want to have several holders with you, since each holds only enough film for two exposures. The film holders are all identical, and each has two identical faces, so you will need a foolproof system to avoid exposing the same sheet of film twice. In most film-holding systems for large-format cameras there is a darkslide to prevent unwanted exposure when the holder is out of the camera. For standard double sheet-film holders, the darkslide performs an additional task — it gives you a way to tell whether the sheet of film it covers has been exposed.

The top rim (or handle) of the darkslide is black on one side, and white (or polished metal) on the other. Run your finger along the white side and feel the short row of bumps or holes. The black side is smooth. These distinctions of color and texture allow you to indicate to yourself whether the film inside the holder has been exposed. White side out indicates unexposed film; black means exposed film or an empty holder. Before you insert a film holder for exposure, make sure the darkslide has its white rim out. When you replace the darkslide into the holder after exposing the film, leave the black side out. When loading or unloading holders, use the bumps on the white side for fingertip identification in the dark.

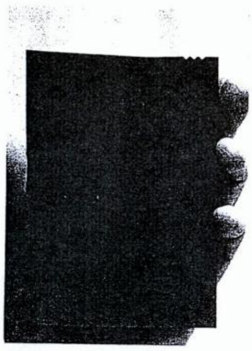
The white edge of the darkslide, signifying unexposed film, has bumps for identification in the dark. The black side is smooth. On each side of the holder's top there is a small wire clip to prevent inadvertent removal of the darkslide.

Film Code Notches

Since only one side of the film is coated with a light-sensitive emulsion to receive an exposure, you must load the film holder so that the emulsion side of each sheet will face the lens when inserted into the camera's spring back. Because you will be loading holders in the dark, some nonvisual means of identifying the emulsion side is necessary.

Film manufacturers cut *code notches* into the corner of each sheet for identification in the dark. To locate the emulsion side, hold the film sheet by its edges in a vertical position, like a page to be read. Feel the perimeter of the film for the pattern of cut notches. When the notches are in the upper right or lower left corner of a sheet held vertically, the emulsion side of the film is facing you. Slide the film into the holder with that side facing out, to be covered by the darkslide.

The notches also identify the type of film. Each different sheet-film emulsion for use in a camera bears a different pattern of notches. Graphic arts sheet films and others that can be handled in safelight are not notched. Film manufacturers publish diagrams of the code notch patterns for all their films along with other film data in pamphlets or books; the notch code for the film in a box is also usually depicted on the film box label or in the instructions packed with it. If you need to identify the type of a sheet of film, for example, if you have gotten two unmarked holders mixed up, use a pencil to trace the outline of the notches onto paper while in the dark. After you put the film away, you can match the code to the manufacturer's diagram. Once you learn a film's notch code, your fingertips will be able to identify the film immediately. Because of the way the notches are cut into a stack of film during manufacture, they may not always be the same depth, but the shape and spacing will be the same.

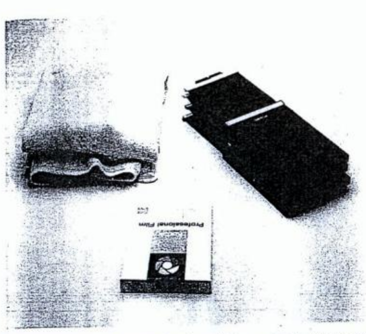


Each sheet of film has code notches in one corner that indicate the type of emulsion and the side on which it is coated.

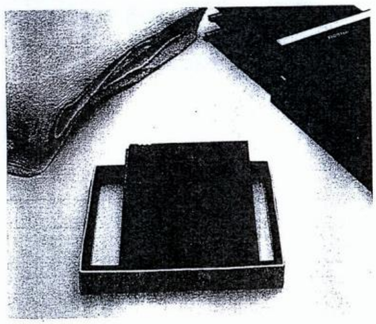
The code notches are your clue to which emulsion is on the film as well as which side of the sheet it is on. Each film manufacturer publishes a list of code notches for identification.

How to Load Film

In your darkroom, prepare a very clean work surface free of clutter. To be comfortable you will need at least a meter's width of counter, with nothing nearby to knock over. Wash your hands thoroughly with soap and water and dry them completely. Any fingerprints you get on the film during loading will appear as permanent marks during development. Have only the box of unexposed film and the empty holders in front of you. If your darkroom is warm, keep a clean towel



Make sure your counter is clean and uncluttered before you try to load film there in the dark. Have your film and holders ready, and keep a towel nearby to clean and dry your hands.



Lay the stack of film across the box it came in with the emulsion side down so it will be easy to find in the dark and stay dust-free.

nearby to wipe perspiration from your hands. Withdraw the darkslides almost all the way, and leave the white side facing out. Dust the holders using a vacuum cleaner, compressed air, or a clean camel's hair brush and stack them to one side.

Before attempting to load any film you expect to use for a photograph, practice loading your film holder in the light with a piece of scrap film. You may wish to begin with a small box of Tri-X Ortho, a black-and-white sheet film you can load and develop under a 1A (dark red) safelight. This practice will make your transition to working with sheet film more gentle.

Turn off the light and, if working in an unfamiliar darkroom, wait a few minutes to allow your pupils to dilate so you can make sure there is no light leaking into the room. Phosphorescent clock and timer dials, or even the afterglow of some fluorescent lights, can fog film if they are near enough.

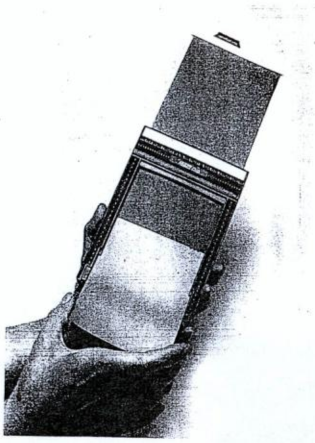
Open the film box and nest the three sections in an open position. Remove the foil pack containing the film, tear it open, and remove the film in a stack, holding it only by its edges. Set aside any paper cover sheets and lay the pack of film sideways across the open box, emulsion side down. This way the film will be easy to find and dust won't settle on the emulsion side of the film while you work.

Handling it by the edges, remove one sheet of film from the top of the stack. *Do not touch the emulsion side*, and touch the back of the film only if necessary. Flip the sheet so that the code notches are in the upper right-hand corner; the emulsion side will be facing you. Pull down the bottom flap on the holder to reveal the tracks or channel for the film. With 4x5 film, you can hold the film holder in one hand and the film in the other. Larger sizes will probably require you to leave the holder on the counter and hold the film with both hands. Slide the film in and up to the top of the holder. Run a fingernail lightly along the track above the film on each side to make sure you haven't gotten it in the track for the darkslide instead. Remember that the code notches must be in the upper right or lower left corner of the holder so that the emulsion side will face the lens during exposure. With the film in its proper position at the very top of the holder, the flap will close easily. Dust the emulsion surface of the film with a camel's hair brush or compressed air. Slide the darkslide into its closed

position; if it seems difficult to close, you may have the film in the wrong track.

Load a sheet of film in the other side of the holder in the same way, load the rest of your stack of holders, and enclose the remaining film in its box before turning on the lights. There is probably no advantage to first returning the film to its foil pack, but many photographers do so. Store and transport the film holders in plastic bags to keep out dust.

If you do not have access to a darkroom, you can load and unload your holders in a *changing bag* made from an opaque cloth. These bags are available from most camera stores, but they are constricting and uncomfortable, and will probably create severe dust problems.



Holding the film by its edges, slide it into the correct slots at the sides of the compartment in the holder. The emulsion is correctly facing out when the code notches are in the upper right or lower left corner of the film sheet.

Exposing the Film

Sheet film is no different from roll film during exposure. Your method of determining the correct exposure will be the same. You will probably use a light meter (p. 138). Make sure you have read and understood the section on exposure compensations (p. 55). The film holder fits into the spring back to form a lighttight seal with the camera body, and you need to withdraw the darkslide (p. 61) for the exposure and return it (black side out) before removing the holder from the back.