

# PRINCIPLES OF VIEW CAMERA FOCUS

by Harold M. Merklinger

View camera focus may be considered to be governed by just two basic rules: the Scheimpflug Rule and the Hinge Rule. While the standard "lens equation" is also a factor, it is already covered by the two rules just cited. If the Scheimpflug and Hinge Rules are followed, the lens equation will be also.

The Scheimpflug Rule and the Hinge Rule are surprisingly similar. Both rules state that three fundamental planes must converge along a common line. For the Scheimpflug Rule, the three planes are the film plane, the lens plane and the plane of sharp focus. The plane of sharp focus is the plane on which the camera is focused. In order for the camera to be in focus, these three planes must converge along a single line: the Scheimpflug Line. Adherence to the Scheimpflug Line alone does not assure focus, however. The Scheimpflug Rule can be obeyed without the camera being in focus. The Hinge Rule states the plane of sharp focus, the front focal plane of the lens and the parallel-to-film lens plane must converge along a common line: the Hinge Line. The front focal plane of a lens is a plane parallel to the lens plane but one focal length in front of (on the subject side of) the lens. The parallel-to-film lens plane is a plane through the center of the lens, but oriented parallel to the film plane.

The "Scheimpflug Rule" was actually discovered by a Frenchman by the name of Jules Carpentier. The "Hinge Rule" was discovered by Theodor Scheimpflug. It seems strange that today we associate Carpentier's discovery with Scheimpflug. And while Scheimpflug's name is well known, the rule that he did discover has tended to languish in obscurity. But Scheimpflug's "Hinge Rule" is probably the more useful of the two rules in view camera practice.

The two fundamental rules are illustrated below.

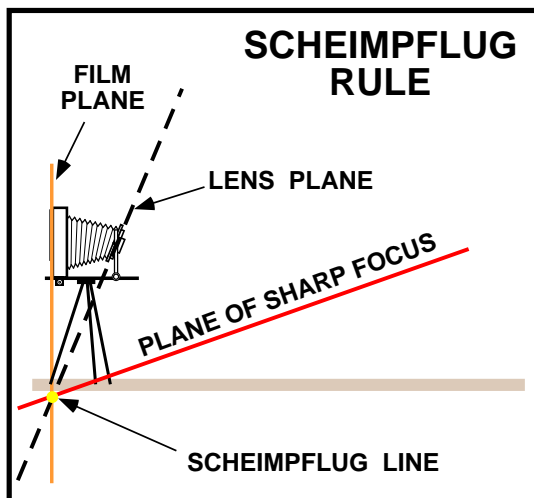


Figure 1: The Scheimpflug Rule

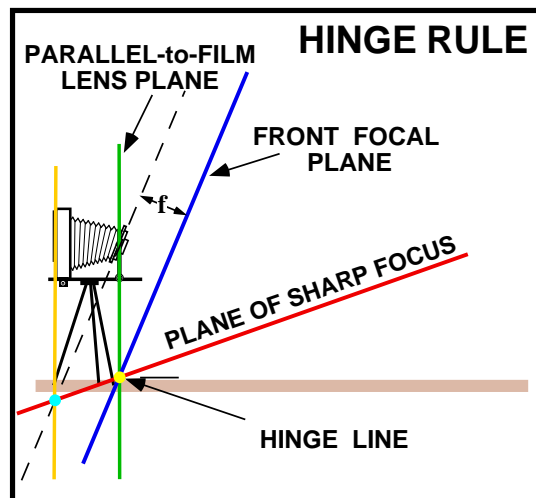
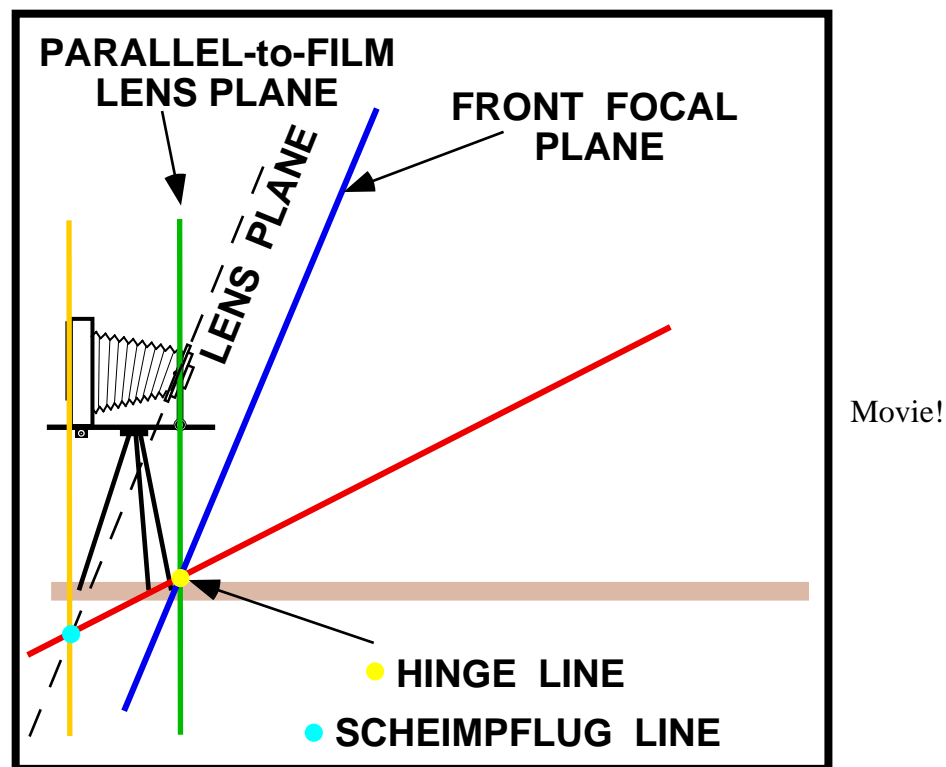


Figure 2: The Hinge Rule

When both rules are obeyed, the camera will be in focus.

Putting the two rules to practical use is a little easier said than done. To illustrate the action of the two rules as applied to a view camera, a few animated diagrams are included here. To see these diagrams animated, you will need to have Apple's QuickTime on your Windows, Macintosh or Unix-based computer. The diagrams that follow should become animated (one at a time) when you click on them with your mouse. It is also necessary to have the QuickTime movie files in the same folder or directory as this PDF file. The QuickTime movies are not embedded in the PDF file.

Figure 3 below illustrates how the Hinge Rule gets its name. The Hinge Rule concerns three planes positioned relative to the camera lens. So long as the orientation of the camera back (and therefore the film plane) is unchanged, the three plane used in the Hinge Rule must converge along a fixed line in space: the Hinge Line. The lens-to-Hinge Line distance (called  $J$ ) depends only upon the amount of lens tilt applied and the focal length of the lens. The distance  $J$  and the position of the Hinge Line are unaffected by normal focusing motions of the back. Since, by the Hinge Rule, the plane of sharp focus must pass through the Hinge Line, the plane of sharp focus can do only one thing as the camera back is focused: it can only pivot on the hinge line. The plane of sharp focus thus rocks like a teeter-totter on the Hinge line as the camera back is moved. And the angle the plane of sharp focus takes up is determined by the camera back's position relative to the lens, and by the Scheimpflug Rule. Watch what happens as the camera back is focused back and forth.



**Figure 3: Illustration of the Hinge Rule and Scheimpflug Rule in joint action!**

The sequence of actions recommend for focusing a view camera are as follows. Imagine in the mind or sketch on paper where you want the plane of sharp focus to lie. In typical landscape shots, you will probably want it to pass just below your feet. Determine the distance from the lens to the plane of sharp focus along a line parallel to the film plane. In most landscapes you will want the camera back to be vertical and so this means one needs to determine the vertical distance from lens to plane of sharp focus. This is the distance J that is required. Given this distance and the focal length of the lens in use, we then determine the amount of lens tilt,  $\alpha$ , needed:

$$\alpha = \arcsin (f/J).$$

This angle is most conveniently determined from a table such as that included with *Focusing the View Camera*, but may also be determined relatively simply with a scientific calculator. For f measured in millimeters and J measured in feet,  $\alpha$  in degrees is approximately given by:

$$\alpha = f/5J.$$

Tilt the lens by the amount so determined towards the intended plane of sharp focus. That is, for example, tilt the lens forward if the plane of sharp focus is to lie below the camera. The next step in focusing the camera is to adjust the orientation of the plane of sharp focus by 'focusing' with the camera back. This is most easily done by observing the ground glass. When you focus on any single object on the intended plane of sharp focus, you should find that all other objects along that intended plane are also in focus.

It helps to understand what happens to the plane of sharp focus as other camera movements are applied. The remainder of this article illustrates the effects.

## Front Axis Tilt

Figure 4 shows what happens as the lens is tilted about a horizontal axis through the center of the lens. In this animation the lens starts off with the lens plane parallel to the film (zero lens tilt) and then gets tilted forwards in increments of 2 degrees. You'll see that the plane of sharp focus also starts out parallel to the film plane, but gets tilted in the same direction as the lens plane as the lens plane is tilted. The amount by which the plane of sharp focus tilts is quite variable, depending quite significantly upon the position of the camera back. The motion is most rapid when the camera starts off focused near infinity. (although this particular effect is not shown in these animations). I did not show what happens when the lens is tilted upwards because the action is completely symmetrical: a tilt from zero degrees to say ten degrees will cause the same amount of rotation of the plane of sharp focus whether the lens is tilted upwards or downwards. In either case the direction of rotation of the plane of sharp focus is the same as the direction of rotation of the lens plane.

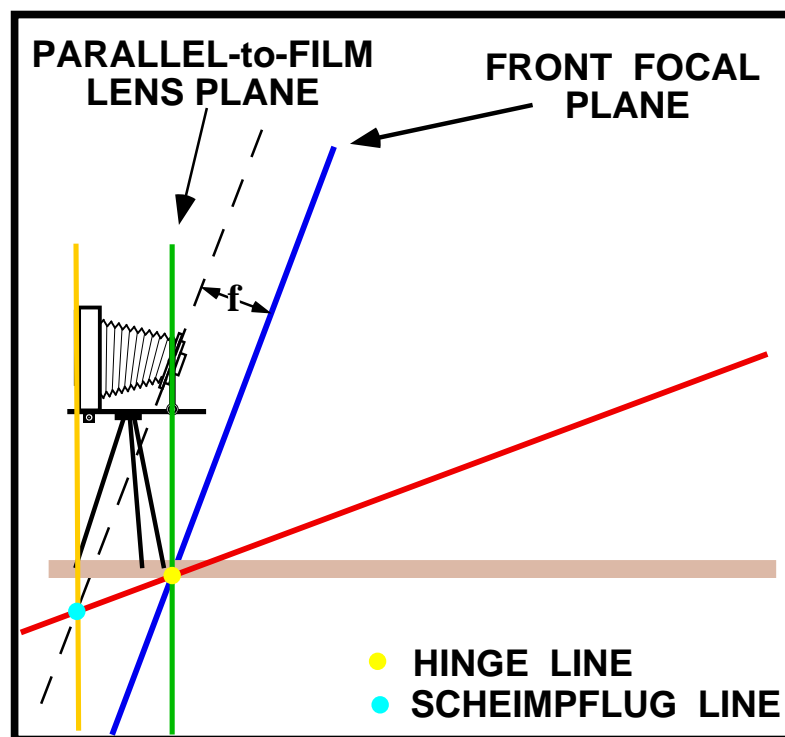
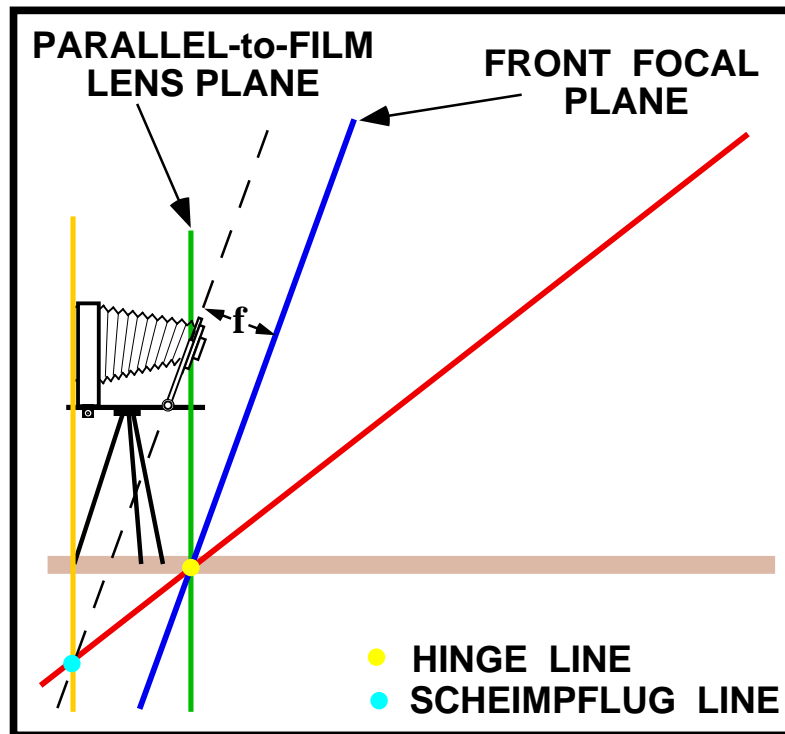


Figure 4: Front Axis Tilt.

## Front Base Tilt

Some view cameras are equipped with "base tilts" rather than (or as well as) "axis tilts". That is, the front standard of the camera can be tilted about an axis near the bed or monorail of the

camera rather than about the center of the lens. For a camera with front base tilts, a forward tilt of the lens not only tilts the lens forward, but also extends the lens. This causes the plane of sharp focus to rotate a little differently from the previous case: not only does it rotate, but it also draws closer to the lens than for the axis tilt case. And when the lens is tilted upwards, the plane of sharp focus is pushed away from the camera as well as rotated: the action is not symmetrical as it is when axis tilts are used. Figure 5 illustrates.

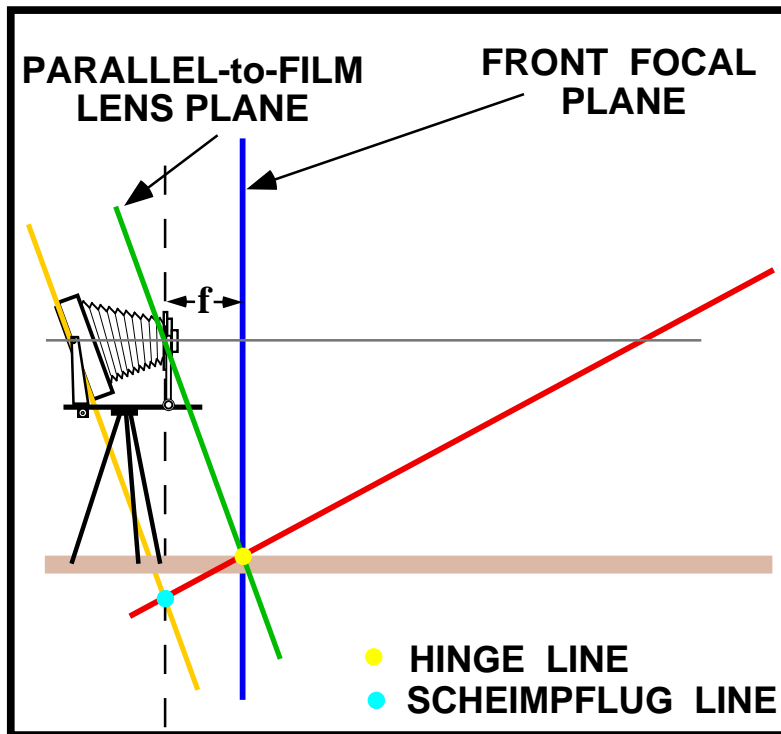


**Figure 5: Front Base Tilt.**

### Back Tilts

In the past, books have tended to suggest that photographers use tilt at the back of the camera to adjust the plane of sharp focus. This is because the motions involved are simpler and more predictable. Furthermore, a knowledge of the Scheimpflug rule alone will suffice to estimate the amount of tilt required. The result of using back tilts, however, is that image distortion is introduced: vertical lines begin to converge. It's OK when only small amounts of tilt are necessary, and there are no obvious vertical lines in the scene. But the result will not be quite 'right' in terms of correct perspective. My recommendation is to keep the back vertical unless perspective distortion is desired for pictorial effect.

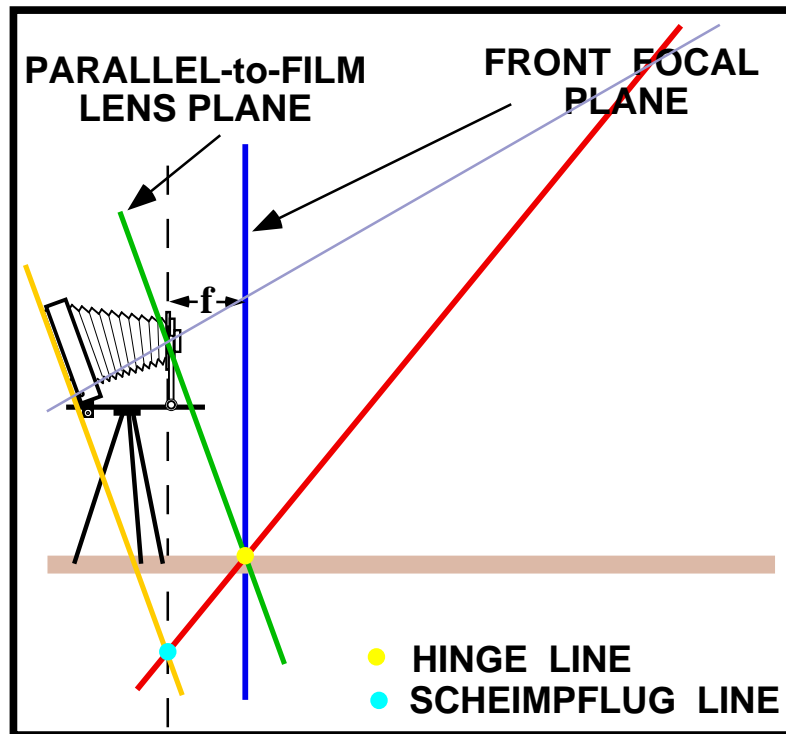
Figure 6 illustrates what happens as the camera back is tilted away from the lens—a motion equivalent for focus purposes to forward lens tilt. The geometry is simplified because the image at the tilt axis remains in focus throughout. The axis about which the plane of sharp focus tilts is imaged at the back tilt axis. Simple!



Movie!

**Figure 6: Back Axis Tilt.**

Figure 7 illustrates what happens if the camera has base tilts for the camera back. Again the motions are simplified. The axis about which the plane of sharp focus swings is now higher, but the same principles apply as for the previous case. As for the case of front base tilts, forward back tilt causes the plane of sharp focus to be pushed away from the camera.



Movie!

**Figure 7: Back Base Tilt.**

## Swings

Rotations of the front or rear standards of a view camera about vertical axes are usually referred to as swings. Swings are exactly analogous to tilts, but are almost always of the 'axis' type. To understand the action of a lens swinging to the right (as seen from behind the camera) just look again at Figure 4 but imagine that you are looking down on the camera from above. Similarly motions for back swings would be just like figure 6 if we were to look down on the camera.

## Final Words

The examples shown here are relatively simple. Many view camera situations are not quite so basic, but the Hinge Rule and Scheimpflug Rule continue to apply just as they did here. For every combination of swing and tilt, and for every orientation of the camera, there is some vantage point from which the camera set-up is equivalent to a simple lens tilt.

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