View Camera Focus and Depth of Field — Part I

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The craft of photography combines technology, skill and opportunity in the creation of gratifying images. Of the factors cited, in-depth understanding of camera technology is probably the least important. One can produce wonderful results with minimal knowledge of how it all works. There are, nevertheless, certain principles that can assist the photographer in doing his job efficiently. The aim of this two-part article is to explain the basic principles of view camera focus and depth of field. It does help to understand what one is doing.

Among the many advantages of the view camera is the ability to control focus in ways impossible with normal cameras. I use the term "normal" to convey two quite independent and yet relevant ideas. On one hand I mean the kind of camera one encounters most frequently. Also, the majority of cameras have the lens axis carefully aligned "normal" to the film: that is, the lens axis is perpendicular to the film. Such an alignment of lens and film causes the camera to be focused on a subject plane that is parallel to the film. The view camera is expressly designed to let the lens and film alignment be adjusted outside of this "normal" condition.

The First Law of the View Camera

Many readers will be familiar with what has come to be known as the Scheimpflug Principle. Captain Theodor Scheimpflug, an Austrian Army Officer, described in 1904 the operation of a device for "rectifying" the geometric distortion present in aerial photographs taken (from a balloon) when the camera lens was not pointing straight down. Through such rectification he was able to produce accurate maps. Scheimpflug's invention acknowledged a similar but earlier camera-like rectification apparatus patented by the Frenchman, Jules Carpentier in 1901. Based on experiment, Carpentier coordinated the tilting movements of the subject plane and film plane in order to keep the image in focus.

Theodor Scheimpflug took Carpentier's observations an additional step by proving that in order to achieve perfect focus, it was necessary that the subject plane, the film plane and the lens plane intersect along one common line. The lens plane is, of course, that plane surface passing through the center of the lens, perpendicular to the lens axis. The plane of the lens board is a useful substitute for the lens plane.

An accompanying sketch illustrates Scheimpflug's principle. Note that in the situation depicted, the intended subject plane may lie at any angle to the ground and still obey the principle. The fact that this plane passes through the Scheimpflug Line is not enough ensure focus, however. The camera will be focused on a plane passing through the Scheimpflug Line, but that plane of sharp focus could be at a different angle relative to the ground. The photographer's job is to make the two planes coincide, as shown.

Scheimpflug's principle alone is not always very useful. There are an infinite number of ways to adjust the focus of a camera, each way obeying the Scheimpflug Principle but still not achieving the desired focus.

Fortunately, there is a second law.

The Second Law of the View Camera

The second law is much like the first. It describes three planes that must intersect along a single line. In this case, one of the planes is the same as before: the subject plane. The new second plane is one through the center of the lens but parallel to the film. I call this plane the parallel-to-film lens plane, or PTF plane, for short. The third plane is one parallel to the usual lens plane but one focal length in front of it. A second sketch illustrates.

The second law, all on its own, tells us how much lens tilt we need for any given situation. The distance from the lens to where the PTF plane and the subject plane intersect is the only factor determining how much lens tilt we need.

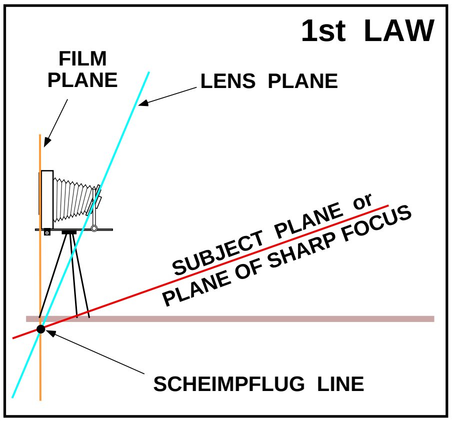
I call the second law "the hinge rule"; a few examples will explain why.

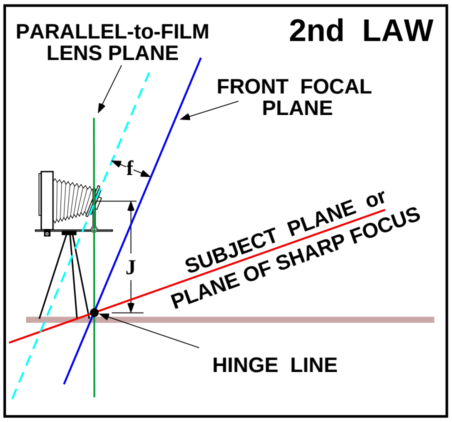
The hinge rule gives us a 'bench mark' (the hinge line) through which the plane of sharp focus will pass. For sharp focus, the hinge line must be on the subject plane.

The position of the camera back, through the Scheimpflug Principle, then sets the angle at which the plane of sharp focus will pass through the hinge line. Moving the back to and fro causes the plane upon which the camera is focused to rotate about the hinge line. This is probably not something you have been taught, but it is, nevertheless, a direct consequence of these two laws of the view camera.

Examples

We used a Sinar F camera fitted





The First Law of the view camera—the Scheimpflug Principle—requires that the Film Plane, the Lens Plane and the Subject Plane must intersect along a single line. In this side view the line is seen as a dot.

A Second Law—the Hinge Rule—requires a plane through the lens parallel to the film, a plane parallel to the lens plane but one focal length in front of it, and the Subject Plane must also intersect along a single line.

with a 150 mm Schneider Symmar-S. The camera back was initially adjusted to be perfectly vertical. Our subject, Lisa, is holding a long ruler—a folding surveyor's rod, actually.

The first two of our four examples show Lisa holding the survey rod at two different angles relative to the floor. The survey rod was hinged at a point 4.2 feet directly below the camera lens. The left portions of the photo pairs show you a side view of the set-up. The right portions of the pairs show the photos taken with the view camera.

You can see that the markings on the survey rod are sharp from end to end in each of the photographs. For both of the examples, the same lens tilt was used: 7˚. The only thing we changed was the position of the camera back. We didn't change the angle of the back; it was vertical throughout. We just slid the back along the monorail to focus, and adjusted the vertical rise if necessary to achieve the desired framing.

Adjusting the lens-to-film distance caused the plane upon which the camera is focused—the plane of sharpest focus—to rotate about the position of the hinge in the survey rod.

We focused simply by observing the ground glass and turning the focusing knob on the back standard until the rod was in focus. When any part of the rod was in focus, the whole rod was in focus. Increasing the lens-to-film separation caused the plane of sharp focus to rotate up towards the camera lens.

How did we know what lens tilt to use? Well, the hinge rule allows us to prepare a simple table. A table for a 150 mm lens is shown here as a sample. The distance from the camera lens to the hinge, I call "J". For a 150 mm lens there is a unique amount of lens tilt required for any particular value of J. For values of J not explicitly shown in the table, we can estimate in-between values. In this case J was 4.2 feet, and so the tilt angle was, near enough, 7˚.

Let's look at another example. For Example 3, we increased the lens tilt to 14˚. Using the table, we see that the distance J must now be just over 2 feet. We raised the survey rod to bring the hinge about two feet below the camera lens, and, there we have it. Notice how we can even achieve focus on a slope away from the camera!

Of course I've glossed over some of the details. There are not many details, but they are subtle. The distance J is measured in a very special way. Although J is the lens-to-something distance, it is constrained to be measured in a direction parallel to the plane of the film. If the back is vertical, J is measured in a vertical plane. If the back is tilted 30˚ from the vertical, J must be measured in a plane tilted 30˚ off the vertical. OK, so J is measured in the PTF plane, but that still doesn't tell us everything. Do we measure up, down, sideways etc.? The lens must be tilted about an axis that is parallel to the intended hinge line, and the front of the lens is tilted towards the intended hinge line. In the examples cited so far, the hinge line was always intended to be horizontal, and so we used simple, classic, lens tilt. The hinge line was below the lens, so we tilted the lens forward—the front rim of the lens getting a little closer to the hinge line. Had the intended hinge line been vertical and to the right of the lens (viewed from behind the camera), we would have swung the lens to the right. In this case the survey rod would need to have rotated from right to left as the lens-to-film distance was increased.

One last example to show a not-so-usual set-up. We tilted the camera back forward 30˚, and the lens was tilted forward at 26˚. The effective lens tilt relative to the back is 4˚ upwards in this case. This gave us a distance J of 7 feet, but it's seven feet measured up and forward of the camera at an angle 30˚ off the vertical. Example 4 is not a set-up one would use often, but it does, I hope, help to illustrate the basic rules of view camera focus.

Whatever happened to our Captain Scheimpflug and his principle? Well, he's been with us all along. His rule has been followed perfectly—and automatically! You see, Scheimpflug is always right, no matter what we do with our camera. The plane of sharpest focus will always obey Scheimpflug's principle. The photographer's job is to make the plane of sharpest focus coincide with the natural subject plane And doing that calls for application of the hinge rule.

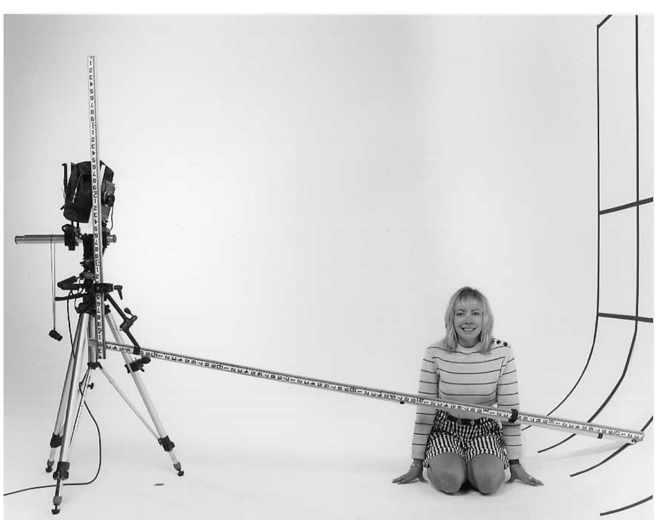
Longer lenses need more tilt; short lenses need less for any fixed arrangement of subject plane and film plane, but the principle is the same for all. The book *Focusing the View Camera*, available through The Book Bin here in *ViewCamera* magazine, explains in more detail. Included with the book is a handy filmholder-sized card with tilt and J distances for a

Example 1: The left photo illustrates a side view of the Sinar F and subject for the result shown at right. The hinge line is located 4.2 feet directly below the lens as illustrated by the vertical portion of the survey rod. The camera is set to focus on the angled portion of the rod. In this case the rod is in a moderately low position and the camera back is almost where it would be for infinity focus.

Example 2: The survey rod was raised to a higher angular position and the camera back moved away from the lens to focus on the rod in this new position. Again the rod is in focus from end to end. So long as the rod remains hinged at a point 4.2 feet directly below the lens, 7° of lens tilt is the amount required to focus on the rod at any angular position.

Distance J (in feet)	LENS TILT f = 150 mm
0.25 (3")	n/a
0.5 (6")	79.82°
0.75 (9")	41.01°
1	29.48°
1.25 (15")	23.18°
1.5 (18")	19.15°
2	14.24°
2.5 (30")	11.35°
3	9.44°
4	7.07°
5	5.65°
6	4.70°
7	4.03°
8	3.53°
9	3.13°
10	2.82°
12	2.35°
15	1.88°
20	1.41°
30	0.94°
50	0.56°
75	0.38°
100	0.28°
200	0.14°

The Hinge Rule lets us associate a specific lens tilt angle (measured relative to the camera back) with a specific lens-to-hinge line distance, J. This table shows the relationship for a 150 millimeter lens. An approximate relationship is that the tilt angle is about equal to the focal length (in millimeters) divided by five times the distance J (in feet).



Example 3: The vertical portion of the rod was raised to put the hinge just over 2 feet below the lens. The required amount of lens tilt is now 14°. The camera will again focus on the whole rod, even when it is angled away from the camera.

Example 4 illustrates the hinge rule under quite different circumstances. 30˚ of back tilt combined with 26˚ of lens tilt (4˚ relative to the back) put the hinge line 7 feet from the lens and about 6 feet directly over the subject's head. Focusing with the camera back now causes the plane of sharpest focus to swing from the hinge line like a pendulum. The result is distorted, but in focus.

variety of common lens focal lengths from 53 mm to 450 mm. I'll warn you, the book is very technical. But if you've understood this article, all you really need for now is that card.

In Part 2, I'll address what happens to depth of field when lenses are tilted. You have probably noticed a few clues here in the illustrations for Part 1. It turns out that the situation is conceptually simpler than is the case for 'normal' cameras! But we do have to pay attention; it isn't always clear what's the best set-up. This is one place where a little art and craftsmanship—or experience—are a definite asset.

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