The Scheimpflug Principle—Part I

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Well, I had thought that four articles about depth of field would be enough. It seems, however, that there are a few Shutterbug readers who want to know more. The most popular question seems to be "How does it work for view cameras?" In order to answer that, I will first have to digress. To understand the answer, there are a few ideas we have to address first.

The next four articles (counting this one), therefore, will be about some optical basics. Things like: Does a fixed focal length lens really have just one focal length? And Is the Scheimpflug principle exact, or is it just another approximation which is only sometimes true? Or, Is there anything else we need to know in order to understand view camera optics?

This first article will address what a view camera is and why it is—or can sometimes be—different from 'ordinary' cameras.

Strictly speaking, I guess a view camera is one that lacks a viewfinder. One views through the camera. The image is composed on a ground glass screen which is substituted for the film during set-up. Then, when all is ready, the shutter is closed, film (or a photographic plate) is substituted for ground glass, and the picture is taken. In standard usage these days, a view camera is also much more. The essential implied feature is that the lens is not fixed with its axis perpendicular to the film. Usually, both the camera back and the lens can be raised, lowered, tilted about a horizontal axis, swung about a vertical axis, shifted left or right, or otherwise contorted in seemingly endless ways. Between the lens and the film is a bellows whose sole purposes in life are to prevent light from getting to the film except through the lens, and to stay out of the way of that light once it has passed through the lens. Well, maybe a red bellows looks pretty, too.

The 'ordinary' camera is very carefully manufactured so that the lens is constrained to move to and fro along its axis. That's how we focus it. And that axis is precisely perpendicular to the film. Anything else and the camera is "out of alignment".

For the expert view camera user, having the lens fixed perpendicular to the film is rather restricting. The are so many neat things one can do with those adjustments. But then, if you can't use the ground glass to see what effect the adjustments have, maybe it's best to stick with the lens perpendicular to the film. It is indeed 'safest' to constrain lens movements to focus-only.

I won't pretend to describe all the uses for view camera adjustments or how to go about setting the camera up for a particular purpose. In fact, I don't claim to be a particularly accomplished view camera user at all. There are several good books on use of the view camera; I leave it to those experts to describe most of the hows and whys. I have used semi-view cameras (like Graphics and Technikas) for decades, but almost all of that time, the only adjustment I have used is the rising front. That prevents tall buildings from looking like they are falling over backwards. As an aside, don't make the mistake of thinking that a Graphic or a Technika is a view camera. It is true that some degree of adjustment is possible, and thus these cameras can do a few of the jobs a true view camera does. But even where such adjustments are possible, they are often very inconvenient. For example, the thing I usually want to do with lens tilt is to tilt the lens downwards. With many of the Technika and Graphic models this is possible only by mounting the camera upside down!

I do claim to understand one or two of the basic optical principles behind view cameras. Most books on the subject leave a lot out, and sometimes they actually have some of the details wrong.

The essential principle exploited by the view camera is the Scheimpflug principle. To understand it we must talk about three planes: the film plane, the lens plane and the plane of sharp focus. The film plane is a flat imaginary surface upon which the film is fixed. The film plane extends well past the physical edges of the actual film. The lens plane is another flat imaginary surface passing through the optical center of the lens, and remaining perpendicular to the lens axis. If these two plane are anything but absolutely parallel with each other, they will intersect. They will intersect along a straight line. The plane of sharp focus is a third imaginary surface positioned such that any object lying on it will be imaged sharply (by the lens) on the film plane. For an 'ordinary' camera, the three planes are parallel to one-another and so they never intersect.

Simply stated, the Scheimpflug principle (named after Mr. T. Scheimpflug, I believe) states that if a lens is tilted such that the lens plane intersects the film plane, the plane of

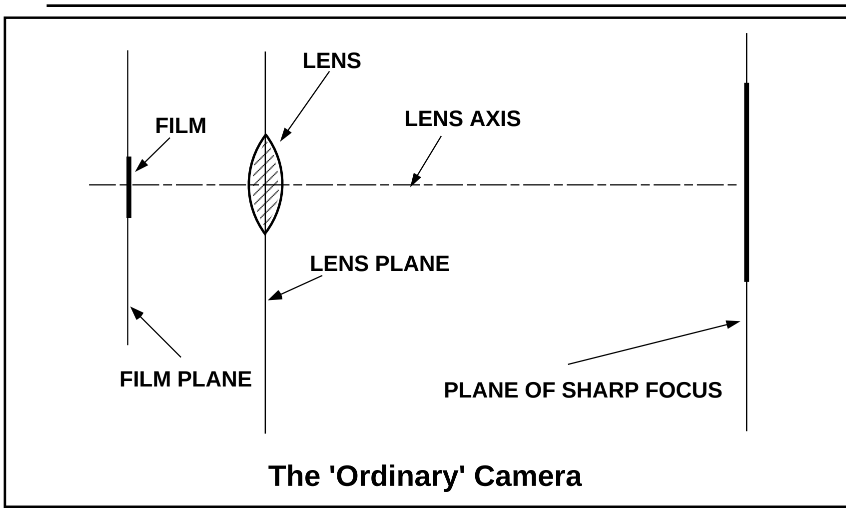

Figure 1: The basic optical geometry of an 'ordinary' camera. Note that each of the three planes is perpendicular to the lens axis.

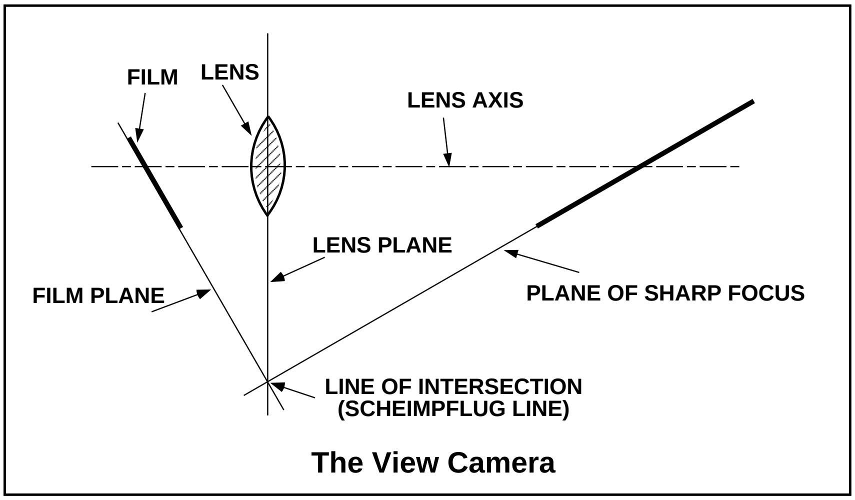

Figure 2: The basic optical geometry of a view camera. The essential thing to note here is that the lens axis and the film are no longer perpendicular to one another. As a consequence, the plane of sharp focus is also tilted.

sharp focus must also pass through that same line of intersection.

The situation is depicted in Figures 1 and 2. In these figure we are actually looking along the edges of the various planes. The planes therefore appear in the drawings as lines. And if the planes intersect, the line along which the planes intersect is shown simply as the intersection of the lines representing the planes. Figure 1 shows the 'ordinary' camera, while Figure 2 shows the view camera. Later in this story, I'll be talking about another special line. To avoid confusion, the line formed by the intersection of the lens plane, film plane and plane of sharp focus, will be called the Scheimpflug line. There is no particular up or down intended in Figure 2. An important point is that illustrating the geometry in only two dimensions like this does not restrict our analysis in any way. Any camera set-up can be viewed from some vantage point to look something like Figure 2.

That's all very nice, but I haven't told you anything yet that is not covered in almost every other book or article about view cameras. Let's start asking questions. Is the Scheimpflug principle exact, or is it an approximation? Does it work for all lenses? If the three planes intersect, am I guaranteed to be in focus? How do I know where that line of intersection should be? What about perspective? Yup, there are lots of questions one can ask. The Scheimpflug principle does not explain all; it's just a help.

To answer a few of the questions just posed: Yes, the Scheimpflug principle is exact—for thin, rectilinear, flat-field lenses. No, it does not work for those lenses lacking adequate flatness of field. I'm not sure if it works or not for non-rectilinear but flat-field lenses. My guess would be that it works for some, but not for others. It does work—in slightly modified form—for thick lenses which are rectilinear and flat-field. No, having the three planes intersect does not at all guarantee focus. Yes, well, the line of intersection should be somewhere along the plane of sharp focus—obviously. Perspective? Well, that depends upon where the line of intersection lies on the plane of sharp focus. Where relative to what? Yes, yes, it will all become clear in time.

The important thing is that for practical purposes, the Scheimpflug principle does work for most lenses. Almost all lenses try to be flat field and rectilinear (distortion-free). Some are thick, but a surprising number qualify as 'thin'—especially among the symmetrical designs intended specifically for use on view cameras. (Telephoto lenses, however, are seldom 'thin'.)

Next time, we'll ask the question: is every lens a zoom lens? The answer, by the way, is "yes".