What You Should Know About *Auto-Focus*

How It Is Supposed To Work... And Why It Doesn't Always Work

by
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You may have auto-focus problems with your digital camera and you just don't know it! When we retired our old Hasselblads, Mamiyas, and Bronicas, we adopted a new technology that we really don't fully understand and which we are fully dependent on for our livelihoods. When we get an occasional soft image, we usually don't think too much about it and simply get in the habit of taking more images than we used to in order to cover ourselves. But that occasional soft image may indicate something that you probably should be concerned about.

Recently, a fellow photographer was commenting to me that she was disappointed with the overall sharpness of her images since she made the transition from medium format cameras to digital. When she first brought this to my attention, I attributed it to "human error." When relying on auto-focus instead of the human eye, several things can go wrong. One of them is not noticing what the actual auto-focus point is on in the composition. If the intent was to focus on a person's face but the focus point was actually positioned over the person's shoulder and is aimed at the background, the background will be in focus and the person's face will be out of focus. I did this once with a group of executives. I composed the group and set my camera on a tripod and took a series of images without noticing that my focal point was actually aimed right over the shoulder of one of the subjects and was focusing on the wall behind the group.

Then, there is the question as to whether to use "all" of the focus points or just "some" of them or even "one" of them. One camera company representative advised that the best results would be obtained from having them "all" turned on. However, my own independent tests showed otherwise. One reason he gave was that users will often set their camera to use "one" focus point (usually the center point) and then aim that at the person's face, lock in the focus, and then re-compose the image. Depending on the aperture used, and therefore the depth of field, that person's face may or may not be in focus after the image is re-composed. But she was working at f8 aperture and, with the lens she was using and the working distance, there should have been adequate depth of field to compensate for a minor error in focusing.

Her camera was several years old so I suggested she consider the latest model (we're not getting into brands at this point). She bought one. But it wasn't long until I received a phone call from her that she was still having the same problem with occasional soft images. Since I felt somewhat responsible, I set out to uncover the mystery.

My first thought was, since this was a brand new camera, the problem had to be the lens. I had studied her technique and had ruled out human error. She was doing everything right. So, I set up a controlled test using three different models of the same brand of camera, along with three identical lenses that included the one she was using. I used every combination of lens with every combination of camera body. Along with this, I included a brand new lens of another brand, just for grins.

My Initial Test

I wanted to test two different things. Not only did I want to tell if the "test subject" was in focus, I wanted to see exactly where the depth of field was (that area in front of and behind the point of focus that remains in focus at a particular aperture... the wider the aperture, the narrower the depth of field, etc.). So, I set up an object that would be easy for the auto-focus mechanism to read, and set this at a normal studio working distance of about eight or nine feet. Alongside the test subject was a yard stick with the "zero" mark closest to the camera and the "36 inch" mark the furthest from the camera, and the test subject at the "18 inch" mark.

I deliberately used a wide aperture for a "shallow" depth of field on all of the shots. To my amazement, I discovered that although all of the test images were in focus, the depth of field varied from one camera to the next (of the same brand). My particular camera, the most expensive of the four that were tested, had a "normal" depth of field range. In other words, from the point on the yardstick where the numbers got sharp until the last number where they started to get blurred again, about 1/3 of that area was in front of the object I focused on and about 2/3 of it was behind. Another camera body, using the same lenses, showed about 2/3 of the area was in front and 1/3 in back. But the "new" camera she had just purchased showed that at least 80% of the depth of field was in front of the test object and 20% or less was behind. This would seem to indicate that the auto-focus mechanism of the camera was somehow focusing in front of the object it was analyzing.

So, what does this mean? As long as the image is even barely within the depth of field, it will be sharp anyway, right? There should be no cause for concern, right? Well, let's assume that the accuracy of the auto-focus system in general is not totally 100% and it might therefore be normal for the auto-focus mechanism to vary three or four inches one way or the other at a normal working distance of eight or nine feet. If the depth of field is normally 1/3 in front and 2/3 in back of the subject we are focusing on and the total depth of field at a given aperture was... let's say 15 inches... that would mean that anything 5 inches in front and 10 inches in back of the subject would be in focus. So, if we were 3 or 4 inches off either way, the subject would still be in that depth of field range and would appear sharp.

But let's say, as in the test case above where the camera seemed to be focusing in front of the subject and 90% of the depth of field was in front and only 10% in back, this would mean that nearly 13.5 inches in front of the subject was within the depth of field and about 1.5 inches in back of the subject would be within the depth of field. As long as the camera consistently focused at that same relative distance in front of the subject, the subject would still be within the depth of field. But if the camera suddenly focused another couple of inches in front of that, the subject would then fall outside the back part of the depth of field. Theoretically, if the camera was consistently focusing behind the subject, the reverse would be true. This might be a logical explanation for the "occasional" soft image.

So, is this auto-focus system that we rely upon for our very livelihoods totally accurate and fool-proof? Not quite... it depends... yes and no!

How Does Auto-Focus Work?

Basically, auto-focus uses a miniature motor to focus the lens for you. There are two basic types of auto-focus systems out there today. One is called "active" auto-focus and the other is called "passive" auto-focus. The latter is what is used on most of the cameras we have in our studios today.

"Active" auto-focus, which is used on many of the "consumer" digital cameras, originally used a system of sound waves emitted from the camera that bounced off the subject much like sonar on a submarine. But today's "active" auto-focus cameras primarily use an infrared pulse of light instead of sound waves. The computer in the camera's microprocessor computes the

time difference between the time the outbound infrared light pulses are sent and the inbound infrared pulses are received. After analyzing this data, the microprocessor circuit tells the focus motor which way to move the lens and how far to move it. The primary advantage of the infrared system over the older sound wave system is the speed in which the microprocessor makes the computations. One primary advantage of the "active" system is that it permits easier focusing, even in the dark, making flash photography much easier.

But the cameras that most of us use in our studios utilizes a totally different system called "passive" auto-focus. This system determines the focus distance to the subject by actually "analyzing" the image itself. The device that performs this task is generally some type of CCD or CMOS pixel line or area detection array that provides algorithms that compute the contrast of the actual pixel elements of the detection array. When light from the scene hits the array, the microprocessor looks at the values of each pixel and evaluates the differences in intensity among adjacent pixels. The AF system is lining up like information very much like an optical split-image range finder system used to. When a scene is out of focus, adjacent pixels will have similar intensities, so the microprocessor moves the lens back and forth to determine if this difference in similarities gets better or worse and selects the point where the adjacent pixels have the most difference. That becomes the "proper" focus distance. That sampling of similar information happens many times per second during the AF operation.

There are some disadvantages to a "passive" auto-focus system. First of all, such a system must have light as well as image contrast in order to evaluate the scene. If you've ever tried to focus on a blank wall or a solid color object, you will understand this concept. The camera is not able to compare adjacent pixels because they all are the same. So, it can't focus.

So, why would such a system fail? Some of the reasons are obvious... poor lighting conditions, lack of contrast in the subject, or even a bad lens with a circuitry problem. But the camera body itself is (theoretically) calibrated to certain specifications. The only problem, is that it is "unrealistic" to expect that every single camera that comes off the assembly line is adjusted fully with identical calibration points."

Lens Calibration

Here's even more disturbing news... There is an internal calibration for each lens, too! So, it appears that you may purchase a camera that may be "within factory specifications" and have poor results because the lens needs to be calibrated, or else you may have a lens that is "within specifications" that may produce poor results because the camera body needs to be calibrated! All of this becomes quite confusing if we have a series of lenses and more than one camera body... all from the same manufacturer... that produce various results with various combinations. In fact, this particular test showed that all of her lenses seemed to be focusing "in front" of the target. But when we tried an "off brand" lens, it tended to have a more normal depth of field! What a mess!

However, it is important to note that the lenses she was using were "variable aperture zoom" lenses. In other words, instead of it being an f2.8 lens or an f4.0 lens, they were f3.5-4.5 lenses and were a less expensive line. When we tested an f2.8 lens, we obtained better and more consistent results... as we did with the f4.0 lens as well.

Testing Your Own Equipment

So, where does that leave the average professional photographer today who uses a digital (or film), auto-focus camera? Is it a game of chance? Are we gambling each time we purchase a new camera or lens? In a way, yes. Is there something we can do about it? Again, yes.

Obviously, the first step is to do some extensive testing on our existing equipment to try to determine for ourselves if the problem is a lens or a camera body or a combination of both. The only other alternative is to send all of your lenses and all of your camera bodies back to the factory and pay them to do it. If your camera is still in warranty, you may be in luck. But my bet is that your camera isn't.

But, in defense of camera manufacturers, it is (most likely) all about economics. We all want the cheapest price on a camera and a lens, so in order to meet our expectations, camera manufactures must (obviously) rely upon "spot checking" a product line as opposed to testing each and every item they manufacture. No company that produces high tech equipment can be expected to adjust every single piece of equipment. That would be totally cost prohibitive. As a result, the best we can expect is that these manufacturers build these items within certain specifications and then test a statistically significant small number of the items and then track and adjust the process in order to "try" to maintain those specifications. This is the reality of the world we live in.

You may very well own a camera body which barely falls within one end of the manufacturer's specifications and a lens which barely falls within the other end of those specifications. The combination may therefore produce unacceptable results while either that same camera body or that same lens might produce acceptable results in combination with another system.

Each photographer has their own set of standards and measures of quality. Sadly, a lot of professional photographers aren't that concerned about the issue and their answer for getting an occasional out-of-focus images is to "take more pictures than usual" to offset the phenomenon. Others do extensive testing on their equipment and demand closer tolerances with their equipment. In fact, camera manufacturers are quick to point out that "better focusing technology does, in fact, exist in the higher level cameras." But many photographers are opting to buy the less expensive camera bodies instead.

Focus performance is part of the camera function, and that has to be considered an integral part of the overall image quality equation. So, for those of us who consider "auto-focus" to be a key issue, we need to keep this in mind. It's something to think about.

Reprinted Courtesy of Texas Professional Photographer, June/July 2007.