MAKING SHARP PHOTOGRAPHS

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It always surprises me how often I see photos that are simply not sharp when they need to be. Of course there are the needs, now and then, for a dreamy landscape or a diffused portrait, but generally a basic rule has applied since the film days: it is easy to soften a photo in the darkroom (and now on the computer) but it is nearly impossible to sharpen one that was soft when it was shot.

There are a number of reasons why a shot is not sharp, most of which are correctable. Generally they fall into these categories:

1. The lens itself is not sharp
2. There is movement in the shot from the subject or camera
3. The aperture is not set to its optically optimum *f*-stop.
4. The subject is not properly focused

Here we'll examine each of these possible problems and what you can do about them to make sure your photographs are as sharp as you can make them.

TERMS: BEING "SHARP" Vs BEING "IN FOCUS"

Here comes a big surprise to many photographers, sometimes even old hands at it. Being sharp and being in focus are two very different things. Being in focus merely means the lens has focused the image so that its minimum sized Circles of Confusion[1] are projected on the image plane.[2] As you probably remember from basic classes, a light ray is a point (of light) but since lenses are not perfect they can only render those points as circles—Circles of Confusion. If those circles, on the print, are approximately 1/200 of an inch or smaller we will see the item comprised of those circles as appearing sharp. Even a poor quality lens will have a point where it is as focused as it can get; that is, it has rendered its projected light rays as small as it is capable of doing. But it will still not render

[1] Sometimes called "Circles of Minimum Confusion" to clear up the confusion…
[2] This is the plane where the light sensitive emulsion lies and in film cameras is called the film plane or the focal plane. In digital cameras it is sometimes called the "sensor plane" but to me the clearest term which works for film and digital is the "Image Plane" since it is the plane where the image is formed in the camera.

detail with sharp crisp edges or for that matter show fine detail at all compared to a high quality lens if at its best focus the circles of confusion are all larger than 1/200 of an inch. This problem is enormously increased with digital sensors so that lenses that seemed sharp when used with film may produce soft images when used with a digital camera because the needs of tiny circles of confusion to enter the photo sites on a chip is a completely different issue than exposing an emulsion.

And when an image is enlarged, so are the circles of confusion. That is why something that looked ever so sharp on a contact print or small proof fell apart when enlarged to a decent sized print.

Bottom line: being "sharp" is an issue of lens resolution and contrast that is independent of how the lens can "focus" what it can capture. This may seem confusing at first blush but is important to grasp as we tackle the common causes of soft images.

ISSUE: THE LENS ITSELF IS NOT SHARP

We will assume there is nothing mechanically wrong with the lens and it is mechanically capable of internally focusing the light rays to as small a circle of confusion as possible for the optics. Our issue is, when it does that, i.e. when it is focused as well as it can be, is the resulting image sharp, i.e. capable of rendering very fine detail and producing 1/200 inch circles of confusion or smaller.

There are lenses and lenses. As a general rule, the manufacturer's "house brand" lenses are going to be the best for your camera. Quality control is higher and the processes involved are held to a higher standard. That is not to say that if you can wade through samples and test them that you cannot find a superb 3rd party lens. But out-of-the-box you will have a better chance of getting a high quality lens if you stick to the lenses made by your camera's manufacturer.

There are occasionally "experts" writing magazine articles who claim an off-brand lens to be the equal of the house brand lenses but you need to read the fine print. For example, I have a Tamron 180mm Macro. It is tack sharp… but only at its optimum "sweet spot" aperture range of about *f*8. At that setting it is an amazingly sharp lens but as you move away from that optimum setting it quickly becomes no match for the Canon version of it. For my own uses it serves me just fine but for many it would be a major disappointment. I can show you very sharp images and claim that represents the lens's results. But that is not exactly accurate. Those sharp shots were composed and shot to the lens's

strengths and avoiding its weaknesses. Is it capable of it? Yes. Would it be typical under normal use? No.

MTF Curves/Diagrams

So how can you determine whether or not a lens is going to be sharp or not generally and specifically at the settings most common to the way you shoot? Well, not to remind us of a former President's clever parsing of words, it depends on what you mean by "sharp?" And how sharp is sharp enough?

In the film days this was far less of an issue, but Digital imaging chips are incredibly intolerant of all but the sharpest lenses. In fact a great deal of technological energy has gone into designing and redesigning lenses to make the suitable for use in the digital world when even the sharpest film lens was not sharp enough. In other handouts and presentations I've covered the issues of film versus digital vis-à-vis how a lens aims its light and how the circle of confusion it projects must be designed to work with the digital imaging chip and its sunken photo sensors. Here we are concerned with the lenses themselves and how to know if they are sharp… or sharp enough for your needs.

The house brand lenses tend to be much more consistent from sample to sample so the published data is generally more reliable in predicting the capability of any given lens in that lineup. Those manufacturers that are confident in their lenses usually publish MTF (Modular Transfer Function) curve data for you to see and compare. The problem is they use statistics (as all do when using them) as a marketing tool: they present them so their product appears in the best light. And so you may see MTF data diagramed somewhat differently from one brand to the next. About all you can rely on is a comparison within brands, but that is still good data given the variety of lenses being made.

But what is this MTF stuff all about anyway? In the old days lenses were simply rated based on how many line pairs could be resolved in smaller and smaller increments, usually millimeters. If a lens could resolve the difference between a black and white line pairs that were 100 line pairs per millimeter that was obviously sharper than one that could only resolve 50 line pairs per millimeter or LPMM. Unfortunately, there is more to a lens's performance than simply its ability to resolve line pairs. Equally important is its ability to maintain contrast. In a resulting picture, even if a lens can actually show you the difference, line pairs that are no longer black and white but now two shades of gray will not appear as sharp or as rich as those that maintain the contrast. MTF curves combine the actual resolution and the contrast into a single data stream.

When is it good enough?

So when do you need to pay twice the price for a few decimal points on the MTF curve? The answer is when you need, for your personal or professional output, the ultimate in detail sharpness. If you shoot for a newspaper or for even magazines, their reproduction quality is poor and will often not display the difference. If you shoot for the web, monitors will often not display the difference unless you enlarge the image to extremes. On the other hand if you make large prints for display or sale then the difference can become obvious pretty quickly.

When in doubt, test it yourself. You can get 'official' lens resolution charts or for a quick real world answer open a newspaper and tape it to a wall. Set your camera on a tripod and make certain the image plane is exactly parallel to the paper. Fill the frame with this small type, focus very carefully, and then shoot at various apertures with all of your lenses. If you are using a zoom, shoot the range of apertures at various "standard" zoom settings. Obviously you will have to compensate with the shutter speed for differences in aperture to maintain the proper exposure. Or you can set the camera to "Aperture Priority."

Put these files into the computer and examine them at 100% at least and compare the sharpness of the type. It will quickly let you know if the center is sharp and whether or not that sharpness is falling off as you push toward the outer edges. If you see red and cyan edge halos around the type, those are the results of chromatic aberration. Not a good thing.

Digital Vs Film

This is a slight digression but it contains an important bit of ancillary data to complete the big picture here. Sometimes things only make sense when you have the full story in hand and this is one of them, at least for me.

In theory film can record much finer detail than digital. A typical medium speed (ISO 125 +/-) B&W film's grain of silver halide is about 2 microns[3] in size. That is much smaller than a photo site on a good chip where the individual sensor might measure anywhere from 6 to 8 microns in size. It would seem then, if you knew only that data based on the capture medium, that the film would be able to handle, perhaps need, far more resolution in a lens than digital.

But film, when it is being developed, suffers an interesting chemical/molecular change as the sensitized halides are turned into metallic silver: they form

[3] A micron is 1 millionth of a meter or 1/1,000 of a millimeter or approximately 1/25,000 of an inch.

"clumps." The clumps are created from 20 to 40 individual grains depending on film and developer combinations. When you look through a grain focuser it is the clumps you see; an actual gain is far too small to see except with a microscope. The math quickly reveals the problem. 20 grain lumps of 2 micron halide grains forms a 40 micron metallic clump. It is that resulting 40 micron clump that defines the limits of a film's real resolution potential. The initial grains and the developed clumps are all black, surrounded by clear film (or white paper on a print) and represent the smallest detail possible. To appear sharp on film the lens really needs only to resolve something the size of the clumps.

The digital image, however, requires a lens that can send a circle of confusion into those tiny photo sites that are a fraction of the size of the film's clumps.

ISSUE: MOVEMENT

As a preliminary comment, we must note that there are times when the photographer purposefully will use movement to create a blur in the image to indicate motion or for special effects. OK, fine. What we are concerned with here are those occasions where the photographer wants and needs the final image to be as sharp as possible. And here, right up there with soft lenses, camera movement is one of the leading causes of image softness.

If you want your images to be sharp then there can be no movement relative to the image plane during the exposure. Period. To see a major jump in sharpness put your camera on a tripod and lock it down. Then use a remote release rather than putting the mass of your body into play and poking the shutter release with your finger.

Of course there are times when a tripod is inconvenient or even impossible to use. What then? One compromise solution has been to use a monopod. This is a one-legged tripod, a sort of collapsible, steady walking stick with a tripod head on it. It does absolutely eliminate the up and down movement of a hand held camera. The combined mass helps smooth out the side-to-side and front-to-rear movements and the result is a several stop gain in shutter speeds. It is not as stable as a tripod but is far better than trying to hand hold a long lens without any support.

To use a monopod really well, learn to use the geometric angles available. The monopod leaned slightly back and you leaned slightly into it is far more stable

than both being bolt upright. With a little practice you can really lock this into place and become quite steady.

Another solution was to use a shoulder stock, sometimes called a rifle stock since the first ones actually *were* modified rifle stocks. These forced the photographer into a more stable stance and the mass of the camera/lens/stock really smoothed out the random higher frequency vibrations and movements. Especially when used for smooth panning such as done by wildlife and bird photographers photographing animals on the move or flight, these were highly effective.

The modern attempt at a solution is the gyroscopically stabilized lens. Every manufacturer has felt compelled to come up with their own nomenclature for this approach. VR (Vibration Reduction), IS (Image stabilized), OS (Optically stabilized), etc. These are advertised to offer miraculous abilities to shoot at shutter speeds of longer and longer durations. But longer than what?

The old rule of thumb was that most people ought to be able to hand hold a camera at a shutter speed that was a fraction made from the lens's focal length, or, as often expressed, 1 over the focal length. For example, a 50 mm lens could be hand held at 1/50 of a second or faster. This was accepted traditional wisdom for ages and perhaps if the results of your shooting were destined to be shown in a magazine or as small prints it was true. But in test after test with fellow instructors shooting our own gear both on tripod and hand held, making 8x10s from cropped 16x20s of all the test shots, neither the instructors nor students had any trouble telling the difference of a normal lens (50mm) up to 1/125 of a second. And for some even at 1/250 you could see the degradation of the hand held shot from the 50mm normal lens.

We are all different, the micro-muscular spasms we have happening all of the time vary from person to person and even, in the same person from time to time depending on such things as when they last ate and even *what* they last ate. Different brand lenses, even of the same focal length, balance differently on their cameras, and different holding techniques become a variable as well. The truth is there is no one-size-fits-all answer to this. You need to determine this for yourself by testing BEFORE that important shoot comes up so you will, as ol' St. Clint said, "know your limitations."

However, the theory would be that based on whatever is YOUR handheld limit for a given lens, the stabilization function should add from 1 stop to a miraculous 4 stops. I think marketing has, as usual, trumped reality in this but these lenses do give you some gain, usually 1 to 2 stops and that can be a life saver. They can give you more, but so can an unstabilized lens if you learn to hold them and shoot them correctly and in the most solid positions.

It must be noted that Sony/Minolta has adapted a different approach. They seek to stabilize the camera body itself. The theory is that then the lenses will be easier to make and therefore less expensive. That is true. But really large, fast, or long lenses often have more mass than the camera body and it seems to be the body would struggle to stabilize the whole package of the body and lens combined. I like the idea a lot, but I would need to see some real-world tests to believe in the results with heavy lenses.

Even without stabilization or support, you can improve steadiness by learning to hold the camera correctly, controlling your breathing, and taking advantage of ANY steady object to help support you and the camera.

ISSUE: APERTURE SETTING

Almost any photographer who has had a beginning class or read any basic photo books knows that depth of field, the illusion of expanding or contracting the focus of a lens further in front or in back of the plane of critical focus, is accomplished by, among other ways, adjusting the aperture. The rule is simple, the greater the *f*-number the greater the depth of field. That means there is more depth of field at *f*22 than there is at f8 but there is less depth of field at *f*4 than there is at *f*8.

But remember what we said up front; there is a difference between focus and sharpness. And in dealing with depth of field that difference becomes critical. In virtually every lens ever made there is a spot in the range of aperture settings in which the light rays coming through the lens are the least disturbed by the iris or by the outer edges of the lens glass. That means that one *f*-stop will produce an image that is sharper than any of the others. That is the so-called aperture "sweet spot" of that lens.

A general rule of thumb is that the aperture-based sweet spot of a lens is found approximately 2 to 3 *f*-stops closed down from the widest aperture of that lens. In other words, if the widest aperture is *f*4 then the sweet spot will generally be found at around *f*8 to *f*11.

It is important to note that this is not always true and some lenses are designed specifically to yield an optimum result in particular parts of the aperture range. Some view camera lenses are designed to be stopped down more, for example. But it is a good starting point and it does point out the issue that regardless of precisely where the sweet spot is, there IS one. And that means that as you open

the lens or close it down from that optimal setting, the lens projects a less sharp image. Worse, whatever distortions or aberrations exist in the lens will be exaggerated as well. The counter intuitive result is that although you may gain in depth of field (an issue of focus or, more properly, the illusion of focus) you will pay for it in loss of sharpness. Frustratingly, the lens will likely be at its worst when it is fully stopped down to gain the maximum depth of field.

How much loss? Well here is where quality trumps most everything. The higher quality lenses degrade much slower as you adjust aperture than low quality ones. To many photographers, when using a high end lens it may not look like there is *any* loss but in a serious test it can always be detected. In some output scenarios it may be utterly inconsequential: newspapers, most magazines, the web, etc. are incapable of showing the difference in the best lenses. But large prints will show it pretty quickly.

Sometimes stylistic requirements such as shooting fashion or portraiture with long lenses shot wide open to compress backgrounds and yield minimal depth of field overrules the need for critical sharpness.

There, a fast long lens is a necessity as it would be for a sports photographer who shoots indoor sports or night games and has to have the widest possible apertures so they can use the fastest possible shutter speeds without resorting to high ISOs and suffering the increase in grain or noise. A really good quality lens will have had less loss anyway and so practicality makes the decision for the photographer over technical accuracy.

But that also means that if you do *not* need fast lenses for fashion or sports or photojournalism, then you are probably paying for functionality that you not only do not need, but that is compromising quality where YOU do need it.

If you want some depth of field, such as for landscape photography, then you need to have a lens where the sweet spot is in that *f*8 to *f*16 range and that means you need a lens where the maximum *f*-stop is *f*4 or *f*5.6 at the widest.

The good news is the "slower" lens will be a lot lighter on both your wallet and on your shoulder.

ISSUE: FOCUS

Wait a minute! Didn't we just explain that there is a difference between being in focus and being sharp? Yes we did. But if you have a good sharp lens, hold it

steady, shoot at the sweet spot, you now still need to be properly focused in order to get the lens to do all it is capable of.

Manual focusing was all that was available until fairly recently. It was easy with medium and large format cameras where the large bright ground glass made the image easy to see in the viewfinder and therefore easy to focus. Even so most pro shooters used a loupe or magnifier to help get the focus as perfect as possible.

Camera bodies designed for 35mm miniature film and especially SLRs where the light traveled from the lens to be bounced off a mirror and then internally reflected inside a pentaprism saw a major loss in light intensity. Coupled with a tiny viewing port anyway, proper focus was far more difficult with the small cameras. But with the small film requiring a greater enlargement, focus became even more important. What a paradox.

Microprisms, split image finders, any number of mechanical/optical solutions were tried by various manufacturers to solve the problem. They each had their adherents and worked to some extent but none were really good for all subjects.

Enter autofocus. Working on either ultrasonic beams (not good for looking through filters or windows) or seeking to find maximum contrast, these worked pretty well. Well, they worked when the thing being focused on was in the brackets for the focus sensor. Playing with depth of field became a problem when in order to set the beginning and end points of your desired plane of focus you actually needed to be focused in mid air.

In the end, it turned out that the best solution remained to manually focus the camera. With a camera on a tripod it is not a major problem to take the time to focus manually. For landscapes that is not a problem… usually. Except for occasionally here in California, the mountains will sit quietly and steadily for you to take your time.

Well, except, of course, there are a couple of problems, as usual. One problem is that it is not always possible, as we noted above, to be using a tripod. If the subject is moving how do you stay on track? In the old days one "zone focused" using aperture and focal distance in combination to find the "hyperfocal distance" which made sure the depth of field covered the expected range of subject movement and then did not worry about it. For sports magazines and newspapers this worked just fine.

But there was no way around it, it was cumbersome, slow, and did require reading and a mastery of one's equipment. Definitely, this is not the modern approach, especially the reading part. The new fangled autofocus was here to

stay and with built in pattern recognition software it was amazingly good at actually following an item to keep it in focus as you panned along with it.

But the digital world has inadvertently created some interesting problems with this, some of which are still being denied by manufacturers (just as they denied there was an issue with the angles of light for digital sensors until Olympus admitted it and made a marketing campaign out of their solution). On some of the latest lenses mated to the latest bodies there is a back focus issue that has the lenses auto-focusing slightly behind the intended plane. It is not much and if stopped down would disappear into the depth of field plane. But for critical focus, or where minimal depth of field is the aesthetic need, the result is a soft image that is not acceptable.

Canon says this does not exist but will happily "align" your system if need be. Of course manual focus works just fine still. But you have to do it if you want the ultimate sharpness with shallow depth of field using autofocus.

The second problem is found in an elegant solution for people like me who wear glasses or contacts. The viewfinders have a built in diopter that allows you to fine tune the focus *of the viewfinder itself*. But the little dial or lever can easily get moved during transport or handling and suddenly, without realizing it, you find it hard to focus and are really guessing. This is not a good thing where sharpness is a quest.

To reset the viewfinder's diopter, either autofocus on a subject with a lens you know has no problem or manually find the best focus by racking the lens focus from in front of the object to behind it until you are the middle of the range. Then, while looking in the viewfinder, adjust the diopter until you get maximum sharpness.

Now if the diopter has marked settings, note where they are for you. If not, take a spot of paint or even something like White Out™ (you do remember White Out don't you?) and mark the diopter and the body so you can return to this setting should it get off in the future.

CONCLUSION

So that's it. If you are seeking critical sharpness in your photographs then you know what you must do.

First, make sure you have a lens capable of providing a sharp image with the camera you are using.

Second, eliminate any camera movement during the exposure.

Third, shoot at the lens's aperture sweetspot.

Fourth, make sure you have actually properly focused the lens for the shot.

So go out and shoot and let's see some crisp images!

-NDK-