Apertures and shutter speeds explained… (again)

Since the relationship is so crucial to understanding how to expose images and avoid unwanted clipping, as well as the impact on image composition, it's always helpful to re-visit the relationship between apertures and shutter speed. We know already that as one increases, the other decreases to retain the same exposure levels, but it helps to keep reminding ourselves of why that matters. The reason we stay cognizant of this is because of the impact increasing and decreasing either the aperture or shutter speed has on your pictures.

For example, if we take a picture that is correctly exposed at f8.0 and a shutter speed of 1/100th seconds, the same "exposure" can be achieved with an aperture of f4.0 and a shutter of 1/500th seconds. Using the f8.0 and 1/125th second setting as a base, we could construct the following table that would result in the same exposure:

Aperture	Shutter Speed
1.0	1/8000th seconds
1.4	1/4000th seconds
2.0	1/2000th seconds
2.8	1/1000th seconds
4.0	1/500th seconds
5.6	1/250th seconds
8.0	1/125th seconds
11	1/60th seconds
16	1/30th seconds
22	1/15th seconds
32	1/8th seconds

So, if you were to take the same picture, with identical lighting, and changed your camera each time to the settings above, you would have the same exposure on your image. But are these the same pictures? No, quite the contrary…

If you were to go through each of these situations, you would find that at the top of the chart (aperture of 1.0 and a shutter speed of 1/8000th of a second), most of the image area outside your point of focus is blurred. In technical terms, this means you have achieved a very **shallow depth of field**. (The depth of field refers to the range of sharpness for your subject.) This means that not much in front of, or behind your subject point is really very sharp at all.

Conversely, if you were to compare an image taken with the settings at the top to one with the settings at the bottom, you would find quite a **wide depth of field**. Again, in technical terms, that would mean that quite a bit of the picture is sharp both in front of, and behind your image.

While the pictures with the shallow depth of field and the wide depth of field are both exposed correctly, they are quite distinct images from one another. Likewise, the range of sharpness and blur (or bokeh to use the technical term) will vary as you move from higher shutter speeds and lower apertures to the converse of lower shutter speeds and higher apertures.

Now, here is the stumbling block that most of us have trouble dealing with. Notice how I said higher shutter speeds require lower apertures? In looking at the chart it seems pretty clear that 1/1000th of a second is much faster than ½ of a second, right? (Would you rather have half of a dollar or 1/100th of a dollar? I'll always take 50 cents instead of a penny!)

But when you look at the aperture numbers, those seem to be going higher as you get slower shutter speeds. Clearly, 32 is higher than 2, right? Sure, in normal terms that's right. But, in photography, the aperture is not an integer…it's a fraction, just like the shutter speed. That bears mentioning again…**the aperture number is a fraction, just like the shutter speed.** So, why is it not displayed as a fraction? Who knows… convention, ease of writing, whatever reason you choose, it's just the way it is. Over time, it's just become the de facto method to indicate aperture values with whole numbers rather than fractions. The same is also becoming the case for shutter speeds too, so lest we forget, these numbers are all fractions. If we were to take out all the fractions, the chart would look something like this:

Aperture	Shutter Speed
1.0	8000 second
1.4	4000 second
2.0	2000 second
2.8	1000 second
4.0	500 second
5.6	250 second
8.0	125 second
11	60 second
16	30 second
22	15 second
32	8 second

This isn't really accurate though, so we're going to put the fractional values back in this table. In doing that, we need to keep in mind the math we learned in grade school (remember fractions?) – the smaller the denominator (the number underneath the line), the larger the number. One half (1/2) of a cake is more than one fourth (1/4) of a cake.

Well, the same holds true for apertures…an aperture of 2.8 is really 1/2.8 and an aperture of 64 is really a value of 1/64. This means that the lens opening is much larger at 2.8 and conversely the lens opening is much smaller at 64. So…smaller apertures are represented by the "higher" numbers like 64, 32, and 16, while the larger apertures are represented by the "lower" numbers like 1.4, and 2.8.

In going back to the original chart then, let's add in the fractional element so we can remember how the numbers change from one end to the next:

Aperture	Shutter Speed
1/1.0	1/8000th second
1/1.4	1/4000th second
1/2.0	1/2000th second
1/2.8	1/1000th second
1/4.0	1/500th second
1/5.6	1/250th second
1/8.0	1/125th second
1/11	1/60th second
1/16	1/30th second
1/22	1/15th second
1/32	1/8th second

This may help to keep things clear of what is happening to the aperture and shutter as you change sizes. Since we are keeping the lighting and the scene consistent though, we can also add the impact of our mechanical changes to the chart. Remember, larger apertures result in a more narrow depth of field, which means less sharpness across the entire image (sharpness only on subject). Conversely, smaller apertures result in a wider depth of field, which translates as more sharpness across the entire image (your whole picture is sharp). So, let's go ahead and add that to the chart:

Aperture	Depth of Field	Shutter Speed
1.0	Most narrow (very little is sharp	1/8000th second
1.4	Very very narrow (still very little is sharp)	1/4000th second
2.0	Very Narrow (sharpness only goes about an inch across the image)	1/2000th second
2.8	Narrow (sharpness goes to about one and a half inches across images	1/1000th second
4.0	Limited (sharpness goes to about 2-3 inches across the sharpest point of the image	1/500th second
5.6	Somewhat limited (sharpness starts increasing noticeably across the image)	1/250th second
8.0	Standard sharpness (most of composition behind subject becomes sharp, still limited in front)	1/125th second
11	Higher sharpness (most of composition behind subject is now sharp, and area in front starts to increase a little more)	1/60th second
16	Strong sharpness (image sharpness extends pretty well across the entire image – lights start exhibiting "star" effect	1/30th second
22	Very high sharpness but starts to have unwanted side effects	1/15th second
32	Extremely high sharpness, but side effects increase – at this point apertures at this value and lower are really only useful for night photography and astrophotography)	1/8th second

Having added the resulting characteristics for aperture values, let's now look at the effect that changing the shutter speed has on an image. This part should be a little easier to grasp though, as a faster shutter can be identified with stopping motion. The faster your shutter, the faster the movement can be that you are able to effectively "freeze". With that in mind, let's start at the bottom of the chart and work our way up. If you have a shutter speed of 1/8th of a second, the amount of motion that you can freeze would be anything moving slower than 1/8th of a second. So, logic says that you probably will not be able to get a clear picture of a racecar or an eye blinking. But, you might be able to get a subject for a portrait to hold still for that long (but that's pretty tough to do, believe it or not.) What you can most definitely get good shots of though are inanimate objects. A pencil on a table, a coffee mug, or a floral arrangement would be good candidates for the shot at 1/8th of a second. Naturally, as you move to faster shutter speeds, you will be able to stop (or freeze) more without any motion blur.

Since we are talking now about introducing motion blur, it may help at this point to make the distinction between motion blur and camera shake. Motion blur is best described as movement of your subject. So, if the wind blows through a meadow where you are taking macro flower shots, you will get motion blur. Likewise, if you take a picture of a Nascar driver in action at a slower shutter speed, you will capture motion blur.

Camera shake, alternatively, is the point at which we can no longer hold the camera steady without moving the camera involuntarily ourselves. For people who shoot with slow shutter speeds, they often counter camera shake with a number of methods, with the most reliable of these being a tripod. Other advances in technology and gadgetry can also counter camera shake to a degree, such as monopods, image stabilization, and altering film speed (or sensor sensitivity) ISO settings. That goes beyond the scope of this though, so I'll save that for another time. In general though, here it is enough to say that the longer we have to hold our camera still, the more likely we are to introduce camera shake. As a general rule of

thumb, you should expect to be able to hold your camera still where the shutter speed denominator (that bottom number again) matches the focal length of the lens. So, if you are shooting a 70mm lens, the slowest you can expect to shoot handheld and still avoid camera blur would be at 1/70th of a second. Since cameras don't have that setting, take the next fastest one or 1/125th. With that in mind, let's go ahead and add those characteristics of shutter speeds to our chart:

Aperture	Depth of Field	Shutter Speed	Motion Blur/ Camera Shake
1.0	Most narrow (very little is sharp except subject center)	1/8000th second	Fastest – stops most movement
1.4	Very very narrow (still very little is sharp)	1/4000th second	Very very fast – stops almost all movement
2.0	Very Narrow (sharpness only goes about an inch across the subject)	1/2000th second	Very very fast – stops most movement
2.8	Narrow (sharpness goes to about one and a half inches across subject)	1/1000th second	Very Fast – stops a lot of movement
4.0	Limited (sharpness goes to about 2-3 inches across the subject)	1/500th second	Fast – most lenses can be handheld at this point without introducing camera shake
5.6	Somewhat limited (sharpness starts increasing past subject and noticeably across the image)	1/250th second	Pretty Fast – lens selections limited to 200mm and shorter for handholding to maintain control over camera shake
8.0	Standard sharpness (most of composition behind subject becomes sharp, still limited in front)	1/125th second	Reasonably fast – lens selections limited to shorter focal lengths – consider monopod
11	Higher sharpness (most of composition behind subject is now sharp, and area in front starts to increase a little more)	1/60th second	Not fast – lens choices limited further, subject matter also restricted – monopod strongly recommended, consider tripod
16	Strong sharpness (image sharpness extends pretty well across the entire image – lights start exhibiting "star" effect	1/30th second	Slow – moving water starts to blur, hand holding becomes difficult even with shortest focal lengths – consider tripod, monopod OK
22	Very high sharpness but starts to have unwanted side effects	1/15th second	Slower – motion blur difficult to avoid, camera shake evident without some sort of mechanical assistance (IS VR lenses) – tripod strongly recommended, monopod less useful
32	Extremely high sharpness, but side effects increase – at this point apertures at this value and lower are really only useful for night photography and astrophotography)	1/8th second	Very slow – motion blur unavoidable outside of inanimate objects, and IS/VR features less useful – tripod required, monopod ineffective

So, that's pretty much it. Aperture and shutter speed are the two single biggest mechanical factors that we have at our disposal in photography. The better we understand them, and how they impact the photo, the better our photography will become. All that's left is to get out and shoot. For those (like me) that need a reminder every once and a while, I've made a handy little pocket reference guide of the final chart that you can print out and keep with you. You can print out the PDF of the chart, and stick it in your camera bag (it folds in half too). Or, if you'd like, I have one with the aperture numbers and results on one side with the shutter numbers and results on the other side. It's also laminated for maximum protection. To get one of those, email me and I'll be happy to share it with you at cost + shipping ($5).Take it out every once and a while to remind yourself. Your results will be better if you do – I promise! Happy shooting!