

Topic 85

Depth of Field & Depth of Focus

Due to similarities in name and nature, depth of field and depth of focus are commonly confused concepts. To simplify the definitions for our purposes, depth of field concerns the image quality of a stationary lens as an object is repositioned, whereas depth of focus concerns a stationary object and a sensor's ability to maintain focus for different sensor positions, including tilt. When a lens focuses on a subject at a distance, all subjects at that distance are sharply focused. Subjects that are not at the same distance are out of focus and theoretically are not sharp. However, since human eyes cannot distinguish very small degree of un-sharpness, some subjects that are in front of and behind the sharply focused subjects can still appear sharp. The zone of acceptable sharpness is referred to as the *depth of field*. Thus, increasing the depth of field increases the sharpness of an image. We can use smaller apertures for increasing the depth of field. The following shows an example. The lens focuses at the middle between the 3 inch and 4 inch marks. Thus, the 3 inch and 4 inch marks are sharp in all images. The 5 inch mark is not very sharp at F3.2, and is improved as the lens closes down to F3.6. Then, it becomes sharp in all subsequent images. The 6 inch and 7 inch marks are not sharp until F5.0 and F6.4, respectively. The 8 inch mark becomes reasonably sharp when the lens closes down to F8.0. The 9 inch and 10 inch marks are not sharp in all images; but, they become sharper as the lens closes down. For the foreground, the 2 inch mark is acceptable at F3.2 and becomes "focused" at F4.0. The 1 inch mark is not sharp until F5.6, and the lead of the ruler becomes reasonably sharp at F7.1. As you can see, the range of sharpness (*i.e.*, depth of field) gets larger as the aperture gets smaller. Therefore, use a smaller aperture if a greater depth of field is needed. Normally, to increase the depth of field you must either:

- decrease the size of the aperture in the final lens A
- decrease the magnification M being used, or
- increase the distance W between the specimen and the lens

Depth of focus is a lens optics concept that measures the tolerance of placement of the image plane (the film plane in a camera) in relation to the lens. The same factors that determine depth of field also determine depth of focus, but these factors can have different effects than they have in depth of field. Both depth of field and depth of focus increase with smaller apertures. For distant subjects (beyond macro range), depth of focus is relatively insensitive to focal length and subject distance, for a fixed f-number. In the macro region, depth of focus increases with longer focal length or closer subject distance, while depth of field decreases.

Determining factors:

In small-format cameras, the smaller circle of confusion limit yields a proportionately smaller depth of focus. In motion picture cameras, different lens mount and camera gate combinations have exact flange focal depth measurements to which lenses are calibrated.

The choice to place gels or other filters behind the lens becomes a much more critical decision when dealing with smaller formats. Placement of items behind the lens will alter the optics pathway, shifting the focal plane. Therefore, often this insertion must be done in concert with stopping down the lens in order to compensate enough to make any shift negligible given a greater depth of focus. It is often advised in 35 mm motion picture filmmaking not to use filters behind the lens if the lens is wider than 25 mm.