Format and DOF

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1 Format effects

There is always heated argument about the DOF achieved from various formats. Often one hears that larger formats have smaller DOF than smaller formats, and many photographers support this view by citing their own experience. They are both right and wrong, and the explanation is something every photographer should understand.

There are two parts to the DOF problem: (1) the technical one which indicates that the same DOF can be attained by any format; and (2) the fact that it is often impractical to achieve the technical part.

2 Technical

Figure (1) shows three lens diagrams drawn to scale horizontally[1]. The focal length in the medium format diagrams is twice that of the small format diagram. It may be seen that the near DOF limit is closer to the subject in the middle diagram than it is in the first. This means that the DOF is smaller for the medium format, but the comparison is not fair.

There are three parameters which determine the near DOF location. They are focal length, image circle, magnification and f-number. As noted, the focal length of the middle diagram is double that of the first, and a close look will show that the image circle is also doubled, as is the magnification doubled in order to make the image span the same subject area. Why should the f-number remain the same? Changing it along with the others results in the bottom diagram, in which the medium format DOF may be seen to be slightly larger for medium than small format. It would seem that one really ought to change the f-number when comparing the formats.

An examination of cameras which use the two formats will show different maximum f-numbers. Medium format cameras will show larger maximum f-numbers than small format cameras: the maximum f-number for a 35 mm camera will seldom exceed 22, while a medium format camera may well have a maximum f-number of 32. There are good reasons for this having to do with

[1]The vertical scale is exaggerated for illustration, but does not affect the argument

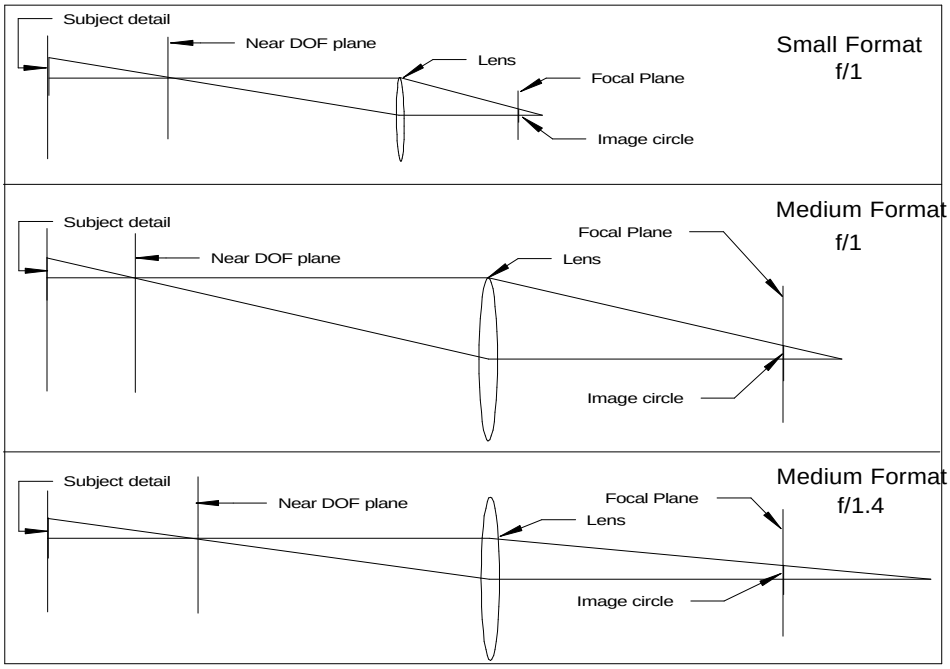

Figure 1: DOF geometry.

diffraction, but the important fact is that medium format lenses are made for use with larger f-numbers than are small format lenses. It is thus possible to adjust the f-number along with the other parameters in order to control DOF.

It follows that the same DOF may be obtained from any format by a proper adjustment of the parameters.

3 Practical

The rub is that if one adjusts the f-number of medium format so that the DOF matches that of small format, one must also change the exposure time, which may be impractical.

Consider the situation where one is photographing some pigeons roosting on a rail some distance away. One would like the DOF to extend from a nearby clump of reeds to infinity. Since pigeons move and reeds sway, one cannot choose too slow an exposure. Say one decides that 1/30 sec is the longest exposure that will stop movement. The available light and the speed of the film will then fix the f-number, and there is nothing else that can be done to adjust the DOF. The problem is constrained by the composition, and a medium format camera may well have insufficient DOF while a small format camera may be adequate.

Thus although in theory it is possible to achieve the same DOF with both

formats, the practical necessity to control times may make it impractical.

4 Magnification

Figure (1)can be used to understand another frequently asked question: "Why do smaller formats have higher resolutions?" The answer is, because of magnification. The subject detail is exactly the same in all three diagrams, yet it produces a smaller image circle in diagram A than in B and C[2]. The image circle in diagram B is twice the image circle in diagram A because the magnification is doubled. Since resolution is the reciprocal of the diameter of the circle, this means that the resolution in diagram A is twice that in diagram B.

Other things being equal, there is a smallest subject detail that can just be resolved by a lens. The diameter of the image of this detail on the film plane is equal to the size of the subject detail times the magnification, which means that the smaller the focal length the smaller the size of the image, or the smaller the focal length the greater the resolution. There is nothing more to it than that, it is all due to the fact that a shorter focal length lens squeezes an image into a smaller area than a larger focal length lens, and so long as the film is capable of recording the finer detail, the on-film resolution is greater, but the detail is captured equally well by both formats.

[2]The image circles are identical in diagrams B and C