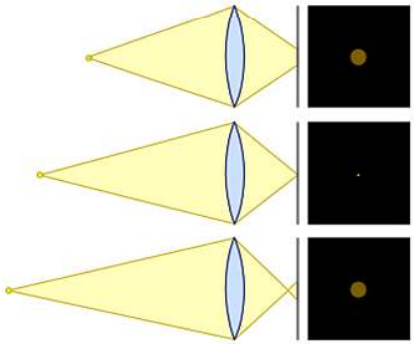
Depth of field, Another HD tool

By Alfonso Parra AEC

As digital cameras increase their resolution, dynamic range and color space, there are few technical arguments left for not using these cameras for cinema projection in big movie theatres. One of the arguments that still holds out and is regularly used against 2/3" digital cameras is their greater depth of field compared to the 35mm format. Depth of field is the amount of distance between the nearest and farthest objects that appear in acceptably sharp focus in an image.

To calculate those values you need to know the Circle of Confusion value (CoC). This value sets the maximum diameter for the point of light that remains sharp created by the focused lens on the focal plane, so that values equal to or below said diameter of any other point in the image would make it appear sharp in the rest of the field.



Depth of field. There is only one focused point; the points behind and in front of this point generate a circle greater than the focused one. If those points are equal or less than the CoC, they will appear sharp and are considered focused although in reality they are not.

The CoC values depend on the eye's resolution, which in turn is affected by the distance from which we observe, and, especially by the contrast and lighting. You also have to keep in mind for the CoC value the blow-up of the image and the viewing distance. With the CoC, you calculate the hyperfocal distance and, with this in hand, you establish the depth of field table. Remember that the depth of field is not uniformly distributed with respect to the lens' focal point. Normally, it is greater behind the focused area and less in front.

Since one of the factors that determines the CoC is the degree of enlargement, it is logical to consider that the greater the image's enlargement, or the closer the viewing of the image, the smaller the CoC. Therefore, formats like the 2/3" or 16mm need smaller CoCs if you are going to enlarge for movie projection in the same proportion as a 35mm image, so that it appears focused with the same sharpness in all cases. In general, we can accept that the depth of field is inversely proportional to the size of the format, although this is not true for all focusing distances.

$$H = \frac{f^2}{Nc} + f$$

$$D_n = \frac{s(H - f)}{H + s - 2f}$$

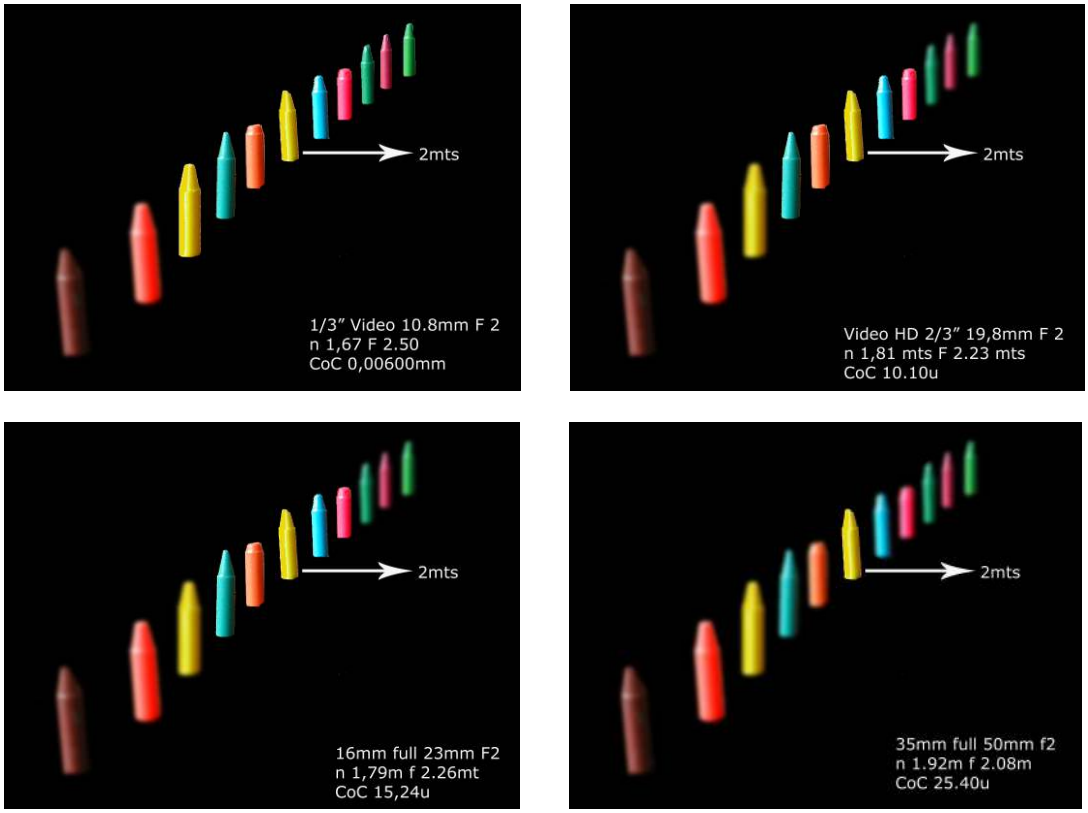
$$D_f = \frac{s(H - f)}{H - s}$$

H Hyperfocal distance in mm
f focal lens in mm
S distance from focused point
N F number of diaphragm
c Circle of confusion in mm
Dn Closest distance with acceptable sharpness
Df Farthest distance with acceptable

Also, less enlargement of an image or a greater viewing distance allows for the use of greater CoCs, so that if an image ends up in a 20" monitor, you would choose a smaller CoC than if it ended on a 9" monitor. The makers of cameras and lenses decide the CoC value and with that, they then develop all the other calculations for each format according to its use. Obviously, the calculations are purely theoretical since, in the majority of cases, people ignore the different lens aberrations or, for example, the distortions introduced by the prism in 2/3" HD cameras. It is thus always necessary to carry out focus tests on all the lenses to be used and in HD, with the camera to be used during shooting.

Given the CoCs relatively arbitrary character, you could think of lowering it indefinitely till you reached a completely sharp image. In truth, this is not possible due to the lens' diffraction effect. The CoC is reduced with smaller diaphragms and the image is thus increasingly sharper in a range of greater distances. But that sharpness is lost due to the diffraction produced by the lens when a ray of light passes through the diaphragm's minimum opening.

The CoC values chosen for HD and 35mm are so that the depth of field in a 2/3" digital format is greater, that is, there are more "focused" elements within a determined range of distances than in the same range for the 35mm format. The 2/3" HD format, by using a small CoC, makes the focus critical, so that any contact looks out of focus and error tolerance is less. Considering depth of field as a technical condition derived from everything said above does not necessarily make it an advantage or disadvantage, but simply something implicit to the format chosen.



Relative comparison of depth of field in different formats with equivalent lens values

From a narrative point of view, the value of depth of field resides in highlighting certain elements against others in the frame. Obviously, the human eye sees and evaluates more the sharp objects in the image than those that aren't. Depth of field, then, has two aspects: first, since it organizes elements within the frame, it enters the scope of composition and, therefore, the scope of cinematography too; and two, as it clearly directs the spectators gaze, it also enters the scope of edition, narrative, and therefore, the director's.

So the decision as to how to work the depth of field belongs both to the director and the cinematographer.

As said before, the combination of lenses, diaphragm, distance from the subject, and the format (as far as these use different CoCs, and, consequently, different hyperfocals) determine the depth of field.

Each medium has its own conditions regarding depth of field and they can all be used as a narrative element. It's enough to verify how in equal conditions, that is, similar lenses and distances from the subject, each medium presents a different depth of field. The 35mm format gives very little depth of field compared to 16mm or 2/3", and these less than 8mm or 1/3".

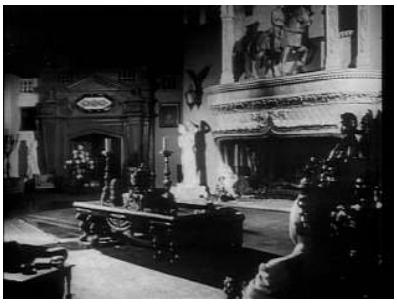
The wish for little depth of field in a movie could be resolved by using two different formats if, for example, there is no concern over using a more zoom lens in the smaller format, for example:

In 35mm (1:1.85 CoC 25.40u) with a 50mm at F2 focusing at 2mts, there is focus from 1.92mts to 2.08mts.

With the equivalent lens in 2/3" (HD Full 1.85 CoC 10.10u), 20mm, at F2 focusing at 2mts, there is focus from 1.82mts to 2.22mts.

Now, if you wanted depth in 2/3" similar to 35mm, you could use a more zoom lens, like a 32mm, and, focusing at 2mts, you'd have focus from 1.93mts to 2.08mts. Evidently, it is practically equal to the 35mm, even though the area covered in the image for that focusing distance is less than the 35mm's; and to achieve a similar area, the HD camera should be separated from the subject to 2.75mts, giving a depth of field from 2.61mts to 2.91mts. In any case, and as is noticeable when handling focusing distances, depth of field can also be used as a narrative tool, like lenses and diaphragms, in 2/3". If you wanted to equal the 35mm's depth to the HD 2/3", you would see that you need to close the diaphragm to 4.8, in other words, you'd need four times more light than for the HD. This wouldn't be a problem in exteriors with natural light, but it would be in interiors. You can also change the lens to a 32mm to give it a similar depth of field but covering a greater angle of vision, in other words, seeing more space, which has to be controlled from the composition, the framing and the lighting. It becomes clear

then that if 35mm is simpler and more immediate for achieving little depth of field compared to the HD 2/3", it is also the same vice-versa; the 2/3" format is simpler and more immediate if you want greater sharpness and depth in the image.

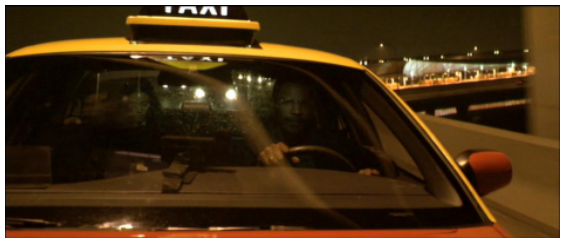




Defending the use of 35mm because it gives less depth of field takes us back to the old dispute between those studio cinematographers that defended soft photography with little depth of field versus those that preferred a sharper and more contrasted image. The former preferred his method because, among other things, the change from silent films to talkies abandoned the use of very noisy arc lamps for the more silent but less efficient lighting, so they had to use very open diaphragms. Such was the case with Toland's much-admired photography in Citizen Kane, where the search for greater sharpness led to the use of more closed diaphragms and wide angle lenses. André Bazin wrote that greater sharpness in the image allowed Welles "*to give back a fundamental quality of the real in the cinematic illusion: continuity". "Orson Welles embraces the entire visual field with even sharpness, immediately turning it into a dramatic field".*

Reality is made more present with a sharper image. It leaves space for movement within the frame and the staging strictly because of what is seen, both close and far, contrary to what Godard said in an interview in Cahiers (2002): *"We get the impression that there is no longer depth of field in digital".*
"For example, there is no longer mise en scène, or perspective; everything is fluid and everything is sharp. There is no impression of light …." A sharp, and therefore "realistic" image forces one to a more demanding staging since there is no disguise for what is seen and no character or space determines its importance with the out of focus. And it is in that sharpness where perspective is fundamental for narrative development, choosing where to place the camera and the lens in each situation to include, better or worse, the relation between the different distances, and, especially, the characters' relations with the surroundings, which can't be excluded for not being as sharp. Again, Bazin points out:"…*but I would like to underscore that depth of field has led Visconti to naturally (and Welles) renounce not only montage, but to reinvent all planning".* Movies like Collateral or Zodiac have explored the depth of field given by 2/3" HD digital cameras, with elaborate staging, realistic and "continuous" that submerges the spectator in a credible world without any apparent artifice. Digital systems are already changing the way in which reality is captured and one of the determining factors in the transformations we observe is the possibility of achieving sharpness in an image unseen before. We must explore these terrains instead of holding onto obsolete conventions that block the complete use of resources offered by 2/3" HD digital cameras.





Collateral





Taxi driver

The pictures here show how depth of field and sharpness from a 2/3" digital camera was helpful. In Collateral, the taxi participates in the city and it is shown at the side- included with wide-angle lenses and the sharpness- in the very taxi. Both realities (the city, the taxi and its interior) converge in a continuum that equally extends to the interior shots in buildings and parking lots. Notice– and except for the distances- the difference with the pictures from Taxi driver; the city is the place where the taxi moves, the background frames it. In Collateral, however, the city converges with the taxi and is not only the background and frame, but the place where everything "happens" together with the characters; the city expresses itself too.



Collateral



Zodiac

There is a similar treatment in Zodiac, where the newspaper staff, like the city in Collateral, acquires its own character, a place that defines itself for the characters and frames their being and actions.

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