An 80 Megapixel Full-Frame DSLR?

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A few months passed during 2011 where a brief hiatus in the race for higher pixel densities on full-frame (24x36mm) sensors was observed, with pixel counts giving the appearance of having finally hit a ceiling at around 24 MP. And this seemed entirely reasonable to most people, but Nikon's February 2012 release of the 36 Megapixel D800 threw down a fresh gauntlet for the other manufacturers.

Nikon ruled the 36 MP perch alone, for a surprising stretch of 20 months, when in October 2013, just a month ago, as of this writing, Sony stepped up with their mirrorless design, 36 MP, full-frame Alpha 7r. To my knowledge, nothing's been heard of Canon on this front since articles referencing a greater-than 75 MP Foveon-like, full-frame sensor being tested by Canon were published in July of this year:

http://camyx.com/rumors/2013/07/canon-75-megapixel-dslr-camera/

http://camyx.com/rumors/2013/07/new-canon-eos-1d-75-megapixel/

http://www.photographybay.com/2013/07/21/canon-testing-a-75mp-pro-dslr/

http://petapixel.com/2013/07/23/canons-75-megapixel-dslr-may-be-due-to-a-stacked-three-layer-sensor/

Sony, too, has patented a Foveon-like sensor, but there's been no leaks regarding any tests the likes of which Canon is performing. My contention with this resurrected pursuit of higher pixel densities for full-frame sensors escapes most people, but it boils down to this:

With equivalent Pixel Count, Print Size, and Viewing Distance...

> **Small Sensors give us *the same DoF and diffraction as larger sensors*,**
> **but *faster* *shutter speeds at smaller f-Numbers,* and thus,**
> ***fewer* *"diffraction-free" f-Numbers from which to choose*.**
>
> **Large Sensors give us *the same DoF and diffraction as smaller sensors*,**
> **but *slower* *shutter speeds at larger f-Numbers,* and thus,**
> ***more* *"diffraction-free" f-Numbers from which to choose*.**

It's the higher enlargement factor required by smaller sensors having the same pixel count as larger sensors that forces the use of smaller apertures (smaller Airy disks at the sensor) before magnification, to produce like-sized, like-resolution prints. At any given f-Number, the size of diffractions's Airy disks will be the same at the sensor, but when a like-sized print is made from the smaller sensor, the greater enlargement factor required will apply greater magnification to those Airy disks!

Whether a 24x36mm sensor uses multi-layer Foveon-like technology or the ubiquitous Bayer-algorithm CMOS technology, an 80 MP full frame sensor will NEVER be able to produce prints as large as the pixel counts will encourage without the diffraction-savvy photographer choosing to either forfeit subject detail to secure print resolutions that simply don't require that many pixels -OR- to confine himself to not stopping down below f/7.3, for example (the maximum f-number at which diffraction would NOT inhibit a print resolution of 5 lp/mm in an unresampled, uncropped, 360 ppi print).

This print, the largest possible 5 lp/mm that could be made from an 80 MP sensor with 10,328x7760-pixel captures, would measure 21.5x28.7 inches.

If we want to secure subject detail at a moderate 5 lp/mm (keeping in mind that adults with healthy human vision can appreciate resolutions as high as 8 lp/mm)...

> … if, you make the print any larger than 22x29 and you'll be limited by the 80 MP sensor's pixel count (any lens, any subject space.)
>
> ... if you stop down any further than f/7.3, diffraction will inhibit your 5 lp/mm print resolution goal (with any lens, any subject space), at that enlargement factor.
>
> ... if the Nearest subject is any closer than 42 feet when Infinity is included in the subject space, while hyperfocused with a normal FL lens, our CoC diameters will become too large at the Near and Far extremes to support 5 lp/mm.

In other words... 24x36mm sensors are TOO SMALL to easily make use of 80 Megapixels!

Even if we cut the desired print resolution goal in half - to only 2.5 lp/mm (180 ppi), the 80MP sensor's pixel count will allow us to make prints that are twice as large (44x58), but everything else remains the same (a diffraction-imposed maximum f-Number of f/7.3, with a resulting DoF-imposed 42-foot Near, with a normal FL lens).

Or, if we cut the resolution in half while keeping the print size at 22 x29, we will not be able to stop down below a diffraction-imposed f/14.6 (we can't use f/16), and we will still have to avoid shooting subjects with Nears any closer than 21 feet (with a normal FL lens).

Yuck!

Contrast this to the current leader of the full-frame megapixel race, the 36 MP Nikon D800/D800E:

The D800 is pixel count-limited to a 360 ppi (5 lp/mm) print size of 13.6 x 20.4 inches, with a diffraction-imposed maximum f-Number of f/10.2 (one stop better than f/7.3), with a DoF-imposed minimum Near subject distance of 21 feet (with a normal FL lens) – one-half the distance imposed by the 80 MP sensor.)

Basically, with a like-sized sensor, cutting the pixel count in half gives us twice the freedom when making prints as large as the pixel count encourages - freedom to actually use more of the f-Numbers available on our lenses, without reducing our desired print resolution, and freedom to make compositions that include Near sharps that are closer, again, without reducing print resolution.

And if you can't see yourself ever really wanting to make a 13.6 x 20.4-inch print, you can cut the pixel count in half *again*, from 36 MP to 18 MP, sticking with the full frame sensor: The 18 MP Canon EOS 1DX (suiting my needs here, as the only full frame DSLR ever made that happens to be right at 18MP)...

The 1Dx is pixel count-limited to a 360 ppi (5 lp/mm) print size of 9.6 x 14.4 inches, with a diffraction-imposed maximum f-Number of f/14.5 (two stops better than the f/7.3 limit imposed with an 80 MP full-frame sensor), with a DoF-imposed minimum Near subject distance of 10.7 feet (using a normal FL lens) – one-quarter the distance imposed by the 80 MP sensor.)

For those of us who can remember making prints from 35mm film, 8x10-inch was about as far as we could go with f/16, before the benefits of DoF began to be outweighed by diffraction's degradation. Compare this maximum of f/16 for 8x10-inch prints from full-frame 35mm film cameras to the calculations I've done in the paragraph immediately above for an 18MP full-frame digital sensor maxing out at f/14.5 for slightly larger 9.6 x 14.4-inch prints. It makes sense, doesn't it? If you tried to make an 11 x 14-inch print from a 35mm negative, you couldn't stop down to f/16 – you would have to open up a little -AND- your DoF would suffer as a result - you couldn't shoot subjects with a normal FL lens where the nears were as close as 11 feet with Infinity also included in the frame.

In other words... 18MP is seriously about as far as a 24x36mm, full frame sensor should be taken if you want to secure subject detail at a moderate print resolution of 5 lp/mm in a 360 ppi, unresampled, uncropped print - the largest that can be made from that many pixels - if, that is, you don't want to be confined to using only the faster f-Numbers on your lenses. We're already having to do that with tiny-sensored, pocket digicams, where shooting wide open is the only way to take advantage of their extreme pixel densities, where Airy disks at the sensor will be enlarged 50x or more to produce the large prints encouraged by those pixel counts. Which begs the question: If you're not going to make large prints, then why pay for higher pixel counts?

And yet, not only do we now have a 36 MP, full frame sensor, requiring that we forfeit one available stop to avoid diffraction and that we re-compose our scenes to push the Nearest subjects farther away from the camera, Canon and Sony might actually tighten these restrictions further still, by a factor of two, with 80 MP full-frame sensors. Really?

It's easy to imagine that these 80MP DSLRs will be used to produce really large prints – the likes of which are currently produced using MF sensors. I predict that the MAJORITY of photographers who attempt this will NOT confine themselves to using the smaller f-Numbers required to actually exploit the resolution offered by that pixel count! And the MAJORITY of them will never even notice that, once they've applied some USM, they'll have achieved acuity (edge sharpness), but they will not have recorded the subject detail (resolution) that all those pixels could have delivered - using wider apertures.

Sadly, the pro cameras are going the way of the tiny-sensored consumer cameras - increasing potential print size without increasing the sensor size - with photographers simply forgetting the joys of subject detail (resolution) that was routinely available with film – where everyone is content with nothing more than edge-sharpness.

You can see interactive examples, distinguishing acuity and resolution, here:

http://www.cambridgeincolour.com/tutorials/sharpness.htm

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