CLEANING THE SENSOR IN YOUR DIGITAL CAMERA
(and avoiding the need to do so)

Stanley E. Prevost
Rev. Original 2/26/2071

I'm sure that many of us have been bothered by seeing dust spots on our images caused by contamination on the camera sensor. It becomes a major time consumer in postprocessing to remove them. There are other contaminants besides dust spots, such as oil spots, but the procedures for cleaning are about the same and no differentiation will be made in this little paper.

You may ask why you need to clean your sensor, because your camera has automatic built-in sensor cleaning. I would say if the built in cleaning function gives you results that you are satisfied with, then there is no need to go any further. The built-in function helps, but usually it is not completely effective and eventually needs some help. As with most things, sensor dust matters more on larger prints, but if it is bad, even a 4x6 print can look bad. Don't even think about entering a juried exhibit with dust spots on the image.

Here is a good way to assess the cleanliness of your sensor. Go outside on a day with a clear sky, point the lens at the sky, turn the focus ring to a close distance, set the aperture to f/22 or f/32, and take a photo of the sky. Camera motion due to long exposure time will not matter. Now go to your computer and examine that image at 100%. You may not like what you see.

Dust spots usually are not a problem in scenes filled with a lot of detail, such as trees with leaves or any other complex detail. But a sky can be ruined by spots. Or any other area with broad smooth tones. This is well illustrated at http://photosol.com/cleaning/ .

How does dust get onto the sensor, with it being enclosed within the camera housing and behind the shutter curtain? Every time you take a photo, the shutter curtain opens momentarily and exposes the sensor to the mirror box environment. Every time you change the lens, the mirror box is exposed to the outside environment. The mirror box is not a sterile environment; there are mechanical things thrashing about when you push the shutter release button, particularly the reflex mirror and shutter curtains, and any dust or other contamination in the mirror box can be stirred up into the air which can then get onto the sensor.

One technical detail before we go further. When you clean your sensor, you are not actually cleaning the actual sensor. OK, that may sound like nonsense, so I will try to explain. My first two digital SLRs, the Canon 10D and 5D (original) did not have automatic cleaning and dust was horrible. Every sensor is an assembly with many layers. There is the actual sensor with the millions of light sensors and colored microlenses, and on top of that are several layers that are optical filters to reduce ultraviolet and infrared light from reaching the sensor and other layer that serve as the antialiasing filter. On those early cameras, all those layers were bonded together into one rigid stack that we just called the sensor. When you cleaned the sensor, you

were cleaning the top layer of that bonded stack of layers. It was not fragile and there was no worry about damaging it. Then comes the automatic cleaning design. It uses a piezoelectric shaker to shake the whole thing to dislodge dust particles adhering to the surface. Thing is, the entire sensor stack is too massive for the puny shaker to do much with. So the designers separated the top layers from the sensor proper and only shake those layers. That works pretty well but those layers are very very thin, measured in microns, and suspended just above the sensor surface with no support except around their edges. Think about a thin piece of glass about as thick as kitchen plastic wrap stretched across a rectangular frame. That may be a slight exaggeration, but still, it is not something I would want to be poking around on with a cleaning swab. So after graduating from my original 5D to a newer camera with autoclean, and knowing of one guy who broke his top layers costing him $3K, I have never tried to clean a sensor again. But that's not a good solution. Just know that you need to be careful in there, don't mash too hard or poke anything. I have not heard of anyone else breaking a sensor layer.

One more detail of the sensor construction. The shaker assembly with those top layers of the optical stack has a border of sticky stuff intended to capture dust that gets shaken off the sensor surface. When you are cleaning, try not to clean the sticky border. I don't know if some sticky can get smeared onto the optics or not, but I would prefer to not find out that it can.

OK, so you take your sky picture and it freaks you out. Gotta clean it. Don't reach in there with some kind of brush or tissue, or your finger, use something specifically suited for the job. Now you have to find a suitable cleaning system. Here is one that you can look at. It is also instructive to discuss because of poor technique and incomplete instructions:

http://tinyurl.com/jdpogwm

I am not promoting this product and I have never used it. An ad for it just showed up in my email today and inspired me to talk about this subject a little.

At your very first glance at the video, you will likely recoil at the obvious poor technique. There are two cameras on the bench, lenses removed, with the open lens mounts directed upward. Now where do you think that dust in the air will settle? Yep, right down into the mirror box. OK, it is just a demo, but I think they are very remiss in not emphasizing (even mentioning) how to get the best results when using their product. They should point out that they are doing things in a way that expedites their demonstration but does not illustrate proper technique. Or, they could just use proper technique in their demonstration. When the lens is removed, ALWAYS keep the open lens mount directed downward, and for as little time as possible. Don't forget the exposed part of the lens that mounts onto the camera lens mount; if it gets dust on it, it can go right back into the camera when you next mount it to the camera. While cleaning, you might have to violate that rule a bit, but be as careful as you can. If you bend over the camera to see what you are doing with a cleaning swab, think about where dead skin cells flake off and fall to, and where dandruff falls to, etc. If you want to up your game a bit, you can go to your kitchen stove if you have an exhaust vent fan over it, turn on the vent fan to high to create an upward flow of air, and wear a hospital mask and hair cover. Still another bit of technique is

to wear latex gloves, but unless you have dry scaly flaky skin on your hands (which some people do), you probably don't need to do this. Just wash then good. You may be surprised that I have actually done those things. Or you may not be. And don't sneeze.

In the demonstration of use of the air bulb blower (I have the Rocket Blower), the video lady never warns you to be very careful to not touch anything with the tip of the blower nozzle, which is easy to do when you squeeze the blower bulb and the nozzle tip squirms around all over the place. Kudos to her for showing that the lens mount should be directed downward when doing the blower thing, so that any dislodged dust will hopefully fall out. It may take a lot of blowing to stir things up in there enough to have a good chance of getting a good portion of the dust to fall out. Note: Don't use compressed air in a can. She shows using the blower with the mirror up and shutter open so that the sensor is exposed. I prefer to first do it with the mirror down and the shutter closed, so that the dust stirred up in the mirror box doesn't go back into the sensor compartment, then to do it again with mirror up and shutter open to blow out the sensor compartment. Don't sweep one room with the door to the next room open.

The video doesn't say anything about the width of the swabs relative to the sensor width. If it is wide enough to clean a full-frame sensor in one swipe in each direction, then on a crop sensor it will overlap the sticky border. If it is just wide enough for the non-sticky area on the crop sensor, it won't cover the whole full-frame sensor area, and two swabs may needed. You will just have to look into this topic for whatever sensor cleaning product you decide on. Some vendors offer two sizes; get the one appropriate for your camera. If you have two cameras with different sensor sizes, get two sizes of swabs.

Some camera stores offer a sensor cleaning service. You might ask them if they assume responsibility for damage. (Yeah, try that with your surgeon.) Your camera manufacturer may offer sensor cleaning ($$). Ask them the same question. No matter who does it, when you get it back, shoot the sky again. You may find your sensor filter layers all smeared up and they will have to do it again until it is clean. You can perform a quick check by shooting the sky or something uniform and white out of focus with high f-number and with long exposure time (1 sec or longer) and deliberate camera motion to blur out any spots on the reference surface, and use magnified viewing on playback of the image on the camera rear LCD, moving the magnified view around over the full image. Another way to get rid of dust is to buy a new camera.

Some cameras or postprocessing software may offer a dust map feature, in which you shoot a frame in a specified way and the camera or external software will then edit out the dust spots on subsequent images based on the dust map. I have never tried using that feature, but if it works well and does not damage an image, it could be very useful to extend the time between sensor cleanings. You could update the dust map occasionally but eventually you will need to clean.

The best way to clean a sensor is to not need to do it, or to rarely need to do it. For that to be an effective strategy, you have to employ effective dust avoidance techniques in use of your cameras and lenses.

1. When transporting you camera in a dusty environment, try to carry it in a closed camera bag, plastic bag, or inside your coat or jacket. Same for lenses.
2. Be dust-aware when changing lenses, minimizing the time the camera is open and the mounting end of the lens is uncovered. An assistant can help facilitate lens changes and reduce the chance of dropping a lens. Keep the lens mount pointing down. If the lens change will be slow, put the cap on the lens mount.
3. If airborne dust is visible, just don't change lenses.
4. If you know you will be in a dusty environment, and are not sure that a single lens will meet your needs, if you can, carry two cameras, with lenses on each that together will cover the needs without any lens changes. I have been in some places where you go in knowing that you just will not change lenses. One example is Upper Antelope Canyon, a slot canyon near Page, AZ. The Navaho guides throw sand and dust into the air to highlight the sunbeams coming through the cracks in the roof of the slot canyon. I have also encountered dust storms, or just high winds blowing dust around.

The precautions that apply to changing lenses in a dusty environment can also apply to a rainy, misty or drizzly environment.

The product advertised in the video has a magnifying scope to allow you to examine the sensor. Maybe that is useful, but I suspect it is an expensive and unnecessary accessory. If there is a problem, the sky test will reveal it. If you see dust, you will need to clean the sensor, and knowing where a spot is doesn't change how you do the cleaning. Besides, the image is upside down and reversed from the sensor, so it can be confusing to relate a spot on the image to its location on the sensor.

The sensor cleaning product I have and used on my early cameras has a liquid called Eclipse (which I think is methanol based, maybe all methanol) and supposedly is all that Nikon approves for their shops to use. It has some cleaning pads they call Pec Pads that you wrap around the end of a small spatula kind of thing. Photographic Solutions says the Pec Pads are no good for sensors but OK for lenses and mirrors. The 'net is filled with information and advertisements, but as usual it is of widely varying quality and you have to sort it all out. Much of it is contradictory.

There are wet methods and dry methods for cleaning, and some vendors say you need both: dry for more frequent brushing off of dry, easy to remove dust, and wet for removal of persistent "welded on" spots or oil spots. There are motorized brushes, sticky gel pads, and about everything you can imagine. I think I favor the Photographic Solutions system as a reasonable way to go, and I will buy one and resume (careful) sensor cleaning. One thing: they offer a guarantee of no damage to the sensor filter layers using their system. However, that only applies to chemical damage to the coatings on the filter layers. They don't guarantee no breakage or no scratching.