HOW TO TAKE BETTER PHOTOGRAPHS

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If you have questions, I want to help. Contact me at wg@waynegeneral.com or 602 397 6007

I do not sell any photographic equipment. Over the past four decades, I have taken approximately 100,000 photographs using large format, medium format, 35mm and digital cameras. (See below for specific sizes.) I have taken six fine art photography courses using large format cameras. Many of the techniques discussed are applicable to film cameras of any format, and can be useful for digital users as well.

Which is more important, the quality of the camera or the skill of the photographer? While most people would agree that both are important, which one of the two is more important?

Even with point and shoot (P. and S.) or cell phone (C. P.) cameras, you can improve your skills. With more sophisticated cameras, you can become even more creative, because you can adjust shutter speed, aperture area (which is based on F-stops, based on the square root of 2 and reflects the area of the aperture relative to the focal length of the lens) and use a variety of filters which simply do not fit onto compact cameras, or P. and S. cameras.

KEYS TO SUCCESSFUL PHOTOGRAPHS

1. Always use a tripod and a shutter release cable or remote release. This slows you down and makes you think about what you are going to do. Vibration reduction (VR) lenses are now common and IBIS (In Body Image Stabilization) is common among mirrorless cameras. These vibration reduction technologies have somewhat obviated the need for tripods and shutter release cables.

2. Use slow, fine-grained film or lower ISOs (50 or 80 or 100) on your digital camera, hence you will have longer shutter times. In the past, this necessitated the use of the tripod and cable release, but now the VR lenses and IBIS (In Body Image Stabilization) can ameliorate these difficulties.

3. Use a small aperture, between F-11 and F-22 for landscape photographs. Smaller than 22 (e.g. 32) can cause diffraction, a source of graininess. The small aperture (F-22 will provide for greater depth of field. (More on this later.) Some P. & S. cameras have a minimum aperture of F-8, due to the smaller size of the sensor. Thus, diffraction may occur at F-8, instead of F-22.

4. Use appropriate filters as necessary: Polarizing, graduated neutral density, skylight and warming filters. These are explained below. Digital sensors do not benefit from skylight or UV filters. Digital sensors do benefit from polarizing and graduated neutral density and neutral density filters.

5. If you are using film cameras, use lenses that are less than 35 years old. Almost anything made now is better than almost anything made before 1990 (given the same price category). This is due to improvements in glass technology and composition, as well as computerized designs. Once you decide on a camera budget, get the best lens you can afford. Thus, the lens is more important than the sensor.

6. Use lenses that have ED (extra low dispersion) glass (or equivalent) and are APO (apochromatic) corrected. (These terms are explained below. This is highly technical stuff for the techies, it is not necessary to know this when simply enjoying picture-taking. You can now skip to #7. on page 4.)

   Chromatic aberration is a phenomenon in which light rays passing through a lens focus at different points, depending on their wavelength. There are two types of chromatic aberration: axial chromatic aberration and lateral chromatic aberration.

   Axial chromatic aberration is a variation in the length of each wavelength of light and lateral chromatic aberration is a variation in the magnification of the different colors of light; becoming more visible at the image periphery. Axial chromatic aberration results in blurred colors in front of and behind the focus position due to the differences in each color's focal point. It can be noticeable at the peripheries of extremely bright portions of an image. Lateral chromatic aberration is the cause of color fringing. It is only seen at the edges of an image.

   Lateral chromatic aberration is reduced to some degree by combining different lens elements with different refractive indices, but optically speaking, it cannot be completely eliminated. In addition to red and its complimentary color cyan, and blue and its complimentary color yellow, some lenses may exhibit complex color fringing that combines these two primary types. It is greatly reduced by low-dispersion ED glass.

   Because chromatic aberration is more often seen in images that are shot with wide apertures, using smaller F-stops is one way that one can try to keep images free from chromatic aberration. Another instance where chromatic aberration is seen is when photographing astrophotography with certain lenses such as the 58mm and focusing on an object not in the center of the frame.

   Software editing programs also have a chromatic aberration correction option.

   Chromatic aberrations are wavelength-dependent artifacts that occur because the refractive index of every optical glass formulation varies with wavelength. When white light passes through a simple or complex lens system, the component wavelengths are refracted (bent) according to their frequency. In most glasses, the refractive index is greater for shorter (blue) wavelengths and changes at a more rapid rate as the wavelength is decreased.

   Blue light is refracted to the greatest extent followed by green and red light, a phenomenon commonly referred to as dispersion. The inability of a lens to bring all of the colors into a common focus results in a slightly different image size and focal point for each predominant wavelength group. This leads to colored fringes surrounding the image. When the focus is set for the middle of the wavelength band, the image has a green case with a halo of purple (composed of a mixture of red and blue) surrounding it.

   An achromatic lens or achromat is a lens that is designed to limit the effects of chromatic and spherical aberration. Achromatic lenses are corrected to bring two wavelengths (typically red and blue) into focus on the same plane. Wavelengths in between these two then have better focus error than could be obtained with a simple lens.

The most common type of achromat is the achromatic doublet, which is composed of two individual lenses made from glasses with different amounts of dispersion. Typically, one element is a negative (concave) element made out of flint glass such as Fx, which is has relatively high dispersion, and the other is a positive (convex) element made of crown glass such as BK_7 which has lower dispersion. The lens elements are mounted next to each other, often cemented together, and shaped so that the chromatic aberration of one is counterbalanced by that of the other.

In the most common type, the positive power of the crown lens element is not quite equalled by the negative power of the flint lens element. Together they form a weak positive lens that will bring two different wavelengths of light to a common focus. Negative doublets, in which the negative-power elements predominates, are also made.

An apochromat or apochromatic lens (apo) is a photographic or other lens that has better correction of chromatic and spherical aberration than the much more common achromat lenses.

Chromatic aberration is the phenomenon of different colors focusing at different distances from a lens. In photography, chromatic aberration produces soft overall images and color fringing at high-contrast edges, like an edge between black and white. Astronomers face similar problems, particularly with telescopes that use lenses rather than mirrors. Achromatic lenses are corrected to bring two wavelengths into focus in the same plane—typically red (-0.590 um) and blue (-0.495 um). Apochromatic lenses are designed to bring three colors into focus on the same plane—typically red (-0.620 um), green (0.530 um) and blue (-0.465 um. The residual color error (secondary spectrum) can be up to an order of magnitude less than for an apochromatic lens of equivalent aperture and focal length. Apochromats are also corrected for spherical aberration at two wavelengths, rather than one as in an achromat.

Low dispersion glass (LD glass) is a type of glass with a reduction in chromatic aberration (less rainbow effect). Crown glass is an example of a relatively inexpensive low-dispersion glass.

Special low dispersion glass (SLD glass) and extraordinary low-dispersion glass (ELD glass) are glasses with yet lower dispersion (and yet higher price). Other glasses in this class are extra-low-dispersion glass (ED glass), and ultra-low dispersion glass (UL glass).

Low-dispersion glasses are particularly used to reduce chromatic aberration, most often used in achromatic doublets. The positive element is made of a low-dispersion glass, the negative element from a high-dispersion glass. To counteract the effect of the negative lens, the positive lens has to be thicker. Achromatic doublets therefore have higher thickness and weight than the equivalent non-chromatic-corrected single lenses.

In comparison to telephoto lenses, shorter focal length objectives benefit less from low-dispersion elements, as their chief problem is spherical aberration instead of chromatic aberration. The spherical aberration introduced by the LD elements can be corrected with aspheric lens elements. The increased sharpness provided by SLD elements allows using lower F-numbers and therefore faster shutter speed. This is critical, e.g. in sports photography and wildlife photography. The shallow depth of field provided by a telephoto lens also allows the subject of the photography to stand out better against the background. (End of techie section #1.)

7. Take notes of your exposures, meter readings, whether or not you bracketed, the F-stop, shutter speed, lens type, film type ISO number and whether any filtration was used. By keeping track of your images, you will learn what works and what does not. Many digital cameras provide this information for you with each image taken, so you would not have to take hand-written notes.

8. Remember the Rule of Thirds and the Dynamic Diagonal. (These terms are explained below.)

9. Maneuver your position to have something close to you, something in the middle and something far away in nature or landscape photographs. Move in closer to make your main point of interest have impact and stand out from the background. You can't always accomplish this with a zoom lens alone.

10. Control the light through fill-in flash, slow-sync and graduated neutral density filter. (These terms are explained below.)

11. Shoot at the stillness of dawn, the equivalent of "alpenglow" which occurs after sunset.

12. Be aware of shadows and textures to add interest to your image.

13. Use backlighting and become familiar with the use of reflectors and diffusers during morning or afternoon hours. (These terms are explained below.)

14. Watch out for "hot spots", such as sun-lit white areas surrounded by darker colors. Either the darks will be insufficiently exposed and you lose details on the bright spot, or the bright spot will overly exposed and you lose details in the dark spots.

15. Make your main point of interest stand out from the background and from the sides of the image.

16. Be aware of lines and curves within your image. "S" and "C" curves are pleasing to the eye and imply serenity. Vertical lines show power and are dignified; converging lines give depth; diagonal lines imply movement and speed.

17. Avoid the "Bull's eye syndrome". Don't always place the principal subject right in the center of your image.

18 Think of odd numbers, they are easier to place randomly, e.g. flowers, rocks, especially think of three's. Keeping it simple, but think in terms of "threes" as a total of subjects, otherwise, what are you trying to say in your picture? E.G. "I took this picture because there was a whole lot of flowers in it."

19. If you have not used your camera in years, remember that glass is a liquid and it will be distorted by gravity over a period of decades. Therefore, move your camera and all lenses, turn them upside down, sideways etc. at least once every year to prevent this from occurring.

Even with Point and Shoot (P. and S.) cameras and cell phone cameras, you can improve your skills. With more sophisticated cameras you can become even more creative because you can adjust shutter speed and aperture and I.S.O. This is the exposure triangle.

The aperture is measured by F-stops, which derive their numbers based on the square root of 2. The F-stop reflects the area of the aperture relative to the focal length of the lens. Lower numbers yield a shallower depth of field and high numbers yield a greater depth of field, irrespective of the type of lens. With more sophisticated cameras, you can use a variety of filters which simply do not fit onto compact cameras, or P. & S. or C. P. cameras.

<u>Digital Cameras</u> use one of three formats:

<u>CCD</u> (charge coupled device) same as scanners and photocopiers (read 1 line at a time)

<u>CMOS</u> (complimentary metal oxide semiconductor) same as digital movie cameras (each pixel is read separately and is used for exposure and focusing)

<u>Triple Well</u> (‘Foveon’ chips from the ‘Sigma’ company. Each pixel sees all 3 colors independently.)

All three types of chips use a mosaic array of light sensitive cells.

In a 20 MP camera, approximately 20,000,000 cells are reacting to light and approximately 20,000,000 cells are “<u>interloping</u>” or “<u>guessing</u>” as to what should be between the two cells that are reacting to reflected light. Sometimes these interloping cells guess correctly and sometimes not, depending on the mathematical formulas built into the camera by the manufacturer. These formulae are known as “Fourier transformations” and MTF, modulation transfer functions.

One factor in resolution is the sensor’s AA (anti-aliasing) filter, or OLPF (optical low-pass filter). Most cameras do <u>not</u> have this filter in front of their sensor.

The AA or OLPF minimizes the <u>moire</u> and artifacts that occur when patterns in the scene conflict with the sensor’s pixel grid and are made worse by the fact that conventional Bayer-array sensors record just one primary color at each pixel site. The AA filter slightly blurs the image at the subpixel level to minimize or eliminate these artifacts. The greater the megapixel count, the less likely you are to encounter subjects that will produce moire. A recent trend has been for manufacturers to eliminate the AA filter because eliminating that blurring filter produces sharper images. The AA filter is a constant, it is built into the camera and is not something that can be turned on or off.

An example of moire is a tweed jacket photographed at a distance of 10 feet. The small pattern of weave is smaller than the array of pixels that are capable of capturing and recreating that pattern accurately. Thus, you have moire.

A solid color blue shirt will look like a field of blue on a sensor, but with a telephoto lens, you can see the weave of the shirt. You can see this weave with a macro lens at very close range. But at a distance of ten feet, the blue shirt will look like a blotch of blue. Now, if there were a very small <u>pattern</u> on that blue shirt, the pattern may be too small for the digital array on the sensor, thus causing moire in the viewfinder.

Many digital mosaics may have a smaller area than that of 35mm film. Film is 24 mm by 36 mm, and some ‘full frame’ digital cameras have equal size sensors. These are typically known as FX or ‘full frame’ cameras and lenses. DX cameras have digital mosaics which are 1.3 to 1.7 times smaller than that. Some are even smaller. This allows a 35 mm film camera or FX camera’s lens to be 1.3 to 1.7 times more powerful, or magnified. This means that a 100 mm lens on a 35mm or FX camera will be 130 mm to 170 mm on a DX digital camera. The telephoto lens becomes a more powerful telephoto lens.

Unfortunately, this means that the wide angle lens also becomes ‘less wide’ by also becoming somewhat more ‘telephoto’. Some DSLRs now have “full frame” sensors, the same as 35 mm cameras. In these cameras, the lens functions the same as on a film camera. (Nikon D780, D800, D810, D850, Z7ii, Z8 and Z9 and Canon and Sony have equivalent sensor sizes.) Some medium format sensors are even larger, see below.

Digital images are stored in files, RAW (unprocessed), TIFF (Tagged Image File Format) or JPEG (Joint Photographic Experts Group).

Think of the red and white stripes on the American flag. While all of the light-sensitive cells are going to be responding correctly to either red or white, invariably, some of the interlopers are going to land on that portion of the flag which has both red and white. Depending on the accuracy of the mathematical formula used and the characteristics of the camera, the quality of the picture rendered will be based on the digital camera’s ability to guess at what belongs in your picture, red or white at each specific pixel. This would account for an uneven line. You may not see this on a four by six photo, but enlarge it to 8 by 10 or larger, and it will become apparent. This is the source of ‘pixelation’.

The sensor mosaic is flat, but the interloping cells are not level with the light-sensitive cells. They are raised higher in a stepwise fashion such as the parapets on European castles.

Interloping cells block peripheral light and angles.

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Light sensitive cells receive mostly straight-on light. Think of them as buckets collecting light.

This is what accounts for the fact that upon enlargement to 8 by 10 or larger, the image appears to be flat, based on the fact that the light-sensitive cells are level to each other.

(What follows is a technological comparison of film and digital capabilities. This may be only interesting to techies.)

Film, while appearing to be flat, is actually thick, and there are a few layers of light-sensitive silver halides, not just one layer. This accounts for the fact that upon enlargement to 8 by 10 or larger, the image appears to have depth. In fact, the 24mm by 36mm image on film contains approximately 87 megapixels! This also accounts for the sharper image rendered by low ISO film over low megapixel digital cameras.

When most people compare film to digital, they aren't comparing film to digital. They are usually only comparing scans of film to digital. Thus, the quality and resolution capabilities of the film is reduced and limited by the ability of the computerized scanner. (Drum scanners are best for reproducing film photographs.)

How many pixels does it take to describe all the detail we can get from film? Fuji Velvia is rated to resolve 160 lines per millimeter, at which point its MTF (modulation transfer function) is near zero. Each line will require one light and one dark pixel, or two pixels. Thus, it will take about 320 pixels per millimeter to represent what is on Velvia 50.

320 pixels times 320 pixels is 0.1 megapixel per square millimeter.

35 millimeter film is 24 by 36 millimeters, or 864 square millimeters.

To scan most of the detail on a 35 mm photo, you will need about 864 times 0.1 or 87 megapixels.

But each film pixel represents true Red, Green and Blue data, not the softer 'Bayer-interpolated data from digital camera sensors. A single-chip 87 MP digital camera still couldn't see details as fine as a piece of 35 mm low speed film.

Since the 'lie factor' from digital cameras is about two, (remember the interlopers) you would need a digital camera of about 87 times 2 = 175 MP to see every last detail that makes onto film.

That is for 35 millimeter film. At the same rates, a 6 cm by 6 cm (2¼" square) would be 313 MP. 4" by 5" (95 by 120 mm) would be 11,400 square millimeters = 1,140 MP, with no Bayer interpolation. A digital camera with Bayer Interpolation would need to be rated at better than 2 gigapixels to see things that can be seen on a sheet of 4" by 5" film.

Color film has the following layers, from light sensitive top to shiny bottom.

Scratch resistant coating
Blue-sensitive emulsion layer
Yellow filter
Green-sensitive emulsion layer
Magenta interlayer
Red-sensitive emulsion layer
Celluloid
Anti-curl and halation layer

It may be this depth in the film/picture which results in apparent depth upon enlargements.

(<u>End of techie section number 2</u>.)

If you are not interested in film, skip this section. This is techie section number 3.

Film speeds: Speed Kills (sorry wrong metaphor)

There are three classifications for film speed, they are:

ASA (American Standards Association) This one is still commonly but not officially used.)
ISO (International Standards Organization) This is the larger number you find on film and on digital cameras.
DIN (Deutsche Industrie Normen) This is the smaller number you find on film.

ISO speeds are the same as ASA speeds, e.g. 25 to 3200 etc.
The higher number reflects a faster film speed or more light sensitive sensor.

(End of techie section number 3.)

Irrespective of whether using film or digital, ISO speeds are important to know.

Pros and Cons of faster and slower ISOs:

With faster ISOs, (3200, 1600, 1000, 800) you can use a quick shutter speed to stop action (1/500th of a second, 1,000th of a second, etc.), and/or use smaller apertures (high number apertures such as F-16, F-22, F-32, F-45, F-64 and F-96) to increase the depth of field. You can use this type of ISO and shoot the camera handheld and in low light or to take action shots. (Beware of diffraction with numbers higher than F-22.) Some cameras allow the ISO to reach 208,000 for supersensitivity for dim light in astronomical photographs. These ultra-high ISO numbers increase graininess which can be removed to some extent in post-processing.

But the image will appear to be grainy upon enlargement, with F-numbers higher than F-22. This graininess is noticeable on 5" by 7" and larger enlargements. (This is because the silver halide particles on the film, which are affected by light, are larger, and turn dark more quickly. These larger halide particles (as opposed to smaller halide particles) is the cause of graininess.) Digital cameras are equally as vulnerable to diffraction/graininess at higher F-stop numbers as film.

With slower ISOs, (25, 50, 100) the silver halide particles on the film are much smaller or finer and it takes longer to expose them all to light. With these ISOs, you must use a longer shutter speed (and should use a tripod) or a larger aperture (larger F-stop) such as F-1.2, F-1.4, F-1.8, F-2.0, F-2.8, F-4.0 or F-5.6). But with larger apertures, you lose depth of field. There is always a compromise.

Example, baseballs and golf balls in a pail. It takes fewer baseballs to fill a pail and therefore less time is required to do it, but the spaces between baseballs is bigger than between golf balls.

Therefore, slow ISOs yield better resolution upon enlargements, as small as 4 by 6 inches.

Consumer vs. Professional Films. Is it worth the difference in price?

Velvia transparency film costs $15.00 for 24 exposures
Portra 400 UC print film costs $15.00 for 24 exposures
Max 800 print film costs $4.49 for 24 exposures

Professional film is manufactured to closer tolerances, is kept refrigerated in the store and is more consistent from batch to batch. I have used these films which have been kept refrigerated, up to eight years after they were purchased with no loss of quality. (Do NOT freeze film, just refrigerate it. The freezing and thawing of self-defrosting refrigerators and freezers harms the film.)

Consumer film is designed to retain its emulsion for a shorter period of time and perhaps spend months in the camera after exposure, before being developed. It is not kept refrigerated at 'Wal-Mart' or most other stores. You sacrifice some resolution accuracy with these films.

All films are getting better. While improvements in film technology have always been made, they are more frequent since the advent of digital photography. Film is now better, in terms of resolution upon enlargement, less grainy (unless you want it to be), and faster. In short, it is more convenient at all levels, than previously. The competition of digital photography has actually improved film photography.

* It is generally recommended that compact film cameras or P. & S. cameras use ISO 400 film because of its versatility, especially with zoom lenses that change aperture, to something smaller, as the telescoping mechanism extends. Variable lenses are thus tricky, but are designed to provide some magnification, at a reasonable price-point and are lightweight. What is a good film? This is like asking someone to pick out a couch for you. You have to decide what characteristics you find desirable. Your decision is based on your experiences.

The same ISO number (400) can be used as a standard setting for the vast majority of digital P. & S. and C. P. cameras. I am accustomed to using ISO 50 somewhat out of a force of habit, but also knowing what a 50 speed would be able to do, detail-wise as well as the far limits of the flash attachment (if one is used).

A good film is one you like the results of; one that is easily available and you can easily afford. If you want to make enlargements, get the slowest transparency available.

ISO=ASA: higher numbers in film caused graininess, sometimes a desired characteristic, but at a loss of clarity. Higher ISO numbers on digital sensors are not as vulnerable to graininess. Whereas the some of the highest ISO films were in the range of ISO 3200, many digital, sensors can reach many times that, some reaching ISOs of 104,000 and 208,000, to enable astrophotography more possible. For routine photography, indoor shots of people for example, one can easily use ISO 800 to 1600 without any loss of resolution and some higher speeds are possible, depending on the quality of the sensor.

Pixel size: Larger pixels on the sensor are more sensitive to light and will produce less noise than the same number of pixels on a smaller sensor. For example, each of the 24 million pixels on a FX sensor will be larger than each of the 24 million pixels on a DX sensor. This is because they catch more light because they are larger, more sensitive, and therefore will produce less noise.

Transparency (slide) film vs. Print (reversal) film.

Transparencies are very exact, demanding, unforgiving and allow no latitude for error. They have a brightness range of 4½ F-stops. (This is the same as most digital cameras.) The images are more precise and are required for magazines such as 'Arizona Highways', 'National Geographic', fashion magazines, etc. Because of the exactitude required of this type of film, it is always a good idea to bracket the exposures. That is, take three pictures of the same scene, the first one at what the light meter indicates, the second one at ½ an F-stop below that and the third at ½ F-stop above that. One of the three exposures will be the best, assuming your light meter is accurate. (Some cameras have an auto-bracketing feature).
Print film allows much more latitude for exposure error. You can be off by 1 to 2 F-stops above or below the ideal exposure and still have very respectable results. Therefore, this type of film is more popular with most consumers.
***(This is the end of the film discussion.)

Apertures or F-stops

High numbered F-stops, (such as 11, 16, 22, 32, 45, 64 and 96) are smaller apertures and allow a smaller amount of light to enter the lens and therefore land on the film or sensor.
But these smaller apertures *increase* the depth of field. Six feet to infinity would be in focus. For example, all flowers in a field would be in focus.

Hih numbered F-stops, which are smaller apertures, require longer exposures of 1/15th of a second, 1/8th of a second, 1/4th of a second, ½ of a second or 1 second up to several minutes in length. This would be appropriate for a night shot of a city skyline. This requires support; a tripod is best, but others will do, bean bag, rumpled clothes, car hood, etc.

Low numbered F-stops, (such as 8, 5.6, 4, 2.8, 2.0, 1.8, 1.4,1.2, 1.0, 0.95) are larger apertures and allow a larger amount of light to enter the lens and therefore land on the film or sensor. But these larger apertures *decrease* the depth of field. For example, the one particular flower you chose to focus on would be in focus, and the others would be out of focus, thus highlighting your chosen flower. The out of focus flowers create what is known as '*bokeh'*.

Larger apertures are great for selective focusing, as in isolating one flower out of a field of flowers. Only the one flower that you chose would be in focus. The rest will be lost in the *bokeh*. It is widely held the more blades in the lens, the smoother the 'bokeh' on the image.

Exposure triangle: aperture, ISO and shutter speed are the three factors of the triangle and all three have to be in balance in order to obtain a well-exposed photograph. An increase in one factor requires an equal decrease in another factor.

How long can I hand hold a camera without noticeable shaking, vibration or blurring?

It depends on whether you just completed a double espresso or not.

The standard answer is:
1 divided by the lens length, also known as the reciprocal of the lens length.

Examples:

28 mm lens = 1/30th of a second (there is no 1/28th shutter speed on film cameras.)
50 mm lens = 1/60th second (there is no 1/50th shutter speed on film cameras.)
300 mm lens = 1/250th or 1/500th second (There is no 1/300th shutter speed on film cameras.)
500 mm lens = 1/500th second

Digital cameras usually have the ability to expose the sensor for ANY length of time, even something as esoteric as 1/247th of a second, as an example.

Many longer lenses can be obtained with and without vibration reduction (VR) allowing one to hand hold the camera for three to five times longer than the times listed above. VR lenses are more expensive, but may obviate the need for a tripod. So, the expense may be worth the result.

Mirrorless cameras have IBIS, (in body image stabilization) which accomplishes the same thing as VR, but would apply to all lenses used on the camera, not only the lenses with VR.

Tripods:

Carbon fiber: very lightweight, very strong and very $$$.
Should you get 3 or 4 leg sections? Three is quicker to set up and stronger; four is easier to pack in a suitcase.
Basalt: very light and strong with good vibration reduction, made at 2700° F.
Wood: absorbs shocks well, is strong and is not too hot to handle in the Arizona summer sun.
Aluminum: silver, black or green. Less expensive, slightly heavier and comes in 3 or 4 leg sections.

Travel tripods, table models and monopods.

* Get a tripod that is able to go flat, with its legs stretched out along the ground, so you can take pictures of flowers while close to the ground.
* Get a tripod that is as tall as you are without using the center pole, because you will not use the pole.

A tripod with a center pole extending at the top of it is not a sufficient support, especially in wind, on with long exposures or with telephoto lenses, especially on vertical shots.

* Get a tripod that is strong enough to support your camera with a telephoto lens on it, to prevent "nose-diving." (Use an Arca-Swiss type locking mechanism to prevent nose diving, because a heavy telephoto lens can cause the camera to point slightly downward.)

If your camera has a mirror and mirror lock-up, use mirror lock-up to reduce vibration on vertical shots. If your camera is mirrorless, skip this notion.

<u>Tripods need heads</u>. A head is a device which attaches the camera to the tripod.

* "Ball and Socket" head vs. "Pan and Tilt" head.

  Ball and socket heads are quicker to allow adjustments of panning left to right and up/down simultaneously. Just loosen the bolt and adjust.

  Pan and tilt heads are slower but can be more precise as you adjust left to right and up/down separately.

  One is not better than the other; it is a matter of personal choice.

* Get the quick-release mechanism for your head, for quick removal of your camera. (Arca-Swiss type locking mechanisms prevent nose-diving.)
  Use a leveling device to ensure that you are perfectly horizontal or vertical. (Some tripods/heads have this built into them). Mirrorless cameras have this leveling device in their EVF or live view screens.

  Tripods are more vulnerable to vibration on vertical shots than horizontal shots due to the mirror vibration traveling from side to side. The mirror travels up and down on a horizontal shot and does not produce this type of vibration. All the more reason to get a <u>*strong*</u> tripod. If you have a <u>*mirrorless*</u> camera, this information is superfluous.

* You should use a <u>shutter release cable</u>, (or remote shutter release) so as to avoid touching the camera when taking either a <u>long exposure shot or</u> a <u>telephoto shot</u>. Touching the camera could cause vibration which would destroy the picture. If you do not have a shutter release cable, <u>use the self-timing mechanism</u> on your camera. There are also remote control devices which allows one to release the shutter from a considerable distance, to stay out of harms way, such as avoiding wild animals, from a hunter's blind, or from a safe location such as a vehicle.

<u>***Q and A***</u>

<u>How can I support my camera if I don't have a tripod</u>?

* Standing: <u>Hold the camera with both hands</u>. Horizontal shots, keep the camera against the face, elbows close to the body, lean up against something solid (wall, tree, fence).
  Vertical shots, keep the camera against the face, arms against torso if possible. If you are using the flash mechanism or use an external flash, have the flash above the lens not beneath it and use left hand to support the camera. A flash placed beneath the lens will cause horrible flashes above the head of the individuals you are photographing.

* Sitting: lean up against an object if possible. If not, place your elbows onto your knees wide apart.

* Lie on your tummy, elbows on the ground, camera supported on a rock.

* Let about ½ of a breath out, then take the picture.

* Always squeeze the shutter gently. Hard or sudden presses may cause vibration and thus blur the photo.

* Many lenses and some cameras have built-in vibration reduction or image stabilization which helps.

When is the best time to take nature photographs?

- The conventional answer is before 10:00 AM and after 4:00 PM.

Why?

Because the sun is lower in the sky, is more directional and therefore allows for more shadows which provide a greater sense of depth in the scene. The lower sun also has to penetrate more atmosphere, more dust particles and this provides a warmer and more diffuse light than at high noon.

Winter is good for this reason. You can take pictures at all times, but overhead sunlight will yield very flat pictures. Winter pictures are less affected by the sun being at a lower angle and is good for details such as in hieroglyphics, carvings and sculptured details.

When taking a nature photograph, is it desirable to have something of interest in the entire frame?

* For example, find a location where you can place a mountain in the background, some trees in the middle-ground and some flowers in the foreground and so forth.

* Also, use a wide-angle lens, such as 28mm, 24mm, 20mm or wider.
Focus on the closest subject that you want in focus and use an F-stop of 16 or 22.

What about cloudy, gray or overcast days?

This is often the best light, it is called *soft* light, diffused all-around every object, flowers, people. There will be almost no shadows. They would detract from the details of your picture.

How can I take good pictures of animals?

* Use a fast film (ISO of 800 for example) or an equivalent ISO on a digital camera and a fast shutter speed, such as 1/250th or faster. (Unless you are photographing tortoises.)

* For distant animals such as in the zoo or further away as in a national park, you will need approximately a 200 mm to 300 mm lens (on a 35mm camera).(If this is your special hobby, you may wish to obtain a 150-600 mm lens or 800 mm lens.)

  50 mm is considered to be the equivalent of what our eyes see. Therefore, a 100 mm lens on an FX camera would be the equivalent of a two power binocular, not very powerful. A 200 mm lens would be the equivalents of a four power set of opera glasses. So, an 800 mm lens would be the equivalent of a sixteen power binocular. This is very powerful, but alas, very expensive and you need a tripod.

  Try to place the animal at one side of the image, looking inward, toward the center of the scene.
  For smaller animals and birds in flight, you may need to have a 500 mm or 600 mm lens.

<u>The Rule of Thirds</u>.

* Imagine a 'Tic-Tac-Toe' grid on your viewfinder. Most successful photographs will have an important detail at one or more of the intersections of the grid. If every one of your pictures complied with this rule, your collection would be boring. However, *most* successful photographs *do* follow this rule.

The "<u>Sunny-16</u>" <u>Rule</u>. (This is useful when your light-meter battery goes kaput.)

<u>In bright sun</u>, no high, thin clouds; no humidity haze and no pollution; from a few hours after sunrise until a couple of hours before sunset, the correct exposure for the average <u>front-lit subject that</u> is <u>larger than a backpack</u> is a <u>shutter speed closest to the ISO of the film you're using and F-16</u>, <u>or any equivalent value</u>.

For example, suppose you use ISO 100 and expose at F-16 for 125th of a second.
One equivalent of that would be: 1/250th of a second at F-11. (You are doubling the amount of light allowed into the lens by opening the aperture but dividing the shutter speed in half by doubling its speed.) Another equivalent would be 1/500th of a second at F-8. Another equivalent would be 1/1000th of a second at F-5.6. Going in the other direction, another equivalent would be 1/60th of a second at F-22.

<u>Caveats</u>: This is not for early morning or twilight, and not for overcast days.
It is not for midwinter days in North America when the sun is low on the horizon.
The Sunny-16 rule is *<u>not</u>* intended for use in close-ups or macro photography.

<u>Use Dynamic Diagonals</u>.

Often, the subject matter is not simply vertical or horizontal, but diagonal, such as the slope of a mountain, or athletes leaning during a play in the game.

* Diagonals are most effective when the diagonal begins in a corner of the image.

Change Your Position.

* Don't take all pictures standing up. Try sitting down, crouching down, laying on your tummy. Your perspective changes with each position. This adds interest to your collection.

* Don't assume that wherever you are, at the moment, is the best possible place from which to take a picture of that subject. Move around. There are many times when a person did not think about crossing the street to get a picture of something, and as a result included the pavement and curb, which certainly detracted from the photo. Some people do not think about walking around something, to avoid including a fence, or a telephone pole in the picture. Oh, sure, you can change some things while using 'Adobe Photoshop' or 'Light Room' or 'Picassa' in your computer, but it is so easy to do it correctly in the first place. Adobe Photoshop is not intended to fix images, it is designed to optimize the image. If you spent the time and money to get to the 'Taj Mahal,' would you only take one photo of it? Move around.

How to photograph Streams and waterfalls

Water in streams and waterfalls are moving, sometimes very quickly, i.e. the speed of gravity. You could stop the flow of water at 1/500th of a second, but this may not be what you want. You may want the image to show motion, a milky white image of moving water.

* A photo of moving water is sometimes considered more satisfying, and provides movement in the sense of flow, at slower speeds. The water is sometimes referred to as being 'milky'. Experiment with 1/30th to 1/4th second, depending on the amount of flow that you desire. Adjust the F-stop and ISO accordingly to achieve the desired longer shutter speed. If the scene is too bright, you need to use a neutral density to filter to block some of the light.

How to photograph Christmas lights

* Using Velvia (film) and ISO 50, (or a digital camera using the ISO of 50) shoot it at 1" at F 5.6, for starters and adjust accordingly, quicker if windy, slower and smaller F-stops for greater depth of field. Use a tripod and *no* flash. Flash would ruin the ambience. If you don't trust me, try it.

How to photograph car headlight or taillight trails on a busy road

* Try a shutter speed of 20 seconds at F-16 at ISO 100. Experiment and adjust from there. Use a tripod and *no* flash.

How to photograph Aerial fireworks

* Try a shutter speed of 4 seconds at f-5.6 at ISO 100. Experiment and adjust from there. Use a tripod and *no* flash

How to photograph Lightning

Lightning is extremely difficult to capture. Try a shutter speed of 30 to 120 seconds at f-11 at ISO 100. Depends on ambient darkness. City lights would provide considerable ambient light and therefore you could shoot at 30 seconds. In the country, there is less ambient light and therefore you could shoot at up to 120 seconds. Use a tripod and no flash.

There is also a tool known as a ‘lightning trigger’ ($400) which activates the camera as soon as lightning occurs. It is activated within milliseconds of the first burst of light. This attaches to your flash mechanism or ‘hot shoe’.

How to photograph the Moon

For focusing purposes, the moon can be considered an infinite distance from Earth. It is always noon daylight on the lighted side of the moon, so your exposure should be 1/ISO (shutter duration) at F-16 (aperture).

Mirror lock-up and manual focusing are suggested.

Recommended starting exposure at ISO 200, manual settings of 1/200 second at F-16, lens pre-focused as above, do not rely on ‘infinity’ focal setting of lens.

Cable or remote electronic shutter release is advised.

Longer lenses mean you should use a shorter shutter duration (to reduce camera shake) and a little wider aperture.

Shutter duration should be shorter than 1/lens’ focal length. That means for example 1/500th second for a 400 mm lens.

When using a tripod, turn OFF your IS (image stabilization) or VR (vibration reduction). This is because the VR mechanism in the lens is searching for vibration and is thus causing its own vibration thus defeating the purpose of a VR lens.

A prime lens will always be sharper than a zoom lens. The longer your lens, the bigger the moon and the less cropping required to enlarge the image.

How to take a photograph of something on TV

* Use a warming filter to counter the blue color temperature of televisions. Set the screen to ensure that color, contrast and brightness are not too extreme. Completely darken the room. Use a tripod, cable release and no flash. Shutter speed at 1/8th of a second or longer.

Make people disappear! (Without hiring the Mafia)

* Use a neutral density (ND) filter and a long exposure. (Variable ND filters up to 10 F-stops are available through Singh-Ray, B & W, Heliopan, Hoya and Schneider).

* ND filters are gray and are intended to impart no color to the image. By blocking a certain amount of light, it allows a longer exposure to be used. As long as people are walking around in the image and not standing in the same place, they will disappear over a few seconds of time. This is a useful technique for shots of monuments, entries into churches and museums etc. where you wish to have no people standing around.
  You need an exposure of 10 to 20 seconds in length, therefore you need a slow ISO and a tripod or other support. VR lenses and IBIS is not sufficient for this.

  ND filters are not the same as GND (graduated neutral density) filters. GND filters are used to balance the light between those areas of the image that are too bright compared to those areas of the image that are quite dark. By reducing the contrast (by one or two F-stops,) the dynamic range of light may be reduced to 4½ F-stops, the range available in digital and film.

People shots

* Avoid the feet. No one cares about the person's shoes or socks, unless you are into shoe fashion (or have a foot fetish.)
* Move in close and take the person's photograph from about the waist up and always focus on the eyes, often thought to be 'the window to the soul'.
  Instead of taking the picture of a friend just in front of a monument, take a picture of your friend, with the monument slightly blurred in the background, but clearly visible.

How and why should I use filters?

There are many different types of filters, ultraviolet (UV); polarizing (collimating the light to enhance colors and reduce glare from glass and other shiny objects such as leaves and water and seeing underwater without glare); star filters (to make a distant point of light become star-shaped in four, six, eight or more directions depending on the type of filter); neutral density filters to reduce the amount of light entering the lens to allow for longer shutter speeds to slow down the flow of water to render a smooth, milky texture; graduated neutral density filters to balance an overly bright and/or overly dark area of the image. These are some of the more common or popular filters.

In purchasing a filter, the best ones (and the most expensive ones) are ‘B. & W.’ and ‘Heliopan’. Both use Schott glass, which is used in making ‘Leica’ lenses and are non-pareil in terms of purity of glass. These are sliced off of a loaf of glass instead of being cut from a sheet of glass. Therefore, these filters are flatter than other manufacturers’ filters. These two filter manufacturers place their glass into brass rings which are much less prone to binding than aluminum rings.

Most filters come in a variety of sizes to fit the front of the lens, from about 39 mm to 135 mm depending on the size of the front lens element. You should get the filter that will fit your largest diameter lens, then buy step down rings to allow that large filter to be used on any smaller lens you have. This is much cheaper than purchasing a filter(s) for each sized lens.

Do you have any pointers on using flash units?

Yes. Use your flash much more often than you probably use it. Most people do not use their flash often enough, assuming the digital camera will be able to adjust for light and dark. Flash makes the color pop, in an array of what would otherwise be ‘muddy’ colors.

Some cameras, both film and digital, have built-in flash mechanisms. These are not very powerful and will only illuminate the environment for about 10 feet from the camera. This may be sufficient for some photography but is only a convenience. The drop off in light intensity is explained by the inverse square law, where 2 times 2 = negative 4. If you double the distance, you divide the light quantity/intensity by four.

If one is choosing to take many flash photographs, it is best to use an external flash unit. These are made by the same company which makes the camera, (OEM) as well as aftermarket flash manufacturers. Usually the OEM units are more expensive and are not interchangeable.

Any flash is a point of light and will therefore cause a shadow behind any object which you are photographing, unless the object is outdoors or there is no background behind it upon which to see a shadow. Think of the sun. Although it is extremely huge in diameter, in the sky it subtends only a very small angle in degrees and can be seen as a small point of light. When you walk on a sidewalk on a sunny day, you can easily see your shadow, which is caused by that very small point of light. However, on a cloudy day, you hardly see any shadow, and this is due to dispersion of light by the clouds.

A flash unit is another point of light, albeit bigger than the one which is built into the camera. But it will still cause shadows unless some techniques are applied.

To get rid of shadows while using an external flash unit, you can use any of the following techniques.

Bounce flash. Flash units are designed to swivel up and down as well as left and right as far as even behind the camera. By pointing the flash head towards the ceiling for example, the flashed light bounces off the ceiling, disperses and lands on all surfaces of the object being photographed without creating shadows. This assumes the ceiling is white and not too high.

You can aim the flash head to the side or even behind you in order to increase the size of the light source. Remember, the larger the source of light, the less likely you will see a shadow.

But, sometimes you can't use the bounce technique, because the ceiling is too high such as in a hotel ballroom with 20 foot high ceilings, or the ceiling is an unusual color such as gold or tan or powder blue and this will alter the image of your object. Sometimes there is no ceiling.

In these instances, you can disperse the light by using a white tissue or clean handkerchief and place it in front of the flash head. This is not optimal, but it can help somewhat. If you are not going to use the flash unit very much, then this would be the cheapest option.

If you plan to use your flash unit frequently, it would be beneficial to invest in a mounted flash disperser. I use one all the time. It is a 'Mag Mod'. (The various models of dispersers are magnetically attached to the front of the flash head, hence the name.)

In taking photographs of people, always have the flash placed <u>above</u> the lens, or you will have unsightly shadows behind their heads. If the wall is many feet behind their heads, there will be no shadow.

<u>Why does my camera make white polar bears look gray and black gorillas look gray</u>?

All light meters, irrespective of cost or manufacturer are standardized to 18% gray. This is because there had to be a standard to which all lenses' apertures can be compared. Think about it, if Canon made a lens to shoot a scene at 2.8 and Nikon made another lens to shoot the same scene at 5.6, the photography world would be chaotic. Where would Olympus, Lumix, Sony, Leica fall on that continuum? There had to be a standard to compare all lenses, and that standard is the 18% reflectance gray card, initially formulated by 'Kodak'.

Because all light meters in all cameras and all hand held light meters are manufactured to the same standard, (18%) they will <u>ALL</u> be adversely affected by extremes in reflected light from the object.

In order to keep the polar bear white, you have to <u>overexpose</u> the image by one-and-a-half to two F-stops. (Use a lower number on the aperture ring.) This is because the light meter is averaging the scene to 18% when it should be, let's say, 40%.

In order to keep the gorilla black, you have to <u>underexpose</u> the image by one to one-and-a-half F-stops. (Use a higher number on the aperture ring.) This is because the light meter is averaging the scene to 18% when it should be, lets say, 6%.)

<u>What about batteries</u>?

All new cameras come with a battery. In most cases, these are rechargeable lithium-ion batteries, with the camera company logo on it. It is desirable to have at least one additional battery with you at all times because you never know when the first battery is going to lose sufficient power to allow you to continue on your photoshoot.

The biggest power drain on a battery is turning on the camera, followed by zooming in and out if you have one wide-to-telephoto lens, as this requires a motor to move the lens mechanism and light up the screen. Another big drain on the battery is the use of flash. Other drains on the battery include Wi-Fi and GPS localization tagging (one of my cameras has both of these.) Another drain on the battery is IBIS.

Therefore, there are several reasons to have a second battery with you at all times.

But what kind of battery should I purchase, OEM or aftermarket?

OEM batteries are always going to be more expensive than aftermarket or third party batteries. In most cases there should be only minor differences in longevity (number of re-charges possible) and power (number of shots per charge) between the two batteries. (I have three OEM batteries for my 'Lumix' and numbered them 1,2,3 and use them in sequence whenever possible. They have lasted seven years at this writing, 2025. Each battery has been charged about 50 times and each holds a charge about as good as new, as best as I can recall.)

But here are some considerations. 1. If you spent $1,000 or more on a camera, do you really want to purchase an aftermarket battery to save $20? Be advised, most camera warranties are voided if you use an aftermarket battery which leaks and messes with your camera.

2. Some aftermarket manufacturers of batteries provide their own charger. Can you be sure the aftermarket charger is as efficient and thorough as the original charger and battery? That is, are you really getting a 'full charge'?

3. Some aftermarket batteries have suffered from 'swelling' making them difficult to install and/or remove from the camera.

It is your money and your camera, but I stick with OEM batteries without fail, unless I have an emergency need for a battery.

Reciprocity Failure. (This is highly technical stuff for the techies #4. *but* it is important if you take long *film* exposures.)

F-stops and shutter speeds are related. By increasing the F-stop one number (from 5.6 to 4) the same result would occur by increasing the shutter speed by ½, such as from 1/60th to 1/30th of a second.

However, films are manufactured to be sensitive only to light within a certain brightness range.

If you use a longer shutter speed than the film is designed for, then the reciprocal relationship fails. The result is that, with shutter speeds of a certain length, pictures can be underexposed, and manual compensation must be used.

At which point reciprocity fails depends on the particular film.

With many color print films, no compensation is necessary until you have an exposure of ten seconds or more.

Slide film has less exposure latitude and compensation may even be recommended for exposures that are as short as 1/10th of a second.

Most slide films demand exposure compensation with shutter speeds of 1 second or longer.

As well as additional exposure, filtration is frequently needed, as reciprocity failure affects the different emulsion layers at different rates. (I warned you that this was technical stuff.)

Some tungsten slide films are specially designed to provide accurate metering at slow shutter speeds. With such films, reciprocity failure does not become a problem until the exposure is 60+”.

Research can sometimes be fun. Use a few films, select your favorites and get to know their characteristics, such as reciprocity failure, color rendition, saturation, sharpness and so on to see how you like it and how you can control its characteristics.

(This is the end of techie session #4.)

“My pictures of friends have red eyes, but they have not been drinking. What gives?”

Photographic strobes penetrate the five corneal layers, aqueous humor, lens, vitreous humor and nine retinal layers before hitting the 10th layer, the pigmented epithelial layer, which is red, partially caused by blood vessels. The flashed light bounces off of layer 10. Since, from physics you know that the angle of incidence equals the angle of reflection (pool players know this well), the light that enters the eye, if it is flashed from a flash which is close to the lens of the camera, (possibly 2 degrees of angle) will bounce off the 10th layer and impart a red dot onto the film or sensor. This is not the developer’s fault. It is not caused by eyeglasses.

OK, so now what do I do?

1. You can use a red-eye reduction mechanism in the camera, which sends out a short burst of flashes to reduce the diameter of the pupil, (by stimulating the intraocular sphincter muscles) thereby lessening the chance of the flashed light bouncing off of the 10th retinal layer and back through the eye’s lens and to the camera’s lens and onto the film or sensor.
2. Or, you can move the flash unit further away from the camera’s lens, by using either a hot-shoe mechanism built on top of the camera, or connecting the flash unit to the camera via a PC cord. This increases the angle of incidence and therefore reflection, possibly to 5 degrees or more. This latter method is used by professional wedding photographers all of the time.

Other flash techniques

Fill-in light, lights up facial features.

Silhouettes are nice, but if you expect to see your friend’s face with the bright sunset behind, you’ll get a silhouette unless you use fill-in flash. This is a reduced flash (1/3 to ½ power) to bring out features of the friend without making the background disappear into darkness.

External flash devices can allow you to use as little as $1/64^{th}$ of its full power to provide minimal fill flash when desired.

Slow light-synchronization

When the background is dark, (cityscapes, skylines) and you want your friend in front of it, use slow-sync. This will keep the shutter open longer than for a normal flash (which is usually $1/60^{th}$ to $1/125^{th}$ second) thus allowing more ambient light to enter the lens along with the flashed light. This gives a more balanced photograph.

Painting with light

Built-in flash illuminates only to about 10' because of its small size. It is there as a convenience, not to provide sufficient light under all circumstances.

Big cathedrals are usually fairly dark; even one good flash unit won't illuminate the entire church interior.

So, what do I do?

You have to paint with light.

Leaving the shutter open, with the camera on a tripod and being aware of reciprocity failure (if you are using film), walk around the church (or whatever big interior of the building you are trying to photograph) while aiming the flash unit at areas you wish to illuminate, but always keep the flash pointed away from the lens.

Make sure that you are not between the lens and the flashed areas, or you'll be silhouetted.

This may take a few minutes, depending on the size of the building and recycling time of your flash unit. This in turn depends to some extent on the freshness or charge of your batteries.

Size matters (no comment)

The bigger the size of the film (or digital sensor), the better the resolution.

35mm film and FF camera sensor images are 24 mm by 36 mm or 1" by 1½" for a total area of 864 square mm or 1½ square inches.
You can make this into an 8 by 10 enlargement (80 sq. inches) with a 6X doubling (starting at 1.5, 3, 6, 12, 24, 48 and 96 (which is more than the required 80).

Medium format comes in three flavors: 6 cm by 4.5 cm; 6 cm by 6 cm and 6 cm by 7 cm.
Converting to inches, the area of the 6 by 4.5 = 2.70". To make an 8 by 10 (80 sq. inches) you double the 2.7 to 5.4, 10.8, 21.6, 43.2, 80+. This is a 5X doubling of the original image. The 6 by 4.5 is usually shortened to be called "645."

Medium format digital cameras are not the same size as medium format film cameras for reasons only known by sales and marketing executives.

Large format cameras begin with a 4” by 5” piece of film. There are no large format digital cameras due to the slowness of processing each image and the computerization required and the amount of hard drive memory required to store the image. A 4” by 5” piece of film is 20 sq. inches. Other sizes of large format cameras are 5” by 7”, 8” by 10”, 11” by 14”, 7” by 17” and 12” by 20”. The largest size cameras are usually used only in the studio, not taken out to the field.

To make an 8 by 10 (80 sq. inches) from a 4 by 5 (20 sq. inches) is only a 2X doubling. From 20 to 40 to 80.

Each enlargement causes a diminution of resolution. One source of loss is insufficient silver halide particles on the film emulsion to provide good resolution (accuracy or clarity). This is the reason why digital photographs can not be enlarged to 16 by 20 with equal resolution of film, there is simply an insufficient number of pixels and the interlopers are guessing.

Another source of loss of resolution is the height of the enlarging light/lens unit from the photographic paper. The larger the print, the higher the height of the light/lens unit, the longer the time required and the more chance of diffusion, a source of blurriness.

Another source of loss of resolution is the quality of the enlarging lens, Rodenstock and Schneider lenses are perhaps the best for enlargers, but they are expensive ($900 or more).

Because of earlier limitations in digital cameras, many wedding photographers who had switched from film to digital switched back to film, for the larger enlargements.
As megapixels dropped in price, many wedding photographers have again switched back to digital photography.

It is possible to obtain a FX camera with 24, 36, 45 or even 50 MP which could cost up to $6500 (2024 prices)

Hasselblad offers a medium format (MP) digital camera with up to 50 MP. It is the H5D-50c but at a price of $27,500; X2D-100c costs $8,200 from B & H in New York.
Leica offers a 37.5 MP sensor for $21.950 (2023) and now a 60 MP FX for $6,000.
Mamiya/Phase One offers the IQ250 back at $34,990 for a 50 MP camera back only. This company also sells an 80 MP camera back. (As of 2023, these are no longer available.)
Pentax offers the 645Z at $8,499 for a 51.4 MP camera (not just the digital back). Now it costs $4,000 in 2025.

As you can see, you need deep pockets to get involved with medium format digital photography. But costs are coming down per megapixel. At this writing, there are no large format digital cameras due to currently insufficient image processing speeds for such huge files and storage of such huge files, about 2 GB per image.

With larger numbers of megapixels, there will be some additional time required for in-camera processing of that data. If one is using the camera in a movie mode or firing in rapid sequence such as birds in flight or airplanes at an air show, the computational time will add up and slow down the picture taking process, as the 'buffer' will eventually need to be cleared by giving it a rest. Additionally, when post-processing the images, more computational time and larger memories are required. For most people this won't be a problem, but if you take hundreds of photographs at an air show, you will need considerable memory for your 46 mp images.

My personal collection currently includes:
Arca-Swiss large format 4" X 5" Camera, four Rodenstock lenses from 75 to 360 mm and Nikkormat 600 mm and 800 mm lenses
Mamiya 6 cm X 4.5 cm medium format camera and five lenses from 35 mm to 210 mm
Canon F-1 and several lenses from 17 mm to 300 mm including a shift/tilt lens
Nikon F100 and several lenses from 17 mm to 300 mm
Nikon Z7ii and one Z lens (S) series, 24 mm to 120 mm
Nikon D7200 DZ cropped format camera
Lumix FZ 1000
Olympus TG5 (waterproof to 50 feet and shock proof when dropped on cement from up to seven feet)
Panasonic S330
I have several tripods from small camping tripods taken on a float trip down the Colorado River in the GCNP one wooden tripod, two carbon fiber tripods, one basalt tripod and several ball heads.

I have recently sold:
Canon AE-1 Programable 35 mm camera
Mamiya Z 6 cm by 7 cm medium format camera
Nikon F100 camera (replacing it with the D7200 above)
Olympus 330

If you have questions, my e-mail address is: wg@waynegeneral.com

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