

# Digital Photography

I will put a copy of this document on my website so that you can download a copy. [www.nohrphoto.com](http://www.nohrphoto.com)

## ***Why do we take pictures?***

There are many reasons.

- Preserve memories
- Vacation trips and family events
- Art
- Genealogy
- Parents and children
- Old photos and documents, faster than scanning
- Records for business or insurance purposes

## ***Film vs Digital***

### **Similarities**

#### **Body**

We need to something to hold on to and put in our purse or pocket. It of course also holds the lens, the sensor or film, the batteries and electronics.

#### **Lens**

#### ***Focus, automatic or manual***

Virtually all cameras now have automatic focus. Really cheap cameras are often called “focus-free”, that is a marketing term that means “always fuzzy”. All middle to upper price range cameras allow manual focus for creative purposes.

#### ***Zoom or fixed (prime)***

Focal length refers to the width of view that the lens sees. About 50 degrees is considered normal. Anything more is wide angle and anything less is telephoto. It is usually measured in mm, but that only means anything if you know the size of the sensor or film. 35mm film has 50mm as a normal lens.

Zoom means the focal length can be changed from wide to telephoto. Most cameras have at least a 3 to 1 ratio. Note that optical zoom is the only thing that means anything. Digital zoom simply removes some pixels, which is better done on a computer later if it must be done.

Fixed or prime lenses are mostly used on high end cameras, although the really cheap cameras will also have a single fixed lens. On high end cameras these lenses are interchangeable for creative uses.

#### **Shutter button**

Push the button, take a picture. Pushing halfway usually makes the camera focus; pushing the button the rest of the way down actually takes the picture.

#### **Exposure controls**

The film or sensor requires a certain amount of light. Too much or too little light results in under-exposed (dark) or over-exposed (light) images. Think of this as putting water in a bucket. Too little and it isn't easily seen, too much and it might overflow.

## ***F-Stop and Shutter***

These settings control how much light reaches the sensor of film and for how long. The shutter speed is how long the light is allowed to pass while the F-Stop controls how much light is allowed through the lens. F-Stop is also known as the aperture and is calculated by dividing the focal length by the effective diameter of the lens. The diameter can be made smaller with an adjustable thingy inside the lens. Smaller numbers mean less light gets through the lens. Standard values are 2.8, 4, 5.6, 6.8, 8, 9, 11, 16, and others above, below, and in between. The aperture value also affects the depth of field, how near and how far things appear to be in focus.

## **Prints**

Excellent prints can be made from either film or digital.

## **Differences**

### **Film vs. Sensor/Memory**

Film is both the sensing and the storage element in traditional photography. In digital the sensor detects the light and the image is stored as a file on a memory card. This means that this image file should be treated as a negative. We'll discuss this more later.

### ***Types of film***

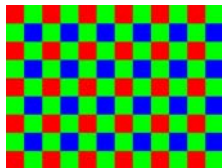
- Black & White
- Color Negative
- Color Slide

There is also a wide range of film speeds and sizes available. 35mm is the most common, but there are many others. With digital you will no longer need to decide what kind of film to have. You also won't find yourself with the wrong kind of film loaded, for example, a high speed indoor film when you need to shoot outside.

### ***Types of sensors***

#### **CCD or CMOS**

Both of these use an array of RGB sensors, usually in what is called a Bayer array.



#### **Foveon**

The RGB sensors are stacked in layers, just like film. This sensor showed great promise but hasn't been commercially successful, at least not yet.

#### **Size**

The sensor has a physical size. This is not the number of megapixels which will be discussed later, more megapixels is not necessarily better. However, a bigger physical size really is better. Most cameras have a sensor that is much smaller than 35mm film.

## ***Dynamic range***

This refers to the greatest difference between light and dark. In other words, the brightest areas (highlights) that can be captured without losing details and the darkest shadows that still show some details. Film is at least 10 stops but digital is more like 6 or 7. This means that either some shadow or some highlight detail will be lost with digital. Jpeg makes this even worse as we will see later.

## ***Grain and noise***

Film has grain. This is due to the little granules, like sand, that actually capture the color values. Grain is more visible in the shadow areas.

Digital uses pixels. Digital sensors also produce noise, which is a bit similar to grain. It shows up mostly in shadow areas. It is also temperature dependent. Colder is better, but that kills the batteries.

## **Viewfinders and LCD displays**

Many small cameras still include a viewfinder that you look through, but most cameras now, with the exception of DSLR's, use the LCD display to show the image that is about to be taken. This works fine most of the time but can be a problem in bright light. It is also harder to hold the camera still when holding it at arms length in front of your face.

## **No negatives or slides**

## **Batteries**

Digital cameras eat batteries. Use rechargeable and carry a spare.

## **Memory cards**

There are many card formats and many different sizes. Buy the kind your camera needs and get several as big as you can afford.

- Sony MemoryStick and MemoryStick Pro.
- CF – compact flash, mostly on higher end cameras now.
- SD and MMC – most cameras except Sony.
- XD – a smaller version of SD.
- Micro SD – mostly on cell phones.

## **Cost**

The cost of film is steadily going up, silver is used and lots of chemicals. The cost of digital keeps going down. Digital images are basically free once you have the camera. Memory card space can be reused. Unwanted images can be deleted. Memory cards are also getting cheaper.

## **Workflow**

This refers to all the tasks that are performed from taking the photo to viewing to preserving the final images.

### **Film:**

- Take picture.
- Develop negatives.
- Make prints (you might also select which ones to print, or you might get double prints of everything). Note that color adjustments are also done here. This is usually handled automatically by the processor so many people aren't aware that this happens.
- Place in album or shoebox for storage.
- Show to your admiring friends and family.

- Or, if digital versions are required for web or other uses, then scanning will be required.

Digital is somewhat different.

- Take pictures. Well, at least this is the same.
- Copy images from memory card or camera to computer.
- If you're really organize, index and archive the images. You also might delete any really bad or useless images.
- Optionally make copies to work on and make any color or other adjustments depending on the image destination.
- Resize images for web or print or DVD or CD or...
- Upload images to website or email or print or burn cd or DVD.
- Bask in the glowing positive comments about your images.
- Index and archive (backup) images. Store CD/DVD's in a safe place.

You might also of course manipulate the images in countless ways on the computer.

Notice that digital doesn't use any nasty chemicals to process the film.

## ***Types of Cameras***

### **Point and shoot**

\$100 to \$300. Fully automatic with some manual overrides. From 3 to 10 MPixels. These are an excellent value for the money. I think the low end ones will disappear due to competition from cell phones.

### **Advanced point and shoot**

\$300 to \$500. Look more like DSLR, but do not have the ability to change lenses. Better image sensors and more manual controls for creativity. Usually from 6 to 10 MPixels.

### **DSLR**

Digital Single Lens Reflex. The bodies go from \$500 to \$3000. Sizes range from 6 to 18 megapixels. They offer interchangeable lenses and anything from full automatic to full manual. They are faster and produce much better images, but they are also heavier and the lenses cost real money.

### **Medium Format**

Hasselblad. Big sensors, 15 to 48 megapixels, \$20,000+. Wonderful image quality.

## ***Technical Stuff***

### **Color Theory**

In the digital image world there are two main standards for working with image color. These are not the only ones, but they are the most common.

- Additive color – RGB, Red Green Blue. This is used for things that glow, like monitors.
- Subtractive color – CMY, Cyan Magenta Yellow. This is used for things that absorb light, like printing inks. Due to limits on the accuracy of the pigments, black is often (actually almost always) added. This is known as CMYK.

These colors have their opposites.

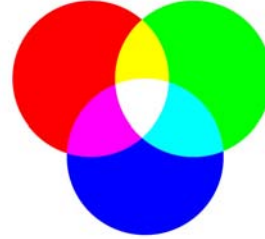
- Red-Cyan
- Green-Magenta

- Blue-Yellow

RGB is also used in JPG files, but this is a convention, not a requirement, images can just as easily be stored in CMYK.

A color is specified by three numbers, one for Red, one for Green, and one for Blue. They can be indicated as either a number or a percentage. The following table gives some examples.

| Red % | Green % | Blue % | Result Color |
|-------|---------|--------|--------------|
| 0     | 0       | 0      | Black        |
| 100   | 100     | 100    | White        |
| 50    | 50      | 50     | Gray         |
| 50    | 0       | 0      | Pinkish      |
| 100   | 100     | 0      | Yellow       |
| 0     | 100     | 100    | Cyan         |
| 100   | 0       | 100    | Magenta      |



## Pixels

Pixel comes from the word, Picture Element. Each one is a tiny square that has a color value. If you have enough pixels you don't see them, just the overall image.

## How many megapixels do I really need?

Good question. It depends.

The mathematics for calculating how many pixels you need before the eye can't see them are pretty straightforward. The number depends on the viewing distance. However, we'll skip the math for the time being.

- Viewing on monitor, you never need more than the resolution of the monitor. Typically 1280x1024 these days. That is of course 1.3 megapixels.
- Printing depends on the size. For most prints that you hold in your hand and view 300 pixels per inch is enough. So for an 8x10 print you would need 8x300x10x300 or 7,200,000 pixels. So 7 MegaPixel is just fine. For smaller prints you can get by with fewer.

Also note that most point and shoot lenses cannot resolve more than about 6 or 7 megapixels so spending money on more is not a good return on investment. DSLR lenses are available that can resolve from 14 to 18 megapixels but these lenses cost \$2000 and up. Putting more pixels on the same size sensor means that each pixel is smaller and thus produces a weaker electrical signal which makes the image noisier.

## Color Balance Demystified

Many cameras have a setting for color balance. They will usually include at least the following settings.

- Automatic
- Sunlight
- Overcast
- Flash
- Incandescent
- Fluorescent
- Measured

Different light sources have different amounts of colors. Sunlight is yellowish while overcast is bluish. Incandescent is very orange or reddish. Our brain corrects colors to an amazing degree because we know how things are supposed to look. The camera sees things as they really are. When we look at a print our brain doesn't correct the color so it is necessary to adjust the colors before printing. This is what the color balance setting does. Automatic tries to guess. This is often good enough, but fails for scenes with large areas of a single color. Consider a scene with lots of green grass. The camera will think there is too much green and will add magenta to cancel the green. This makes any faces in the scene very red/purple looking. Another common problem image is a sunset. The camera sees too much red/orange and subtracts it from the picture which makes the sunset look dull. Using one of the camera preset modes will make the picture appear more natural when it is viewed or printed.

Some cameras also have a manual mode that allows you to measure the color content by taking a picture of a gray or white sample. This is the most accurate.

Here is an original shot in automatic color balance compared to the same image corrected for incandescent. You can see the orange cast caused by incandescent lighting.



## Speed or ISO or Sensitivity

The ISO rating refers to how much light is necessary for proper exposure. Larger numbers mean you can take pictures in less light, but the noise in the image will increase. Digital cameras have a similar feature often called sensitivity. In automatic modes you don't have to worry about it, the camera will make the best choice it can. Just be aware that images in dim light won't be as good as those in bright light.

## File Formats

- GIF – 254 colors, non-lossy, use for graphics only.
- JPG – millions of colors, lossy compression but good for email and web. Do NOT edit and resave JPG's as this causes image degradation (image-rot). As an aside: There really isn't any such thing as a JPG file. The file is actually a JFIF format that contains a JPG compressed image. However, calling this file a JPG has passed into common usage.
- TIFF or PSD – millions of colors, non-lossy. Excellent for editing and printing. PSD is Photoshop native format.
- BMP – millions of colors, non-lossy. No compression so files are large. This is the Windows native format.
- RAW or DNG – Original sensor data from Pro and Prosumer cameras. Excellent for archiving. Proprietary format, each vendor has his own. DNG is a new format from Adobe. If camera manufacturers start using it will become the RAW standard and make life better.

I strongly recommend you use RAW or TIFF or DNG if your camera supports it as this preserves the most detail in your photos. Most cameras only do JPG, so treat it as a negative. Always make a copy if you have to edit it and save as a non-lossy format. Change back to jpg only when emailing.

It is actually a sad thing that JPG became the image format that cameras use. The 8 bit color limitation restricts the number of color levels and the lossy compression damages images. The camera sensors are usually capable of at least 10 or 12 bits of resolution but JPG loses this. 8 bits can handle 256 levels, while 12 bits is 4096 levels. More levels allows for smoother gradients, fine details and more room for color corrections and other editing tasks.

## ***Taking Pictures***

Start with full automatic. Just point the camera in the right direction and then push the button at the right time. What is right does of course take time to learn. Later you might want to experiment with some of the less-automatic modes to be more creative in your images.

With virtually all cameras pressing the shutter button halfway down locks the focus and exposure. This can be useful to make sure you intended subject is focused. Put the subject in the middle, press and hold the shutter button halfway, then re-frame the picture while holding the button halfway down. When ready, press the button all the way down. This technique is also useful for sports pictures. The focusing time of most digitals is very slow. By pre-focusing at the right distance the camera is ready for when the action happens.

Examples of manual modes that can be controlled:

- Flash. Often available light looks much more natural. But slower shutter speeds can result in blurred images due to camera shake. It isn't easy to hold the camera still for anything less than about 1/30 second. For the technically minded the actual minimum value rule-of-thumb is  $1/(\text{equivalent focal length of 35mm camera lens})$ . This says that it is easier to hold a wide angle setting than it is to hold a telephoto setting.
- Focus. Use to isolate the subject by blurring other elements like the background.
- Exposure. Make the picture darker or lighter for mood or artistic effect. This can also be important for capturing highlight or shadow detail in scenes where the contrast is too great to capture. Sometimes it is also necessary to override the cameras automatic exposure, for example in strongly backlit scenes. Automatic exposure is very good in modern cameras but it isn't perfect.

## ***Getting the pictures into the computer***

There are two common methods of getting the images from the camera to your computer.

1. Connect a USB cable to the computer.
2. Remove the memory card from the camera and put it in a card reader.

Most cameras come with vendor software that will help in transferring the images using the USB cable. In some cameras the camera will appear as a drive when it is connected. Then you simple drag and drop files. The camera vendor supplied software usually tries to make things easy. Sometimes this works. Other times not. They often put the images in some folder that can be difficult to find for backup purposes. On the other hand there is often a pre-view ability and options to fix many image problems.

A card reader always appears as a drive. You simply select the images and drag them to the folder where you want to save them. You have to make decisions about folder names and where to save the images.

## ***Saving your pictures***

Do not save the only copy of your image files on your computers hard disk. It will fail someday, maybe tomorrow. DVD and CD are both good, but buy only quality media. Never use any of the RW formats, there are incompatible standards and the media wears out very quickly. DVD+R is faster than DVD-R for random access. Do not use the DL DVD's, they are not as reliable.

You can also save your images to external hard drives. They are readily available in sizes up to 500 Gbytes at reasonable cost. As long as you don't run them continuously they should last for a long time. However, if the drive fails you lose everything. If a CD or DVD fails you only lose what was on that piece of media.

Finding your photos after you have collected 1000's of them can be a problem. There are many software programs designed to make it easier to find them by using keywords. The best of these allow off-line storage browsing. I.E. you can have your images stored on many CD's or DVD's, and you can look at thumbnails without putting the CD/DVD's in the drive.

You can also simply store your photos by creating named folders. The names can be dates or something more meaningful. You can then store related photos on CD and put them in a safe place, preferably two safe places.

For managing, here are some programs that I have either used or looked at. It is not a comprehensive list, there are many and more are appearing with great regularity. They are useful when you have lots of images to process. Many of them also allow for slide show and web page creation. They have features to index, sort, and find images. Often simple image editing is also available.

- Adobe Lightroom, excellent color correction, rotation, red-eye, and many other things.
- ACDSee, from Victoria BC. Comprehensive program, editing and off-line storage.
- BreezeBrowser, excellent web page generator and easy simple editing.
- iView MediaPro, great indexing and off-line storage handling.
- Extensis Portfolio, similar to above.
- Canto Cumulus
- Thumbz
- Apple Aperture
- Google Picasa is free and pretty good.

## ***Editing your pictures***

To improve your photos there many things that can be done. You'll need a computer!

- Overall color balance.
- Contrast and Brightness adjustments.
- Red-eye removal.
- Cropping, removal of unwanted elements.
- Change to Black&White.
- Sharpen or blur.
- Artistic changes.
- Removal or addition of elements. Compositing (combining elements in a single image).
- Tools for image evaluation. The histogram is extremely useful.

There are many software packages available for editing and managing your images. Many cameras come with basic programs that are adequate for most people. When you find you want to do more with your images then look into more powerful programs.

For editing:

- Photoshop, for just about any kind of editing, is still the best, but it takes some learning to use.
- Photoshop Elements is a more affordable version and is quite good.
- Ulead PhotoImpact. Excellent and easy to use.
- Corel Paintshop Pro.

Again, note that the original images files should be safely saved; i.e. treat them as a negative. Even simple things like lightening or boosting the contrast of an image will cause some information loss in the image that can never be restored.

An important consideration when fixing colors is that your monitor and printer must be color adjusted so that they show and print the correct colors. There are devices available to do this. For the monitor, it is a color calibration system. For the printer, it is usually referred to as a color profiling system. Without this

you don't know if what you see on the screen is correct, or what prints is accurate. Printing is more complex since there are many combinations of papers and inks that all have different color characteristics.

## **Printing**

The biggest difference in printing is the type of paper used. The photo papers are generally the best, but note that they are not all of equal quality. Stay away from store house brands. It is also best to use paper made by the printer manufacturer. This will usually give the best results. One exception is the Kodak Inkjet Photo paper, which is quite good. There are websites that test many of the ink, paper, and printers that can be used to determine the quality and longevity of prints. Wilhelm Research is one of the better places.

## **Inkjet**

The printer is inexpensive but the ink costs are high. There are two basic kinds of inkjet printer technology used in consumer models. There is a third type, continuous, but it is only used in large expensive commercial printers.

- Dye (like food color), has wider color ranges than pigments but the prints fade over time.
- Pigment ink prints can last 100 years or more, but the colors aren't as bright.

There are two basic kinds of ink spitters.

- Steam, HP and Canon.
- Piezoelectric, EPSON.

The photo quality of modern inkjets is excellent, rivaling that of photo printing if you use good paper. Print times range from slow to molasses slow.

Inkjet printers must be used at least once a week or the ink can dry out. This results in wasted ink or in come cases a wasted printer. Epson does not allow owner print-head replacement. HP has the print-head in the cartridge. I do not recommend refilling ink cartridges; there are quality and color issues. Often the refill ink clogs faster. Since the colors don't match the original exactly you will get color shifts. You could re-calibrate the colors based on a refilled cartridge but you will probably need to do this each time you get a refill. The vendor's inks tend to be more consistent.

The water resistance of prints varies. Epson with pigment and plastic paper is excellent, as is the new HP pigment printers. The dye printed pictures are typically not very waterproof. The paper does make a difference, even with dyes. The micro ceramic coated papers from Ilford and others is actually fairly moisture resistant and is almost instantly dry out of the printer. However, it does fade faster over time than some of the other paper types. Good dyes and papers can have lifetimes of 75+ years. This is actually better than traditional photo prints.

There is a lot of information in Wikipedia for further study on printer technologies.

## **Color Laser**

These still cost \$250 and up. However, printing is many times cheaper and many times faster. Image quality is not as good as inkjet, but they are getting better. The quality is excellent for graphics and acceptable for photos. Also note that the toner does not dry out in the printer if you don't use it for months. The prints are more or less moisture proof depending on the paper. The lifetime is very long.

## **Photo**

Digital images can be printed on traditional photo paper. Fuji (?) LightJet is one of these and produces stunning quality prints. Cost is about \$500,000 so you'll want to use a photo service that has one.

## **DyeSub**

These prints are excellent quality, better than inkjet, but also more costly. Alps makes one, and there are others.

## **DPI vs PPI**

Printer manufacturers are guilty of advertising different numbers. Epson advertises 14,400 dpi and others like HP advertise much smaller number. Are they comparable? I normally print at 300 for HP/Canon and 360 on Epson. This provides fine quality.

There are two measurements that are important.

- PPI – pixels per inch, this is how many pixels are printed per inch.
- DPI – this is how many little tiny dots are placed inside each pixel.

The 14,400 dpi Epson actually prints at 360 ppi. This is enough for the finest art prints. HP prints at 300 or 600 ppi, and the prints look just as good.

## **How many pixels per inch do I need?**

Printing at 300 dpi is adequate for most situations, but it really depends on the viewing distance. The further away, the fewer pixels you need. This is due to the resolution limits of the human eye. The greater the distance to the image, the fewer details the eye can see.

## **What is the best printer?**

It depends. Consider the above comments and decide which features are the most important for you.

## ***Photography as Art***

### **Picture Tells a Story**

A picture tells a story visually. You control the elements to get the viewer to understand the story and what you are trying to say.

TSCT

- Topic – example nature scene
- Subject – example a tree
- Composition – how we present it, see below
- Technique – the mechanics of how we take the picture

### **Composition**

Composition is how we arrange elements in the photo to direct the viewers eye to the important parts of the story and how the story is told.

- Golden mean or rule of thirds – arrange things in a timeless pleasing fashion
- Circular – lead the viewers eye to an important element
- Diagonal – direct the viewers eye to something important
- Lines and shapes – use to direct the eye
- Light and dark – using light or dark elements can direct the eye