# Art

and

# Science

# of Photography

by

Jan Steinman

Contents


| | |
|---|---|
| Introduction | 1 |
| Camera Basics | 3 |
| Exposure | 5 |
| Perspective | 7 |
| Motion Control | 9 |
| Depth of Field | 11 |
| Light | 13 |
| Macro | 15 |
| Composition | 17 |
| Field Trip | 19 |

# Introduction

There are two types of people in this world: those who divide the world up into two types, and those who think there is more to it all than that.

I guess I fall into both groups — I can't make up my mind!

On the one hand, it is useful to stereotype people, to better understand their motivations and desires. On the other hand, how dare anyone put me, or anyone else, in a nice, tidy box!

Dividing up the world into "art" types and "science" types is a useful way to look at things. So much of what we do falls neatly into one category or another. Play music? Art. Build a machine? Science.

On the other hand, no one exists who lives wholly in the realm of the aesthetic, just as technology alone cannot provide a full life.

I'll be making a special effort to bring these two together, but you have to join me in that effort. If you are an "art" type, try to pay special attention to the "science" bits — they'll help you achieve the artistic effects that you may have thought were up to luck. Or if you are a "science" type, try to spend time on the "art" topics — they'll help you get beyond technically proficient, but boring, images.

Look for these signs throughout the text for material that concentrates on one side or the other:

Art this topic particularly addresses aesthetics

Science this topic is focused on technology

This course is designed around a progression of ideas that build from one to the next in a logical manner. If you miss something, try to go back and get familiar with it, or further sections may not make the most sense.

First, we'll get familiar with your camera and its basic controls. Then we'll start using those controls. Once you understand how to control your camera, we'll use it to control common shooting situations. Then, we'll wrap it all up by spending time on what to do once you have all this control.

We'll be using a "discuss, try, critique" format. Each class will have a discusson on a topic or technique, then you go out and try to use that technique or demonstrate that topic, then the next class begins with a critique of the assignment.

If you're using film, you'll be shooting a roll of Kodak Elitechrome 100 each class. You will need to have it processed by the following class. This can be a challenge on an island — contact Apple Photo and let them know about your needs.

When you bring your slides to class, please orient them for proper viewing, then put your FULL NAME along the bottom edge.

If you're using a digital camera, bring your digital images to class on a CD-ROM, or make arrangements to email them to me. Please prefix each file name with your first name, like "Judy-PIC21187.jpg" so it will be easier to sort them out for viewing in class.

# Camera Basics

There are three basic camera types:

- **Mechanical *(M)***
  older film cameras with most or all functions controlled mechanically or manually, with rotating, mechanical settings indicators.

- **Electronic *(E)***
  newer film cameras with most or all functions controlled by buttons or electrical knobs, with digital readout of the settings.

- **Digital *(D)***
  similar to Electronic, except an electronic sensor replaces the film.

There are three basic systems that operate in all cameras:

- **Viewing System**
  The viewing system allows a human being to see, with varying degrees of accuracy, what image will strike the film or sensor at the time of exposure.

- **Light Gathering System**
  The light gathering system is camposed of one or more pieces of glass which gather light reflected from an image and focus that light on the film or sensor.

- **Exposure System**
  The exposure system allows a precisely controlled quantity of light to strike the focal plane, where it ***(M/E)*** causes chemical changes in dyes and silver compounds that eventually result in a viewable image, or it ***(D)*** causes electrons to be stored in cells that eventually result in pixels on a electronic display.

These basic camera types control their basic systems using:

- **Shutter Release**
  The button you push to record an image. ***(E)*** it also advances the film to the next frame.

- **Focus**
  ***(M)*** A ring on the lens, or ***(E/D)*** a button or lever, that changes how sharp or fuzzy an image appears in the viewfinder.

- **Aperture**
  ***(M)*** A ring on the lens, or ***(E/D)*** a button or knob, that changes how much light is allowed to pass through the lens.

- **Shutter Speed**
  A button or knob that changes how long light strikes the ***(M/E)*** film or ***(D)*** sensor during exposure.

- **Zoom**
  ***(M)*** A ring on the lens, or ***(E/D)*** a buttor or lever, that changes the focal length of the lens.

- **Film Speed**
  ***(M)*** A knob, or ***(E/D)*** knob or menu selection, that determines how sensitive the imaging system (film or sensor) is to light.

- **Exposure Compensation**
  Similar to film speed, a knob that changes imaging system sensitivity, typically used on a per–image basis for unusual lighting.

Other controls perform supplementary functions:

- **Self Timer**
  Allows you to be in the picture; also useful as a stability aid.

- **DOF Preview**
  Allows you to see the affect of aperture on focus.

- **Flash Modes**
  Allows control of built–in flash.

- **Exposure Modes**
  Allows different ways of measuring light, such as average, spot, matrix, etc.

- **Exposure Lock**
  Keeps exposure values from one shot to the next.

- **White Balance *(D)***
  Compensates for different types of lighting.

- ***(D)* Menus, Previews, Resolution, and More!**
  Digital cameras can have a bewildering array of additional functions and settings, few of which are crucial to basic photography! Don't get hung up on these — default values will serve you well for now.

# Exposure

There can be a lot of light, or there may be very little. "Exposure" is what we talk about when we describe how the intensity of light is controlled to suit a particular film or sensor.

Art

*Overall exposure determines how light or dark an image is. Photographers call light images "high key" and dark images "low key," wheras artists refer to lightness and darkness in an image as "value."*

Science

*Light is measured in terms of "exposure value," which is a logarithmic absolute scale. Each increase of 1 EV represents a doubling of light.*

Exposure is determined by four variables:

- **the amount of light illuminating the subject,**
  You often don't have much control over this, but you may be able to move lights around, or to move your subject from shadow to sunlight, or to use a reflector to move light onto your subject.

- **the sensitivity of the film or imaging sensor,**
  Film comes in different sensitivities, specified by their "ASA" or "DIN" numbers. Digital cameras can have different sensitivity settings per image. In either case, greater sensitivity means more "grain" or "noise," less sensitivity means longer exposure times and blurring.

- **the "focal ratio," or aperture of the lens,**
  Generally mis-called the "aperture," this is actually the ratio of the length it takes to focus the image (focal length) to the effective width of the lens (focal width). It is often represented by the symbol "$f$".

- **and the length of time the film or sensor is exposed.**
  Also known as "shutter speed," this is typically fractions of a second up to tens of seconds, and is represented by the letter "t".

Your camera's exposure system gives you control over the latter two, and your ***(M/E)*** choice of film or ***(D)*** sensitivity setting control the second item.

For “normal” lighting situations, your camera’s exposure system wants to use settings that result in midtone gray. But this is not always what you want!

What if you are taking a picture of a polar bear in a snowstorm, or a raven in a coal mine? In these situations, you have to trick the camera’s exposure system into keeping white white, or black black.

Most cameras have an “exposure compensation” control to help with such subjects.

Neither film, nor digital sensors come anywhere near being as sensitive to the wide range of light that the human eye can perceive. The range of light to dark in an images is called the “scene contrast,” and you often have to choose to sacrifice shadow detail in order to get highlight detail, or vice–versa.

Assignment: bring four images to the next class that illustrate control over exposure:

- **at least one “high key,” or bright subject on a bright background**
  (like a polar bear in a snowstorm, or an egg on a white countertop)

- **at least one “low key,” or dark subject on a dark background**
  (like a raven in a coal mine, or a black cat on a black couch)

- **at least one “high contrast,” or combination of light and dark**
  (like a polar bear in a coal mine, or raven in a snowstorm, or an egg on a black couch, or a black cat on a white countertop)

# Perspective

Art

Distant objects appear to be smaller than nearby objects. Parallel lines, like the edges of a long, straight road, converge in the distance. Looking up at a tall building makes it look like it recedes into the distance. This is artistic perspective.

In photography, perspective is manipulated by two means:

- **the focal length of the lens,**
  This is the distance from the lens's rear nodal point and the film or sensor, and it determines both the magnification of the imaged subject, and the angle of view of the imaged scene.

- **and the position of the lens relative to the film/sensor.**
  This is normally fixed in common 35mm and digital cameras, but is variable in large format view cameras and with some specialized 35mm lenses.

Perspective is divided into three categories:

- **Wide Angle**
  These lenses enhance perspective — close objects appear much larger than normal, far off objects appear much smaller than normal.

- **Normal**
  These lenses correspond to the perspective we are used to seeing with our own eyes.

- **Telephoto**
  These lenses reduce or compress perspective — close objects and far objects are closer in size to each other than our eyes perceive them.

Perspective comes from the ratio of focal lenght to the diagonal measure of the film or sensor. This is why 35mm cameras (with a diagonal measure of 50mm), have a different focal length for a given perspective than cameras with other sized film or sensors.

In particular, digital cameras generally have smaller sensors, so the perspective for any given focal length is greater than it would be with most film cameras' lenses of the same focal length.

The focal length is the primary thing that is changed when you "zoom" a lens, so most people are familiar with its operation. But most people use zoom for "lazy composition," rather than for purposeful manipulation of perspective.

If you want a subject to be closer, without changing the relationship between the subject and its surroundings, get closer to the subject!

Practice using zoom strictly for manipulating perspective; telephoto settings reduce perspective, wide–angle settings enhance perspective.

**Science**

- *Wide angle lenses correspond to human "circle of perception," the angle at which we can sense objects.*
- *Normal lenses correspond to human "circle of attention," the angle of the fovea, an area of the retina that has an expanded number of cones.*
- *Telephoto lenses correspond to human "circle of detail," the area upon which we concentrate when we examine tiny objects, such as text.*

Assignment: bring four slides to class that illustrate use of perspective:

- **at least one that uses perspective shortening**
  (what you get with telephoto lenses)

- **at least one that uses perspective exaggeration**
  (what you get with wide angle lenses)

If you only have a single, fixed focal length lens, you can still experiment with perspective by getting closer and farther from your subject.

# Motion Control

Much of the time, you want your images to be nice and sharp, as though frozen in time. You control this by having an appropriate shutter speed.

However, once you master sharp images, you may find it interesting to indulge in purposeful, controlled blurring. If the desire is to impart a feeling of motion, purposeful blurring is usually more effective than frozen action!

**Science**

*Human "persistence of vision" is an effect by which quickly moving objects appear blurred. It is how movies and television are able to create the illusion of continuous motion, when they're actually a sequence of quickly changing still images.*
*The eye cannot perceive changes that happen in less than about 1/10th to 1/15th of a second, so if you want motion to appear as you see it, choose such a shutter speed.*

Motion is controlled through a variety of ways:

- **Shutter speed**
  is how you control how long it takes to form a latent image on the film ***(M/E)*** or how long photons are collected by a sensor ***(D)***.

- **Camera motion control**
  like a tripod, is how you keep camera motion from impacting the exposure as it is in progress.

- **Subject motion control**
  like telling the child, "Sit still!" is how you keep subject motion from impacting the in–progress exposure.

The first technique, shutter speed, is the first to come to mind, but it rarely can have much impact without other considerations. It depends on several other items:

- **Lighting**
  if possible, choose bright lighting to stop action, dim lighting to purposefully blur action. A flash also stops action.

- **Film sensivity**
  determines how fast a shutter speed you can use for a given lighting situation.

- **Maximum aperture**
  of a given lens also impacts shutter speed. A lens with a large maximum aperture ($f2$ or larger) is often called a "fast" lens, because it enables faster shutter speeds for a given lighting situation than a "slow" lens ($f3.5$ or smaller) does.

Many techniques enable camera motion control:

- **Tripod**
  is essential for serious photography! But don't simply leave it in your closet — a lightweight tripod may get used more than a more expensive, sturdy, heavy one!

- **Cable release**
  if you use a tripod, you need a cable release! Pushing the shutter button, even when on a tripod, may move the camera.

- **Self-timer**
  set your camera on a stable surface, compose your shot, then use the self-timer to capture the image. This can be used instead of a cable release.

- **Carful hand-holding**
  make yourself into a human tripod!

You often have more control over subject motion than you imagine:

- **Plane of action**
  shoot into the motion of travel

- **Peak of action**
  shoot when the subject has the least relative movement.

Bring four slides to the next class:

- **two that demonstrate stop-action techniques, and**
- **two that demonstrate purposeful blurring.**

# Depth of Field

In studying perspective, we defined it as the size relationship between near and far objects.

Depth of field ***(DOF)*** determines the relative sharpness or fuzziness of near and far objects. It is directly controlled by two factors:

- **the reproduction ratio**
  this is the ratio of the size of the subject to the size of the final image; smaller (farther) subjects have greater DOF

- **the focal ratio (*f*–stop) of the lens**
  smaller aperture settings (bigger *f* numbers) have greater DOF

***MYTH:*** There is a popular mis–conception that DOF is some sort of absolute — that making certain camera settings will ensure that a certain range of distances will be "in focus."

***REALITY:*** There is exactly ***one*** plane of focus. DOF affects the degree to which objects that are ***not*** in that plane appear fuzzy or sharp.

If the reproduction ratio is changed by making a larger print, objects that appeared acceptably sharp in smaller prints may now look fuzzy.

When a point is ***not*** at the plane of focus, it will image as a tiny circle instead of a point. The farther the point is from the plane of focus, the larger the circle. The wider the aperture seting, the larger the circle. These "circles of confusion" are what determine if an object appears sharp or not.

***MYTH:*** wide–angle lenses have greater DOF than telephoto lenses.

***REALITY:*** for the same reproduction ratio and focal ratio, wide–angle and telephoto lenses have equal DOF, in terms of absolute distance from the focal plane.

However, wide–angle lenses create the perception of greater DOF, because they enhance perspective — more objects have a smaller reproduction ratio, and thus "look" more in focus, but blow those up to the size they would be if shot with a telephoto at the same focal ratio, and they will be equally fuzzy.

To have great DOF:

- **use a small aperture (large *f* number)**
  generally the smallest that will support the shutter speed you need for the light that is available
- **avoid close objects**
  to avoid large reproduction ratios
- **use wide–angle**
  to allow enhanced perspective and to make distant objects have a smaller reproduction ratio

To have small DOF (also known as selective focus)

- **use a large aperture (small *f* number)**
  generally the largest you can use without "running out of shutter speed" at the high end
- **get closer to your subject**
  to increase the reproduction ratio
- **use telephoto**
  to allow compressed perspective and to make distant objects have a larger reproduction ratio.

Bring four slides to the next class:

- **two that demonstrate great depth–of–field, and**
- **two that demonstrate selective focus.**

# Light

This is it. This is what it is all about. Without light, there would be no photograhpy.

Yet, we take it for granted, and pay scant attention to it, except to curse when we don't have enough.

By learning to analyze light, we become more aware of it, and thus more likely to bend it to our will.

Light has six basic qualities:

- **intensity**
  (amplitude, brightness, value) how bright or dim the light is
- **colour**
  (frequency, spectrum, temperature) warm, cool
- **direction**
  (angle, vector) front, top, bottom, side, back
- **contrast**
  (size & shape) soft, harsh
- **polarization**
  invisible to the human eye, but manipulable for special effects
- **number of sources**
  multiple light sources, each of which will have their own set of the five characteristics above

As we already learned, the ***intensity*** of light is largely negated by your camera's exposure system, which guides you in choosing shutter speed and focal ratio such that the average light reflected from the subject will result in proper exposure.

But by manipulating intensity, we can indirectly control other factors:

- **the expression of time, via motion-control techniques,**
- **the sharpness of objects, via DOF techniques.**

The ***colour*** of light has a lot to do with the emotions your images evoke in the viewer. Warm light often conveys feelings of well–being, cool light can invoke tension or angst.

***Directionality*** of light is perhaps the most taken for granted. Yet it is primarily responsible for how "unusual" an image looks.

We see top light every day — it comes from the sky, ceiling fixtures, etc. Front light has become popularized by camera–mounted flash.

Other directions lend drama and impact to images, whether via artificial lighting, or via sunrise or sunset.

The most poorly understood quality of light is ***contrast***. A high contrast light source has a small angular size, such as the sun. It tends to produce sharp, hard–edged shadows.

A low contrast light source has a large angular size, compared to the subject, such as the entire sky on an overcast day. It tends to produce soft, fuzzy–edged shadows.

Polarized ***light*** has all its waves lined up in the same direction. With polarizing filters, you can selectively produce or view certain polarization angles, while filtering out others.

Rarely will there be exactly one light source! ***Multiple sources*** come not only from multiple lights, but also from reflections from other objects and surfaces.

Bring four slides to class:

- ***None*** **of them can use front or top light!**
- **At least one example of back or side light.**
- **At least one with high contrast light.**
- **At least one with low contrast light.**
- **At least one with multiple light sources.**
  Slides may combine techniques to cover more than one of the above in a single slide!

# Macro

Macro is a much–abused term that is generally used to mean "close up." Formally, it means "large," which might seem strange, until you consider that when you close enough to something, it looks large!

More precisely, macro properly refers to a ***reproduction ratio*** that is close to 1:1 — in other words, objects appear on a slide or negative at actual life–size.

The difficulties of macro photography revolve around:

- **reproduction ratio**
  The size of the subject divided by the size of the subject's image on the film or final print. This is a measure of how "close up" you can shoot.

- **flatness of field**
  Focusing on a flat object that is parrallel to the film should produce an image with that flat object in focus from corner to corner. Inexpensive, add–on macro solutions often have poor flatness–of–field, but this is not so much a problem for nature photography.

- **sharpness and contrast**
  Inexpensive, add–on macro solutions generally sacrifice sharpness and contrast over dedicated macro solutions.

- **depth–of–field**
  Low reproduction ratios have extremely thin depth–of–field. This is no different in a $1,000 macro lens or a $10 close–up–filter!

- **subject motion**
  Low reproduction ratios mean that the slightest subject motion will be amplified into a blur at typical macro shutter speeds needed for adequate depth–of–field.

- **getting enough light**
  Getting adequate depth–of–field requires small apertures, which means slow shutter speeds.

There are numerous ways to explore macro, to suit almost any budget. They all have advantages and disadvantages:

- **close-up filters**
  go on the end of a lens, like a filter. ***PLUS*** inexpensive ($10–$30 each), simple to use, lightweight, no light loss, ***MINUS*** poor flatness–of–field, poor sharpness and contrast, limited range of reproduction ratio.

- **lens reversers**
  allow the lens to be mounted backwards, exploiting its ability to focus on a flat field. Best used in combination with extension tubes or bellows. ***PLUS*** inexpensive ($10-$40), good flatness–of–field, ***MINUS*** fixed focus (unless used with bellows), exposes lens rear element to danger, difficult to use, not suited to electronic cameras.

- **focal length multipliers**
  go between your camera body and lens, and multiply the lens's focal length by 1.4, 2, or 3 times, without changing the minimum focusing distance, therefore increasing reproduction ratio by the same factor. ***PLUS*** moderate expense ($30–$100), versatile — useful for more than macro, ***MINUS*** reduces light by 1, 2, or 3 stops, some image degradation, limited improvement in reproduction ratio.

- **extension tubes**
  go between camera body and lens to extend focusing range, and typically come in three sizes. ***PLUS*** inexpensive ($10–$30 each), good quality, especially when combined with a lens reverser, ***MINUS*** reduces light, difficult to use.

- **bellows**
  most of the advantages of extension tubes with a continuously variable length. ***PLUS*** easier to use that extension tubes, ***MINUS*** moderately expensive ($75–$150)

- **close–focus zoom**
  is a zoom lens with a separate "close up" or "macro" setting. ***PLUS*** versatile — not limited to macro, ***MINUS*** only moderate quality, may only work at certain focal lengths, expensive ($100 and up).

- **dedicated non–zoom macro lens**
  designed for particular reproduction ratios. ***PLUS*** ultimate quality macro, ***MINUS*** expensive ($100 and up), may require bellows.

Assignment: bring in four close–up slides:
- two that emphasize texture, and
- two that emphasize shape or form.

# Composition

Art

*Although this topic comes last, we have been talking about it all along in our assignment viewings.*

Science

*Although this topic seems particularly "arty," there are sound scientific principles that can be applied.*

All is not over once you understand the technical details of photography! Indeed, it is just beginning — mastering techniques of exposure, motion control, focus, lighting, etc. enable you to concentrate on higeher goals.

Here are some "rules of thumb" to use when composing an image. Purposely breaking the rules can be fun, too!

- **avoid symmetry**
  Your brain sees half of the image, and decides it's seen it all.
- **pay attention to background and foreground**
  The greatest subject will be lost if placed in a distracting setting.
- **choose orientation carefully**
  Flipping the camera sideways enhances vertical subjects.
- **frame carefully**
  It's not necessary to capture the ***entire*** subject. Leaving something to the imagination by cropping the subject often adds interest.
- **get close**
  Cropping and getting close creates a feeling of intimacy.
- **look around**
  Move around a lot while looking through the camera. What you first thought was your subject often is not the best subject. In sequences of the same subject, latter frames are most often better.
- **use two (or more) subjects**
  An interplay between subjects is often more interesting than a single subject.

- **connect the dots**
  The eye concentrates on small, bright objects, and instinctively draws invisible lines between multiple such objects.

- **shapes, colours, line directions equate to emotions**
  Horizontal lines depict stability; vertical, strength; diagonal, action; curved, grace. "Warm" and "cold" colours have those names for good reason!

- **the frame is part of the composition**
  It is the "gauge" by which lines (and implied lines) are measured.

- **avoid tangents with the frame**
  It is better to cut off the top of someone's head than to have it just barely touch the frame.

- **use contrast**
  to draw attention. It can be contrast in the broadest sense: complementary colours, sharpness/blurring, lines/curves, etc., as well as light/dark contrast.

- **watch foreground highlights**
  The eye is drawn ***first*** to foreground highlights, which will convey an impression of the sharpness of the overall image.

- **"rule of thirds"**
  Divide the frame into thirds, both horizontally and vertically, and place your subjects at the intesections of the lines. Place your prominent horizontals (horizon) and verticals (trees) along the thirds.

- **the light itself is a subject**
  Having your suject face a light source has an entirely different feel than facing away from it.

- **avoid "arrows" out of the frame**
  A mountain peak in the center, or edges of a road leading into the corners, invite the eye to leave the frame, unless blocked somehow.

- **change your point of view**
  Get on your belly and look up; climb a ladder and look down!

Your assignment this week is open, but concentrate on composition. Be prepared to discuss the compositional aspects of your four images that you bring.

# Field Trip

The field trip for this class will be held ***TBD.*** I will post the destination no later than 8AM on the day of the trip at:

`http://www.bytesmiths.com/Courses`

or you can simply go to www.bytesmiths.com and click on the "Class Stuff" link.

In any case, be sure to bring:

- **camera gear (duh!)**
  Include film, macro things, tripod, spare batteries, reflectors and diffusors, sherpa to carry it all for you...

- **sturdy, water-resistant shoes or boots**
  Sneakers or sport shoes are probably insufficient for three-quarters of the year.

- **appropriate clothing**
  Dress in layers so you can adjust your clothing to the weather and pace. A lightweight, moisture-passing inner layer combines nicely with an air-trapping outer layer, like a sweater.

- **appropriate outer wear**
  You'll probably want an outer shell that is water- and wind-resistant. You may also consider mittens or gloves. You should have headwear of some kind, even if the weather looks good.

- **water**
  at least 1 liter, tightly-capped, so it won't damage your camera.

- **lunch**
  Forget your diet, we'll be exercising! Trail mix or some other high-energy munchable is always good. Avoid food that doesn't crush well. Package food so it won't end up all over your camera gear.

- **backpack or waist pack**
  A camera bag with a shoulder strap is not going to feel good on a five-mile trek! Try to find some way to keep your hands free.

- **extra socks, change of shoes**
  will make the trip home more comfy.

Please let me know if you'll be taking part, so we won't be waiting around for you, and please be on time if you're coming!

Plan for about two (bad weather) to six (loop trail hike) hours out, subject to the needs and desires of the group. We will be back at the parking lot before dark. If you have to leave early, let me know so I won't miss you at the end of the day!

***Your final assignment:*** combine all that you've learned to date to bring four images from the field trip to the final class. Be prepared to discuss the techniques you used in the images.

(If you can't be on the field trip, bring four images of your own choosing.)