B A S I C B L A C K & W H I T E

P H O T O G R A P H Y

S t e v e n B e r k o w l t z

the CAMERA & LIGHT
LENSES, METERS & EXPOSURE

T y l e r S c h o o l o f A r t
U n i v e r s i t y
D e p a r t m e n t o f
A r t & A r t
E d u c a t i o n
T U C C
P h o t o
L a b

LIGHT and VISION

LIGHT

There are two general theories to describe the nature of light. One sees light as waves of energy, the other sees light as particles of matter. Both of these viewpoints have been proven to be correct by scientific method, yet the two are incompatible. Things are either waves or particles, energy or matter. They cannot be both! Physicists now call this the wave/particle duality of light. This is one of the major dilemmas of particle physics today. For the sake of photography it is more convenient to think about light as particles called photons.

REFLECTIVITY

What do you see? You do not see things. At least not directly. Unless you are looking at a light source, what you do see is the light reflected off the surfaces of things. Do you remember when they told you in third grade that you don't really see the moon, you see the sunlight being reflected off of it? Gosh, I really thought I could see the moon. They really like to destroy your beliefs in third grade don't they!

LUMINANCE is one important term here. It is the measure of how much light is being reflected. This is more commonly called the brightness of an object. The brighter an object appears the greater the number of photons being reflected off its surface. Your black sweatshirt looks dark because it is absorbing most of the photons that are hitting it. Conversely, a white shirt is reflecting most of the photons striking it. This is also why dark colored garments will keep you warmer and light colored clothing will keep you cooler.

CHROMINANCE is the other major aspect of light. Chrominance is the measure of the frequency of light that is being reflected. This is more often called the color of an object. The spread of colors that the human eye can see is called the spectrum of visible light. Remember when they told you in third grade that white light is not really white, but a combination of all the colors? White light sure looked white to me. Your red shirt is reflecting the red end of the spectrum while absorbing most of the other frequencies, whereas your blue shirt is reflecting the blue frequencies and absorbing all the others.

Combining chrominance and luminance gives you light blue versus dark blue and so on. An object can be reflecting a lot of the blue photons or just a few. With black and white films luminance is the major factor determining how things will be recorded. A bright red apple and a bright green pear will look more similar on black and white film than will a bright red apple and a dark red apple.

VISIBLE LIGHT

The spectrum of light that is visible to the human eye is actually only a very small range of the electromagnetic spectrum of energy. This spectrum ranges from gamma rays to x-rays to ultraviolet light above us to infrared light, heat, radar and finally television and radio waves below. Our eyes perceive frequencies from about 400 nanometers to 700 nanometers. A nanometer is one billionth of a meter. The shortest gamma rays (ultrahigh frequencies) are about 10 nanometers while the longest (low frequency) radio waves are 13 kilometers. To make a musical analogy, the visible light spectrum is less than one octave of frequencies while human hearing is about ten octaves - from 20 hertz to 20 thousand hertz. The electromagnetic spectrum is an outrageous 30 octaves. It is worth noting that there are animals that have seeing and hearing ranges that are considerably different than those of human beings or even musicians.

the CAMERA and the EYE

Indications of the existence of the camera go back to the days of Aristotle some 2500 years ago. If that does not exactly fit with your concept of a camera, maybe it is time to figure out just what the definition of "camera" really is. Basically it is a box that captures light. More specifically it is a device that can create an image from that light.

PINHOLES are used in the most simple cameras to focus light. Actually there are three elements at work here. A pinhole, the material the pinhole is made in, and a receiving surface some short distance behind the pinhole. In general, light is always bouncing around in every direction. A pinhole allows only the light rays that are coming directly at it, in a straight line from any object to the pinhole, to pass through. The material surrounding the pinhole acts as a barrier to block all the other light rays. The receiving surface behind the pinhole is where the image is actually formed.

By placing a pinhole through one wall of a small room one can build a camera obscura or "dark chamber". The light comes through the pinhole and projects an upside down and backwards image of whatever is outside the room onto the back inside wall. A piece of paper can be tacked to the wall and a drawing can be made by tracing the projected image. Throughout the centuries many very exact and detailed drawings were made in this manner. In time the room was gradually reduced to a portable box and became a widely used tool of the artist.

LENSES were developed during the fifteenth century when it was discovered that curved pieces of glass could bend the path of light. This overcame the main drawback of the pinhole. In order to make very sharp images the opening has to be very small. This causes a significant reduction in the amount of light entering the camera, producing very faint images. The lens bending the light allows the use of a much larger opening or aperture, yielding images bright enough to be really useful. Today's lenses use an adjustable diaphragm which allows us to change the size of the aperture, easily controlling the amount of light admitted to the camera.

HUMAN VISION

The cornea is the outside surface of the eye that acts as a lens and helps to focus the light entering the eye. The pupil is the "hole" formed by the iris which acts act as a moveable diaphragm to control the amount of light entering the eye. Behind this is an aperture that has the ability to alter its size it also focuses the light coming into our eyes, bending and directing its path. The interior of the eyeball itself is the darkened chamber, and the retina is the rear wall that is the receiving surface where the image is formed. The rods and cones of the retina have different functions. The cones in the center are more sensitive to chrominance and are responsible for the sharpness of our perceived image. The surrounding rods are more sensitive to luminance and can see well, although less sharply, in reduced light.

The image making part of the equation is where the human physiology differs from that of photography. Instead of producing fixed images as physical objects, the optic nerve converts the ever changing images created on the retina into electrical impulses that travel to the brain where it is evaluated, stored and eventually acted upon. The transmission of electrically encoded images that change through time sounds like video terminology, doesn't it. The storage of these images, and their subsequent evaluation gets us into the computer realm. It is only the acting upon the impressions of these images that separates man from his technology. Do we want to discuss the development of artificial intelligence in the computer labs of our universities yet?

FILM and the PHOTOGRAPHIC PROCESS

FILM

composition
- scratch resistant layer, protects the soft gelatin emulsion
- emulsion, a gelatin layer containing light sensitive crystals
- acetate base, a plastic roll to hold the emulsion
- anti-halation coating, prevents reflections from reentering the film

light sensitive crystals
- silver halides, most typically silver bromide crystals
- silver ions, positively charged = missing one electron
- bromide ions, negatively charged = having one extra electron
- free silver ions, not connected to bromide ions
- additional impurities, to help bind free silver ions and electrons

PROCESS

latent image
- photons strike the film, freeing electrons from the bromide ions
- electrons merge with the free silver ions and impurities
- this forms a site which will become visible when film is developed

development
- metallic silver is built up through time around the latent images sites
- fixing with sodium thiosulfite removes the halides not struck by light

IMAGE REVERSAL

the real world
- materials reflect light depending on their structure

the negative
- a collection of silver specks on clear plastic film
- most dense where struck by the many photons
- least dense where few photons have struck
- yielding an image which is light where the source image was dark
- and vice-versa, i.e. a negative image

the positive
- a collection of silver specks on opaque white paper
- basically the same emulsion as on the film
- light in an enlarger is projected through the negative
- the negative acts as a mask allowing some of the light through
- other parts of the light are blocked
- the silver in the emulsion turns dark where struck by light
- yielding an image which is the reverse of the negative, i.e. a positive
- the white paper blends with the black of the silver
- creating a wide range of gray tonalities

the CAMERA

A camera is merely a box that captures light. The modern camera has had some features added to the old *camera obscura*. These make it a much more accurate and controllable device. The two main additions are the lens, which deals with focus, and the meter, which deals with exposure. Each of these is its own area of study that is covered in depth in the next several pages.

In the long run, however, it is not what tools you have at your disposal that matters, it is what you do with them. The next time someone comes up to you and asks you what kind of camera you have, realize who you are dealing with.

CAMERA BODY

film formats	disk 110	35mm	2 1/4"	4 x 5"
viewing systems	rangefinder	SLR	TLR	ground glass

PARTS & FUNCTIONS

mirror	reflects the light entering the camera up onto the ground glass
ground glass	where the image is formed
pentaprism	flips the image left to right
viewfinder	where the image is seen
shutter	opens to allow light to hit the film
shutter release button	trips the shutter
shutter speed setting dial	controls how long the shutter will stay open
film guides	make sure the film moves along the correct path
pressure plate	holds the film flat against the shutter
sprockets	pull the film through the camera
take up spool	holds the exposed film
frame advance lever	advances the film to the next frame for the next shot
frame counter	counts how many frames have been shot
ASA setting	tells the meter what speed film is being used
rewind button	disengages the sprockets that help advance the film
rewind crank	turns clockwise to roll the exposed film back into the film cassette
auto-exposure compensation dial	alters the way the meter measures light in auto exposure cameras
timer	trips the shutter automatically with a 10 second delay
depth of field preview button	closes the lens aperture down to what will be used
lens release	releases the lens so it can be removed from the body
battery compartment	holds the battery
tripod connector	attaches the camera to a tripod
motor drive connectors	sends control data between the camera and motor
motor drive link	allows the motor to advance the film
hot shoe	attaches a flash unit to the top of the camera
flash PC cord connector	connects a remote flash unit electronically

LOADING and REWINDING

LOADING

open the camera back
place the film cassette into the back of the camera, nose down
engage the leader of the film with the take up spool
rotate the take up spool backwards
make sure the full width of the film is hooked over the sprockets
advance the film with the film advance lever with the camera back still open
check that the film is advancing properly
close the camera back
leave the rewind crank up a little bit
advance the film another one or two frames
watch for the rewind crank to move
this is your absolute assurance the film is moving through the camera

If there are no pictures on the film after it has been developed it is because of one of two reasons:
there are frame numbers on the film = the film never went through the camera,
but it was properly developed (the frame numbers are exposed onto the film at the factory)
there are no frame numbers = the film was improperly processed

REWINDING

press in the rewind button on the bottom of the camera
this disengages the sprockets that move the film forward
turn the rewind crank clockwise about 31 times
notice when the tensions releases, and a small click is heard
stop rewinding when this happens
the film has disengaged from the take up spool
but has not gone all the way back into the cassette
open the camera back
remove the film cassette from the camera
bend the nose of the film to mark it as exposed
it is also possible to cut off the nose of the film, or write on the cassette
cut the nose of the film off in between the sprocket holes before developing
the film tends to load with less problems if the film is cut between the sprocket holes

It is no tragedy if the film goes all the way into the film cassette, it just means the nose has to be cut off in total darkness.

HOLDING the CAMERA

It is important to hold the camera in a supportive way. This means that if the camera is placed in a vertical (portrait) orientation, the camera should be rotated in a clockwise direction and held from below with the right arm so the right elbow is against one's torso. Otherwise, if the camera is rotated in a counterclockwise direction it is being suspended from above where perpendicular movement can set in and make it extremely unstable.

the SHUTTER

TYPES of SHUTTERS

materials	metal or cloth
travel	vertical or horizontal
control	electronic or mechanical (usually only on view cameras anymore)

SHUTTER SPEEDS

speeds	the shutter speed setting determines how long the shutter will stay open calibrated in fractions of a second, usually 1/1000 th to 1 second, plus B
light	shutter speed controls how much light reaches the film each shutter speed is half as long or twice as long as its neighbor BIG NUMBER= small light, small number = BIG LIGHT
movement	the amount of time that passes as the shutter is open determines how much movement can occur while the shutter is open this will greatly affect how the image looks

AESTHETIC CONSIDERATIONS

frozen motion, hard edges -
- fast shutter speeds even with fast movement
  - captures events with camera vision,
  - things people cannot directly perceive

nominal motion -
- moderate shutter speeds with moderate movement
  - implies a sense of motion in a still image
  - an illusion which did not show up in painting until photography

blurred or abstract motion -
- slow shutter speeds with moving objects
  - evokes the feeling of doing something rather than
  - depicting the thing being done not the person doing it

LONG EXPOSURES

control	the shutter speed B holds the shutter open as long as desired using a cable release with a lock enables hour long exposures
film speed	normal film is designed to take pictures in 1 second or less time longer exposures result in reciprocity failure it takes much longer for a picture to build up on the film in very low light situations exposure times must be adjusted to allow for this effect

the LENS

TYPES of LENSES

	wide			normal	telephoto		
focal length	20	28	35	50	105	135	200
angle of view	94	75	63	46	21	18	12
special purpose	fish eye, mirror, zoom, macro						

FOCUS

moving internal elements, determine what the center of the field of focus will be
distance scales show how far the lens' focus is
calibrated in feet and meters to infinity

APERTURE

the diaphragm, made of overlapping leaves of thin metal
move to open up or close down to make a larger or smaller aperture
aperture is calibrated in f/stops, fractions of the focal length of the lens
the relationship is relative so all f/stops are consistent between lenses
the smaller the aperture is the fewer the number of photons will reach the film
each aperture allows either half or twice the amount of light to pass through
BIG NUMBER = small light, small number = BIG LIGHT

DEPTH of FIELD

pin holes — as the aperture approaches the size of a pinhole,
light is automatically focused
the depth of what is in focus can be changed by altering the size of the aperture
the smaller the aperture (the closer to a pinhole size) the larger the depth of field

preview — it is possible to calculate the depth of field using the markings on the lens
the depth of field preview button allows you to see the actual image
by closing the lens down to the aperture set on the lens

focusing — while focusing, the aperture is held wide open
to allow as much light as possible so you can see clearly
so you can pinpoint the center of your depth of field
the focus is one third of the way back in the depth of field

AESTHETIC CONSIDERATIONS

shallow depth of field - wide open apertures
zeroes in on a specific element of a picture
renders background out of focus and throws extreme foreground out of focus
helps define what is relevant to your subject, visually editing as your brain does
this is one major difference between camera vision and human vision!

in between depth of field - the middle apertures
what you usually end up with while trying to balance *f*/stop with shutter speed
be careful to really look at what is and what is not in focus
shifts in focus make subtle differences in the way your image material will be viewed

deep depth of field - very small apertures
puts almost everything in the photo in focus, beyond the capability of the human eye
indicates an interest in clarity and detail
makes a viewer evaluate the relationships between elements

LIGHT METERS

HOW LIGHT METERS WORK

- Spot Meters — read light in a small area
- Averaging Meters — read the overall luminance
- Incident Meters — read the light falling on the subject
- Reflected Light Meters — read the light reflected off the subject
- Hand Held Meters — can be different combinations of the above
- In-camera (35mm) Meters — center weighted averaging meters reading reflected light

WHAT LIGHT METERS DO

- Light meters tell you how to render your subject GREY!
- They do not tell you what the right setting is.
- They read the luminance of your subject and compare that light value to middle grey.
- They then tell you what possible combinations of *f*/stops and shutter speeds will give you that grey
- Then you have to compare your subject to middle grey in your head.
- A compensation must be made by you depending on what light value your subject really is!

READING A LIGHT METER

- Manual Match Needle meters
  - adjust either *f*/stop or shutter speed until the needle points in between the plus and minus

- Automatic meters Aperture priority
  - the meter will tell you which shutter speed it will use as you adjust the *f*/stop, giving you control over both variables by moving only one control.

- Automatic meters Shutter Speed priority
  - the meter will tell you which *f*/stop it will use as you adjust the shutter speed, giving you control over both variables by moving only one control.
- Program meters
  - the camera will select both *f*/stop and shutter speed, giving you no control whatsoever, always a compromise yielding mediocre depth of field and movement.

EXPOSURE

EXPOSURE DETERMINATION *expose for the shadows!*

- general reading - assume the meter is correct
- average shadows & highlights - deal with the extremes
- grey card - in the studio you can compare to the true standard
- shadows & compensation - find the darkest shadow with detail, then underexpose by 2 stops
  the most accurate exposure determination due to film density curve
  this is based on the Zone System
- bracket - take one or two extra shots at other exposures

EXPOSURE COMPENSATION

- actual exposure varies from the meter's suggestion according to the tonality of your subject
  - if subject is lighter than middle grey, overexpose (more light)
  - if subject is darker than middle grey, underexpose (less light)
- in general
  - avoid back lighting or any bright light in viewfinder
  - move close to your subject if necessary

CHOOSING THE EXPOSURE

- there is an infinite number of combinations of *f*/stop and shutter speed which let in the same amount of light.
- thus, there is no single correct exposure setting!
- which combination of *f*/stop and shutter speed to use is decided by aesthetics.
- if depth of field is a priority set the *f*/stop first then adjust the shutter speed.
  (note: *f*/stops are continuously variable)
- if movement is a priority set the shutter speed first then adjust the *f*/stop.
- a compromise will usually have to be made due to a availability of light.

SETTING THE EXPOSURE

- Manual meters
  - set exposure according to meter
  - adjust *f*/stop and / or shutter speed to over or underexpose
- Automatic meters
  - adjust compensation lever which allows over or underexposure in 1/3rd stops
  - set exposure as usual