BUILDING A FILM SENSITOMETER

by
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Here I go again. . . doing something I said I would never seriously become involved with. Testing is a dirty word in my vocabulary. Dirty in the sense that it can become an obsession. But the truth is, you have to do some amount of testing to understand what is going on. The testing I am referring to is, Film Testing. I really hate Film Testing! Now that I have that out of my system, let me get on with the project at hand.

In order to understand how film and developers interact with each other, you need to do some rudimentary sensometric testing. I really hate crunching numbers and running plots, but it is the best way to see graphically what happens when you choose a particular film and developer combination. It is also a very expedient way to compare different materials.

I have been using Pyro film developers for many years now. They deliver, what I believe is a more information packed negative. At least, for me, I like what I see, and that is what photographic art is all about. I have experimented with several of the formulas and have found what works for me, but there is always that something extra that you are always striving for. The biggest problem is finding reliable information on various developers. Everyone has an opinion and I am really only interested in my opinion. Reading the Internet will give you a headache. Seems most any discussion about developers just turns into an argument. Reminds me of going to a bar and asking, Ford or Chevy? A fight is sure to result.

THE TEST

Now, having said all of that, it is time to get down to brass tacks. I test film speed and developing time by using a 4x5 camera and a Stouffer Projection Step Wedge. Now I know immediately that there are those that say you can't do that. Seems to always be someone that will tell you about how wrong your procedures are. But in reality, the in camera test is plenty accurate enough to give you a starting point. And, maybe accurate enough to work just fine.

So, why build anything more complicated? Ease of use is the best answer I can give to that question. In order to do in camera testing you have to take the camera outside on a sunny day and shoot the step wedge, mounted in a film holder using a constant light source. I use the south, white painted wall on the back of our house. Works great, if you have a nice clear day.

The trouble is repeatability. To do this kind of testing, you need the exact amount of light every time you test. I found that some days were cloudy and if I needed a set of test film, I

had to wait. Also the time of day will affect the exposure. To obtain repeatability you have to shoot near the same time of day and have the same weather conditions. Not always convenient nor possible!

The only reliable solution to this quandary is to build a device that gives consistent controlled exposure, at the proper color temperature indoors. That device is a Sensitometer. I looked at the little tabletop Sensitometers that you find on the auction sites. They are great, except they only generate green or blue light. They are for calibrating X-Ray film. What you need for accurate data is a light sauce that is about 5K Kelvin. A near replacement for midday sunlight.

So, rather than wasting time waiting for the weather to cooperate, I decided to build a sensitometer. My needs were somewhat simple. I wanted a device that would give me consistent, reliable exposures. Not too much to ask.

THE BASIC DESIGN

Having decided to build a sensitometer, the next step was to define exactly what I needed. Here is a list of objectives:

- Design and build a working sensitometer (obvious!)
- Device should be as small as possible
- Use a Stouffer 21-step 4x5 wedge
- Color temperature of 5k Kelvin
- Repeatable exposure
- Adjustable exposure
- Calibrated in full stop increments
- Absolute even light across film aperture

These criteria defined the basic idea of what I was looking for. Next I needed to tackle exactly what was needed. First the light source. I decided that an electronic flash would be the best source of light. It is the correct color and one with variable power would allow intensity adjustment and could be calibrated.

My next big design hurtle was evenness of illumination of the film exposure aperture. I test using a Stouffer 21 Step Wedge in 4x5 size on 4x5 film. I needed to illuminate the film aperture evenly from corner to corner. This would require diffusion material, and I knew that the Plexiglas used on a light box would be perfect.

With a little research on the Internet I found that Plexiglas acrylic sheet 0.25” thick was appropriate for my needs. You should be able to find this material at any plastic supply. Specify Plexiglas acrylic #2447. I purchased a cut sheet 26.1/2" x 20.5/8 " from a seller on eBay.

My favorite material for building most everything is white Melamine. Easy to keep clean, cheap, and you don't have to finish the stuff. Plus, I had some white Melamine in the scrap heap. I needed the inside of the mixing chamber to be white and this was just right.

THE BOX

The first consideration was that I needed a light-mixing chamber. To get an idea of what I needed, I examined the mixing box on a color enlarging head. I deduced that if I built a fairly large box and placed a sheet of diffusing material on one side, and if the box had enough volume, then the light across the diffuser should be even. To hedge my bet, I opted to build a large box, about 12 inches cube. My idea was to use two diffusers. One would be the size of the box and would be about 12" square. The second diffuser would be spaced several inches above the first and would be smaller, with an aperture of 4x5 inches to accommodate the step wedge. My main concern was just getting the light even across the test film.

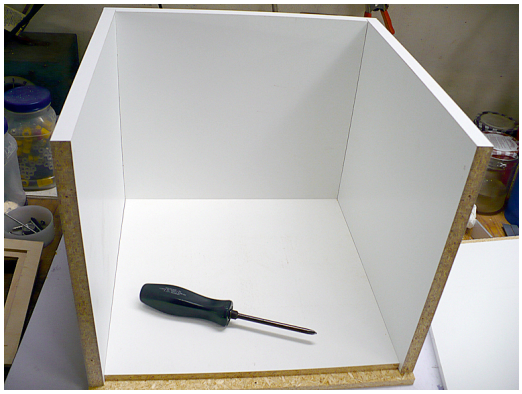

Figure 1

The box partially assembled. The inside of the main box is about 12" square and made from white Melamine with rabbet corners.

The box was assembled using rabbet joints on all sides to help make them light tight. I assembled the box using deck screws, just in case it needed to be dissembled. The top was unattached so it could be changed, just in case I wanted to build another aperture. The large Plexiglas diffuser was located 3" below the top of the box. The top of the box was machined so the second Plexiglas diffuser would fit flush with the top surface.

The first, inner diffuser, is the size of the inside of the box. The second diffuser is about 8" square and once mounted in the top, in theory, should be evenly illuminated. The film aperture was cut from a sheet of heavy black card stock and attached to the smaller diffuser in the top of the unit with double-sided tape. The film aperture opening used for the 4x5 wedge was cut 4.125" x 5.5" to allow the step wedge to be taped to the upper diffuser across one end.

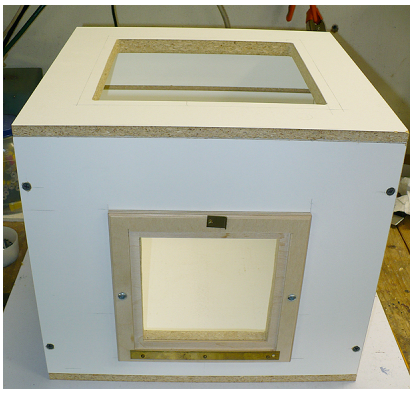

Figure 2
The fully assembled box with the mount for the flash unit and cutout top. The second diffuser is mounted in the cutout in the top.

A 10" square of Melamine was attached to the top using a strip of piano hinge. The hinged lid was aligned so a 4" x 5.5" piece of black foam aligned with the film aperture. This would serve as a pressure plate when closed, to press the test film firmly against the step wedge and the upper diffuser surface.

THE LIGHT SOURCE

Now I needed a suitable electronic flash. I had in a box of old equipment buried in the closet a Sunpak Auto 511 electronic flash. This, I decided, would fit the bill for sure. The only concern was the fact that this is a really powerful flash and would require a lot of light attenuation. That was not a real concern, since I could use any number of devices to lower the light output. The most important thing was the flash had variable power ratio in its manual mode. Prefect for what I was designing.

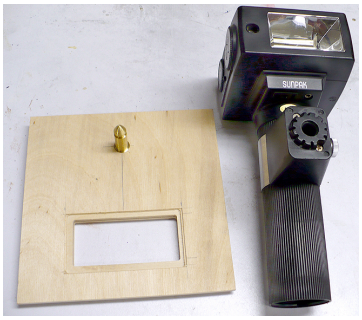

Figure 3
This is the modified Sunpak flash and the mounting board. The ND filter pack is held to the back of the mounting board with tape. The ND filter pack is used to calibrate the light output of the flash.

I made a mount for the flash that resembled a lens board for a wooden camera. The flash was mounted so it fired through an opening in the board. Black foam was used to form a light-tight seal around the flash head. The flash with its removable mount board was attached to one side of the box, centered left to right and about 4" above the bottom on one side.

A big concern with the flash unit was to be sure the output was repeatable. I decided that the only way to be sure the unit had the appropriate amount of power was to run it off of AC power using the adapter that came with the unit.

Figure 4

The flash unit attached to its mounting board on the side of the main box. The flash fires into the large box which acts as a mixing chamber to evenly illuminate the large diffuser.

Since I had no intention of running the unit off batteries I removed the battery holder and instilled a pushbutton switch in the end of the handle. In my configuration, the flash is mounted upside down, so the fire button was in a convenient place to locate in the dark. I cut up an old flash cord and attached it to a N/O push button switch to fire the unit.

ATTENUATING THE LIGHT

I knew beyond a shadow of a doubt that the flash output was far too intense. Even in the manual power ratio mode set to 1/64 power, it was evident there was way too much light when the flash fired. I needed an attenuator and that is what a Neutral Density Filter is for. I really didn't want to use an expensive filter so I proceeded to make my own.

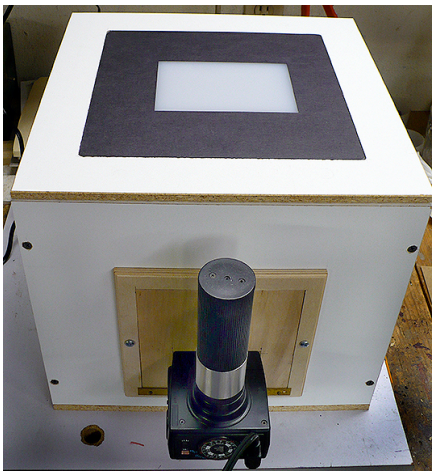

Figure 5

Here is the main assembly of the sensitometer. The flash is attached and the top with its film aperture mask has been assembled.

There were several sheets of 4x5 Tri-X film on my desk from who knows what. They had been there for years and were beyond a doubt fully exposed. I found a quart bag of Kodak D-76 developer under the darkroom sink and proceeded to mix it per the instructions. I placed the film in the developer, with the lights on, and agitated for about ten minutes. I wanted maximum density and that is what I got. After fixing and washing the film I cut a piece of film that just covered the flash opening and taped it into place.

At this point the sensitometer was pretty much mechanically complete. Next, the big test for evenness of illumination of the film aperture.

TESTING FOR EVENNESS

With my homemade ND filter in place I could see that the light was much less in the film aperture. My burning question was still, is the light across the aperture even? I turned the sensitometer on its side and aimed my digital camera toward the aperture, tuned out the room lights, and made several exposures of the unit as it was fired.

Figure 6
Here is the test setup for checking the evenness of illumination of the film aperture. Note that the sensitometer box is on its side with the flash on top.

Upon opening the files in PhotoShop I was pleasantly surprised to see that the evenness across the entire aperture varied by only one pixel count. This confirmed that I had very even illumination. Next I needed to calibrate the light intensity.

CALIBRATING THE FLASH

My next test was to calibrate the sensitometer light output to a known level. For this I used a film and developer combination that I knew from experience would give me an Exposure Index of 200. I proceeded to install my step wedge, then shoot film and develop and measure using a densitometer. I was looking for an exposure that would center the step wedge range on the film. Of course, the output was still way too hot.

Figure 7
This is the setup for calibrating the light output of the flash unit. Note the paper dial attached to the power ratio wheel on the flash. Also visible is the homemade ND filter over the sensor of the meter.

My goal was to calibrate the sensitometer to an EI 200 value with the power ratio dial set to mid range. On my Sunpak, this was 1/8 power. I had to add several more layers of my homemade ND filters, but I finally found the correct exposure.

I had already decided that I could not trust the power ratio dial on the flash to be calibrated close enough for my use. I now knew that the mid setting of 1/8 power was EI 200, but I needed to devise a way to accurately calibrate the power ratio dial in one-stop increments above and below this setting. I ended up removing the flash, with the ND filter pack attached, and then C-Clamped it to my tabletop to keep it from moving. Next I taped a Minolta Auto Meter IV aligned just below the flash head.

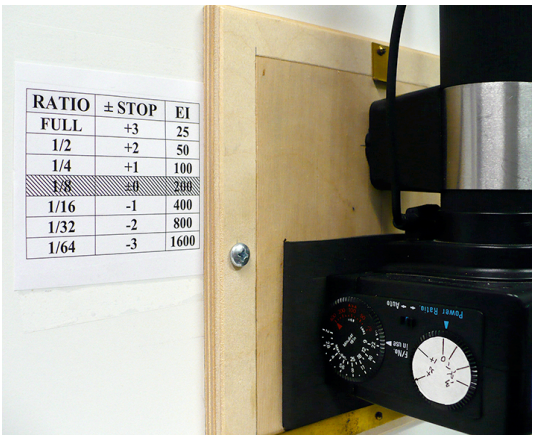

Figure 8
Here the flash is installed on the finished sensitometer. Note the new calibrated power dial on the flash and the cross-reference attached to the box.

I knew I still needed some serious attenuation of the light so I cut another piece of ND filter I had made for the box and placed it over the meter sensor. I removed the white incident dome from the meter also. By playing around with the ND filters and the distance between the flash and the meter I was able to get a mid scale meter reading with the power ratio dial on the flash set to its mid point.

As I suspected, the calibration of the dial from the manufacturer was far from correct. I made a paper overlay for the dial and marked each full stop increment either side of the mid power point. I marked my mid point as zero and made a cheat sheet that I attached to the side of the sensitometer for future reference. With this calibration I have at least two stops either side of my mid point calibration. The sequence looks like this:

RATIO	± STOP	EI
FULL	+3	25
1/2	+2	50
1/4	+1	100
1/8	±0	200
1/16	-1	400
1/32	-2	800
1/64	-3	1600

Figure 9

This is the calibration cross reference for the calibrated flash unit. This unit was calibrated to a known EI of 200.

At this point, I now have a fully functional sensitometer. Now it is just a matter of putting it to use.

USING THE UNIT

Using the sensitometer could not be easier. With the unit calibrated all you need to do is load the step wedge into the aperture and expose. I use a small strip of gaffer's tape to hold the wedge in place. All you do is dial in the exposure required for the film test, turn out the lights, place a sheet of film in the aperture sandwiched with the step wedge, close the top, and push the button.

Though the Sunpak flash should recycle instantly, I always wait at least thirty seconds between exposures. This is not normally a problem since it takes at least that long to put the exposed film up and get another. Remember, to be sure to keep your exposed and unexposed film covered in a box so you do not fog the film with stray light when the flash fires.

Figure 10

This is the finished sensitometer ready for use. Note the hinged top and foam pressure pad have been added. The step wedge is taped into the film aperture in the top. With the flash set to the proper power it is ready to expose a sheet of test film.

I have used this homemade sensitometer for several series of tests and it has proven more than accurate enough. Sometimes you just have to do what is necessary and this little project has been more than useful for me. If you decide to build your own sensitometer I hope you find this information helpful.

FINE ART PHOTOGRAPHY
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