TUTORIAL: How to Pick the Perfect Film Scanner

By Mark -Amateur Photographer

Technology advancements have pushed us into a digital world, which promises faster speeds and better quality. Products like TVs, camcorders and cameras are all going digital. The market for traditional film has diminished due to the popularity of digital cameras, which came into our lives in the early nineties. The demand for digitizing legacy film has dropped dramatically. Consequently, the major players, such as Nikon and Kodak have dropped out of the film scanner arena. When professional photographers try to digitize their past, the choices of film scanners are now greatly limited.

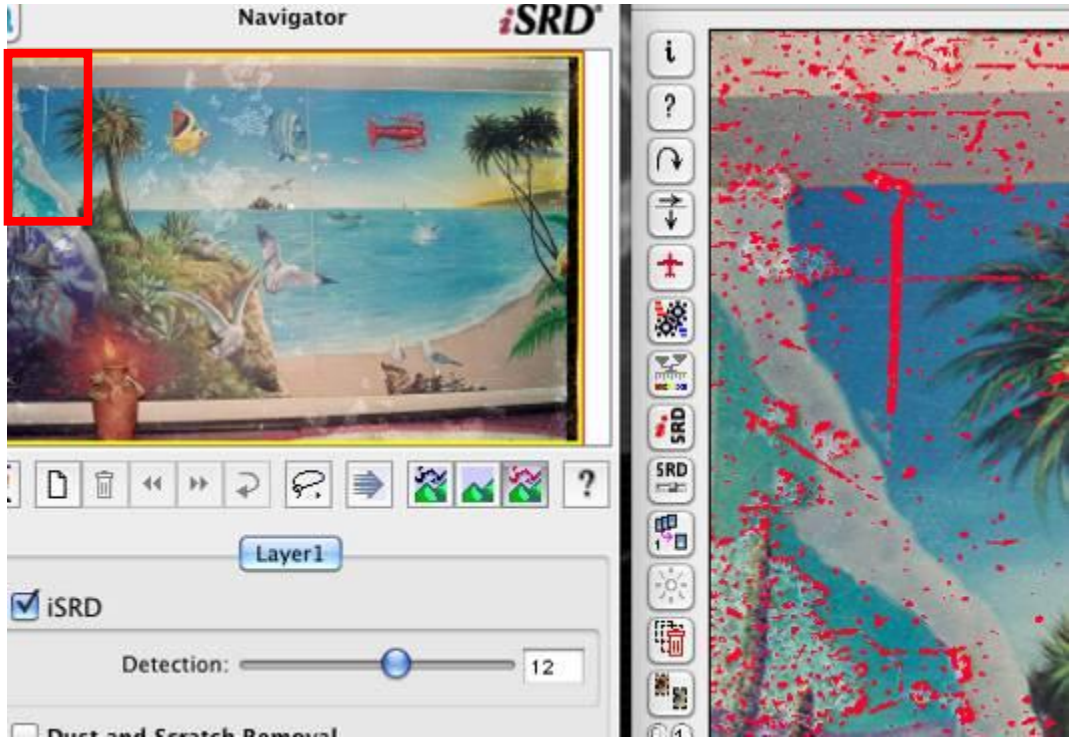
There are many elements required in order to produce the quality needed to satisfy the most demanding professional and amateur photographers; they are, Infrared Dust/Scratch Removal, Multi-Exposure, LED light source and Multi-Sampling features:

Ultra high measured resolution

Due to the size of film is one-fifth of a 5 x 7 photo; if a professional scan a 5 x 7 photo at 600 dpi(1200 dpi) then 5 times of that is 3000 dpi (or 6000 dpi). However, for the future use, you want to preserve your film at highest MEASUREED resolution.

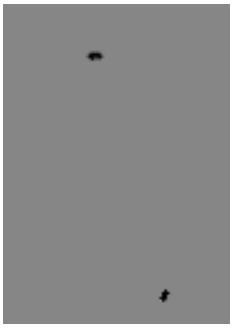
Infrared dust/scratch removal

You may find hundred of scratches/dusts on an aged film easily (see screen capture below; the defections are shown on red). Without this technology, users end up spending hours on each scanned file to clean up.



Some people mail their films to a service depot for digitizing and they never know that during the transportation, dozens of scratches have been created to their beloved films. The best way to handle films is to have them mounted in a film holder and never allow them to physically touch any objects besides the holding area (both edges) and the best way to preserve them is to digitalize them.

Infrared dust/scratch removal technology requires a scanner be equipped with a tertiary infrared channel. The infrared channel (something not found on low-end film scanners). The regular light channel generates RGB color images (the left picture) while the infrared channel produces grey images due to all colors respond equally to infrared light (the middle one). Any dust spots or scratches on the film appear as dark spots in infrared gray image. The software will locate the scratches/dust from the grey image and find the corresponding spot on the RGB image. It analyze the surrounding area of the defective pixel on the RGB image and then create cloned, original-like data through proprietary algorism to replace the defective pixels(the right one). This hardware-based infrared dust/scratch removal technology delivers unmatchable results compared to software based dust/scratch removal, which often time mistakenly removes objects.


Multi-Exposure:

Multi-Exposure -a must-have function is a combination of hardware and software engineering. Different colors on film respond to the light differently. The exposure time (measured in microseconds) required to produce a particular live color is different from color to color. Certain amounts of light (exposure time) may not be enough for darker area such as “green” and can be too much for lighter area such as “RED” (causing over exposure). A scanner should have the ability (using *both* hardware and drive software) to

capture each pixel in varying amounts of exposure in order to satisfy all colors accurately. Once the hardware has properly identified each pixel (according to its unique color attributes and varying exposure times) the scanner software should them be able to recognize this data and assemble a perfect scan! As a result, Multi-Exposure increases the Dynamic Range dramatically. Even Kodachrome films, which have a high density in dark sections, are no longer a problem for film scanners equipped with such hardware *and SilverFast scan* software technology.

This area needs more light (longer exposure) to show the details as on the left

Without Multi –Exposure

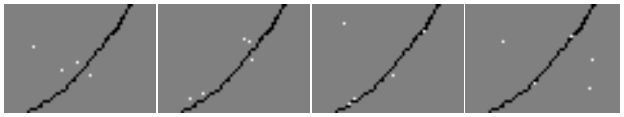
With Multi –Exposure

To enhance scan speeds, Multi-Exposure may be set to capture the same pixel of an image only in two different amounts of exposure time. By comparing the change in exposure time and the change in color, the software is able to figure out what a proper exposure time and its corresponding color is.

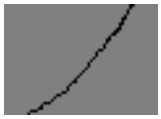
LED light source:

The traditional cold-cathode illumination systems produce an unbalanced light source that may not be bright enough for green color on the film. They also take longer to warm up, stabilize, and tend to degrade easier. Users not only have to wait for warm up but also need to calibrate from time to time. The LED based illumination system not only saves energy (up to 30% more efficient), but also overcomes all the issues of cold-cathode illumination systems to deliver live colors.

Multi-Sampling:



Four Samplings
(Those white spots are noises)



The final scanned clean image

Under our working environment, subtle electronic noises occur quite often. They come and go all the time; even when people nearby power on/off a light or a device, a noise is emitted into the scanner to affect the CCD analog signal and the scanned image. The noise affects the most on the darker areas of images, where the CCD sensors have a very small amount of light and the signal is very weak, and generates "strayed pixels".

Multi-Sampling technology capture images multiple times to identify and eliminates the noises at a pixel level. By comparing the different images captured, the software is able to isolate the noises (the offending pixels) and replace them with a clean image. The multi-sampling can proceed with single pass or multiple pass scanning:

Single pass Multi-Sampling means every single line will be captured multiple times before proceeding to the next line. The scanner has to drop the moving speed of its image sensor to ensure the alignment of the multi-sampling and prevent the noise becomes a constant during very short period time when the image sensor is sampling a specific line.

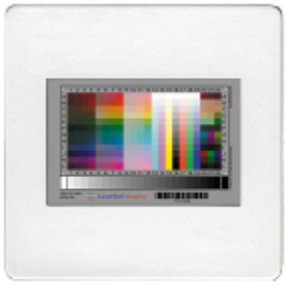
Multiple pass multi-sampling scans the whole image multiple times. Each line captured is from a different pass of the scan. This approach may look slower, however the interval of each line is the scanning time of the whole image and most noises during the first scan should have gone and new noises have come to different pixels. The movement of the CCD may produce misalignment during a different scan, however, by comparing the image during noise removal the software is able to overcome the disposition and deliver a clean image.

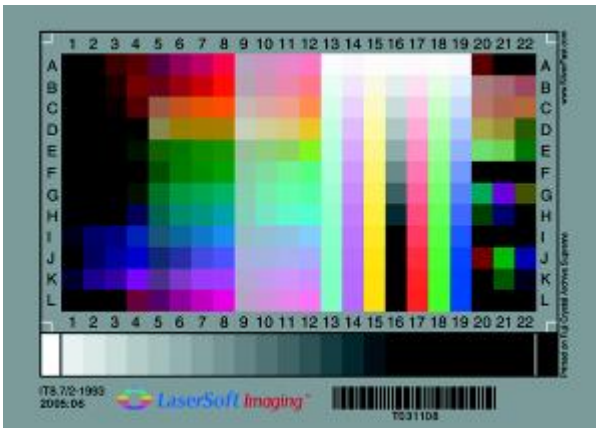
About Color Output (ICC profile)

When looking for color accuracy, you need an ICC (INTERNATIONAL COLOR CONSORTIUM) profile from the scanner, which tells the output device how to display/print all different colors to match the original object scanned. As long as all devices in the loop have been calibrated per ICC standards, the accurate colors can be ensured in all steps of processes.

To calibrate the film scanner, you need to have a standard color calibration sheet called IT8 Target (per ANSI IT8.7/1 and ISO 12641) to create an ICC profile. There are companies produce the IT8 Target such as Fuji Film, Kodak and LaserSoft Imaging. The

price ranges starding from $50 per sheet and the most expensive handmeasured one tagged $325 per sheet. The full range of high quality IT8 targets is from LaserSoft Imaging , the SilverFast company. Good news is some high-end film scanners have already bundled the IT8 target. Surly you need software to perform the calibrations and create the profile. Most high-end film scanners have come with that. During the calibrations, the software locates a specific color block(see the photo below) and read its average color value then compare to the corresponding standard color value (the so called "reference value") of that location (block) to create the ICC profile.





The IT8 Target may cost you up to $325 for individually handmeasured targets

Conclusions:

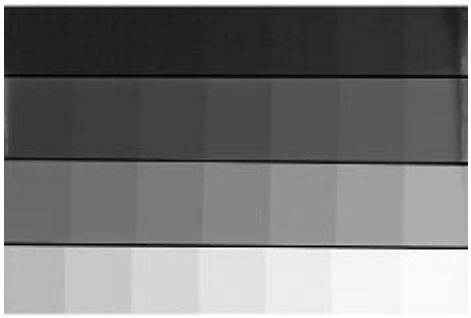
When all elements come to play, the bundled software has to act accordingly. There two software companies dedicated to improve the quality of scanning images.

SilverFast (LaserSoft Imaging) offers Multi-Exposure, Multi-Sampling and infrared dust/scratch removal. With its professional and powerful tool, the SilverFast has dominated the industry. The LaserSoft Imaging released its iSRD - infrared Smart Removal of Defects in 2008 for all slides includes Kodachrome.

Digital ICE (Image Correction and Enhancement): Kodak's Austin Development Center developed the technologies in 1950. It is a driver level software offers infrared dust/scratch removal for non- Kodachrome slides.

The mystery of dynamic Range (or intensity range)

A best PMT (Photo-Multiplier Tube) based drum scanner, costs up to $50,000 and weights up to 150lbs, may be able to deliver a dynamic range of 4.0. Then what happen to those desktop scanners claim its dynamic range as high as 4.8?
Regardless of the math and theories, in a simple term, the Dynamic Range is the levels of detail an input device is able to identify. By scanning a Dynamic Range testing chart(shown below), then use software to read the transition value among the blocks.



The white (light) area is easy to a scanner; however, the darkest "black" block, which delivers the weaker signal to the image sensor, is tricky. The darkest block a scanner can identify represents its Dynamic Range.

There are two factors contribute to the Dynamic Range that are the quality of analog image captured by an image sensor and the grade of the AD converter used to convert the analog signal to digital.

The thermal noises are mixed into data stream during scanning. To isolate the thermal noises, a PMT scanner uses a vacuum tube since electronic noises require media to transmit. To further reduce the thermal noise, the PMT system usually works under a "cool" environment. With the low thermal noise of clean data, the software is able to amplify those weak signals of the darkest area and reveal its details.

The AD converter is the 2nd contributor to dynamic range. By theory, supposed there is no thermal noises, the highest 8 bit AD converter can produce a 24 bit color image with 2.4 of Dynamic Range and a 12 bit AD converter create a 36 bit color image with possible Dynamic Range of 3.6, again no thermal noises. Finally, a 16 bit Ad converter would possibly deliver a 4.8 Dynamic Range of 48 bit color images if the image sensor received no noises.

By now you may have already found that instead of stating "Dynamic range is 3.6 (or 4.8)", the scanner manufactures should have just said "We use 16 bit AD converter and possibly offer the highest Dynamic Range is 4.8 if our sensor receives no noises at all"

As shown earlier on the document, a scanner may apply multi-exposure to increase the Dynamic Rage especially if the thermal noise is very low. To apply those features the scanner has to bundle a proper image enhancement software to do that.