Scanning

Overview

The role of a scanner in the digital workflow is perhaps the single most important function of the entire process. There is an inevitable loss of information in your image as it goes through its transitions culminating in a print. All other things being equal, you will generally produce a finer print if you start with a superior scan. While there are techniques to correct some of the problems created by lower quality scans, you will at best get closer to where you should have been to start with. And with many images, it will prove impossible to recover the tonal range and color saturation you desire without introducing various digital artifacts such as posterization and color shifts.

What Makes A Good Scan?

There are several key factors that contribute to the quality of a scan. These include resolution, bit depth, software algorithms, ICC profiles, dynamic range and the skill and technique of the person operating the scanner. The Color Folio Heidelberg TANGO™ drum scanner offers unparalleled capabilities in each of these categories. Let's examine each in turn.

1. Resolution

Scanner resolution measures the number of samples the scanner sensors take per square inch of film. Scanners are all RGB devices, so they provide three numerical values for each sample. Each of these values represents the amount of red, green or blue present in each part of the tonal range. The greater the resolution the image is scanned at, the larger the resulting file size. Larger initial scans allow you to output larger prints with less degradation of image quality. Scanners typically allow you to scan at "optical" resolution as well as "interpolated" resolution. Optical resolution results in a file consisting entirely of information actually measured on the film while interpolation uses information measured on the film to fabricate new values to create a larger scan. You should always use only optical resolution as the interpolation performed in the scanner interface may not result in as high a quality as interpolation performed by other applications such as Photoshop, if such interpolation is even necessary.

How much resolution is enough? We recommend that you scan your film only once, so it is important to get the best scan possible to start. Our empirical tests have shown that today's fine grain films, such as Velvia, do not contain useful information past about 5000 dpi (or samples per inch). So scanning above this level takes more time and costs more, but does not typically result in a superior result. For 35mm film, this resolution results in a scan size of about 100mb - larger film formats at that resolution produce scans at least 300mb in size.

Very few scanners on the market can provide true optical scan resolutions of 5000dpi. Color Folio's Heidelberg TANGO™ drum scanner can actually scan at resolutions greater than 10,000dpi for any size film.

2. Bit Depth

Scanners can differentiate varying levels of color and tonality by virtue of their bit depth. Some low end scanners only sample information at the rate of 8 bits of data per channel - this means they only distinguish 256 shades of any given color. High end scanners, such as the TANGO™ drum scanner, sample at 16 bits per channel which allows them to distinguish over 65,000 shades of each color! At some point in the workflow it is necessary to convert your file to 8 bit mode since today all output devices accept only 8 bits of data.

Higher bit scans allow you to not only capture subtler tones and colors but subsequent adjustments to the file which may damage the image quality at the 8 bit level have no such effect on 16 bit files.

If you start with only 256 shades and make changes to them, particularly large corrections, there is a chance that you may create gaps where some of the 256 potential values are "depopulated". This can result in loss of smooth tones or digital artifacts such as posterization. If you start by making changes to 65,000 shades and then convert to an 8 bit file with 256 shades, it is much more likely that there will be no gaps in the tonal range - you are less likely to have "depopulated" any of the final 256 shades. Many scanners actually perform the scan at the greater bit depth but when saving the scan to disk clip the file to 8 bits. It is certainly preferable to at least scan at the greater bit depth - it is even better to have the option of saving all 16 bits to disk. This can not only reduce risk to image quality later but as output technology improves it is possible that having archived all 16 bits of information from the scan may prove beneficial.

3. Software Algorithims

Scanner software is probably at least as critical to the quality of the scan as is the hardware. Numerous times I've seen significant improvement in quality simply when the scanner manufacturer releases a new software upgrade without any change at all to the hardware. This has not only to do with the control the interface gives you but also with the quality of the internal algorithms that do the work. The Heidelberg TANGO™ uses the Linocolor software, a full featured interface with internal algorithms written to completely support 16 bit scanning. Shadows are clean, dynamic range is excellent and colors are accurate.

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4. ICC Profiles

ICC scanner profi les are used to normalize minor discrepancies in how each individual scanner interprets colors. They also help to compensate for different types of film stocks when scanning. Ideally you should have custom profiles for color negatives and transparencies for different types of film. At Color Folio, we have custom profiles for Fuji, Kodak and Agfa films. We have further made specific edits to the profiles to increase even further the high degree of shadow detail revealed by the scanner. Scanners allow you to make prescan corrections in a low resolution preview of the image. The scanner software should combine in that preview the ICC monitor profile, the scanner profile and the corrections in order to show you what you will get in the final scan.

5. Dynamic Range

Dynamic range (sometimes referred to as dMax) is the measure of how much information the scanner can pull out of the film, particularly critical to capture of dark shadow detail. You will typically find dynamic range ratings from 3.0 on the low end up to 4.2 on the high end. This is a logarithmic scale, so each .1 difference actually represents a fairly signifi cant increase in information.

Unfortunately there is no standard way to measure dynamic range making it very difficult to compare one scanner to the next. It is safe to say that drum scanners have a greater dynamic range than film or flatbed scanners. We believe that a dynamic range of at least 3.6 is required for fine art printing and ideally the rating should be over 4.0. The TANGO™ drum scanner has the highest industry dynamic range rating of 4.2.

6. Skill and Technique

As in most endeavors, success depends partially on the proper gear, but probably more on who is using it. Is the person making the scan a technician who looks at each image as merely a set of numerical values, or someone who understands art and photography as well as technology? Is their eye looking for something they know will translate to a high level of aesthetic quality when the final print is made? Are the scans done using the scanners “automatic” settings to increase throughput, or is each image measured individually to ensure that its particular color and tonal range requirements are accounted for? Our experience is that these perspectives and techniques are a necessary ingredient in all successful fine art scans.

What should you expect to see when you open up a good scan. First you should look for a good histogram. It should be smooth with no gaps and should occupy the part of the tonal range appropriate for the image. Often the scan will look slightly flat and perhaps desaturated. This is because one of the key objectives of a scan is to preserve all shadow and highlight detail that might be in the image. By keeping the blackest blacks at an RGB value no lower than 10-15 and the whitest whites no higher than 240-245, we ensure that if there is detail in those areas it will not be clipped and lost by the scan. It is easy to adjust this afterwards in Photoshop by adjusting the end sliders in Levels or with an S-curve in Curves to add contrast. This will typically re-saturate the colors as well.

The scan will look somewhat soft as well. This is because all sensors slightly soften an image when scanning. The image will need to be sharpened in order to bring back the detail that is in the film. Sharpening during the scan is possible but not desirable for two reasons. First, the proper amount of sharpening is dependent on the size of the final print and the resolution of the output device. This cannot always be known at scan time and may vary over time. Secondly, scanners apply sharpening to the overall image. We do not generally recommend this for fine art prints, but rather recommend a much more sophisticated selective edge sharpening strategy that is only possible in Adobe Photoshop™.

The Tango™ drum scans produced at Color Folio have smooth histograms, controlled highlight and shadow values to retain detailand are not sharpened at all. These are critical characteristics that should be present in all your scans.

Types of Scanners

There are three basic types of scanners: flatbed, film and drum. Each uses different transport mechanisms and sensor technology. While there are expensive, high end flatbed and film scanners, these products are typically lower end, desktop models priced at a level affordable to most consumers. Drum scanners are all manufactured for the high end, and priced accordingly.

Flatbed scanners have become ubiquitous. Many are priced in the $100-$200 price range. Most allow you to scan reflective art as well as film, though the latter often requires an adapter. The art or film is placed on the bed of the scanner and sensors are moved along one dimension to do the sampling (a few flatbeds actually move the bed across a sensor array). Flatbed scanners use arrays of CCD (Charge Coupled Device) sensors, often using thousands of these tiny devices to perform the scan. Most flatbed scanners offer relatively low dynamic range (3.3-3.4) and optical resolution (1200-1600dpi). While this is often sufficient for reflective art, it is marginal for large film formats and insufficient for anything but tiny web images for 35mm film.

Film scanners are devices dedicated to scanning only film. Most handle 35mm but there are models that can scan medium format and 4x5 film. Generally film is placed in a holder that traverses a CCD sensor array for sampling. Resolution ranges from 2700-4000dpi and dynamic range is generally in the 3.6-3.9 range. Recent claims from some manufacturers that their desktop film scanners match the 4.2 dynamic range of a drum scanner are highly suspect. Film scanners are more expensive than flatbeds ($1500-$2500) and only scan film, not reflective art.

Scanning

Drum scanners can scan both film and reflective art, limited in size only to what can be wrapped around their drum. Film is typically “wet mounted” meaning that it is suspended in fluid between the drum and optically pure mylar. Wet mounting keeps the film surface uniformly flat, clean and clear. Wet mounting is traditionally done using oil, which can break down the film emulsion over the long term. We recommend the use of KAMI™ fluid, a petroleum based solution that evaporates instantly and will not damage film over time.

Drum scanners use Photomultiplier (PMT) tubes rather than CCD sensor arrays. PMT tubes are extremely sensitive to light - they have the ability to detect light from stars! As a result, they produce very clean scans with very low noise. This results in high dynamic range ratings - the Color Folio TANGO™ scanner has a dynamic range of 4.2 and is very capable of pulling out shadow detail you probably can’t see even on a light table. High resolution at any film size is another quality of drum scanners. The TANGO™ can scan at over 10,000dpi if necessary and all resolutions on a drum scanner are true optical resolutions.

Summary

Just as you want your music to sing as it reaches your senses from your audio system, you want your images to sing to the viewer as they hang on the wall. You’ve recorded that image on film and starting it on it’s way to a fine art print with a superior quality scan is an essential step. Compromises in quality at that stage will ripple through every subsequent step and will ultimately compromise the viewers experience as well. It will interfere with the viewers pure interaction with the art. As we have seen, there are many technical and aesthetic factors involved in creating a high quality scan and each must be tuned and orchestrated to enable the creation of a beautiful fine art print.