

The Plustek Optic Film 7600i-Ai Scanner

Lasersoft Imaging Inc. (LSI) asked me whether I would be interesting in preparing a review of the Plustek 7600i-Ai film scanner, which comes bundled with SilverFast Ai 6.6 Studio and a SilverFast IT8 target for profiling the scanner. The agreement between LSI and me was that they would arrange a loan of the scanner/software, I would design the review, test the package, receive technical support from them if needed and “call the shots” as I see them.

The Plustek 7600i is a rather unique product in the scanner industry for a couple of reasons. Firstly, it is the product of a close collaborative relationship between independent developers of hardware and software. The scanner was designed to work optimally with SilverFast, and the two companies cooperated to assure operational coherence between the hardware and the software.

Secondly, if you look around the market for dedicated film scanners these days, you will see that there is precious little available – especially of equipment which can deliver quality scans with high dynamic range and high resolution in 16-bit format. You can still buy a Hasselblad Flextight in the range of USD 13,000~20,000. Short of that, you may be lucky enough to find a retailer with an unopened Nikon Super Coolscan 9000 ED (B&H still lists it for USD 2200, but for quite some time now as “temporarily unavailable”), while the much sought after Nikon Super Coolscan 5000ED has been discontinued and a number of them sold on eBay this year for around twice or more the original retail value of about USD 1300. Minolta once made the very high quality Dimage Scan Elite 5400 and 5400II models (which were also in the thousand dollar range), but vacated this line some years ago.

The Plustek 7600i-Ai retails in the USA for \$520. An independent purchase of the bundled software would cost \$218 from LSI’s website, hence the residual value of the scanner for the advertised specifications (16 bit/channel depth, 3.5 dynamic range, 7200 PPI optical resolution and availability of the infra-red channel) is really very low relative to the prices of previous equipment in its technical range. So given the paucity of considerable alternatives for quality film scanning and the very attractive pricing of this model for the stated specifications, I thought it would be most interesting to try it and see what it could deliver – at least in my hands.

This is a results-oriented review set in a comparative context and limited to 35mm positive and negative colour transparency films. The comparators are scanners capable of delivering high optical resolution, good dynamic range and 16-bit depth: specifically the discontinued Nikon Super Coolscan 5000ED and the still current Epson Perfection V750-M Pro which is Epson’s high-end flatbed scanner with the film scanning adapter built-in to the lid (US \$850). While the Nikon scanner is discontinued, I believe it remains a comparator of interest because it sets a benchmark against which to evaluate the quality and price-quality trade-offs of the test equipment, and it does become available on the resale market from time to time.

The results of interest to me, and I expect to most other photographers who scan film, are (in no intended order of priority): (a) operating speed, (b) efficiency of dust and scratch removal, (c) edge and texture rendition (d) colour consistency between the original media, the scan and the same image opened in Photoshop and (e) rendition of detail in the lower quarter-tones. Hence this review examines the Plustek in the context of the three scanners for both positives and negatives.

Before getting into the testing procedures and results, I should convey a few impressions about the scanner itself.

Figure 1. Plustek Optic Film 7600i-Ai



It is a compact machine provided with two quite robust film holders – one for mounted slides and the other for film strips. It is fixed focus, and there are no mechanics for using the film holders. The user slides them through the scanner's side-slot, there being a decisive "click-stop" provided by notches on the holders each time the next frame is correctly placed. The strip holder accommodates six frames and the mounted slide holder four slides. The strip holder holds the film strip securely and as flat as possible absent a glass sandwich. Slides can be no flatter than provided by the mounted media. The scanner also operates very quietly. This simplicity and smoothness of operation are appreciated, though one may ask about any sacrifice of sharpness without manual focus. The Epson scanner cannot be focused manually either, but NikonScan allows the Nikon scanner to be focused using alternative focus points on the image preview selected in the software. SilverFast for Nikon does not support this feature. The Minolta Dimage Scan Elite 5400 and 5400II could be focused manually, but I never needed to do so, nor have I seen the need with the Nikon scanner.

Installation of the scanner and the SilverFast software proved to be a straightforward, seamless procedure, with one caveat especially for users on Windows operating systems:

it is NECESSARY to exactly follow in order the new Quick Guide Instructions dated from April 13, 2010 onward in order to prevent potential conflicts between devices at the system level. This is easy to manage. I now turn to operating experience and results.

(a) Operating Speed

Scanning is a two stage procedure: a pre-scan within the scanning software to perform all the edits entering into the intended result, and then the scan itself, which then exports the scanned image to a folder on one's hard-drive and, if desired, opens in an external editor such as Photoshop. The Plustek pre-scan is very fast – it takes less than 10 seconds. The Epson pre-scan is also fast, considering that it pre-scans a letter-sized film holder containing numerous images, from which one may select a single frame of interest or do a batch scan. The Nikon pre-scan is considerably slower than that of the Plustek. The scanner goes through an automatic focusing and exposure determination routine before showing the pre-scan preview image. This can take over half a minute.

The speed of the scan depends on file size. The more data which needs to be scanned, the longer it takes. I decided to standardize my resolution and file size to 360PPI and uncropped image dimensions of about 14 inches by 9.2 inches. (This roughly provides pixel dimensions of about 5040 by 3312 pixels [360 * 14 by 360 * 9.2], or 16.7 megapixels.) The resulting file size is in the range of 95 MB. (Please see Inset 1 for the correct formula to convert image/pixel dimensions to file size; but relax – you can also read the same results in the SilverFast Frame Tab; I just wanted to be a bit geeky by providing the arithmetic for the benefit of the curious ☺).

Inset 1. Image Dimensions to File Size

$$\text{MB file size} = \text{PPI}^2 * (\text{L} * \text{H}) * (\text{b}/8) / 1024 / 1024$$

Where:

PPI = Pixels per Inch Output Resolution

L = length of output file in inches

H = height of output file in inches

b = sum of bit depth of all channels

MB = megabytes

Example:

Scanning a three channel (R,G,B) 35mm negative or positive in 16 bit depth to have output dimensions of 16.5 by 11 inches at 360 PPI on output:

$$\text{MB} = 360^2 * (16.5 * 11) * (48/8) / 1024 / 1024 = 95.5 \text{ MB}$$

Explanation: Squaring 360 provides the pixels per square inch. L*W provides the number of square inches. Multiplying PPI² by square inches provides the total number of pixels.

The pixels have bit depth. For an image being scanned as three channels each at 16 bit depth, the total bit depth per pixel of all three channels is 48. Because we are aiming for bytes and there are 8 bits to a byte, divide 48 by 8 to derive the equivalent bytes. Divide all of this by 1024 to convert to kilobytes from all the bytes, and divide again by 1024 to convert from kilobytes to megabytes.

On my computer (WinXP Pro SP2, dual-core Xeon 5160 processors at 3.33 GHz, 4GB RAM), the Plustek takes about three minutes to scan a file of this size, whereas the Epson can take up to 4 minutes and the Nikon about 30 seconds. This includes from the time the scan button is activated till the image scans, gets rotated and saved to hard disk.

(b) Efficiency of Dust and Scratch Removal

Thanks to SilverFast's iSRD function and the scanner's in-built infra-red channel, this is an area where the Plustek scanner really shines. Readers of my recent SilverFast review (<http://www.luminous-landscape.com/tutorials/scanning-old-new.shtml>) will be familiar with iSRD. It uses the infra-red channel to identify and isolate dust and scratches, and provides controls for their elimination, hardly affecting the sharpness of non-identified pixels. The Epson scanner also provides this functionality; for the Nikon scanner the Mac version of SilverFast provides it, but the Windows version does not – I've been allowed to "spill the beans" and say that this will be forthcoming in a future program release. The Plustek versions of SilverFast provide it for both Windows and Mac, and it works very well. While extra scan time is needed for scanning the infra-red channel, this is most often well worthwhile compared with the alternatives of using inferior alternative scratch and dust removal algorithms which do affect overall image sharpness, or cloning out these imperfections one-by-one in Photoshop. Figures 2 to 5 illustrate the effectiveness of this relatively rapid, hardly destructive procedure on the same image, at 100% screen magnification.

Figure 2. iSRD: Image Detail Before Clean-up

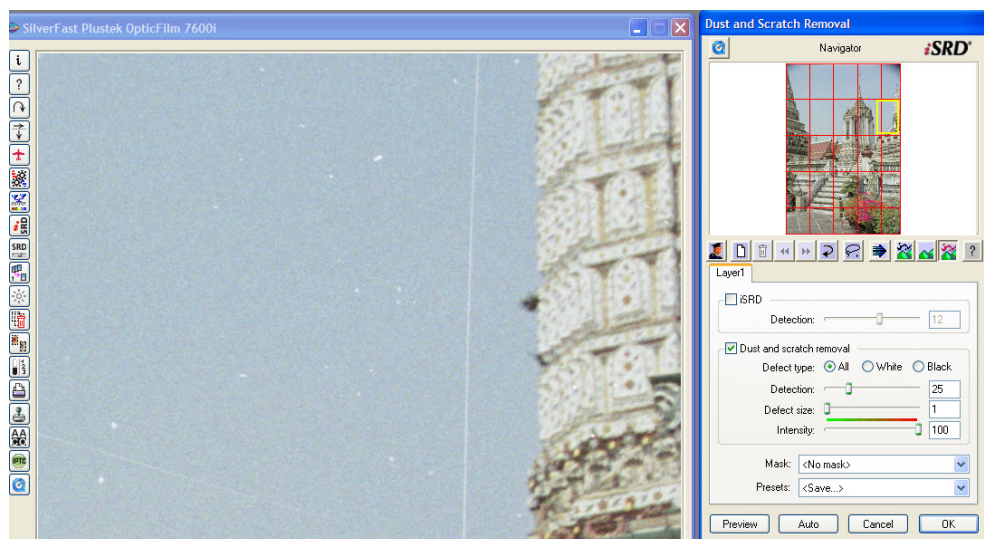


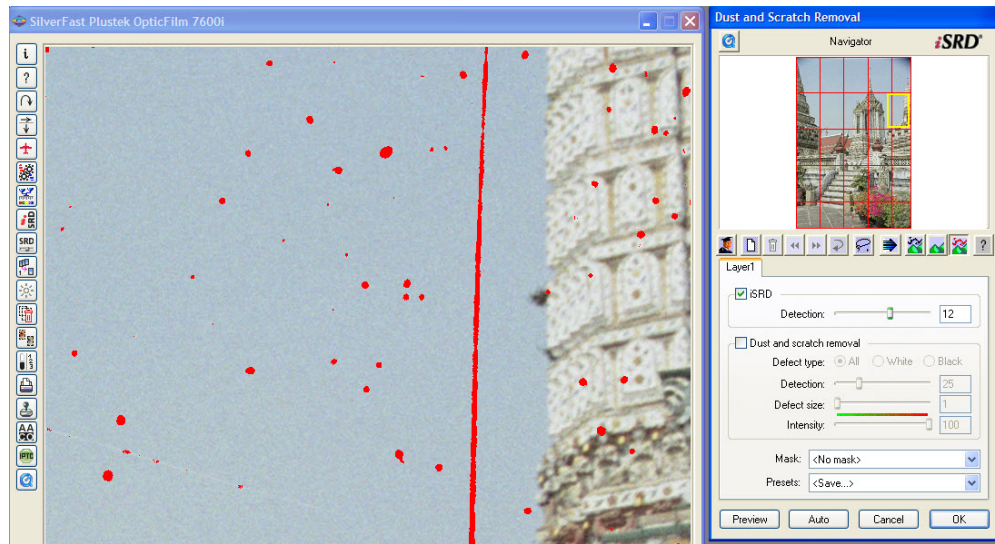
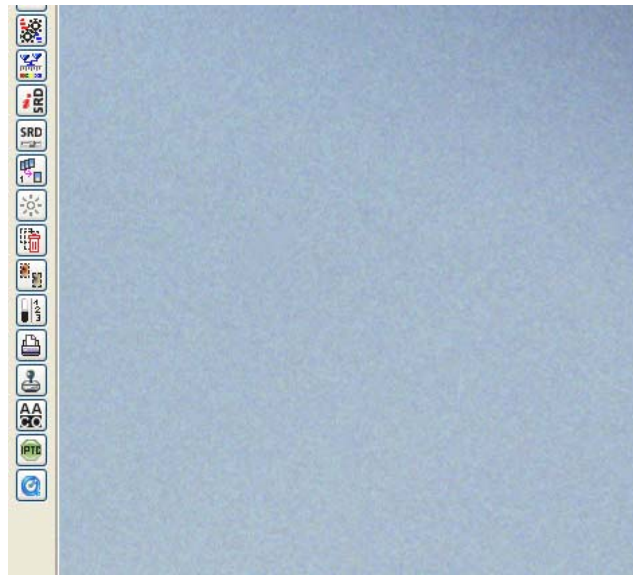
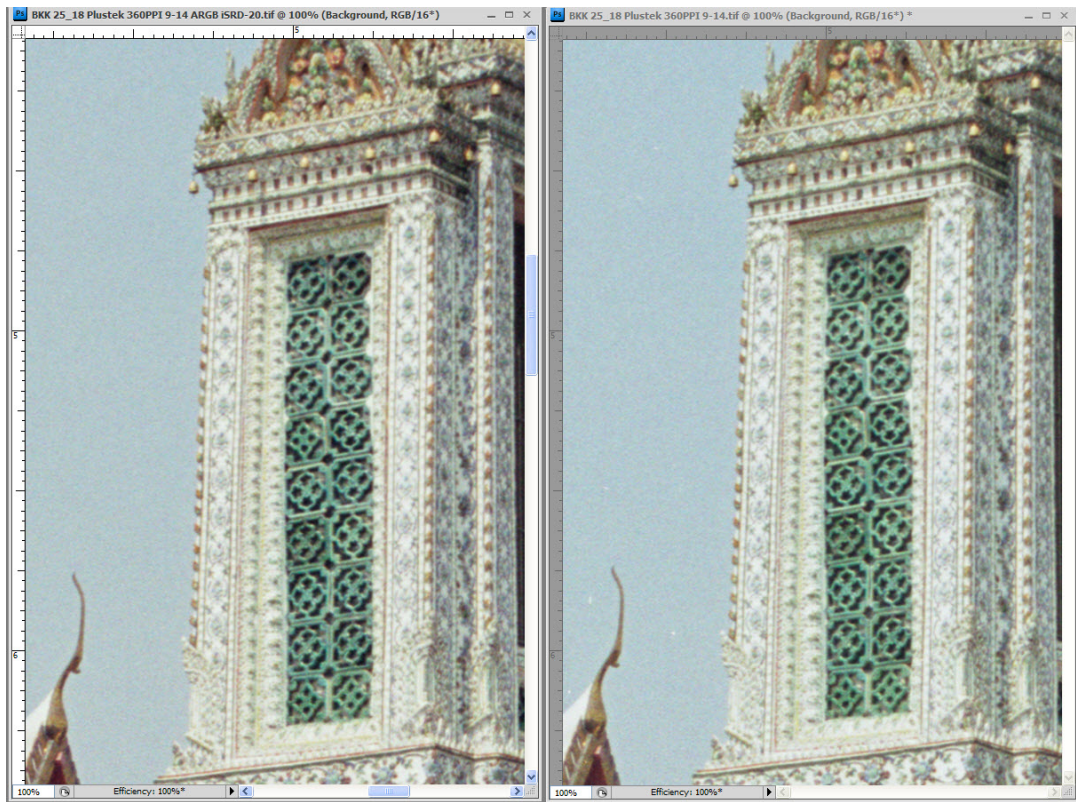
Figure 3. iSRD: Level 12 Dust and Scratch Detection**Figure 4. iSRD: Magnified Detail of Sky After iSRD Operation**

Figure 5. iSRD: Detail Retention, After (left) and Before (right)



Having this capability bundled into such a low cost scanning package is a real plus.

(c) Edge and Texture Rendition

For many, this is the heart of the question about scan quality: how sharp are the results? Perceived sharpness has two basic aspects: edge sharpness, and texture detail. Therefore to give readers an impression of how these scanners perform on both variables, selection of images is rather critical, remembering that we are dealing with film which has grain and the lenses I used years ago when I made the photographs, which were very good, but not the top-of-the-line professional picks. (I'm not discussing reduction of film grain in this review, because I recently covered that topic in my review of Topaz De-Noise <http://www.luminous-landscape.com/reviews/software/topaz.shtml>).

One of the test images I'm using here for illustrating sharpness with colour negatives is a shot of one building on the Wat Arun temple complex in Bangkok, scanned with the Nikon on the left and the Plustek on the right.

Figure 6. Full Image Resolution Comparison: Nikon (Left) and Plustek (Right)



Seen at this distance and at this size, image quality difference between the two scanners is not easy to perceive. It is necessary to scale-up the image in order to see the differences between the two scans, as shown in the fragments below at 100% magnification (Figure 7), as before – Nikon to the left and Plustek to the right. It is important to bear in mind that these magnifications would represent VERY large prints.

These samples show that the Nikon scan has more granularity (literally) and definition, but the Plustek scan is not really far behind. Recall, you are viewing a JPEG grab of a really small piece of this image very heavily magnified. As the “bottom line” for operationally significant resolution is what shows on a print, I printed both full-image scans at the scanned-in size (9*14 inches, c.360 PPI)¹ in my Epson 3800 printer on Ilford Gold Fibre Silk paper. At this size, the results are not far apart. Unfortunately, this is not possible to see over the internet, so you will have to trust my eyesight. The Plustek scan appears a tad softer than the Nikon scan, but shows well on its own. Indeed, after it has been capture-sharpened and output-sharpened, the end result is truly well defined (Please see Figure 8).

¹ Please see the side bar on a scanning resolution debate for further insight on this choice.

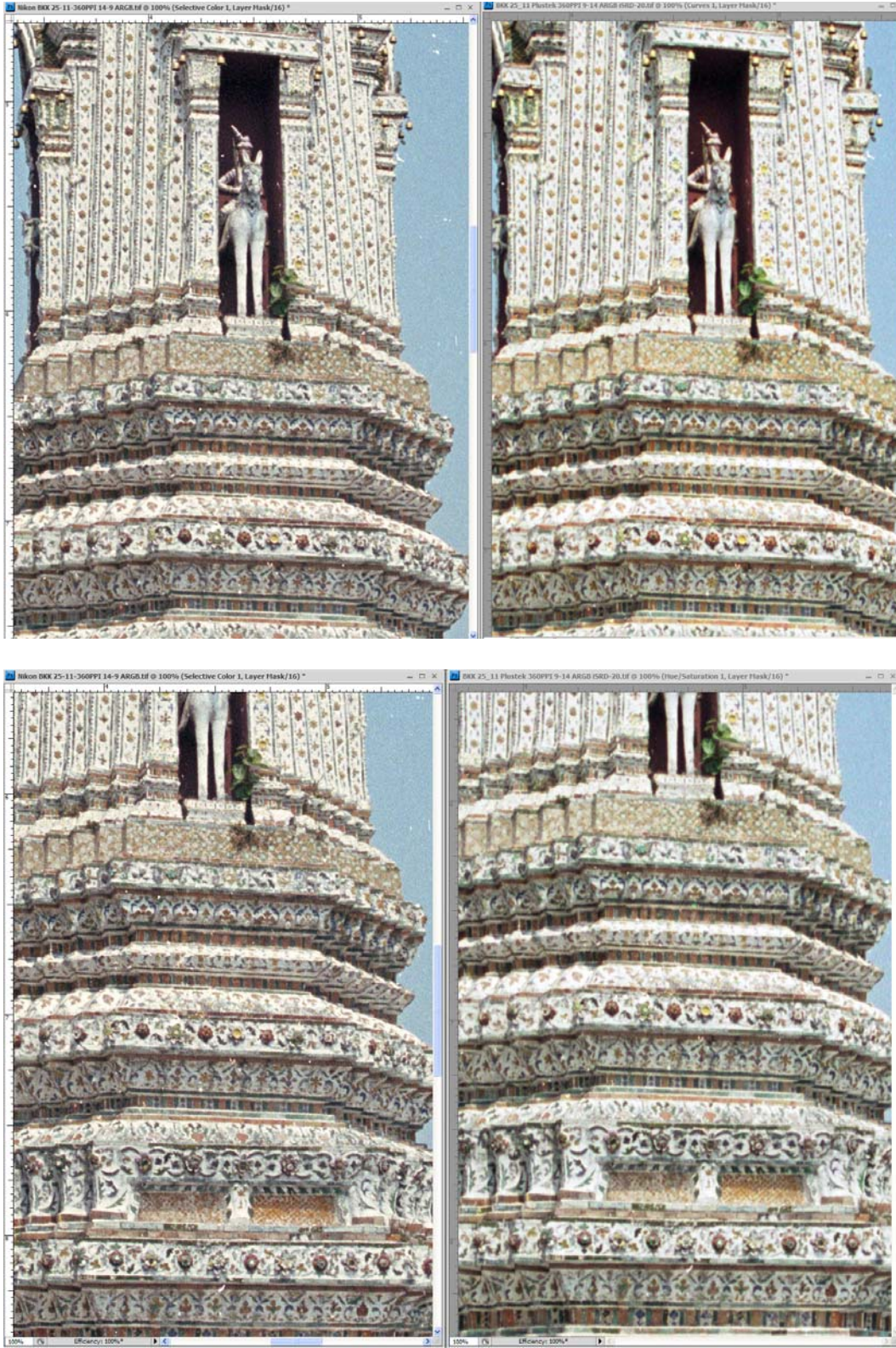
Figure 7 Image Resolution Comparison, Fragments: Nikon (Left); Plustek (Right)



Figure 8a, 8b. Wat Arun 50% Magnification, sharpened Nikon and Plustek



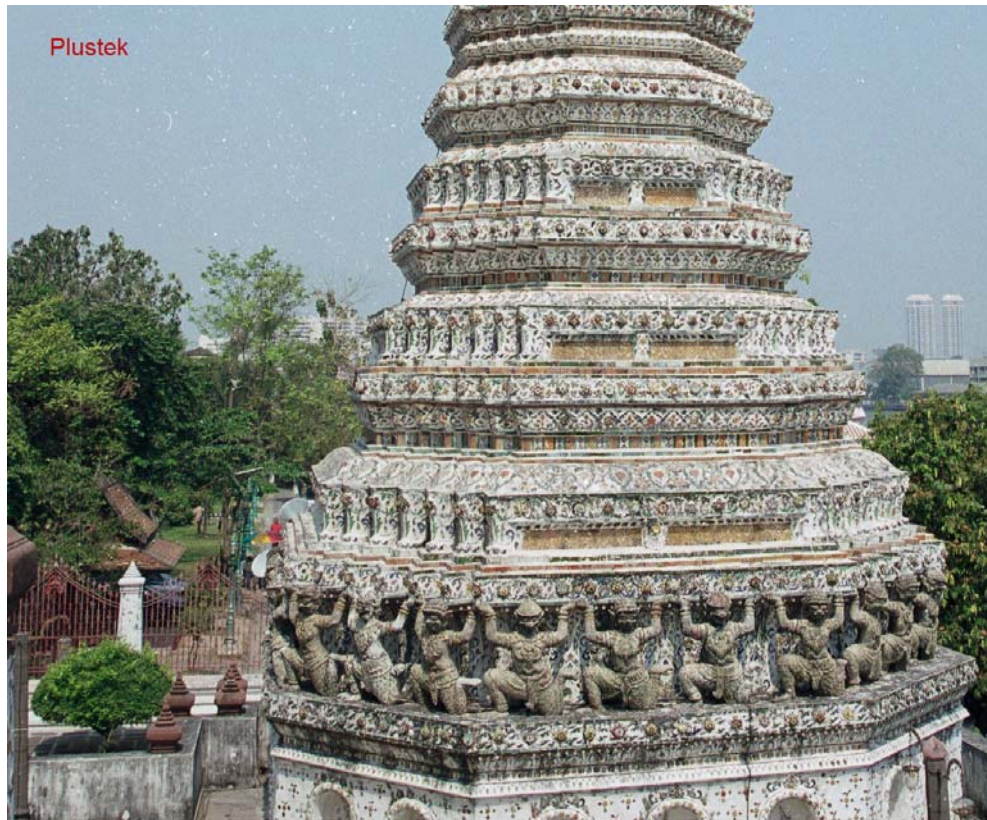


Figure 9 Epson V750M (Left) and Plustek (Right)



Figure 9 above shows a comparison between the Epson and the Plustek, Epson left, Plustek right. The Epson result is somewhat softer than the Plustek scan, to be expected from the difference of technology. Flatbed scanners are generally not preferred for 35mm film scanning compared with a good dedicated film scanner. Nonetheless, the Epson result is a very good one for a flatbed scanner. I had the opportunity to scan a medium format transparency in the same Epson scanner, and the result was considerably sharper, indicating that this scanner seems better suited to medium format transparencies than to 35mm media. I hasten to add, however, that when a 35mm Epson film scan starts with a sharp original and is appropriately Capture and Output sharpened in post-processing, like the Epson and Nikon scans, it enlarges well up to at least 11*16.5 inches.

I also scanned several positives to see whether the same order of resolution would be replicated with this media, and the answer is yes – it is, as shown in Figures 10 and 11. Image dimensions, determined at the scan stage, are about 9 by 14 inches at 360 PPI. I made the photograph at Café Sacher in Vienna, July 1989, with a Nikkormat and the Nikon 50mm f/2 lens, using Kodachrome. I like this image for demonstrating sharpness and resolution because of the highlight detail in the paper napkin, the small scratches in the silverware and, literally, the granularity of the cocoa powder on the cappuccino. (By the way, the real Sacher Torte was out of this world – I hope the tradition lives on.) I scanned it in the three scanners using custom profiles for Kodachrome made with the SilverFast Auto-IT8 profiling process discussed below. The Epson scan needed a bit of brightening on the cocoa powder to make sure its detail shows as best the scanner can deliver it. I mildly tweaked colour balance on all three in SilverFast, for better matching given the issues involved with profiling Kodachrome (next section).

Figure 10. Café Sacher – Complete Image, Scanned in the Plustek Scanner.



Figure 11. Café Sacher, Detail at 100% Magnification – Nikon, Plustek and Epson.

Viewed at 100% magnification, all three scanners managed the paper napkin very well. At this magnification, the Nikon has an edge on the other two for granularity of the cocoa powder, there being not much difference between the Plustek and the Epson in this rendering. One needs to remember that the Figure 11 images are each approximately a 3.5 * 2.25 inch area of a 14* 9 inch original, magnified about 400%. While the Nikon result is outstanding, and therefore also shows some outstanding graininess, the other two are respectable for the medium. I printed the three images at about 300 PPI, 11*16.5 inches with Capture and Output sharpening applied, and the results on paper are only subtly different from each other, with the Nikon being marginally more granular than the Plustek and the Plustek marginally more granular than the Epson.

Side-bar on a Scanning Resolution Debate

LSI recommends selecting the scan resolution and image dimensions appropriate to the largest output resolution and image size the user will want to make. For example, in the illustrations for this review, those dimensions are about 9*14 inches at 360PPI output resolution to my Epson printer. Others have contended that it is best to scan at the scanner's highest optical resolution and then downsize the image in post-processing as necessary. Those who favour this workflow claim it yields cleaner, sharper images. I have tried it both ways, in print, and frankly I find very little difference of outcomes, but LSI's recommendation delivers a slightly superior result. If others have done similar tests and come to the opposite conclusion, that's fine, but my experience is as stated.

Users of SilverFast experimenting with output resolution and image dimensions in the Frame Tab will see another consideration at play here. The software was written intentionally to limit pixel dimensions to no more than twice the scanner's optical input

resolution. The distance from maximum to twice the maximum input optical resolution they call the “range of interpolation”. SilverFast prevents users from scanning beyond the range of interpolation because in their judgment the resulting image quality wouldn’t be acceptable. For example, in the case of the Nikon where maximum optical resolution is 4000 PPI² the outer limit of the range of interpolation is 4000*2 or 8000 input PPI and the corresponding maximum file size is 414.4 MB.

Now, let us say I select 14*9 inch linear dimensions at output resolution of 363 PPI – one of the scanners fixed resolution points³. The resulting magnification ratio from the original media (about 1.4 by 0.9 inches) is about 1055%. At this point, depressing F6 (Windows) SilverFast shows me that the input resolution is already at 3832 PPI, only about 150 below the scanner’s input optical resolution limit of 4000 PPI. I can continue increasing output PPI up to 758 PPI ($[8000/1055]*100$) at the same scale and linear dimensions, because I am working within the range of interpolation. For example, at output resolution of 720 PPI at the same scale, pressing F6 shows me that I have just about reached twice the optical input resolution of the scanner (7191 PPI – only about 800 pixels below the 8000 limit.) At 758 PPI output resolution I’ve reached 8000 PPI input resolution, or twice the scanner’s maximum optical resolution.

When I move beyond 758 PPI output resolution, it reduces scale and image dimensions to constrain pixel dimensions to that yielded from twice the input optical resolution and the resulting file size to 414MB – already well into the overkill range unless one is printing posters at lower resolution. So for example, the next output resolution stop is 800PPI, where the range of interpolation has been exceeded and the 8000 PPI input resolution has become the constraint; file size is stuck at its maximum of 414MB because the maximum pixel dimensions were reached, and the scale is reduced to 1000% and corresponding linear output dimensions therefore reduced to 13.3 by 8.5 inches. At the extreme, by increasing output PPI to 8000, the program brings the scale to 100% and the linear output dimensions are the same as the media – 1.4 by 0.9 inches.

(d) Colour Consistency and Scanner Profiling

As I covered the Auto-IT8 profiling process in my previous article on SilverFast, I shall not repeat that material here, but having now worked it with three scanners and two different profiling targets (Fujichrome and Kodachrome), I do have new observations about this process.

The colour consistency objective is to produce a scanned image for print or web which is as faithful as possible to the original media with minimal post-processing for colour balance or luminosity. Because every scanner sees colours and luminosity differently,

² Plustek model 7600i-Ai is considerably higher at 7200 PPI)

³ Scanners are designed to scan at fixed PPI intervals over the range from minimum to full optical resolution. Users can input whatever value they wish, but the scanner will operate at the nearest fixed resolution point.

they should be custom-profiled for best results, and the appropriate profile used in a colour-managed workflow.

There are two major issues with this: firstly, a number of scanners have difficulty accurately “seeing” Kodachrome film, such that custom profiling them even with a Kodachrome target will not necessarily produce a very high quality profile. Secondly, it is not possible to profile a scanner for colour negative film, the alternative in SilverFast being to use their Negafix module which has a large number of canned film profiles for producing a decent positive image. Here again, the results of a Negafix profile for the same image on the same film will differ from scanner to scanner because of inherent technical differences between the scanners. One does the pragmatic thing and selects the film profile which gives the image its best starting point before making further adjustments. SilverFast makes this very easy to do, just by flipping from one film preset to the next in Negafix and looking at the outcome in the image preview window. I’ll say no more here about using Negafix as I discussed this topic in my previous articles (Luminous-Landscape, 2006) on scanning colour negatives with SilverFast.

What matters for present purposes is how the Plustek scanner performs with SilverFast’s very convenient Auto-IT8 profiling procedure for 35mm positives, compared with performance of the other two scanners. The Plustek Optic Film 7600i-Ai package comes bundled with a scanner profiling target processed on Fujichrome film. (Those who wish to make a custom profile for Kodachrome using SilverFast’s Auto IT8 process would need to purchase a Kodachrome target from LSI.) Hence the resulting profile would be useful for non-Kodachrome positive 35mm slides. I used this target to create custom profiles for all three scanners, for comparison of outcomes between the scanners, and I also compared the performance of the custom profiles with the canned profiles which SilverFast made and provides for both Kodachrome and non-Kodachrome positives.

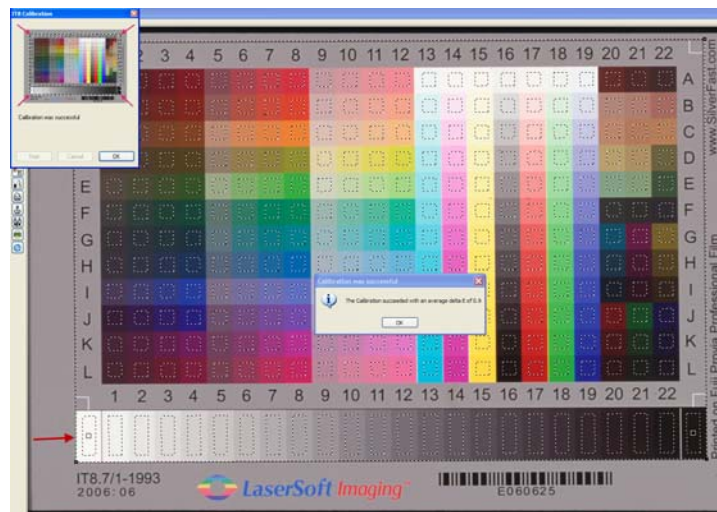
Without the luxury of costly colour management tools such Monaco Profiler or Profile Maker 5, I cannot perform automated comprehensive Delta-E calculations for measuring the overall performance of a profile relative to all of the data in the profiling target’s reference file. But I developed and implemented an alternative “manual” procedure described below, which reflects the same principles in reduced-form. The possible merit of this procedure is that anyone with Excel, SilverFast Ai, the reference file and Photoshop can do it without investing about \$3000 in high-end colour management software.

The reference file which accompanies a profiling target contains the colour values for each patch in the target, usually in L^*a^*b and XYZ colour measurement scales. One can measure the internal consistency of a profile’s behaviour as follows: First, perform the Auto-IT8 profiling process using the relevant SilverFast IT8 target for the film stock being profiled and leave the target in the scanner. Second, with the resulting profile now loaded (automatically) as the default profile for that scanner and film combination, scan the target (as one would scan an ordinary photograph) to open as a TIFF file in Photoshop. Gamma and colour space should be the same for the scan and in Photoshop. Third, use Photoshop’s eyedropper and info panel to measure the $L^*a^*b^*$ values of a set of patches

in the TIFF scan of the target and compare these measurements with the values for the same patches in the target's reference file. The difference between the measured and the reference file values is an indication of the extent of the profile's performance error, which is formalized in a "Delta-E" or "dE" calculation. We call this a "round-trip" internal consistency check – to see how well a profile created from a target can reproduce the values of that target when it is scanned as a photo. If the dE values are less than 1 (a source in Wikipedia says even up to 2.3 would be hard to see), this means that at least the profile is behaving with acceptable internal consistency. Whether it also produces a reasonably accurate scan on normal photographs still remains to be determined; but for that to happen, a "pass" on the round trip internal consistency check is a necessary, although not necessarily sufficient condition.

To make this exercise tractable for present purposes (which are indicative, and not claimed to be 100% determinative), I selected the "grayscale" band of patches across the bottom of the SilverFast target (Figure 12, right of red arrow). I put "grayscale" in quotation marks, because even though they look grey, the reference values for those patches indicate that they are not gray, and indeed they do not measure as gray in these tests. (To be gray, a^* and b^* each need to be 0, whereas these values vary within a range of several points around zero.) The reasoning is that a sample set of measurements using this band should be a sufficient indicator of profile performance for the target as a whole, because if a profiling solution can reproduce these tones quite correctly, chances are it will do a similar job on most of the colours in the target.

Figure 12. Auto IT8 Calibration



Once all 24 patches are measured, the differences between measured and reference values are noted and then averaged in three sets: one for L^* , one for a^* and one for b^* , with an aggregate average provided for $a^* + b^*$. The arithmetic is shown below in the sidebar "The Arithmetic (Used Here) of Profile Measurement", which you may skip if your main interest is the gist of the story-line, rather than the geeky details; the source for the formulae used is CIE dE (1976). Technical staff at LSI have examined this procedure and they think the approach is correct and useful as intended.

| | A | B | C | D | E | F | G | H | I | J | K | L | M | N | O | P | Q | R | S | T | U | V | W | X | Y | Z | black | AA |
|----|-------------------|--------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|------|
| 1 | Purket 1TB Fpg | white | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | AVG | |
| 2 | Custom | L'R | 88.46 | 86.98 | 83.80 | 84.00 | 79.77 | 76.09 | 72.28 | 68.23 | 64.04 | 59.89 | 55.72 | 51.10 | 46.65 | 42.35 | 37.75 | 33.61 | 29.16 | 24.86 | 20.87 | 16.38 | 11.66 | 7.09 | 3.91 | 1.43 | 0.87 | |
| 3 | | L'M | 89.00 | 87.00 | 84.00 | 80.00 | 76.00 | 73.00 | 69.00 | 64.00 | 60.00 | 56.00 | 51.00 | 47.00 | 42.00 | 38.00 | 34.00 | 29.00 | 24.00 | 20.00 | 15.00 | 10.00 | 6.00 | 3.00 | 2.00 | 1.00 | | |
| 4 | | Diff+2 | 0.29 | 0.00 | 0.04 | 0.05 | 0.01 | 0.52 | 0.59 | 0.00 | 0.01 | 0.08 | 0.01 | 0.12 | 0.12 | 0.06 | 0.15 | 0.03 | 0.74 | 0.76 | 1.90 | 2.76 | 1.19 | 0.83 | 0.32 | 0.02 | | |
| 5 | | SQRT | 0.54 | 0.02 | 0.20 | 0.23 | 0.09 | 0.72 | 0.77 | 0.04 | 0.11 | 0.28 | 0.10 | 0.35 | 0.36 | 0.25 | 0.39 | 0.16 | 0.86 | 0.87 | 1.38 | 1.66 | 1.09 | 0.91 | 0.57 | 0.13 | 0.5 | |
| 6 | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 7 | | a'R | -1.66 | -2.92 | -2.83 | -2.74 | -2.41 | -2.49 | -2.75 | -2.60 | -3.24 | -2.77 | -3.40 | -3.27 | -3.26 | -3.07 | -3.35 | -3.08 | -3.72 | -3.13 | -3.03 | -3.04 | -2.08 | -1.50 | -1.27 | -0.16 | | |
| 8 | | a'M | -1.00 | -3.00 | -3.00 | -3.00 | -2.00 | -2.00 | -3.00 | -3.00 | -3.00 | -3.00 | -3.00 | -3.00 | -3.00 | -3.00 | -3.00 | -2.00 | -2.00 | -1.00 | 0.00 | 0.00 | 0.00 | 0.00 | -2.00 | -1.00 | | |
| 9 | | Diff+2 | 0.44 | 0.01 | 0.03 | 0.07 | 0.17 | 0.24 | 0.06 | 0.16 | 0.06 | 0.05 | 0.16 | 0.07 | 0.07 | 0.14 | 0.12 | 0.17 | 0.26 | 1.28 | 1.42 | 0.94 | 2.43 | 2.25 | 0.53 | 0.706 | | |
| 10 | | SQRT | 0.66 | 0.08 | 0.17 | 0.26 | 0.41 | 0.49 | 0.25 | 0.40 | 0.24 | 0.23 | 0.40 | 0.27 | 0.26 | 1.07 | 0.35 | 1.08 | 1.72 | 1.13 | 2.03 | 3.04 | 2.08 | 1.60 | 0.73 | 0.84 | 0.8 | |
| 11 | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 12 | | b'R | 0.69 | 1.65 | 1.17 | 0.35 | 0.35 | -0.03 | -0.53 | -1.08 | -1.37 | -1.53 | -2.05 | -2.59 | -2.75 | -3.06 | -2.92 | -2.95 | -3.29 | -3.20 | -3.70 | -3.43 | -3.33 | -1.94 | -1.39 | -0.28 | | |
| 13 | | b'M | 1.00 | 2.00 | 1.00 | 0.00 | 0.00 | 0.00 | -1.00 | -1.00 | -2.00 | -2.00 | -3.00 | -3.00 | -3.00 | -4.00 | -4.00 | -4.00 | -4.00 | -5.00 | -5.00 | -6.00 | -5.00 | -3.00 | -3.00 | | | |
| 14 | | Diff+2 | 0.10 | 0.12 | 0.03 | 0.12 | 0.13 | 0.00 | 0.22 | 0.01 | 0.00 | 0.22 | 0.00 | 0.17 | 0.06 | 0.00 | 0.17 | 0.06 | 0.50 | 0.50 | 0.50 | 0.50 | 0.50 | 0.50 | 0.50 | 0.50 | | |
| 15 | | SQRT | 0.31 | 0.35 | 0.17 | 0.35 | 0.35 | 0.03 | 0.47 | 0.08 | 0.63 | 0.47 | 0.05 | 0.41 | 0.25 | 0.94 | 0.08 | 1.05 | 0.71 | 0.80 | 1.30 | 1.57 | 2.67 | 3.06 | 1.61 | 2.72 | 0.9 | |
| 16 | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 17 | Total SQRT a*+ b* | SQRT | 0.73 | 0.36 | 0.24 | 0.44 | 0.54 | 0.49 | 0.53 | 0.41 | 0.67 | 0.52 | 0.40 | 0.49 | 0.36 | 1.42 | 0.36 | 1.51 | 1.86 | 1.38 | 2.41 | 3.42 | 3.38 | 3.41 | 1.77 | 2.86 | 1.2 | |
| 18 | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 19 | Canned | L'R | 88.46 | 86.98 | 83.80 | 79.77 | 76.09 | 72.28 | 68.23 | 64.04 | 59.89 | 55.72 | 51.10 | 46.65 | 42.35 | 37.75 | 33.61 | 29.16 | 24.86 | 20.87 | 16.38 | 11.66 | 7.09 | 3.91 | 1.43 | 0.87 | | |
| 20 | SFT Optic 7600i | L'M | 89.00 | 87.00 | 84.00 | 80.00 | 76.00 | 73.00 | 69.00 | 64.00 | 60.00 | 56.00 | 51.00 | 47.00 | 42.00 | 38.00 | 34.00 | 29.00 | 24.00 | 20.00 | 15.00 | 10.00 | 6.00 | 3.00 | 2.00 | 1.00 | | |
| 21 | | Diff+2 | 0.29 | 0 | 0.04 | 0.05 | 0.01 | 0.52 | 0.59 | 0 | 0.01 | 0.08 | 0.01 | 0.12 | 0.12 | 0.06 | 0.15 | 0.03 | 0.02 | 0.76 | 1.90 | 2.76 | 1.19 | 0.83 | 0.32 | 0.127 | | |
| 22 | | SQRT | 0.54 | 0.02 | 0.20 | 0.23 | 0.09 | 0.72 | 0.77 | 0.04 | 0.11 | 0.28 | 0.10 | 0.35 | 0.65 | 0.25 | 0.39 | 0.16 | 0.14 | 0.87 | 1.38 | 1.66 | 1.09 | 0.91 | 0.57 | 1.13 | 0.5 | |
| 23 | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 24 | | a'R | -1.66 | -2.92 | -2.83 | -2.74 | -2.41 | -2.49 | -2.75 | -2.60 | -3.24 | -2.77 | -3.40 | -3.27 | -3.26 | -3.07 | -3.35 | -3.08 | -3.72 | -3.13 | -3.03 | -3.04 | -2.08 | -1.50 | -1.27 | -0.16 | | |
| 25 | | a'M | -1.00 | -3.00 | -3.00 | -3.00 | -3.00 | -2.00 | -2.00 | -3.00 | -3.00 | -3.00 | -3.00 | -3.00 | -3.00 | -3.00 | -3.00 | -3.00 | -2.00 | -2.00 | -1.00 | -1.00 | -1.00 | -1.00 | -4.00 | -3.00 | | |
| 26 | | Diff+2 | 0.44 | 0.01 | 0.03 | 0.07 | 0.35 | 0.26 | 0.06 | 0.16 | 0.06 | 0.05 | 0.16 | 0.07 | 0.07 | 0 | 0.12 | 0.01 | 0.52 | 0.02 | 1.06 | 1.08 | 1.17 | 0.25 | 7.45 | 8.066 | | |
| 27 | | SQRT | 0.66 | 0.08 | 0.17 | 0.26 | 0.69 | 0.51 | 0.25 | 0.40 | 0.24 | 0.23 | 0.40 | 0.27 | 0.26 | 0.07 | 0.35 | 0.08 | 0.72 | 1.13 | 1.03 | 1.04 | 1.08 | 0.60 | 2.73 | 2.84 | 0.6 | |
| 28 | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 29 | | b'R | 0.69 | 1.65 | 1.17 | 0.35 | 0.35 | -0.03 | -0.53 | -1.08 | -1.37 | -1.53 | -2.05 | -2.59 | -2.75 | -3.06 | -2.92 | -2.95 | -3.29 | -3.20 | -3.70 | -3.43 | -3.33 | -1.94 | -1.39 | -0.28 | | |
| 30 | | b'M | 1.00 | 2.00 | 1.00 | 0.00 | 0.00 | 0.00 | -1.00 | -1.00 | -2.00 | -2.00 | -3.00 | -3.00 | -3.00 | -4.00 | -4.00 | -4.00 | -4.00 | -5.00 | -5.00 | -6.00 | -5.00 | -3.00 | -3.00 | | | |
| 31 | | Diff+2 | 0 | 0.12 | 0.03 | 0.12 | 0.12 | 0 | 0.26 | 0.01 | 0.14 | 0.26 | 0 | 0.17 | 0.06 | 0 | 0.01 | 0.5 | 0.64 | 0.32 | 2.79 | 3.42 | 2.79 | 1.37 | 0.37 | 0.168 | | |
| 32 | | SQRT | 0.31 | 0.35 | 0.17 | 0.35 | 0.35 | 0.03 | 0.53 | 0.08 | 0.37 | 0.53 | 0.05 | 0.41 | 0.25 | 0.06 | 0.08 | 0.05 | 0.71 | 0.80 | 0.30 | 0.57 | 1.67 | 2.06 | 0.61 | 0.72 | 0.5 | |
| 33 | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 34 | Total SQRT a*+ b* | | 0.73 | 0.36 | 0.24 | 0.44 | 0.69 | 0.51 | 0.59 | 0.41 | 0.44 | 0.58 | 0.40 | 0.49 | 0.36 | 0.09 | 0.36 | 0.09 | 1.01 | 0.81 | 1.07 | 1.19 | 1.99 | 2.12 | 2.80 | 2.93 | 0.9 | |
| 35 | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 36 | Pos Diff (SQRT) | | OK | OK | OK | OK | OK | 0.16 | 0.2 | 0.05 | OK | OK | 0.05 | OK | OK | OK | OK | OK | OK | OK | OK | OK | OK | OK | OK | OK | 1.03 | 0.08 |
| 37 | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

Figure 14 shows the bottom-line results by scanner, film type, profile type and measurement series.

Figure 14. Summary Results of dE Measurements

| | A | B | C | D |
|----|-------------------|-------------------|-------|-------|
| 1 | Condition | Average dE Values | | |
| 2 | | Plustek | Nikon | Epson |
| 3 | Fuji Custom | | | |
| 4 | L* | 0.50 | 0.27 | 0.67 |
| 5 | a*+b* | 1.25 | 0.58 | 0.53 |
| 6 | | | | |
| 7 | Fuji Canned | | | |
| 8 | L* | 0.49 | 1.05 | 1.56 |
| 9 | a*+b* | 0.86 | 2.14 | 1.82 |
| 10 | | | | |
| 11 | Kodachrome Custom | | | |
| 12 | L* | 0.43 | 2.74 | 0.52 |
| 13 | a*+b* | 1.47 | 4.93 | 0.72 |
| 14 | | | | |
| 15 | Kodachrome Canned | | | |
| 16 | L* | 3.04 | 0.97 | 0.46 |
| 17 | a*+b* | 5.29 | 3.19 | 0.89 |

Perhaps the most interesting aspect of these results is that there is no clear winner across the board (kind of like the election results in a number of multi-party democracies these days, where political conditions are almost as murky as the waters of colour management)! To summarize the summary of the internal consistency checks:

- Taking anything above 2 as an indicator of potential trouble, 6 values of the 24 are in this category, and of those, 5 are for Kodachrome and of those 5, 3 are for Nikon and 2 for Plustek. Plustek accounts for only 2 potentially troublesome values in the chart.
- The Nikon scanner's relatively poor colour management performance with Kodachrome is very consistent with this scanner's reputation for having difficulty accurately scanning Kodachrome media. This is an interesting confirmation that the analytic approach taken here produces results consistent with other findings one can read in the literature.
- Custom profiles generally performed better than canned profiles, and that is to be expected because of variations between scanners even of the same model, which demonstrates value to SilverFast's Auto-IT8 custom profiling solution. The only exception on the chart is for Plustek Fuji, where surprisingly, the canned profile (also made by LSI let us not forget) somewhat outperformed the custom profile. The difference between the two would hardly be noticeable in a print, even before post-scan adjustments in an external image editing program. The data shows that

the Plustek scanner really needs and benefits from the custom profile for handling Kodachrome.

- Finally, the Epson scanner did a really fine job with the Fuji custom profile and both Kodachrome profiles. In fact, it's fair to say that on the whole the Epson scanner handled Kodachrome the best of all three in respect of colour management outcomes.

Just to prevent anyone else from saying so first, I see I managed to wade through a whole discussion of colour management completely in black-and-white, except for the image of the SilverFast profiling target and some yellow lowlights in the Excel spreadsheet. Maybe this just goes to show what kind of a subject colour management really is, but joking aside, this is one of the more important aspects of productivity in a scanning workflow and deserves a somewhat analytic treatment. The analysis does show that as long as users of the Plustek Optic Film 7600i-Ai avoid using the canned profile for Kodachrome, they can profile this scanner with SilverFast and expect decent colour management outcomes. We'll revert to photos in the next section, on the treatment of lower quarter-tones.

(e) Rendition of Detail in the Lower Quarter Tones

Photographers are usually concerned about the DMax (or scan density range) of the hardware, because the higher it is, the more likely it will do a better job of separating the range of luminosity within the quarter-tones, hence the better the shadow detail. DMax is measured on a logarithmic scale, hence what looks like small differences numerically can actually mean larger differences in practice. Plustek specifies DMax for the Optic Film 7600i at 3.5, whereas Epson claims 4.0 for the V750M Pro and Nikon claims 4.8 for the Super Coolscan 5000ED. My objective is to see what one sees in practice with dense images, ignoring this data. Figure 15 shows the selected scan (from colour negative media, because colour negative film can often reveal shadow detail more clearly compared with positive film). I am particularly interested in the dark areas of the stone elephants (shot in Chiang Mai, Thailand, in case you were curious to know), where the luminosity range of interest varies from 2 to about 25, and there is considerable "granularity" to be seen, if it can be.

Figure 15. Stone Elephants – Full Image



Figure 16. Shadow Detail – Elephants



Figure 17. Shadow Detail – Elephants Legs

Careful, magnified inspection of these three extracts in Figures 16 and 17 shows that the differences of performance between the three scanners are subtle, with the Nikon showing subtly more distinct deep shadow tonal separation. Bottom line – for this kind of image, remembering that the medium being scanned is a colour negative, the Plustek scanner shows comparatively decent tonal separation in the deep quarter tones, despite its nominal Dmax being rated lower than that of either the Nikon or the Epson.

But that's not the end of this story. When a scanner reads a negative, the dark tones are actually light in the original scan medium. So what we are observing above is the ability of three scanners to discern detail in the most transparent areas of the negative. Hence an additional test is needed to see comparatively how well they perform when the original scan medium is a positive and the scanners must detect the tonality of the darkest areas therein.

To do this, I selected a colour slide (shot on Fuji film) with dense shadow areas, selected an area of interest (the reddish flower pot and surrounding earth) and looked at how the three scanners handled it with no adjustments except for the "maximum exposure case". This latter case shows how much dense shadow detail the scanner can reveal using the maximum exposure boost which SilverFast's Exposure adjustment allows. Thus, it is a useful way of seeing "what's there". This is one kind of adjustment (amongst others) which is particularly effective at the scan stage. Because the Nikon scanner advertises the highest DMax of the three scanners, Figure 18 shows the base and maximum exposure cases of the flower pot image as seen using the Nikon scanner. I turn next to the base (unadjusted) exposure cases from the three scanners, because we are attempting to discern their relative strength at separating very dark tone values.

Figure 18. Shadow Detail from Positive Scan (Base and Boosted Exposures)



Figure 19 shows the flower pot from the three scanners - Nikon, Epson and Plustek ranked in order of their stated DMax (4.8, 4.0 and 3.5 respectively).

Figure 19. Shadow Detail from a Positive Scan – Three Scanners



From this visual comparison (less evident here than the original images on a display), firstly, colour balance differs between the three scans, despite each scanner being custom-profiled. The differences aren't large, but they exist. For example, measuring the grey band of the air-conditioner just above the center screw at the bottom of the casing (see red circle), the value of the "a" channel is 0 for Nikon, +2 for Epson and +5 for Plustek ("b" channel results are much closer). The same air conditioner in a digital capture indicates that "closer to neutral" is more correct. That aside, the quality of luminosity in the dark shadow area more or less mimics the relative ranking of Dmax for the three scanners. A careful look where the red flower pot sits on the earth (bottom of red rectangle), the pot is best differentiated from the earth in the Nikon scan, followed by the Epson and Plustek results. Only the Nikon scan provides a differentiated L value, from 1 to 2 moving from the earth to the pot at the bottom of the red rectangle.

More generally within the red rectangle, the Nikon scan L value range is from 1 to 9, whereas for the Epson it is 2 to 7 and for the Plustek from 2 to 5. This doesn't mean a hopeless loss of dark tone separation from the Plustek scanner. It does mean that users should judiciously adjust scan settings and post-scan editing to achieve a more desirable result. The scanner, aided by SilverFast and Photoshop, can reveal much more shadow detail and corrected colour than revealed by the base settings. Figure 20 (left) shows the result of changing the exposure value in SilverFast from 0 to 3.0, and adding two Curves in Photoshop – one in Color Mode for neutralizing the colour of the air conditioner casing, and the other in Luminosity Mode to improve image contrast without affecting saturation, while preserving the tonal separation provided by the exposure boost. I then complemented the Luminosity Curve with a 25% Saturation boost.

Figures 20 (L), 21 (R). Plustek - Adjusted for Shadow Detail and Colour Balance



Figure 21 (right, above) shows another rendition designed to improve highlight retention while opening shadow detail. This was done by reducing the Exposure adjustment in SilverFast from +3 to +2.2, again in SilverFast normalizing the histogram by pulling in the blacks and whites to values of 20 and 251 respectively, then in Photoshop adding two Curves, one for slight colour balance adjustment and one for slight contrast boost from the lower mid-tones to the upper quarter tones. The highlights are no longer clipped, and the tonal separation between the earth and the flower pot, where they join, now ranges from L+4 to L+7. Tonality could be refined further, but for present purposes, suffice to say that the Plustek scan provides the raw material necessary to produce good tonal separation very near the bottom of the tone scale.

These workflow options, by the way, yet again underline a point I made in my previous Luminous Landscape article⁴ to the effect that combined use of feature-rich programs such as SilverFast with Photoshop or Lightroom provides significant flexibility to maximize the quality and effectiveness of image rendition.

Summing-Up on the Plustek Optic Film 7600i-Ai

I believe this is a very respectable package, especially considering its price:

- Physically the scanner looks well-constructed (though I have no idea of its longevity – or that of the others); the simplicity of its feed mechanism and fixed focus augur well for maintenance. The preview time is very fast, and the scan time ranges from fast to slower (than the Nikon) depending on the pixel dimensions of the images being scanned.
- SilverFast iSRD works well with this scanner, which is a real boon to productivity in terms of obtaining clean scans in little time.
- Granularity of fine detail, when seen in a properly sharpened 11*16.5 inch print, is close to that obtained from the Nikon scanner.
- The combination of the Plustek Optic Film 7600i and SilverFast Ai Studio with Auto IT8 profiling provides a viable colour management solution for the scanner component of a colour-managed workflow. It performs considerably better on Kodachrome than achieved from the Nikon scanner using the same software for Nikon. On the whole, the Epson scanner handled Kodachrome the best of the three.
- Separation of tones within the quarter-tone range is acceptable and better than may be expected from its lower stated DMax rating (compared with the Nikon and Epson scanners).

Now, is this the scanner for you?

⁴ “Scanning: The Old World Joins the New” (<http://www.luminous-landscape.com/tutorials/scanning-old-new.shtml>)

As usual, it depends. It is a dedicated 35mm film scanner, so if you need to scan other media and will buy only one scanner, this is not the one for you – a flatbed with film scanning capability such as the Epson would be the indicated choice. If you want a dedicated film scanner for the extra bit of quality the technology can deliver with 35mm film, you don't mind spending time colour correcting Kodachrome and you want the best granularity obtainable for less than 15,000 dollars (e.g. Hasselblad Flexscan) and you don't mind spending over 2000 dollars on eBay for a Nikon Super Coolscan 5000ED, bide your time, bite the bullet and go for the Nikon. If you want a practical, immediately available, very reasonably priced and high quality scanning solution for 35mm film, the Plustek Optic Film 7600i-Ai is good value for money.

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