Preface

Dear Reader,

Digitizing slides and negatives is still a hot topic, which is why this book is already in its third edition in Europe and its second in the US. Just about every home has its shoeboxes and slide magazines (and occasionally more professional repositories) full of analog photographic treasures, just waiting to be rediscovered. The advantages of digital image processing are widely accepted these days, and anyone who owns a scanner can use it to digitize their slides and negatives. This book will illustrate in detail all established scanning and image processing techniques, and will help you to quickly achieve great results. Your choice of scan software is just as important as good quality hardware, although the choice of commercial programs currently on the market is limited to VueScan or SilverFast. In addition to these two specialized programs, most scanner manufacturers bundle a proprietary software package with their scanner products, although these are not usually particularly powerful or easy to use. Nikon Scan is the exception to the rule.

Just as in the digital photography world, the trend in scanning is moving towards the use of RAW data formats. RAW files include the complete, unaltered image data captured by the scanner's image sensor (at least in theory), but scanning is a complex subject and has plenty of its own idiosyncracies. Please take the time to view the DVD included with this book, as it includes many high-resolution sample scans created using film and flatbed scanners from all the major manufacturers, and clearly illustrates the differences in scan quality that can be produced. I would like to thank all the readers who have provided me with feedback so far. You can contact me any time through the www.slidescan.info website, and I am looking forward to reading all your new comments and suggestions.

Sascha Steinhoff — Bangkok, January 2009

Picture: Siegfried Gromotka, um 1960

Darkrooms are passé: the rise of digital image processing has made fumbling around with chemical baths a thing of the past. Modern technology helps to make even 50-year-old negatives usable.

The rather flat RAW scan is just the first step. The final image is developed by stretching the levels curve and by correcting the tonal curves.

Introduction

For some time now, the digital revolution has included photography; the presence of conventional cameras in photo shops is dwindling. Unjustly so, because photographers who want to continue to work with film can also enjoy all the advantages of digital image processing by using a high-quality scanner. Owners of an archive of slides or negatives can also benefit from digitizing their existing collection. Despite the omnipresence of digital photography, there are still good reasons to shoot on film. This chapter will compare the various working methods.

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Images: Nikon, Fuji

▲ For negative film, the processing lab is the key factor that determines the result of the printed images.

1.1 Analog and Digital Workflows

Analog Workflow for Negative Film

Over years, or even decades, many photographers accumulate boxes filled with countless negatives (although more professional storage containers are available, too). The classic workflow for negative film is as follows:

- Exposure – although this is not as critical as with slide film
- Developing and printing
- Proper archiving

However, there are some drawbacks to working with negative film:

- Negatives age and fade over time
- Negatives scratch easily
- Each trip to the lab causes new scratches, and wear and tear on the negatives
- It can be difficult to locate a particular image within a large archive
- Customized image processing is possible only in one's own darkroom

The lab work is crucial to the final result. But many photographers neither do their own processing nor do they deal with professional labs. Therefore, it is questionable whether the printed image meets their expectations. Even if the lab does a good job, there is still some latitude for variations.

The default settings of one-hour labs are generally suitable for typical snapshots from a holiday on the beach. It is a different story for photos taken in nonstandard lighting conditions. High-key, low-key, or sunset pictures often do not work well with the lab's default settings. Standard lab settings are adjusted for an average gray value, which can ruin the intended mood and render the prints unusable. Even when reordering a print from the same photo lab, the result is rarely identical to an earlier print. Only in a custom darkroom can all the parameters be controlled

to create the desired image. To make a long story short, only with a personal darkroom can one benefit from all advantages of negative film.

Analog Workflow for Slide Film

The typical workflow for slide film differs from negative film in a few important points. It looks roughly like this:

- Accurate exposure is necessary; slide film is not forgiving
- Filmstrips are cut and framed
- The framed slides are filled into slide trays
- The images can now be projected or viewed on a light tablet

This conventional practice has disadvantages:

- Slides age and fade
- Slides get scratches, although they are less delicate than negatives
- For frequent slide shows, duplicates are needed because slides fade easily in the intense light of the projector; this is especially a concern for Kodachrome slides
- It is time-consuming to find a particular slide in a large collection
- Rearranging a slide show takes a lot of effort; to run more than one slide show simultaneously, duplicates are needed
- It is almost impossible to post-process slides

The biggest problem with slides is that they can hardly be post-processed. Poor exposure or a color cast can only be corrected with great difficulty. On the other hand, an underappreciated advantage is that the lab can do very little wrong during the processing of slides. The result is pretty close to what the camera produced. This tight control over the created image is a significant reason why ambitious photographers prefer slide film to negative film.

▲ The untreated negative shows inverted colors: on film, the white signboard is black.

▲ After inverting the colors, the signboard becomes white, but there is still the orange masking.

▲ When converting to positive, the color characteristics of the films need to be considered.

Hybrid Workflow: Shooting Analog, Scanning, Digital Processing

In recent years computer technology has advanced dramatically. Today, a standard PC actually delivers what the computer manufacturers promised more than 10 years ago: high-quality digital image processing. For those who still shoot on film, the question remains how to best get the slides and negatives into the computer.

A standard PC and a film scanner are all the hardware needed to achieve this, and the investment is manageable. The key to good quality scans is in the skill of the user. Satisfying results can only be achieved with extensive study of the matter.

Of course a quick scan is possible, but the results generally will be of poor quality. Photographers who spend a lot of effort to take quality pictures with film cameras will be unable to avoid familiarizing themselves with the subject of scanning. Only then will they be able to transfer the quality of their film-based images to the digital world.

Just like the skill of taking pictures, the skill of scanning film needs to be acquired first, in order to get good results. Sufficient time for acquiring this skill should be allowed.

This mixed workflow – shooting analog, scanning, digital processing – is also called hybrid photography. It offers all the advantages of digital image processing:

- "Digital negatives" don't age, scratch, or fade
- A well-maintained image database can retrieve images in a matter of seconds
- Digital images are easy to edit
- Digital images are easily turned into slide shows or galleries
- Digital images are easily sent over the Internet
- Digital images don't need to be touched up by the photo lab; the photographer has almost full control over the final image
- It is possible to make lossless backup copies of the images

▾ The film processing lab has no margin for variation: with slide film, the result from the lab is exactly what the camera produced.

Images: Nikon, Fuji

However, there are a few disadvantages:

- Scanning is time-consuming and fairly complex
- The image information of the film cannot be read without loss; unavoidably, there are losses in the transfer from analog to digital
- Scratches, dust, and other blemishes cannot always be removed from the film automatically during the scan (post-processing is a solution here)
- Not all types of film are equally suitable for scanning

To sum up, there are many good reasons for digitizing your film material, so don't put it off much longer. The latest high-grade film scanners do a fine job of extracting the image information from the film material. Unlike with an analog workflow, all relevant parameters for image quality can be defined on the computer. When ordering prints from a lab, using digital images leads to significantly better results than working from negatives. In addition, there are no more annoying scratches and fingerprints, which usually further damages the negative with every trip to the lab.

In the early days of digital photography, when digicams were as expensive as picture quality was poor, there were many photo enthusiasts who propagated hybrid photography as the best solution for quality-conscious people. Since then, however, much has happened in the world of photography and there are only a few who still shoot pictures on old-fashioned film. We are living in a fast world, and nobody has the time to scan filmrolls all evening. Due to this, everybody has a digital camera and hybrid photography is only important for archiving purposes.

▼ Home users can explore digital image processing with a desktop film scanner.

Images: Nikon, Fuji, HP

Digital Workflow: Shooting and Editing

Purely digital workflow requires that images be generated and processed digitally. Technically this is desirable because it eliminates the potentially degrading analog to digital conversion between image and image file. However, for practical photography, there are a few limitations:

- There is still no common standard for a "digital negative"
- Existing equipment for analog SLR camera systems can only be used with certain restrictions
- High-resolution digital cameras with a full format sensor are significantly more expensive than analog cameras, although prices keep dropping (in addition, there are fewer analog cameras available)

Still, the advantages are undeniable and have led to the unstoppable success of digital photography:

- Digital images can be edited directly on the computer
- Subsequent quality-degrading steps of Analog/Digital (A/D) conversions of the picture are eliminated
- No more burning film – memory cards are much less expensive in the long run
- The picture can be checked immediately after it has been taken – good cameras have a built-in histogram display for checking the exposure

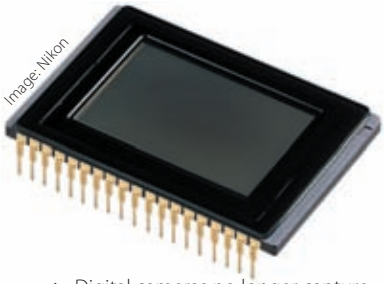


Image: Nikon

▲ Digital cameras no longer capture the image on film, but through either a CMOS or CCD sensor chip (here Nikon D2H). Sooner or later, this technology will completely replace 35mm film.

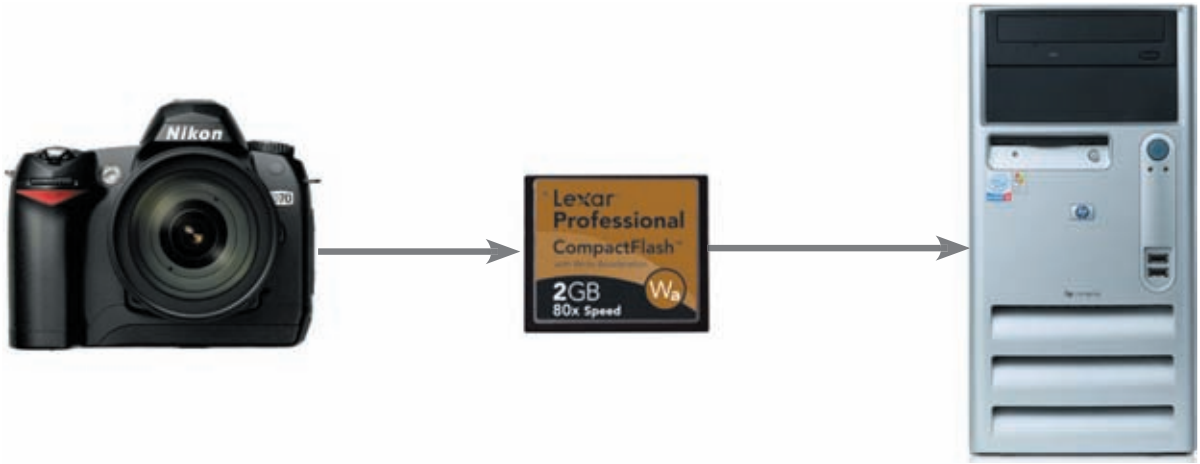
An often-underappreciated benefit of the hybrid workflow over the digital workflow is having a tangible piece of film. In addition to the digital image file, there is always the analog backup. As long as there is no cross-platform standard for file formats and storage media, this is a major advantage over the purely digital workflow. With technology constantly progressing, digital images must be periodically transferred onto different backup media. Neglecting this step can cause the data to become unreadable or completely lost. As an example, in the early nineties home computers had floppy disks, then came CD-ROMs, and now we have DVDs, external hard disks, and USB (Universal Serial Bus) thumb drives. A current computer system can no longer read the types of media that were common in the mid-eighties.

Analog images must merely be stored dry and free of dust; no other measures are needed. However, if you store both a slide tray and a DVD with image files in the attic and 30 years later someone finds them, the chances are low that the image files on the DVD can still be used – provided that the DVD can still be read at all. The slides, on the other hand, will be slightly faded, but with recognizable images.

The digital photography boom has raised the level of image quality and availability to a level unimaginable to most amateurs in the old, analog photography world. The price for this ease of use is often paid with flawed or faulty data storage, and there is still no digital storage method that is as robust as conventional camera film. In 2008, for example, lost pictures taken over 70 years ago by the legendary Magnum photographer Robert Capa turned up largely unharmed after decades

Image: Fuji

▲ From the digital camera or scanner directly to the lab: now most photo labs offer a digital printing service.



▲ A digital workflow allows lossless transfer of images from camera to PC.

of storage in a suitcase. Digital images would certainly not have been able to survive that long without being professionally archived. There are services that offer to expose your digital pictures on slide film for archiving purposes. But to be completely on the safe side, neither analog nor digital photography is useful anyway. For maximum durability, you should do as in Egypt: carve your information in a solid piece of stone and bury this in a protected place in your garden.

▼ The digitizing of archive material is of ever-increasing importance (Image: Siegfried Gromotka, around 1960).

Image: Nikon

▲ Nikon D300: 12.3 megapixels and continuous shooting of six frames per second.

Image: Nikon

▲ The quality of the lens essentially determines the effective resolution, both for film and digital cameras.

1.2 Alternatives to the Film Scanner

Scanning filmstrips with a film scanner is time-consuming and has a steep learning curve. Because not everybody has the time, knowledge, or hardware needed, let's discuss the possible alternatives.

Megapixel in Comparison: DSLR, Film Scanner, 35 mm Film

Quite often, only the nominal resolution is considered when comparing DSLR, film scanner, and 35mm film. According to this criterion alone, analog cameras would come out on top. However, it is not that simple. For a DSLR, the sensor and the lens determine the resolution of the final image. This limiting factor is always the weakest link in the camera-lens combination: if you mount an inferior lens on an excellent DSLR, the sensor cannot utilize its maximum resolution.

It's all about the lens

Only high-grade lenses have enough quality reserves for a good DSLR. The resolution of current 35mm DSLRs is between 6 and 16 MP. Lens aberrations are very noticeable with DSLRs. Unlike an image from an analog camera, the digital image is usually examined at maximum size on the computer monitor. To notice such aberrations on a 35mm slide, it would take a high-power loupe. Scanning film is a more complex issue. Here the image is generated in two steps: first, the subject is shot on 35mm film, and then this image is scanned. Therefore, we have to look not only at the quality of the material to be scanned, but also at whether the scanner is capable of capturing the image adequately. For the resolution of the film – let's say 35mm film – the combination of film and lens is crucial. A high-quality, fine-grain 35mm film has a

resolution corresponding to 40–60 MP. Standard film has a substantially lower resolution, which corresponds to around 20–30 MP; but even that resolution can be achieved only with high-quality lenses. Simple lenses achieve a resolution of approximately 10 MP; only high-grade lenses will surpass 20 MP. The popular amateur zoom lenses are typically inferior to the optical performance of comparable prime lenses. More than likely, the majority of amateur pictures have a resolution of less than 20 MP.

The nominal resolution of a scanner is often the single most important purchase criterion for the layman. For this reason, manufacturers (especially those of lower quality scanners) tend to advertise their products using improbably high resolutions. Plustek, for example, advertises resolutions of up to 7200 dpi which are rarely actually achieved. Furthermore, a resolution of more than 4000 dpi is not actually necessary for most practical purposes. Artificially high resolutions also lead to unnecessary use of additional storage resources.

Effective Scan Resolution is Crucial

The effective resolution of a film scanner is potentially a bottleneck that can limit the resolution of the image. Currently most high-quality film scanners have a resolution of 4000 dots per inch (DPI or dpi), which corresponds to around 20 MP. If you choose a film scanner that not only promises this resolution on paper, but can also scan it optically, then loss in image resolution will not be noticed.

There are already 35mm film scanners with 7200 dpi, which corresponds to a resolution of 70 MP. To fully utilize this dpi, the slide or negative has to be of excellent quality, which means a fine-grain film exposed with a very sharp lens. The same is true for the scanner. It not only has to have a high-resolution sensor but also excellent optics.

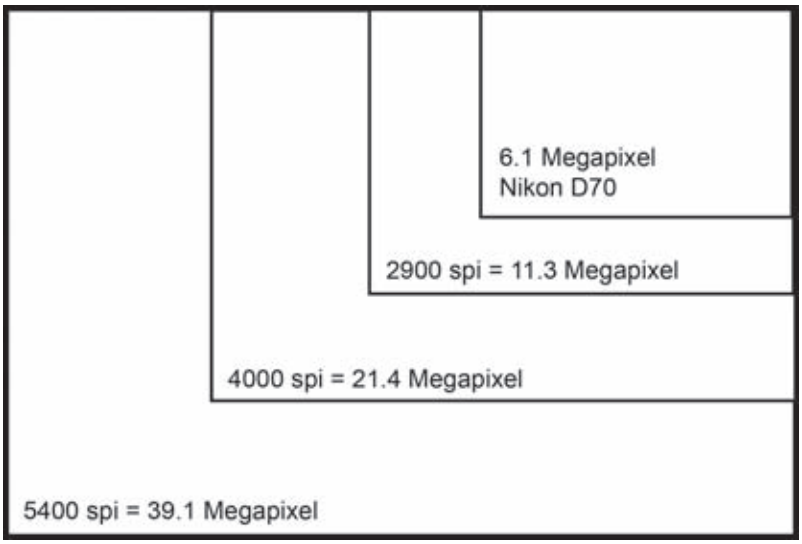
I am not aware of any current desktop film scanner that in actual use resolves more than 4000 dpi. For most source material, a resolution of 2900 dpi would be sufficient. Also, keep in mind that file sizes get very large with increasing resolution, especially with medium and large format scans. With file sizes of over 200 megabytes (MB), image processing will be very difficult on a regular home PC. When choosing the suitable scan resolution, the entire workflow has to be considered.

Meanwhile, professional DSLRs have approached the nominal resolution of far less expensive analog cameras. For example, the Canon EOS 1Ds Mark II is fitted with a full-frame sensor which has a nominal resolution of 16.7 MP. According to the tests in www.dpreview.com, the actual resolution is only 2800 lines horizontally and 2400 lines vertically. Thus, the high nominal resolution translates into an actual, measured resolution of only 6.7 MP. A similar ratio between nominal and measured resolution applies to all models of digital cameras.

6 MP Easily Beats 20 MP

When comparing image quality between scanned analog images and digital images, it is not sufficient to only consider nominal resolutions. The degree of quality loss that occurs during film scanning depends on various factors such as scan density and film flatness. But keep in mind that there is always a loss when converting analog to digital. Due to this, even a 6 MP DSLR is superior to a 4000 dpi (20 MP) scan in most cases, despite the nominally lower resolution.

▸ Looking just at the numbers for the near future, film scanners will nominally remain far superior to amateur DSLRs – such as the Nikon D70 or D70s.



Digital Single Lens Reflex Cameras

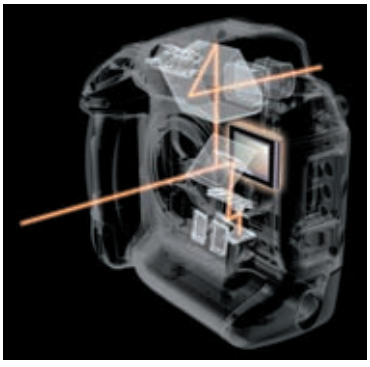
Some years ago there was an ongoing battle among photographers as to whether analog or digital cameras would be the best choice for superior quality. According to current sales figures, this battle has been won by digital cameras, but the technology still has some limitations.

Digital cameras are without discussion the best for product shots and other technical pictures. For portraits, it is a complete different story. On the one hand, the skin tones of the digital image are rarely as expected; on the other hand, the faithful and accurate digital reproduction is not always flattering to the subject, since even the slightest skin imperfection will be precisely recorded. Therefore, in the area of portrait photography, many professionals still prefer film for its very particular, slightly grainy appearance.

The other weak point of digital photography is the always touchy subject of data backup. In the hybrid workflow, there is always the original filmstrip to go back to, but with digital photography all will be lost should the computer crash one day. It remains to be seen how "future-proof" digital images will be.

A 50-year-old negative can still be processed today without any problem. This may in the future not be the case for all of today's popular file formats. Image files without backup can be quickly and permanently lost in a computer crash, while slides and negatives have shown more robustness over the last decade.

And last but not least, there is one crucial reason why even the latest digital camera will never be able to replace a scanner. It has no go-back button; you cannot use it for pictures of your own childhood or anything else that happened in the past. Due to this, you will sooner or later need to make use of a scanner. Digital cameras are great, but not of much use when you are digitizing your analog archives.



▲ The sensor of a DSLR does not reflect light the same way as film (here Nikon D2H). For this reason, the TTL metering of older flash units does not work on modern digital cameras.(Image: Nikon)

Images: Epson

◂ The Epson Perfection V700 is not quite as good as a film scanner, but it is clearly better than a traditional flatbed scanner. For medium format, it is a viable alternative.

Flatbed Scanners with Transparency Adapters

Flatbed scanners have developed enormously over the last few years. They were originally developed for scanning documents. But, flatbed scanners have achieved a resolution which is unnecessary for scanning documents alone. There are many models with transparency units that allow the scanning of film. At present, this technology remains inferior to specialized film scanners.

However, flatbed scanners are faster than film scanners, an advantage not to be underestimated. Though flatbed scanners advertise resolutions of up to 4800 dpi, tests show that this is incorrect. Flatbed scanners that boast a nominal resolution of 4800 dpi can actually only capture 1700 dpi from a transparency. At that resolution, a 35mm slide can only be enlarged up to 5" × 7" at 300 dpi. Also, the color and contrast do not come close to what you can expect from a good quality film scanner. Please compare the scanned files on the DVD accompanying this book.

For scanning medium- and large-format film, the maximum resolution is not so critical, since the film size is several times larger than 35mm film. Average flatbed scanners have a glass stage for holding the originals. However, this glass plate reduces the optical performance of the scanner. In a dedicated film scanner, there is no glass between sensor and medium. This is the reason that, for the foreseeable future, conventional desktop flatbed scanners will not match the performance of dedicated film scanners. Epson tried to improve the unsatisfactory performance of flatbed scanners with a new design approach. The Perfection V700 has a separate lens for scanning film. It achieves an effective resolution of 1920 × 1770 dpi and a maximum density (Dmax) of 3.4, which is just below a good film scanner.

Even the best flatbed scanners cannot achieve the quality you can obtain using a specially designed film scanner, but they are more flexible when it comes to the sizes and formats of originals that can be scanned. If you only want to scan negatives and slides, you are better off using a film scanner, whereas flatbed is better if you need to scan varying formats. Ideally, you should have both types for use in different situations.

Nikon Coolscan 5000: The dedicated filmscanner points out details very clearly and produces consistently vivid colors.

Epson V750 Pro: At first glance, this flatbed scan appears to be of good quality, but a direct comparison to the Nikon (left side) shows a lack of sharpness and less accurate color reproduction.