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inside

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5 of the best from 70-600mm
Telezoom Test
Canon, Sony, Nikon, Tamron, Sigma

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Up Close and Personal

Reducing Shutter Noise
9 Slide Scanners Tested
Tricks of the Trade
How the Fine Art Market Works

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On Color**

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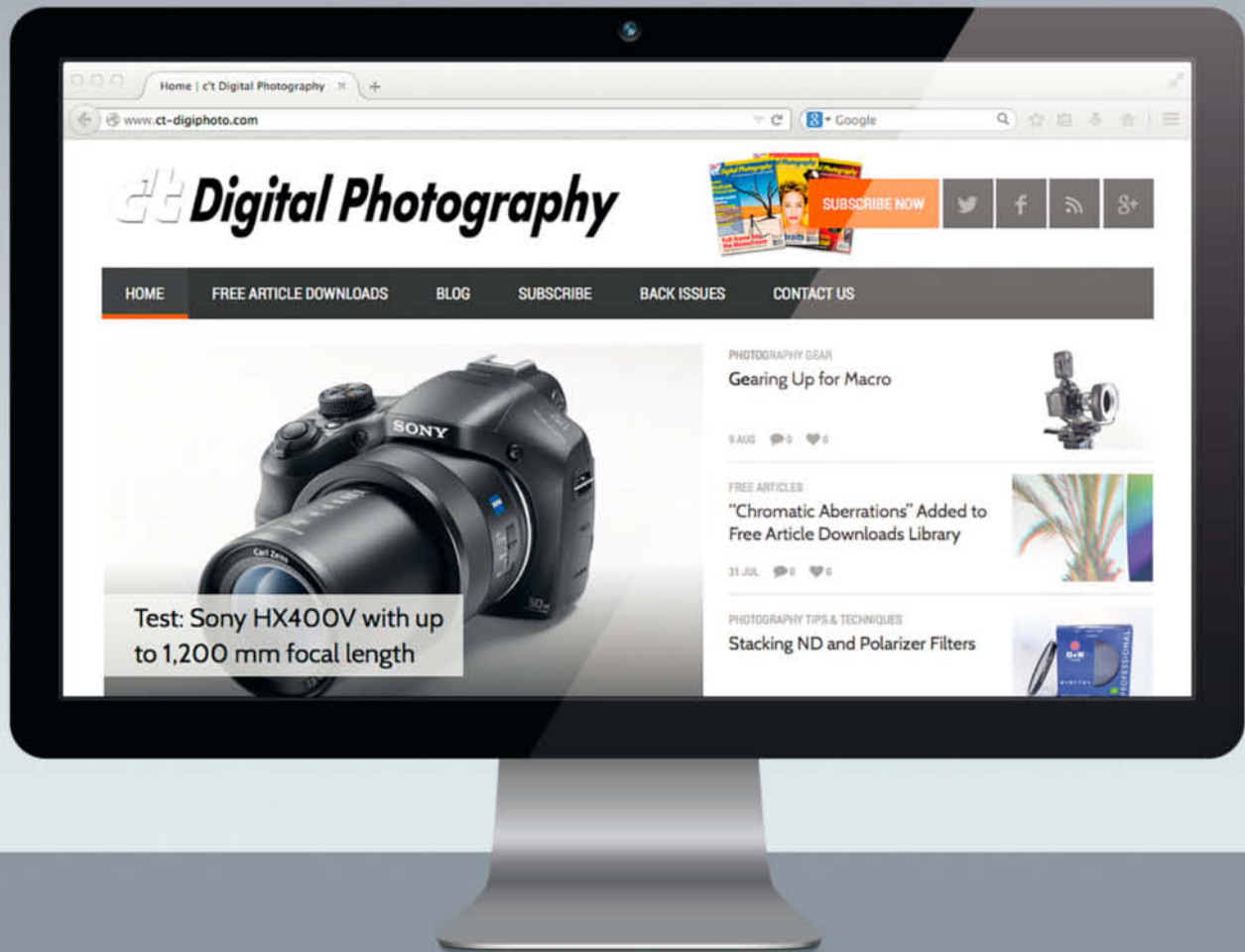
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DISPLAY UNTIL DECEMBER 17

New Website!



We invite you to look around the new **c't Digital Photography website!** The teams in both the U.S. and Germany are beyond excited to present this shiny new online home for c't Digital Photography. Apart from the sleek new look, the website boasts an integrated blog, which is continually updated with industry news and original content from our editors in Germany, the U.S., and our professional photography friends who want to share their knowledge. ct-digiphoto.com will bring our stellar online community closer together, spark lively and

important discussions about this quickly changing photo industry, and offer artistic support and knowledge for those seeking it.



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Our art director Thomas Saur was skeptical when we asked him to illustrate our *Lab Color Corrections* title story and got him to try out some Lab color edits for himself. Once he had given them a go, he was just as convinced as we are that Lab mode makes a fantastic editing tool. Once you know how, you can use it to separate color and brightness data in your images and edit them faster and more precisely than ever before.

The familiar RGB editing steps no longer apply, and you will have to alter your rhythm and style when it comes to adjusting your images, but don't worry – it's definitely worth leaving the familiar terrain of RGB and giving Lab mode a try, at least for a while.

Some of you have commented on how few photos of animals we print, so issue 17 is where we make amends! Alongside our portfolio of fabulous images of horses, our workshop with acclaimed wildlife photographer Benny Rebel will give you all the tips you need to capture wonderful images of our scaly, furry and feathered friends, whether at home, in the zoo or on safari.

Happy shooting and see you next time!



Juergen Rink



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Pro photographer Thomas Saur explains how he created this issue's stunning cover shot.

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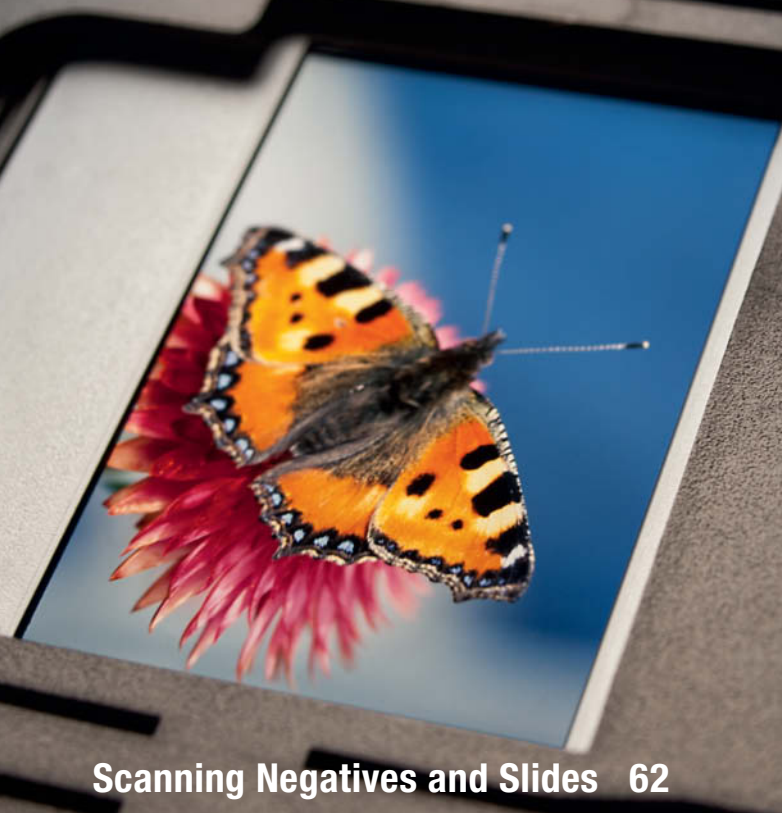
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Free DVD

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Full Version Software: Zoner Photo Studio Pro 16 PRO

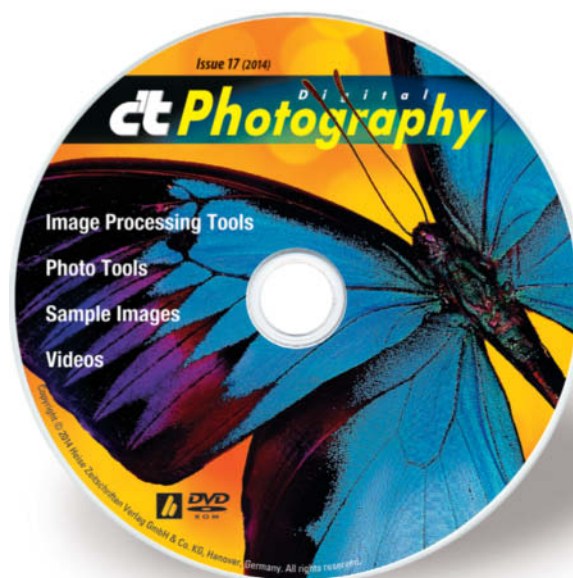
A comprehensive image editing suite with a wide range of tools for correcting, managing, archiving and presenting your digital image archives.

Camera Shutter Sounds

We tested 30 different DSLR, SLT and mirrorless cameras and measured the noise levels they produce while making an exposure. The original audio files are included on DVD.

Videos

- Elliott Erwitt and Marc Riboud: Around the World in 80 Years
- Outdoor Workshop: Safe Portraits II
- Tutorial: Sharpening in Lightroom
- Workshop: Changing Light Direction



Reader Forum

Shooting RAW

I have a complaint about your review of the subject cameras in issue 15. You determined the camera ratings based on JPEG images and only mentioned RAW as an 'afterthought'. I believe that a majority of people buying a camera of this type will be shooting in RAW and processing the images themselves. Personally, I shoot only in RAW and use Lightroom 5 and Photoshop CC to process and edit images. JPEG only shows how the manufacturer's in-camera software processes the image and RAW shooters do not depend on in-camera software. Considering that DxO Mark Labs rate the Canon EOS 70D sensor at a score of 68 and the Nikon D7100 at 83 out of 100 your claim that the Canon produces slightly better images in JPEG is misleading. I am very disappointed in your article.

I have bought almost all issues of *c't Digital Photography* since the beginning. I think you are the best in-depth photo magazine on the market and I buy the magazine because you publish tech info that goes far beyond that provided by most magazines. I am an advanced user since the 1970s and have done some part-time pro work. I bought a Nikon D7000 about 3 years ago because I could use it with my kit of 4 prime Nikkor lenses. I have been very happy with this camera and will probably add the D7100 soon. Others too may need a better review you than the one you published. Thanks for considering my comments. I will continue to buy *c't* anyway.

Marlin Collier

You're absolutely right: Most people buying a camera like the Nikon 70D or the Nikon D7100 will shoot in RAW - most likely because they can process their images much more effectively than they could using just JPEG. The issue here is deciding which of the millions of possible

outcomes is the 'right' one. Pictures captured with different camera models utilize totally different RAW formats and the latest ones are often not yet compatible with popular RAW processing software. We are constantly faced with the question of which software to use for our tests. Lightroom? Or why not darktable? We also have to decide which process to use, and that's just the beginning... We assume that all camera manufacturers will attempt to produce the best possible results with their JPEG processing algorithms, so we consider using JPEGs to be a fair way to work around the endless choices involved. Of course, each camera can still produce better quality images with appropriate processing. To help you form your own opinion as to which version is better, we will be including RAW versions of our test images on all future DVDs.

Color Temperature

c't Digital Photography issue 16 is great. I think the best articles were the macro photography, natural light and 'learning to see' articles. Please keep those composition and open-source software articles coming.

There is an error in issue 16, page 81 in the caption: "The famous 'blue hour' shortly before dusk produces..." 'Blue Hour' is shortly after dusk or before dawn. 'Golden Hour' is shortly before dusk or after dawn.

Near the bottom of column 2, page 81 you state: "Low Kelvin values indicate warmer-looking colors, while higher values represent cooler colors." From an astronomer's point of view lower Kelvin values are indicative of red (cooler) stars and higher Kelvin values represent blue (hotter) stars. In photography we look at color temperature differently: low Kelvin values are for cooler, blueish light and high Kelvin values are for warmer, reddish light. On page 81, you say: "Daylight on a

cloudy day has a color temperature of about 5500K, whereas a cloudless sky has a Kelvin value somewhere between 8000 and 12000." According to my camera manual (Nikon D800, page 145) and a few other books, direct sunlight (i.e. cloudless sky) has about 5200K, a cloudy sky about 6000K and shade about 8000K. Thanks for the wonderful publication.

Richard

The 'blue hour' is a slightly subjective term and depends on how you define "dusk". For example, according to ask.com, dusk is "The commencement of darkness in the evening that occurs after twilight". In other words, after "twilight" (i.e., sundown) is before "dusk".

There are also quite a few conflicting descriptions of color temperature in circulation. The most common definitions we have found give morning and afternoon sun a value of about 5000K, midday sun and cloudy sky 5500K, overcast sky 6500-7500K and cloudless sky just before or after sunrise 9000-12000K.

Focus Stacking

Your article on focus stacking in issue 16 got me thinking about image size. As focus is changed by either moving the entire kit on focusing rails or simply using lens movement to focus, the size of the image varies and the effect is different at different distances. I.e., three items with a height of 10 mm separated by 10 mm of depth will have different size ratios dependent on where the focus plane is, thus making perfect alignment impossible.

I've seen this in some of my own flower pictures where the desired depth was quite large (~100 mm) and I could not get perfect petal edge alignment using Photoshop. The author did not address this.

Randy Lund

c't Digital Photography Now on Android

The *c't Digital Photography* app for browsing and reading our top-notch content is now available for Android. The new app includes search, bookmarking and sharing functionality and is virtually identical to the

iOS version. You can use your subscriber login details to access all issues, regardless of when your subscription actually began. The app is compatible with Android 4.0 and higher and is available on Google Play.



Tell us what you think:

We are always happy to receive your comments and suggestions in a letter, an e-mail (editor@ct-digiphoto.com) or at www.facebook.com/ct-digiphoto. We reserve the right to abbreviate your input for publication. Our comments are printed in italics.

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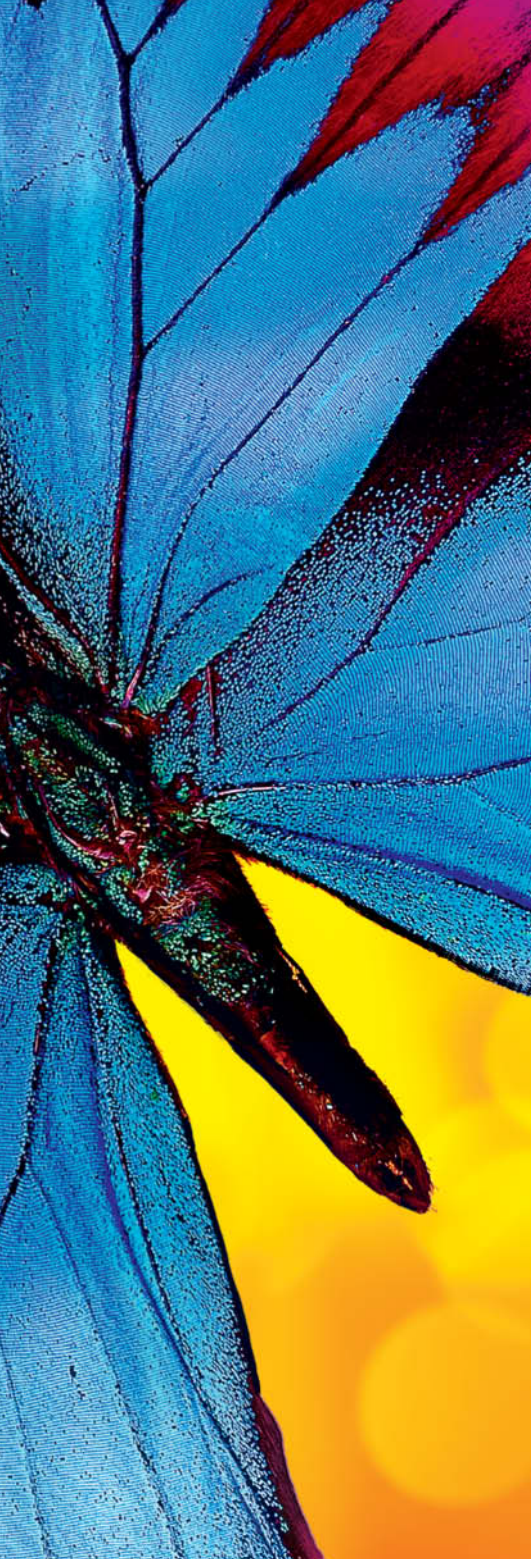
ADORAMA
MORE THAN A CAMERA STORE



Butterfly Shoot

How this issue's cover image was made

Pro photographer and art director Thomas Saur produced the fantastic shot of a Blue Mountain Butterfly for this issue's cover. This article tells you how he created the image and how he solved the challenges involved in capturing this wonderful close-up.



Photographers are often described either as 'picture takers' or 'picture makers' and Thomas Saur definitely sees himself as one of the latter. He leaves nothing to chance when constructing his images and is always in control of the situation, right down to the very last detail. Our brief for an animal portrait with bright, shining colors was right up his street. Instead of portraying a living creature in natural surroundings, Saur decided to photograph a prepared specimen that he bought on eBay for about US\$50. Explaining his choice of a blue butterfly he says, "Butterflies are one of the few insects that people perceive positively. I also found its beautiful shape and bright colors extremely appealing."

His first few attempts to portray his subject in daylight fell flat: "Butterflies are very sensitive to changes in light and I wasn't able to control the daylight precisely enough." Saur decided to head back to his studio where he was able to take complete control of his lighting. Different lighting setups produced varied results, and sub-optimum lateral light quickly led to images that made the butterfly look like crumpled aluminum foil. He finally ended up using colored lights set up as shown in the sketch below. The butterfly itself was placed on a sheet of glass and the images were captured in RAW format using a medium-format Hasselblad H4D with a 120mm macro lens.

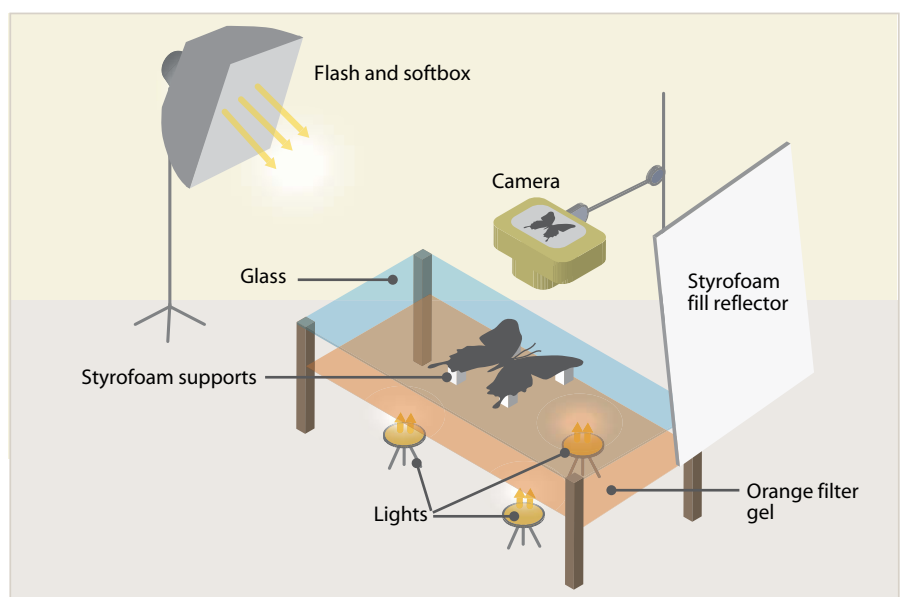
The final image was constructed from two separate source images captured using different exposure parameters. In addition to optimizing the colors, sharpness and contrast, post-processing also involved a number of 'beauty' corrections. "I retouched a lot of tiny dust particles and damaged spots on the butterfly's wings", says Saur. In close-ups



Photographed in daylight, our subject looks really quite mundane

like this, even the tiniest imperfections are immediately obvious to the viewer. The final version has intense, shining colors and makes a perfect cover image. Unfortunately, the limitations of the offset printing process don't allow us to reproduce the colors to look as enticing as they do in the digital original, which we have included on this issue's free DVD. (see) **ct**

Thomas Saur
www.thomassaur.de



Colored lights give the image a much more intense look

DVD Highlights & Contents

Safe Portraits II: Outdoor Workshop

Video tutorial: Pro photographer Bert Stephani shows you how to quickly create perfect portraits in tricky outdoor situations.



In part 1 of this workshop (see issue 16 of *c't Digital Photography*), renowned portrait photographer Bert Stephani explained how to create expressive indoor portraits in no time. The second part of his workshop goes into detail on what to look out for when you are shooting portraits in outdoor situations: for example, how to position female subjects so that you don't produce unwanted shadows around their eyes or nose. Stephani also investigates the differences between shooting portraits of men

and women. He often uses 'harder' lighting, different viewpoints and more dynamic perspectives to portray male subjects, explaining that, "Men don't like to look pretty, they like to look handsome and cool." It is surprising how much difference a tiny change of camera position can make to the look of the resulting image.

This video tutorial clearly demonstrates the individual steps involved in applying these techniques and offers plenty of examples to help you see how they work. To conclude, Stephani also talks about how to choose an appropriate background.

Image editing plays a secondary role in Stephani's work, and he sticks to a minimum of processing steps, such as cropping, sharpening, basic contrast and color corrections, or conversion to black and white. His overriding motto is always to keep things simple, during a shoot and at the post-processing stage. (sea)

Camera Shutter Sounds

Sample audio files: This issue's camera noise test investigates the wide range of sounds that modern cameras produce. Check out these audio files to hear how loud our test cameras really are.

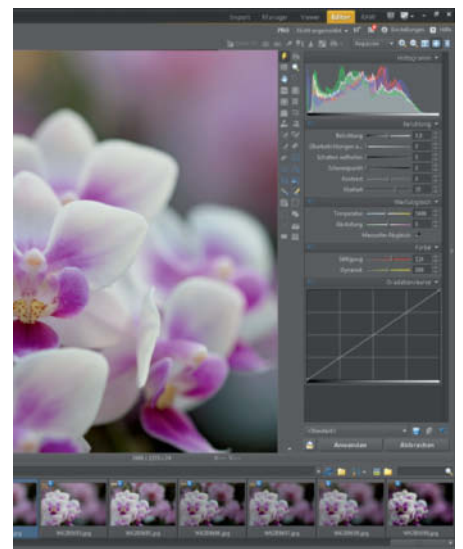
In a comprehensive test performed in the *c't* audio lab (see page 88), we tested 30 different DSLR, SLT and mirrorless cameras and measured the noise levels they produce while making an exposure. The original audio files

for each camera are included on DVD. Using a suitable audio player such as *Audacity*, you can play back the audio files and visualize the sound level curves produced by each camera's shutter. (sts)



Zoner Photo Studio 16 PRO

Full version software: Zoner Photo Studio 16 PRO is the perfect solution for processing, managing, archiving and presenting your digital image archives.



Zoner Photo Studio 16 PRO is a comprehensive and easy-to-use image processing package. The image editor is one of the first available with dedicated touch-driven functionality and includes tools for straightening horizons, red-eye removal, geotagging and content-based scaling. The program offers a range of selection tools, while layers functionality makes editing images a quick and efficient process.

The tools in the latest version are arranged clearly in an easy-to-use sidebar and, if you don't have time to edit your images individually, the unique Quick Fix feature can be used to optimize images automatically. A non-destructive RAW editing module rounds out the program's image processing functionality. The image management and presentation tools provided by the program include upload and share functionality for Facebook, Flickr, Picasa and Web Albums.

This issue's DVD includes a full version of the software. To use the PRO functionality, you have to register your copy from within the program interface. For more details on the software, visit www.zoner.com. (tho)

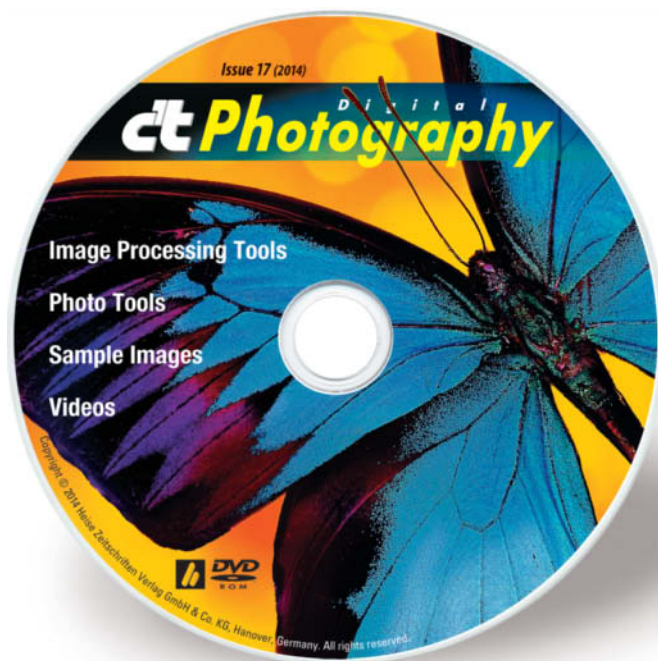


Image Processing Tools

GIMP 2.8.10
 GIMP Portable 2.8.10
 GREYCs Magic Image Converter (GMIC) 1.5.9.3
 Inkscape 0.48.5
 Inkscape Portable 0.48.5
 Luminance HDR 2.4.0
 Photivo 2014-05-25
 PSPI 1.0.7
 Raw Photo Processor 4.7.2
 RawTherapee 4.1
 UFRaw 0.19.2
 Zoner Photo Studio PRO 16 Pro full version

Photo Tools

Enblend/Enfuse 4.1.3
 EnfuseGUI 2.1.3
 ExifTool 9.69
 FastStone Image Viewer 5.1
 FastStone Image Viewer Portable 5.1

GeoSetter 3.4.16
 Geotag 0.094
 GPSBabel 1.5.1
 GTKRawGallery 0.9.9
 GTKRawGallery Portable 0.9.9
 MacPorts 2.3.1

Sample Images and Files

Camera Shutter Sounds
 Digital Original from our Cover Shoot
 Film Scanner Sample Images
 Lab Mode Images and Actions
 Nikon Df and Panasonic Lumix DMC-GH4 CameraTests

Videos

Elliott Erwitt and Marc Riboud – Around the World in 80 Years
 Safe Portraits II – Great Outdoor Photos in No Time
 Tutorial: Sharpening in Lightroom
 Workshop: Changing the Direction of Light

Get in the Picture



c't Digital Photography gives you exclusive access to the techniques of the pros

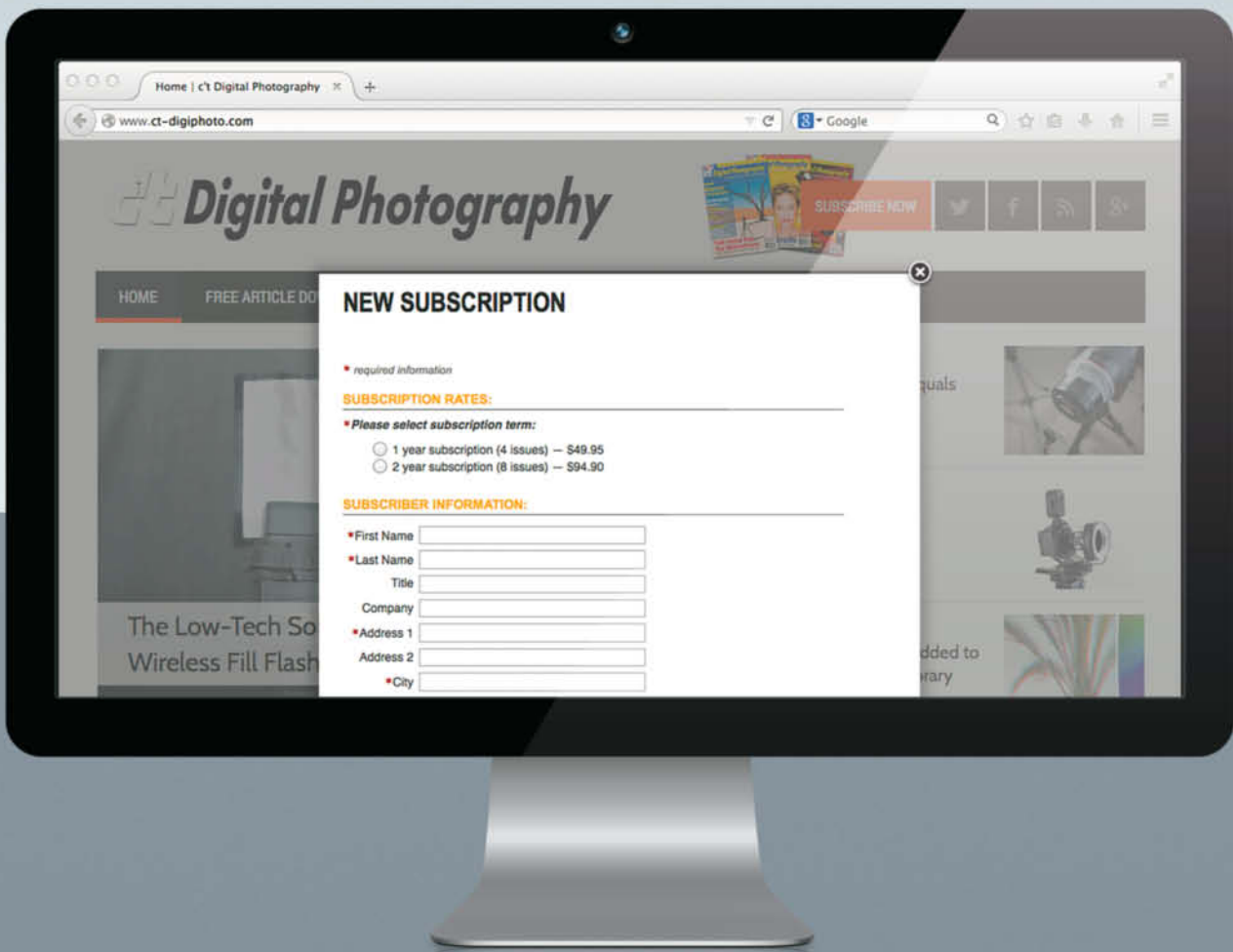
Keep on top of the latest trends and get your own regular dose of inside knowledge from our specialist authors. Every issue includes tips and tricks from experienced pro photographers as well as independent hardware and software tests.

There are also regular image processing and image management workshops to help you create your own perfect portfolio.

Each issue includes a free DVD with full version software, practical photo tools, as well as eBooks and additional video material.

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Falsterfee. The idea here was to capture this wonderful mare at a slight angle as she jumped. This was a significant challenge for her, as we had to set up the jump at a very specific angle to the background and our lamps.

Canon EOS-1Ds Mk II | 125 mm | ISO 100 | f10 | 1/250 s



Portfolio

Wiebke Haas

Sometimes they appear wild and headstrong, at other times almost flirtatious, and often simply lost in their own world. Photographer Wiebke Haas has mastered the art of photographing animals in a way that reveals their individual characters – even if she knows that the effect is sometimes only a figment of the viewer's imagination.

When you see the image reproduced here, you know, immediately that the mare in the picture is bursting with strength and energy – her powerful muscles and wiry shoulders tensed to the max at the start of a jump are precisely the features we are intended to see. This is a consummate animal portrait.

Wiebke Haas is only 23 years old but has been fascinated by animals and how they affect people since she was a child. "We often read human characteristics into animal behavior," she says, "although we never really

know what's going on inside their heads." That contradiction is the main inspiration for her photographic experiments.

In the photos on pages 17 and 18, the Haflinger stallion *Mozart* appears to be flirting with the camera and the viewer, and almost seems to be smiling while shaking his wonderful mane. But does this really represent the truth? Not at all, Haas tells us. "For this shot, I got my assistant to tickle his ear, which immediately made him to shake his head and produce exactly the effect I was looking for."



Ellie is a large German Mastiff with a mind of her own. Haas describes the shot: "I like the symmetry involved in portraits shot head on, although the subject's markings and her collar add some asymmetry to the overall composition. The difference in height of her shoulders also offers a contrast to the otherwise strict visual language and contributes a sense of vitality."

Nikon D3 | 70 mm | ISO 100 | f5.0 | 1/250 s

Explaining the allure of her images, Haas says that because we often see human characteristics in animals, "It's natural to look for similarities between their behavior and ours. It is easy to find hints of charm, whimsy, wildness, vulnerability or simply inherent 'humanness' in all of these creatures."

A qualified portrait photographer, Haas doesn't stick to just one tried and trusted idea. She approaches her subjects in a highly emotional way. "Sometimes, I simply photograph an animal as it is, and other times I deliberately try to find the human angle. Some days, I even look for the aspects of an animal's character that we don't necessarily want to see."

In horse-riding circles, it is often said that a horse's eye is a window to its soul – a conjecture that is well illustrated by the image *Soft Eye* on page 20. Haas: "This close-up is intended to provide just such a 'window' but also reflects the viewer's gaze, giving us the

feeling that we and our intentions are being observed just as closely."

In *The Beauty of Insight* on page 21, the interplay between the subject and the subtle lighting produces a surreal effect. Haas tells us that she has received a lot of emotionally charged, almost lyrical feedback on this image. She likes to use selective lighting and dark backgrounds to bring out the unique physical form of her 'models'. To achieve these effects, she uses a mobile studio equipped with Hensel studio flashes powerful enough to light even large arenas.

High Standards Mean Plenty of Work

Haas learned much of her craft during several months' work with internationally acclaimed photographer Tim Flach. Like Flach, she uses her concentrated style and high technical standards to produce photographs that are

accepted as fine art. That means a lot of hard work during the preparatory stages, the shoot itself and post-production. Editing the image of *Falsterfee* on page 14 took two whole days. This is the kind of dedication that makes the difference between cheap snapshots of animals and the masterful works shown here. (keh)

Wiebke Haas on the Web

For more details, visit www.wiebke-haas.de



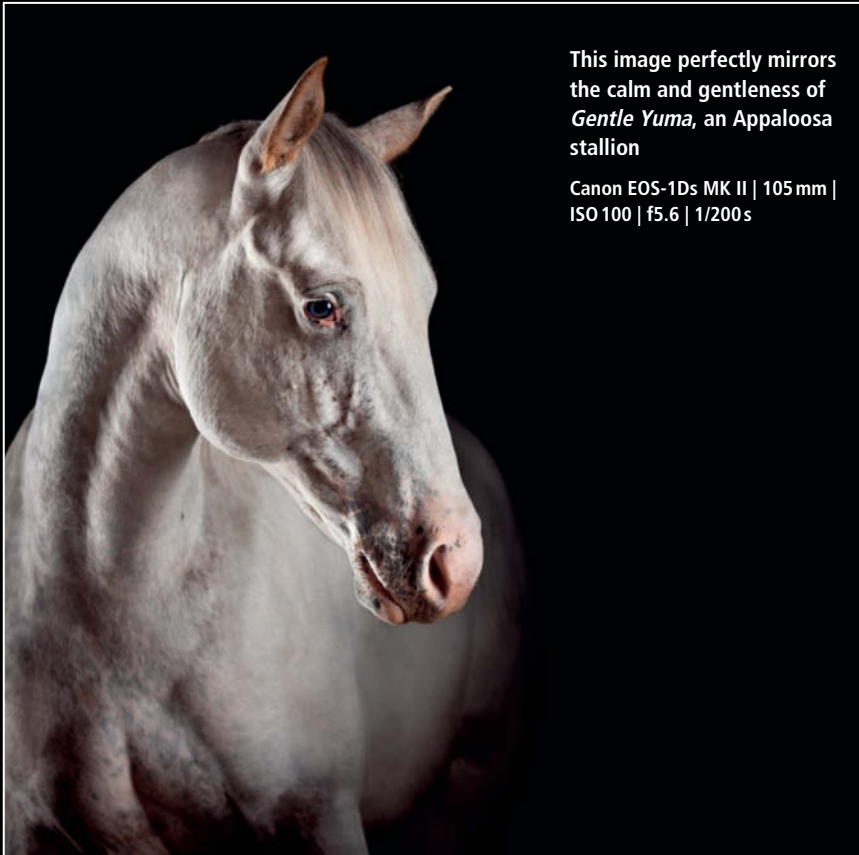
Mozart is a pedigree Haflinger stallion. For this shot, the photographer's assistant tickled his ear to get him to shake his mane.

Canon EOS-1Ds MK II | 130mm | ISO 100 | f13 | 1/250s



Another image of *Mozart*,
again displaying his
magnificent mane and his
innate animal elegance

Canon EOS-1Ds MK II | 130 mm |
ISO 100 | f13 | 1/250 s



This image perfectly mirrors the calm and gentleness of *Gentle Yuma*, an Appaloosa stallion

Canon EOS-1Ds MK II | 105 mm | ISO 100 | f5.6 | 1/200s



Pepe is a crossbreed hunting dog. In this shot, his body is moving toward the right-hand edge of the frame, but his backward glance appears to tell a different story, and we find ourselves asking what attracted his attention.

Canon EOS-1Ds MK II | 105 mm | ISO 100 | f7.1 | 1/250s



Those in the know often say that a horse's eye is the window to its soul. This close-up gives us the opportunity to see for ourselves whether this is true.

Canon EOS-1Ds MK II | 200 mm | ISO 100 | f10 | 1/250 s



In this shot, the 'model' turned toward the light at just the right moment, producing an image with a poetic, almost surreal feel. The interplay of light and shade make the subject's head distinctive and fascinating to behold.

Canon EOS-1Ds MK II | 105 mm | ISO 100 | f6.3 | 1/250 s



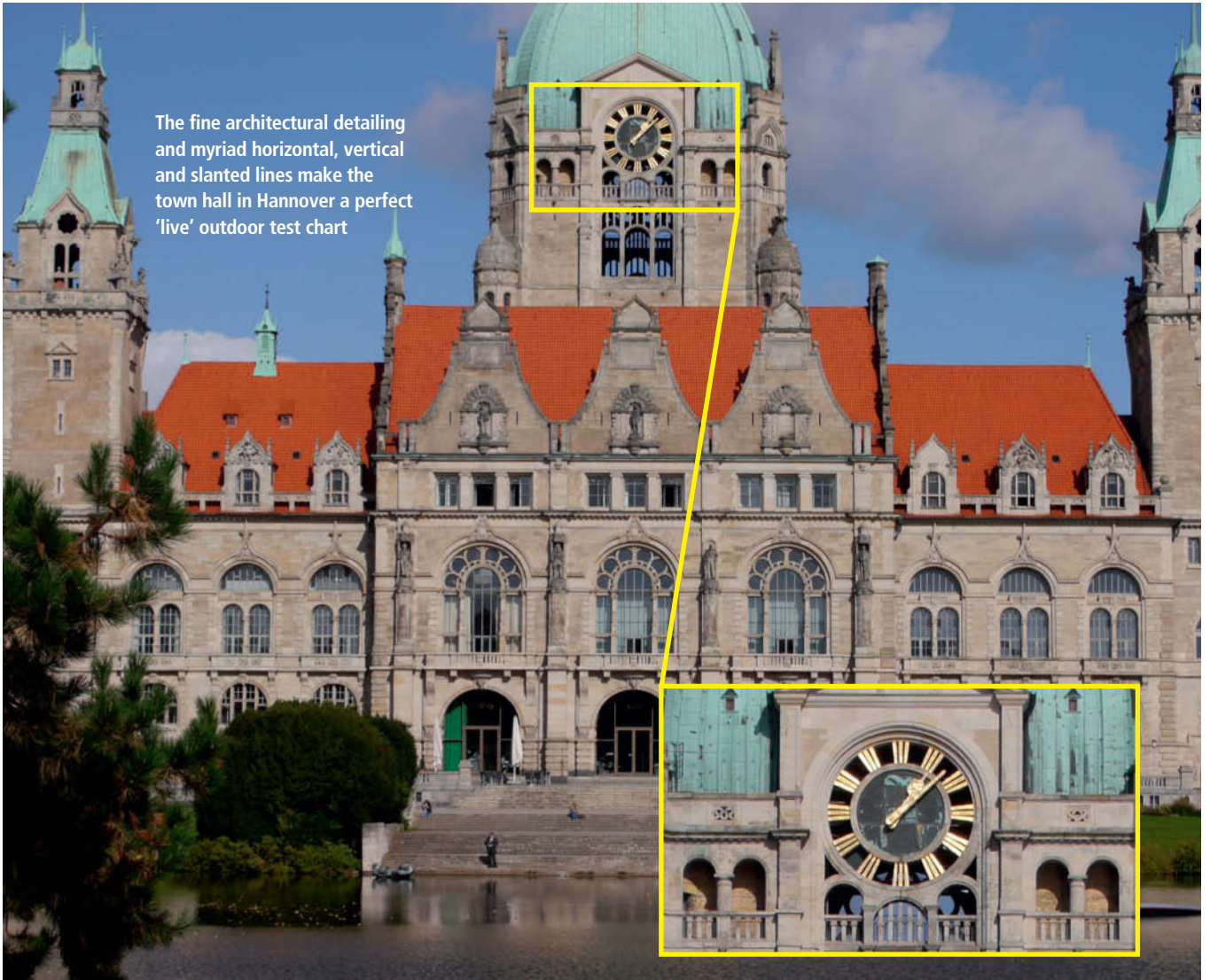
Sophia Sieber, Thomas Hoffmann

Big Guns

Full-frame Telezoom Test

Telephoto zooms are the favorite tool of many vacation photographers but enjoy less of a reputation among pro photographers. We decided to see for ourselves what these monsters are capable of and tested some of the top models from Canon, Nikon, Sigma, Sony and Tamron with zoom ranges between 70 and 600mm.





The fine architectural detailing and myriad horizontal, vertical and slanted lines make the town hall in Hannover a perfect 'live' outdoor test chart

These lenses are large, conspicuous, heavy and expensive. Most photographers have considered investing in a telephoto zoom at some point and, let's face it, who isn't intrigued by the idea of capturing previously unreachable subjects in fantastic, close-up detail?

On safari or nearer to home, only very few timid animal subjects allow photographers to get close enough to take decent photos

and, with some wild animals, you are better off keeping your distance anyway! A telephoto zoom (or 'telezoom' as they are often called) is the perfect tool for capturing such subjects at a safe distance. Sports events, too, are where this type of lens comes into its own and, instead of producing results that you need to view with a magnifying glass, they enable you to freeze the action in highly detailed

photographs. Additionally, photos shot using a high zoom factor have a dramatic and highly individual look and allow you to crop tightly while you are shooting.

Telephoto zooms compress perspective and reduce the apparent camera-to-subject distance, producing a distorted view of reality that is often just right for capturing your own unique view of a distant subject. For example, the ship in the image opposite



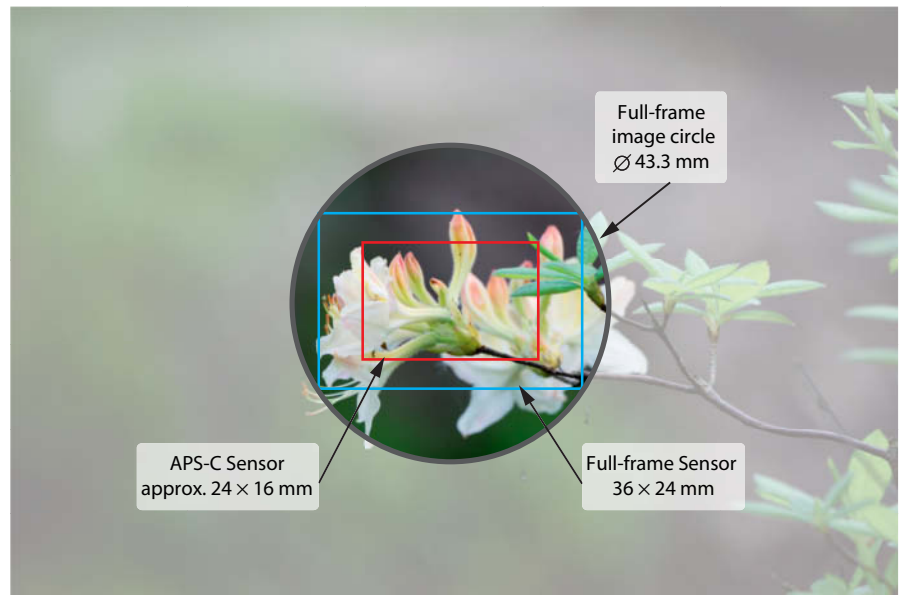
The Canon EOS 5D Mark III and the fully extended Tamron 150-600mm telezoom are a powerful-looking team

would not look half as impressive if we had captured the same shot using a normal lens – the compression that makes the ship seem so close and so large would be lost and the resulting image wouldn't produce the same level of emotional response that the telephoto version evokes.

The Test Field

We tested the AF-S NIKKOR 80-400mm f/4.5-5.6G ED VR, the Canon EF 100-400mm f/4.5-5.6L IS USM and the Sony 70-400mm f/4-5.6 G SSM II and, to complete our overview, we also checked out the Sigma 150-500mm f/5-6.3 DG OS HSM APO and Tamron SP 150-600mm f/5-6.3 DI VC USD models. Both third-party lenses are a lot cheaper than their manufacturer's original counterparts but nevertheless offer greater zoom ranges. The current US\$870 street price for the optically stabilized Sigma seems like a real bargain compared with the US\$2,700 Nikon demands for the 80-400mm. And, while Sony asks around US\$2,100 for its 70-400mm model, the Tamron (also with a built-in stabilizer) costs US\$1,070.

Regardless of price, using a zoom lens always involves making compromises with regard to overall image quality and the maximum available aperture. At the long end, the third-party lenses we tested both have a maximum aperture of f6.3, making either perfect lighting conditions or a high ISO setting essential if you want to keep moving subjects adequately sharp. Pro sports photographers generally prefer to use high-end fixed-focal-length lenses with bright maximum apertures of f4 or more. The problem here is that such lenses can easily cost four or five times as much as those in our test lineup. For example, the Canon EF 400mm f/2.8L IS II USM currently retails for around US\$11,800 and Nikon's AF-S NIKKOR 600mm f/4G ED VR costs nearly US\$10,000. The large apertures offered by



An APS-C sensor utilizes only the sharp center portion of the image circle projected by a full-frame lens, producing images that contain fewer errors and artifacts than those shot using a full-frame camera

these models make it possible to shoot using relatively short exposure times at relatively low ISO settings, which of course improves the quality and consistency of the results.

Outdoor Test Shots

We used Nikon D610, Sony A99 and Canon EOS 5D Mark III bodies to perform our main tests and we also captured additional shots using crop-format Nikon D7100, Sony A58 and Canon EOS 70D bodies to see how the lenses fared when used with an additional crop factor. Used with the EOS 70D, the Tamron has an equivalent maximum focal length of 1,000 mm!

Due to a lack of telephoto-sized space in our lab, we shot our full-frame Siemens star

test shots with the lenses set to their shortest focal lengths and to just beyond 300mm. We also captured some outdoor test shots at the Hannover Adventure Zoo and at the local town hall, which offers plenty of challenging details and allowed us to make additional (albeit subjective) visual image quality judgements.

To complete the picture, we also captured outdoor test shots using our APS-C test camera bodies. The results definitely benefit from the large (43mm) image circle projected by the full-frame lenses, as only the sharpest center portion of the image fits into the 27 or 28mm diagonal of the APS-C sensors. The downside of using full-frame lenses with crop-format cameras is that the increased pixel density raises the bar on the image quality the lens has to deliver.

The perspective compression produced by long telephoto zooms creates dramatic images with a highly individual look. In this photo, the ship appears to be steaming past just a few meters from the beach, whereas in reality it was several kilometers distant.





Canon EF 100-400mm f/4.5-5.6L IS USM

The lens: This model first hit the streets in 1998, and its old-school push/pull zoom ring is sure to cause some inquiring looks from younger photographers. Older users, too, may find that this design doesn't provide sufficient sensitivity when selecting zoom settings. However, the resistance of the zoom ring can be adjusted between 'smooth' and 'tight' to suit your shooting style, and rotating the zoom touch adjustment ring all the way toward 'tight' locks the current setting.

If you are prepared to ignore these limitations, the all-metal Canon is a virtually indestructible workhorse. But don't allow yourself to be fooled by its robust look – this particular model is neither dust nor moisture resistant, so care is required when using it in harsh environments.

In spite of its age, the lens has a full feature set, with an effective built-in stabilizer and an ultrasonic motor that ensures fast, quiet focusing.

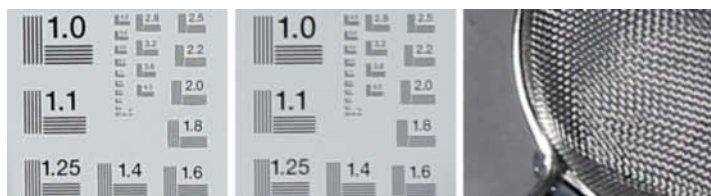
Test results and image quality: In the lab, the Canon delivered solid results and produced images with more than 80 percent

of its potential maximum center resolution throughout the zoom range. Edge resolution was less satisfactory, especially at wider apertures and longer zoom settings.

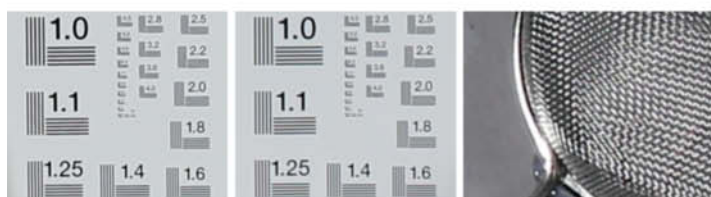
Stopped down, center resolution dropped off slightly but the edges looked slightly better. At medium zoom settings, the Canon resolved around 300 line pairs more than at the short end. Image errors and artifacts were non-critical throughout the zoom range.

Canon EF 100-400mm

Max. aperture / Min. focus distance	f/4.5-5.6 / 180 cm (5.9 ft.)
Length / Weight	189 mm / 1380 g (3 lb)
Current Street price	US\$1,700
Test Results	Wide Open / +2 Stops
Short-end resolution (Edge) ¹	1653 (1361) / 1621 (1536)
Average resolution (Edge) ¹	1617 (1072) / 1592 (1360)
Vignetting ² at max. aperture (wide-angle/max. zoom)	0.5 / 0.8
Distortion at max. aperture (wide-angle/max. zoom)	0.03 % / 0.47 %
Chromatic aberration at max. aperture (wide-angle/max. zoom)	0.5 pixels / 0.6 pixels
¹ in line pairs ² in f-stops	



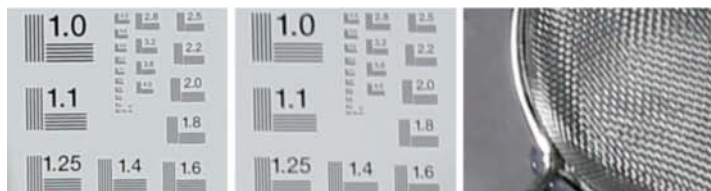
EOS 5D Mark III | f5.6 | 100 mm



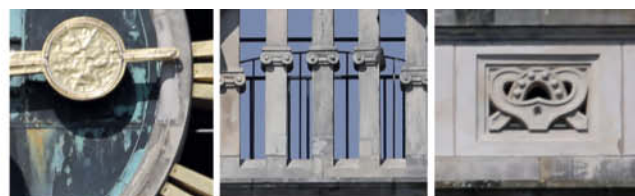
EOS 5D Mark III | f11 | 100 mm



EOS 5D Mark III | f5.6 | 310 mm



EOS 5D Mark III | f11 | 310 mm



EOS 5D Mark III | f5.6 | 400 mm



EOS 5D Mark III | f11 | 400 mm



EOS 70D | f5.6 | 400 mm



EOS 70D | f11 | 400 mm

Rhinoceros on the move, captured
using the 100-400mm Canon zoom

Canon EOS SD MKIII | 400 mm |
ISO 200 | f5.6 | 1/250 s | Tripod-mounted





Sigma 150-500mm f/5-6.3 DG OS HSM

The lens: This model is available in Nikon AF, Canon EF, Sigma, Pentax and Sony A-mount versions, and we tested it using our Canon EOS 5D Mark III full-frame and EOS 70D APS-C bodies. The overall build quality is good, and we particularly liked the grippiness of the matte surface of the barrel, although some people don't like the way the material glitters in bright sunlight. On the downside, our test lens had trouble retaining its zoom setting when tilted even slightly forward. There is a zoom lock button, but this only works at the short end of the zoom range, and we would prefer to see a better system that works for the entire range.

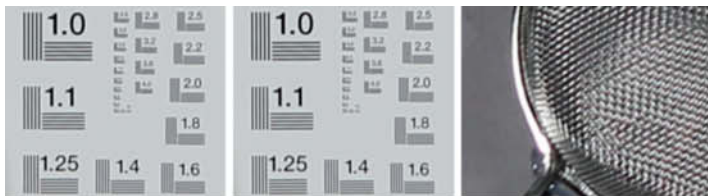
Test Results and image quality: True to our expectations, the Sigma didn't produce market-beating results in the lab, but nevertheless delivered consistent results, with its best performance between f8 and f11. Wide open, the images we captured were generally softer at the short end and in the middle of the zoom range, although there was virtually no detectable difference between center and edge resolution. Stopped down, edge resolution at medium

zoom settings was better than at the short end of the range.

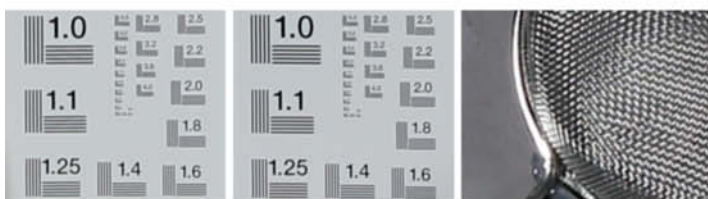
Our outdoor test shots confirmed our lab-based findings, producing slightly soft images that lack detail contrast when captured wide open. Stopping down improved things a lot, producing much clearer, more three-dimensional images. As with our indoor shots, our outdoor test images showed poorer resolution at the edges of the frame than in the center.

Sigma 150-500mm

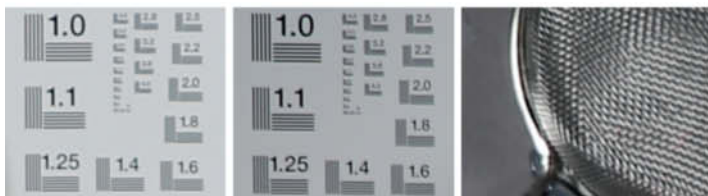
Max. aperture / Min. focus distance	f/5.0-6.3 / 220 cm (7.2 ft.)
Length / Weight	252 mm / 1910 g (4.2 lb)
Current Street price	US\$ 870
Test Results	Wide Open / +2 Stops
Short-end resolution (Edge) ¹	1423 (1379) / 1509 (1511)
Average resolution (Edge) ¹	1542 (1196) / 1568 (1446)
Vignetting ² at max. aperture (wide-angle/max. zoom)	0.5 / 0.8
Distortion at max. aperture (wide-angle/max. zoom)	0.2 % / 0.3 %
Chromatic aberration at max. aperture (wide-angle/max. zoom)	0.47 pixels / 0.9 pixels
¹ in line pairs ² in f-stops	



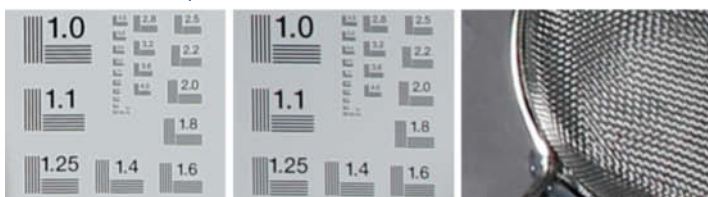
EOS 5D Mark III | f5.6 | 150mm



EOS 5D Mark III | f11 | 150mm



EOS 5D Mark III | f5.6 | 289mm



EOS 5D Mark III | f11 | 289mm



EOS 5D Mark III | f6.3 | 500mm



EOS 5D Mark III | f11 | 500mm



EOS 70D | f5.6 | 500mm



EOS 70D | f11 | 500mm

A gorilla photographed at the
Hannover Adventure Zoo using
the Sigma 150-500mm lens

Canon EOS 5D Mark III | 500 mm |
ISO 800 | f6.3 | 1/200s | Tripod-mounted





Tamron SP 150–600mm F/5-6.3 Di VC USD

The lens: The Tamron has the longest maximum focal length of all our test lenses, peaking at 600 (full-frame) millimeters. It is a great lens for capturing sports and paparazzi-style shots. To keep the price, size and weight to a reasonable level, the Tamron has a fairly small maximum aperture of f5 at the short end and f6.3 at its longest zoom setting. These specifications make using a teleconverter virtually impossible, especially if you want to continue using autofocus.

In spite of its greater range, the difference in size between this lens and the 400mm competition is not as great as you might expect. Thanks to its plastic barrel, the Tamron weighs less than 2kg and, in view of its great price, overall build quality is perfectly acceptable.

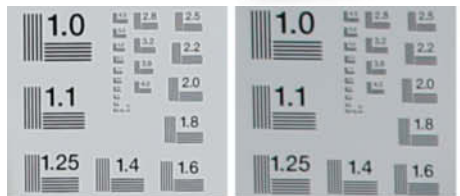
Test Results and image quality: Center resolution came in at above 80 percent of its theoretical maximum throughout the zoom range and increased to 87 per cent at the short end. Edge resolution improved when the lens was stopped down and improved further with increasing focal length.

Vignetting was negligible, and we measured acceptably low levels of distortion and chromatic aberration. Our outdoor test mirrored these results and, even at its maximum zoom setting, the Tamron produced sharp details and plenty of contrast, especially when we kept the subject in the center of the frame.

Tamron 150-600mm

Max. aperture / Min. focus distance	f/5.0-6.3 / 270 cm (8.9 ft.)
Length / Weight	258 mm / 1951 g (4.3 lb)
Current Street price	US\$1,070
Test Results	Wide Open / +2 Stops
Short-end resolution (Edge) ¹	1675 (1515) / 1629 (1563)
Average resolution (Edge) ¹	1517 (1240) / 1454 (1386)
Vignetting ² at max. aperture (wide-angle/max. zoom)	0.4 / 0.5
Distortion at max. aperture (wide-angle/max. zoom)	0.49 % / 0.54 %
Chromatic aberration at max. aperture (wide-angle/max. zoom)	0.56 pixels / 0.5 pixels

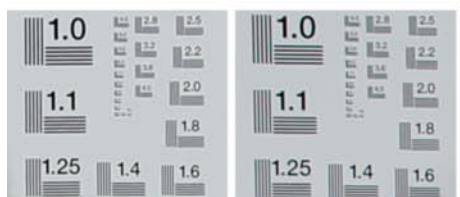
¹ in line pairs ² in f-stops



EOS 5D Mark III | f5.6 | 150mm



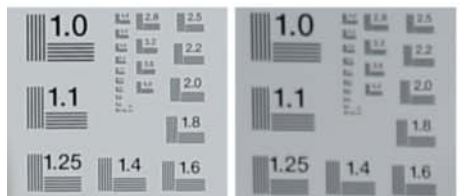
EOS 5D Mark III | f6.3 | 600mm



EOS 5D Mark III | f11 | 150mm



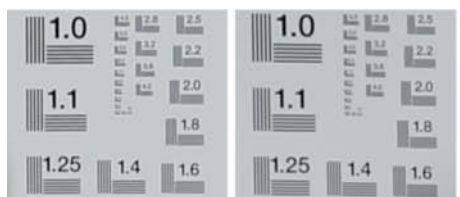
EOS 5D Mark III | f11 | 600mm



EOS 5D Mark III | f5.6 | 300mm



EOS 70D | f5.6 | 600mm



EOS 5D Mark III | f11 | 300mm



EOS 70D | f11 | 600mm



A seal relaxing in its enclosure,
photographed using the
Tamron 150-600mm lens

Canon EOS 5D Mark III | 600 mm |
ISO 200 | f6.3 | 1/400 s | Tripod-mounted



Nikon AF-S NIKKOR 80-400mm f/4.5-5.6G ED VR



The lens: The mixed metal and plastic construction makes this quite a heavy lens with excellent build quality. There is no excess play in the focus ring and the zoom ring can be rotated smoothly using just one finger. If you look at the front element from the side, you can see the high-end coating that minimizes internal reflections within the complex 20-element design.

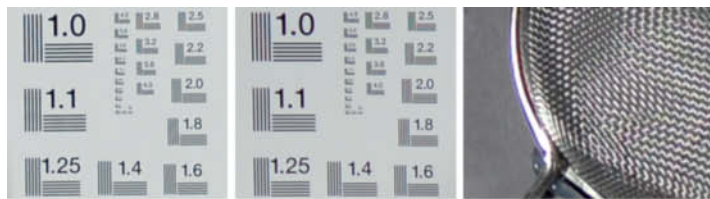
For the high price it charges, Nikon delivers a full feature set that includes a built-in image stabilizer, a fast and quiet ultrasonic focus motor and three different focus modes. The maximum short-end aperture of f4.5 makes this a useful protrait lens and helps to make it a great all-round lens for everyday use.

Test Results and image quality: Wide open, the Nikon recorded excellent center resolution of 1764 line pairs, dropping off by only 10 per cent toward the edges of the frame. Stopping down provided some additional sharpness and, at medium apertures, center and edge resolution were

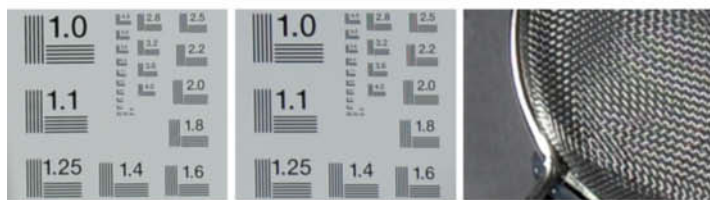
just about the same. Our test images were visibly softer at the long end and recorded less than 80 percent of the D610's potential resolution, even stopped down.

As is to be expected, Nikon has managed to reduce distortion to an absolute minimum at all focal lengths. Chromatic aberration and vignetting effects, too, were the best we recorded in the course of our test.

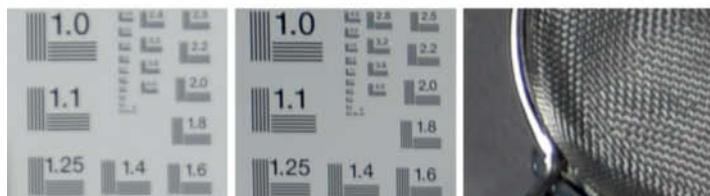
Nikon 80-400mm	
Max. aperture / Min. focus distance	f/4.5-5.6 / 175 cm (5.7 ft.)
Length / Weight	203 mm / 1570 g (3.5 lb)
Current Street price	US\$2,700
Test Results	Wide Open / +2 Stops
Short-end resolution (Edge) ¹	1764 (1543) / 1723 (1654)
Average resolution (Edge) ¹	1252 (1150) / 1473 (1371)
Vignetting ² at max. aperture (wide-angle/max. zoom)	0.4 / 0.4
Distortion at max. aperture (wide-angle/max. zoom)	-0.03 % / 0.38 %
Chromatic aberration at max. aperture (wide-angle/max. zoom)	0.6 pixels / 0.4 pixels
¹ in line pairs ² in f-stops	



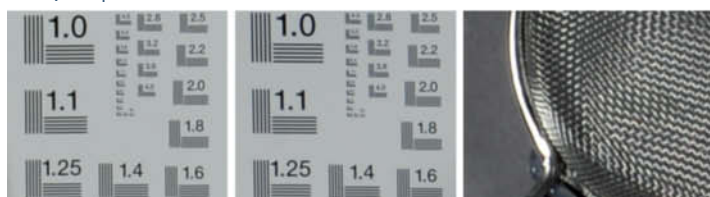
D610 | f5.6 | 100mm



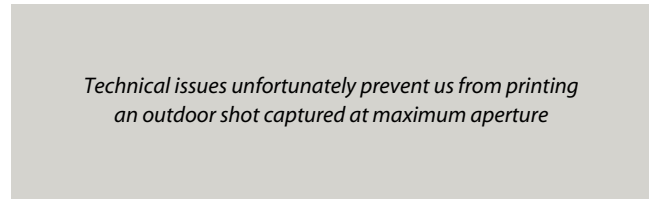
D610 | f11 | 100mm



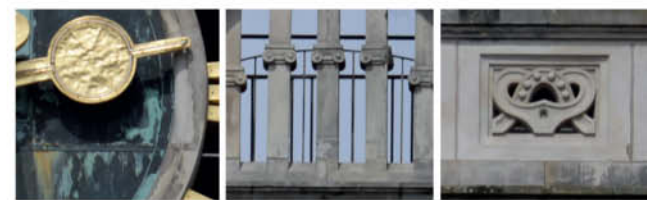
D610 | f5.6 | 320mm



D610 | f11 | 320mm



D610 | f5.6 | 400mm




D610 | f11 | 400mm



D7100 | f5.6 | 400mm



D7100 | f11 | 400mm

A black and white penguin with pink eye-rings is sitting on a sandy floor. The penguin has a black head with a white stripe through its eyes, a white neck, and a black and white patterned body. It is looking slightly to the left. The background is a blurred indoor setting with a white metal structure on the right.

Penguin in captivity,
photographed using the
Nikon 80-400mm lens

Nikon D610 | 400 mm |
ISO 560 | f5.6 | 1/1600s

Sony 70-400mm F4-5.6 G SSM II



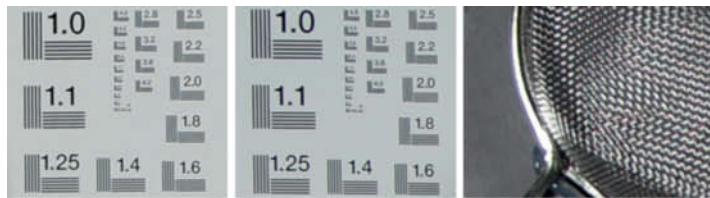
The lens: The Sony is an extremely solid contender with excellent build quality and no looseness in its controls. As with all the other lenses in this article – except the Sigma 150-600mm – it has a switch for limiting the focus range. It also has a focus-hold button. We mounted our test lens on the Sony SLT-A99 body and it proved quiet, fast and accurate throughout the test procedure.

Test Results and image quality: The Sony performed extremely consistently at all test apertures and focal lengths, although our lab tests showed a slight overall improvement between f8 and f11. At these apertures, we recorded between 1617 and 1595 line pairs compared to the A99's theoretical maximum of 2000. The average resolution was also very good and differed only slightly between the center and edges of the frame. Detail contrast was also very good at 100 mm but is still not as good as that produced by an equivalent fixed-focal-length lens. Longer focal lengths produced slightly softer results.

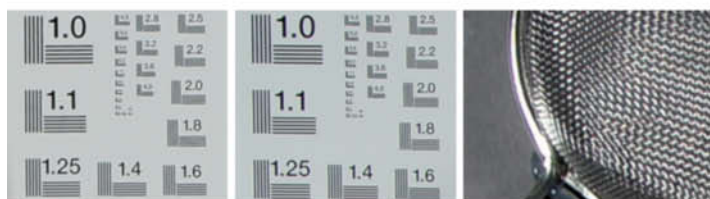
Outdoors, our test shots at the long end of the zoom range show acceptable center

sharpness at all apertures but are still not as crisp as we would have liked. Overall sharpness drops off toward the edges, but not as obviously as it does with the Sigma, for example. Our biggest gripe is the obvious chromatic aberration that we recorded when using the lens wide open (i.e., f5.6) at its maximum zoom setting.

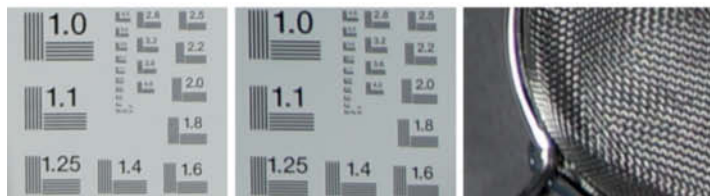
Sony 70-400mm	
Max. aperture / Min. focus distance	f/4.0-5.6 / 150 cm (4.9 ft.)
Length / Weight	196 mm / 1500 g (3.3 lb)
Current Street price	US\$2,100
Test Results	Wide Open / +2 Stops
Short-end resolution (Edge) ¹	1523 (1545) / 15959 (1580)
Average resolution (Edge) ¹	1542 (1457) / 1588 (1575)
Vignetting ² at max. aperture (wide-angle/max. zoom)	0.6 / 0.4
Distortion at max. aperture (wide-angle/max. zoom)	0% / 0.3%
Chromatic aberration at max. aperture (wide-angle/max. zoom)	1.17 pixels / 0.84 pixels
¹ in line pairs ² in f-stops	



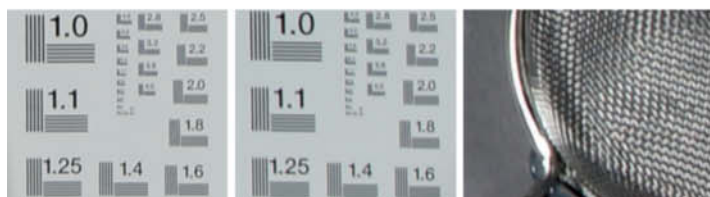
A99 | f5.6 | 100 mm



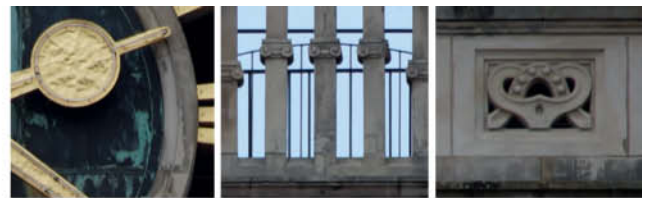
A99 | f11 | 100 mm



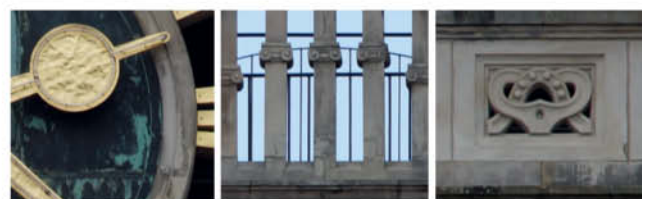
A99 | f5.6 | 300 mm



A99 | f11 | 300 mm



A99 | f5.6 | 400 mm



A99 | f11 | 400 mm



A58 | f5.6 | 400 mm



A58 | f11 | 400 mm



Captured during a horse race at the
Neue Bult racecourse in Langenhagen

Sony SLT-A99 | 140 mm |
ISO 1600 | f7.1 | 1/2000s

Conclusions

Opinions are usually split when it comes to telephoto zooms, with pros mostly turning up their noses while hobby photographers can't get enough. Many users see 4× and 5× zooms as a viable, lightweight alternative to carrying and switching between multiple prime lenses, while others complain about the middling image quality produced by lenses that aim to cover all the bases but can't quite fulfill the expectations that their ambitious specifications generate.

As is often the case, the truth of the matter lies somewhere between these two extremes. None of our test lenses produced any truly awful results and, as expected, we recorded the poorest results at the long end of the zoom range. Of course, an average-quality photo is better than one that didn't get captured at all.

Don't get us wrong: all of these lenses performed well throughout the zoom range but none delivered that little extra sharpness that makes a good photo great, especially for subjects located toward the edges of the frame. The price that has to be paid for that kind of imaging excellence can be expressed in terms of thousands of additional dollars and the kilograms of glass that make up high-end

telephoto primes. At the end of the day, it is up to you to decide whether that kind of investment is worth the increase in quality that it promises.

During this test, we had a lot of fun capturing familiar surroundings from a new perspective. Particularly the photos we captured at the zoo provided us with all sorts of fascinating views that kept us glued to our monitors back at the office. Even in ideal lighting conditions, these lenses usually require the use of a solid tripod so, even if a telezoom makes your equipment lighter, your kit will probably end just as bulky.

A test like this also raises the question of which is the right lens to acquire. The Canon is the oldest of our test models and has a mid-range price to match, while the relatively new Nikon was the most expensive model we tested. In the value for money stakes, the clear winner is the Sigma, with its current street price of around US\$900. The downside of this 'bargain' is its relatively poor short-end performance. In this respect, the Nikon is definitely top of the heap.

At medium focal lengths, the Canon just comes out on top for centrally-placed

subjects but cannot really compete when it comes to edge resolution. The Sony performed most consistently in the center and at the edges throughout the zoom range. It produced virtually no distortion at its 70mm setting but did show some color fringing.

The Tamron remained under the radar in the resolution and image quality stakes but scored highly with its additional zoom range. More range of course means more weight, and the 150-600mm was the heaviest in our test field. Overall, it performed well enough without producing spectacular highlights or obvious errors.

In this category of lens, Nikon and Sony users who aren't looking for a bargain are best off using original equipment, but the Tamron is definitely worth a look if you want to spend less money.

If you are a Canon owner, the online rumor mill is currently suggesting that the long-awaited successor to the EF 100-400mm will be announced at this year's Photokina, although the price will probably be significantly higher than that of the current model. (ssi, tho) **ct**



Telephoto zooms are not the most inconspicuous of lenses, and capturing a full set of test shots with several cameras and lenses and a solid tripod definitely saved us a trip to the gym!



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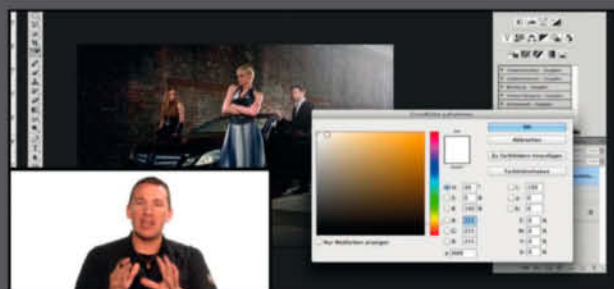


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Thomas Hoffmann

Panasonic Lumix DMC-GH4

A stills camera for video pros

Most of the models in Panasonic's flagship GH range have won great acclaim among video fans. The latest, the GH4, offers high-end stills specifications coupled with pro-grade 4K video recording capabilities. We took the camera and its matching 25mm prime Leica lens for a spin.

Detail from the *c't* studio test scene (see this issue's free DVD for more sample images)



Panasonic's GH mirrorless system cameras have long represented the state of the manufacturer's art regarding features and handling. The fourth iteration of the series shows that, even if it has not yet found its way into most people's living rooms, 4K video is now available to the mass market in a high-quality and relatively affordable package.

Handling

For its latest model, Panasonic has stuck to its tried and trusted SLR form factor and its dust and moisture resistant magnesium alloy design. The body incorporates many direct settings options including three control dials and dedicated buttons for a number of major functions. The body also includes a tilt/swivel OLED touch screen monitor with 1,036,000 dots of resolution. The 16:9 OLED viewfinder measures 2048 × 1152 dots and produces a pleasantly sharp image. The large grip on the front of the camera ensures safe and positive handling.

The differences between this and the previous model are minimal and you have to look closely to see which is which. The mode dial lock is the most obvious difference in the newer camera.

Features

Both the sensor and the image processor have been updated and the new camera is capable of processing video data at speeds of up to 200 Mbps. The new 9AHD quad-core Venus Engine also boosts burst shooting rates, enabling shooting at up to 8.5 RAW or 9.7 JPEG images per second.

The Micro Four Thirds Live MOS sensor has the same 16-megapixel resolution as its predecessor, and the relatively large pixels produce largely noise-free results. Panasonic claims to have doubled processing speed in comparison to the GH3 – a feature that also ensures less rolling shutter effects during video capture. The revised autofocus system

now has 49 AF areas (as opposed to 23 in the GH3) and new functions like eye detection for portraits and automatic focusing when you look through the viewfinder make using the camera simple and convenient. Thanks to 'Depth From Defocus' (DFD) technology, which compares the distances of near and far out-of-focus areas, the GH4 focuses extremely quickly. Panasonic claims focusing speeds as fast as 0.07 seconds, although we measured a slower average of 0.33 seconds using the Leica DG Summilux 25mm f/1.4 ASPH lens.

The GH4 includes NFC and Wi-Fi functionality that enables fast image transfer and remote control via a smartphone or tablet computer.

The real killer feature of this camera is its video functionality. It is the first mirrorless model to incorporate 4K resolution video (Cinema 4K at 4096 × 2160 and 24p, or QFHD at 3840 × 2160 and 30p). The camera can process ALL-Intra video at 200 Mbps and IPB at 100 Mbps. The available video formats include MOV, MP4 and AVCHD Progressive, and video signals can be outputted either to the memory card or via the built-in Micro HDMI interface, which is capable of processing 10bpc 4:2:2 streams.

The camera also includes a number of features that were hitherto only found in dedicated video cameras, including 'zebra' overexposure warnings and focus peaking to aid focus point selection. Other pro-grade video features include sound testing, SMPTE, EBU and ARIB color bars, gamma and black point adjustment and time coding. You can also set the luminance level to ranges of 16-235, 16-255 or 0-255.

To prevent moirés during video capture, the camera uses only part of the sensor surface and records each pixel at life size, resulting in video frames with an enlargement factor of 2.5 compared to full-frame footage.

The available accessories are also squarely aimed at videographers and include a shotgun microphone that adapts sound

Panasonic DMC-GH4 at a glance



Technical Data

Sensor resolution	4608 × 3456
# of megapixels	16
Sensor size	17.3 × 13.0 mm (Micro Four Thirds)
Crop factor	2
RAW capture	yes
Autofocus system	contrast detection
Focus areas	49
Shortest/Longest exposure times	1/8000 s / 60 s (Bulb)
Sensitivity	ISO 100-25 600
Viewfinder	electronic
Viewfinder resolution	2,359,000 dots
Monitor	touch responsive OLED
Monitor size / aspect ratio	3" (7.6 cm) / 3:2
Monitor resolution	1,036,000 dots
Monitor articulation	tilt / swivel
Dimensions (W/H/D)	133 × 93 × 84 mm
Weight (including battery and memory card)	560 g (1.23 lb)
Memory card types	SD, SDHC, SDXC
Connectors	USB 2.0, HDMI, AV, WLAN/NFC, microphone, headphones, remote control
Street Price (body only)	US\$1,700

Test Results

	better ▶
Sensor resolution (line pairs)	1728
Center resolution (ISO 100)	1728
Center resolution (ISO 400)	1722
Center resolution (ISO 1600)	1663
Center resolution (ISO 6400)	1569
Dynamic range (ISO 100)	10.4
Dynamic range (ISO 400)	10.4
Dynamic range (ISO 1600)	10.1
Dynamic range (ISO 6400)	10.1
	◀ better
Visual Noise (ISO 100)	1
Visual Noise (ISO 400)	1.2
Visual Noise (ISO 1600)	2.2
Visual Noise (ISO 6400)	2.8
Shutter lag at 1000 lux	0.3s



The GH4 shows excellent noise characteristics in this image, shot at ISO 200. Noise continues to be a non-issue all the way up to ISO 800.

Panasonic GH4 with the Leica 25 mm f/1.4 | ISO 200 | f1.4 | 1/8s | Tripod-mounted

recording to suit the zoom setting you are using. There is also a large (and expensive) interface unit available with four parallel SDI connectors, built-in time coding, XLR audio inputs and a 12V DC input.

Test Results

Equipped with the Panasonic Leica 25mm standard lens, the GH4 delivers outstanding resolution, recording 100 percent of its theoretical maximum of 1728 line pairs in the center of the frame all the way up to ISO 800. Edge resolution is only slightly poorer, coming in at an excellent 95 percent.

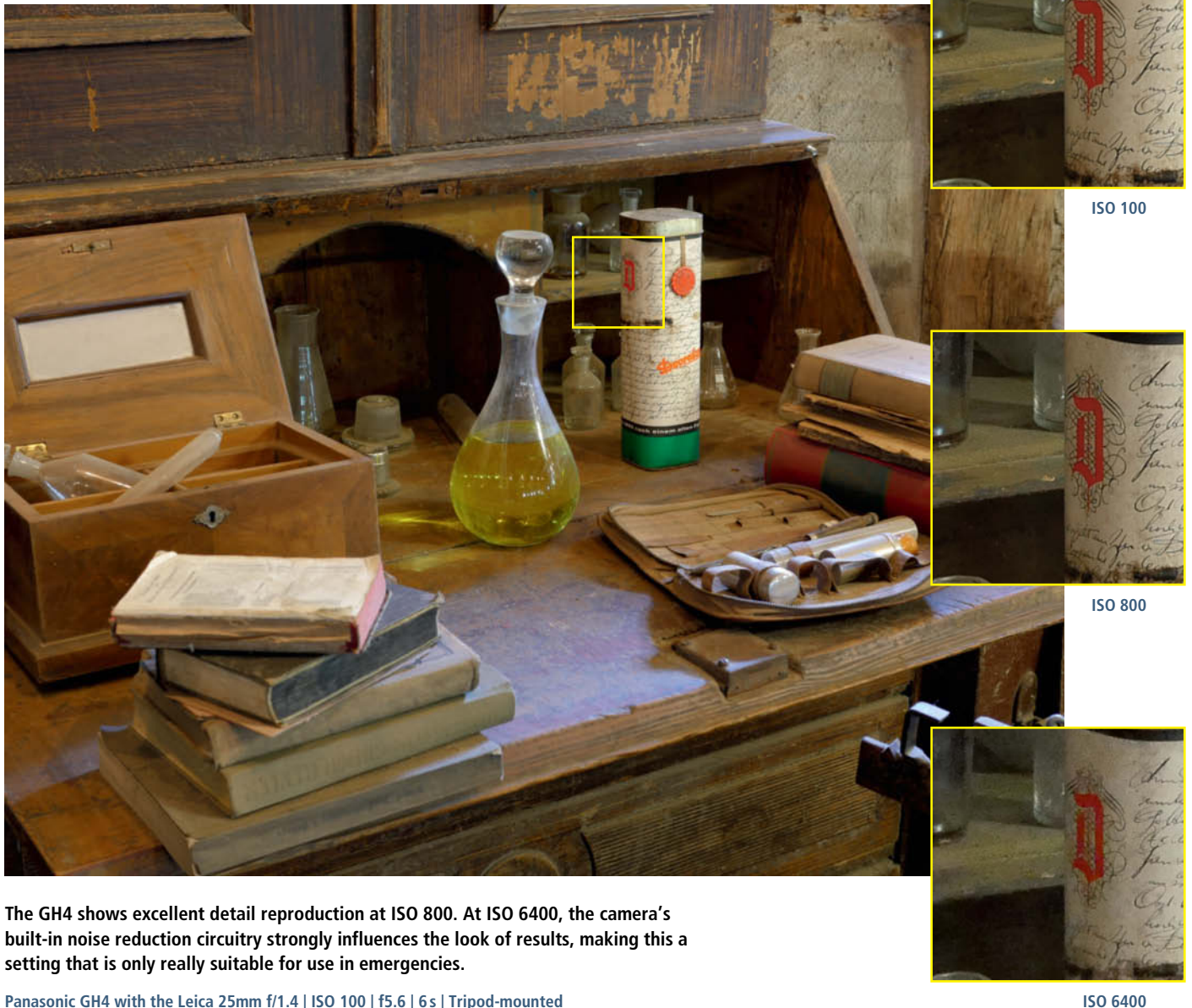
Noise, too, is non-critical up to ISO 800 and only begins to show (with a visual noise value of 2.2) at ISO 1600. Values up to 2 are considered negligible. Dynamic range at ISO 6400 is more than 10 stops, although the influence of the camera's built-in noise reduction begins to soften detail reproduction at ISO 1600 and above.

The error correction built into the lens works extremely well and, although measurable (at 0.13 pixels), chromatic aberration was not visible in the results we recorded. Distortion came in at a negligible 0.03 per cent and the half-stop of vignetting is easy to remove during processing.

Conclusions

The Lumix DMC-GH4 is a sophisticated system camera with excellent reproduction characteristics and great handling. Build quality and the feature set, too, provide no grounds for criticism.

It is up to you to decide whether you really need 4K video functionality, as this requires extreme high-end processing power and enormous amounts of disk/memory space. You also need expensive high-end equipment to process 8-megapixel video footage. In view of its US\$1,700 price tag, the GH4 is nevertheless an interesting option for keen photographers who also wish to record Full HD video. (tho) **ct**



The GH4 shows excellent detail reproduction at ISO 800. At ISO 6400, the camera's built-in noise reduction circuitry strongly influences the look of results, making this a setting that is only really suitable for use in emergencies.

Panasonic GH4 with the Leica 25mm f/1.4 | ISO 100 | f5.6 | 6s | Tripod-mounted

ISO 6400



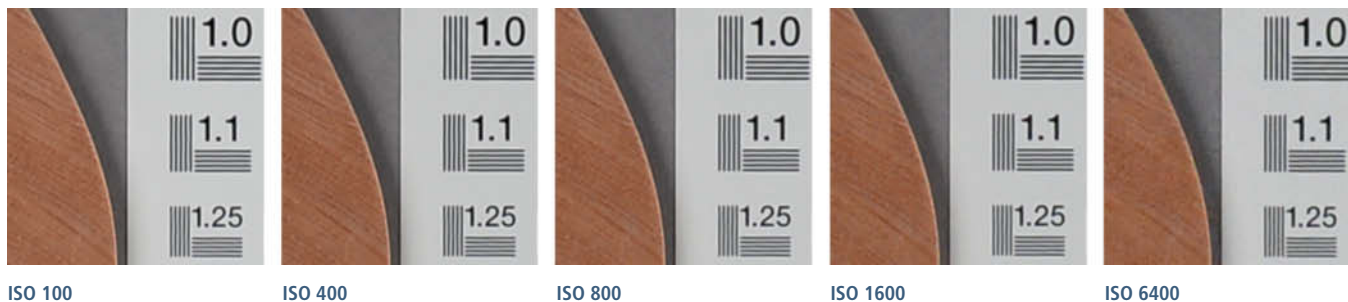
Peter Nonhoff-Arps

Nikon Df

Life in the Slow Lane

Recent years have seen an increasing number of retro-style digital cameras hit the market, most of which are either compact or mirrorless models. Nikon's long-awaited and heavily hyped Df is the first 'classic' style high-spec DSLR with a full-frame sensor. This article investigates whether reality matches the ambitious concept.

Detail from the c't studio test scene



The Df's prominent, angular mirror box is highly reminiscent of Nikon's 1980s analog SLRs. However, appearances are often deceptive, and the Df is no exception. This camera is full to bursting with the very latest digital photographic technology. The 16.2-megapixel full-frame (FX) sensor and the Expeed 3 image processor are taken from the D4 pro DSLR, and the camera offers an ISO range of 100-12 800. The AF system comes from the entry-level D610, giving the Df the same maximum burst shooting rate of 5.5 fps and a shortest exposure time of 1/4000 s.

The Df is designed as a stills-only camera and has no video mode, although live view is still part of the package. In live view mode, autofocus is contrast-based, which is noticeably slower than the phase detection system that switches in during normal shooting.

Handling

The Df is made mostly of magnesium alloy and is surprisingly light. The built-in grip is smaller than the ones we are used to from the D800E or the Canon EOS 5D Mark III, making the Df better for use with smaller prime lenses than with bright, heavy super-zooms.

The camera's many buttons and dials are not only pleasantly nostalgic but also extremely useful. The system is quick to master, with dedicated dials for ISO, aperture, shutter speed, exposure mode and exposure compensation. Using these to select all of your exposure settings manually forces you to slow down when shooting and enables you to check your settings visually without having to refer to the monitor or look in the viewfinder. But this camera is not only for lovers of 'historic' photo gear. The comprehensive menu system offers a massive range of settings that cover just about any situation you can imagine. Just like any other pro-grade DSLR, the Df offers custom settings for autofocus, exposure, the monitor display and

bracketing, as well as custom assignments for the various controls.

The combined battery/memory card compartment on the bottom of the camera is not very practical, and means you have to remove the camera from your tripod before you can swap cards. We would have preferred to see a more accessible memory card slot positioned on the camera's side. The bayonet in our test camera was quite stiff and we had to use more force than we expected to swap lenses. On the plus side, the shutter button has a built-in thread for a mechanical cable release, which is a very nice retro touch.

Test Results and Image Quality

We tested the Df with the supplied AF-S NIKKOR 50mm f/1.8G kit lens. This is a solid standard lens that provides a good basis for expanding your collection of high-end gear. Our test lens produced its best results at f8 and f11, with edge performance dropping off visibly at f2.8. Center resolution came in at 1500 of the theoretical maximum of 1640 line pairs (91%), while edge resolution measured a thoroughly respectable 1400 line pairs.

In view of the camera's high-end specifications, our lab test results bore out our expectations. The signal-to-noise value of just under 100 is on a par with that of the D4, which is really very good. Subjective visual noise also fared well with a low value of just 0.8 up to ISO 200, after which it climbs steadily to around 2.4 at ISO 6400, which is still hardly noticeable and is directly comparable with the values delivered by the Canon EOS 5D mark III. Detail contrast is very good all the way up to ISO 3200, beyond which we noticed slight drop-off.

Our test shots mirrored the lab test results, delivering consistent results with fine detail resolution and great texture reproduction right up to ISO 1600. Drop-off toward ISO 6400 is moderate and visible artifacts only begin to appear at higher ISO values.

The Nikon Df at a Glance



Technical Data	
Sensor resolution	4928 × 3280
Megapixel count	16.2
Sensor size	Full-frame (36.0 × 23.9 mm)
Crop factor	1
RAW capability	yes
Autofocus	Phase detection
AF areas	39
Shortest/Longest shutter speed	1/4000 / 30 s (Bulb)
Sensitivity	ISO 100-12 800 (extendable to 50-204 800)
Viewfinder	Pentaprism
Viewfinder resolution	-
Monitor	LCD
Monitor size / Aspect ratio	3.2-inch (8.1 cm) / 3:2
Monitor resolution	921,000 dots
Monitor articulation	no
Dimensions (W/H/D)	144 × 88 × 102 mm
Weight (incl. battery and memory card)	765 grams (1 lb 11 oz)
Memory card types	SDHC, SDXC
Connectors	HDMI, USB, X-Sync, cable release
Price (MSRP/street)	US\$2,750 / US\$2,750
Test Results	
	better ▶
Sensor resolution (lp/h)	1640
Resolution (ISO 100) ¹	1498
Resolution (ISO 400) ¹	1485
Resolution (ISO 1600) ¹	1452
Resolution (ISO 6400) ¹	1394
Dyn. range (ISO 100) ²	10
Dyn. range (ISO 400) ²	10
Dyn. range (ISO 1600) ²	10
Dyn. range (ISO 6400) ²	9.5
	◀ better
Visual Noise (ISO 100)	0.8
Visual Noise (ISO 400)	1.0
Visual Noise (ISO 1600)	1.6
Visual Noise (ISO 6400)	2.4
Shutter lag ³	0.37
¹ In the center ² In f-stops ³ At 1000 lux	



The Nikon Df makes it possible to capture even the finest nuances of skin texture and details of light and shade

Nikon Df with an AF-S NIKKOR 58mm f/1.4G
| ISO 100 | 58 mm | f6.3 | 1/250 s

Conclusions

The idea of packing modern high-end technology into an old-school package isn't new and is guaranteed to have its detractors as well as its hardcore fans. Since its introduction, this camera has been the subject of hot debate. It delivers high-quality results in the lab and in real-world situations, but whether you actually like using it is, as ever, a matter of personal taste. If you don't rely on fast burst shooting rates and super-fast autofocus as part of your everyday photo workflow and prefer to take a more meditative approach to your photography, the Df is sure to be right up your street. I am not a dyed-in-the-wool Nikon fan, but I nevertheless quickly got to like the Df a lot.

If you have any non-CPU Nikon lenses lying around at home, you can use the Df to give them a new lease of life. Legacy lenses are nearly always smaller and lighter than their modern AF counterparts and cut a great figure when used with the new camera.

The most significant obstacle for a potential new generation of old-school photographers will probably be the price, which at US\$2,750 for the body only is well above that of the D800, which is just as capable as the Df in every respect. Nikon needs to reconsider its pricing policy if this particular model is to gain any real traction in today's market. (pen) **ct**



The kit lens produces hexagonal background bokeh at f5.6

Nikon Df with AF-S NIKKOR 50mm f/1.8G | ISO 100 | 50 mm | f5.6 | 6 s

Image quality is good enough for full-screen enlargement, even at ISO 12 800

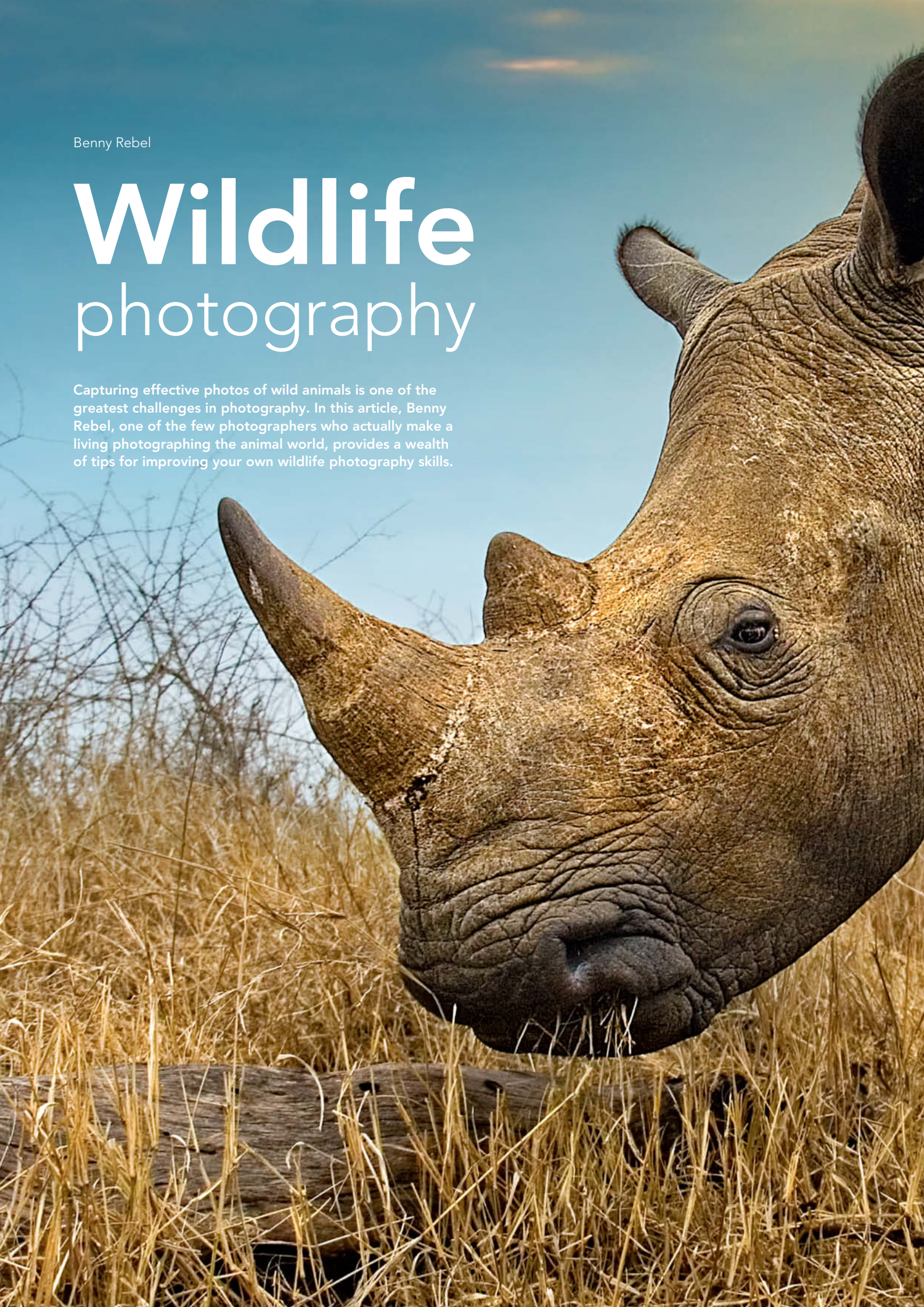
Above: ISO 12 800 | 50 mm | f5.6 | 1/15 s
Below: ISO 100 | 50 mm | f5.6 | 5 s



Benny Rebel

Wildlife photography

Capturing effective photos of wild animals is one of the greatest challenges in photography. In this article, Benny Rebel, one of the few photographers who actually make a living photographing the animal world, provides a wealth of tips for improving your own wildlife photography skills.





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The Allure of Wildlife Photography

Benny Rebel tried out 36 different jobs until he finally found one that gave him a feeling of fulfillment. The market for photographs of animals is small and extremely competitive, making it tough to earn a living from this type of work. There are only a handful of wildlife photographers worldwide who can actually live exclusively on what they earn from their images of animals.

Rebel began to develop his own distinctive style early in his photographic career and his unique wide-angle and super-wide-angle photos of animals in the wild have brought him widespread recognition. His spectacular work includes images of lions, leopards, rhinoceroses, elephants, crocodiles, venomous snakes and countless other dangerous creatures. 'Wide-angle Wildlife' has become something of a trademark for Rebel, but this is not the only trick in his book: some animals simply

cannot be photographed at close range, so he often resorts to using long telephoto lenses to produce frame-filling images of his animal subjects.

Rebel's training as a park ranger stands him in good stead for his close-up work. Years of experience have taught him when animals are likely to accept his approach and when it is better for him to keep his distance. He is also adamant that his close-up shoots shouldn't disturb his subjects in any way, although he still has to be ready to hotfoot it if a situation becomes threatening.

For most people, wildlife photography begins at home with a pet or under controlled conditions at a zoo. Photographing animals in their natural habitats usually comes a lot later. See the box on the opposite page for details on how to get started and, if you already have some experience, how to develop your own wildlife photography skills.

Equipment

Reliable, high-end gear is indispensable on safari in the African bush. Rebel currently uses Sony gear and usually carries several Alpha 99 DSLR bodies, a high-resolution Alpha 7R body and an RX-100M2 for spontaneous snapshots in his bag. His main lenses are f/2.8 24-70mm and 70-200mm zooms, a 70-400mm f/4-5.6 telephoto zoom, a 500mm prime and an f/2.8 16-35mm zoom. In addition to these, he also takes a bright standard lens and a 100mm macro along on most of his trips.

One of Rebel's most important accessories is his collection of solid tripods that ensure shake-free results, even when he is shooting under harsh conditions. He also takes along an accessory flash that he uses on- and off-camera. In addition, he has a stereo microphone and an external monitor that he uses to help capture the video footage he occasionally shoots using his stills cameras.



This shot of a caracal was captured in the backlight of the setting sun in South Africa. The foreground was lit using soft fill flash.

Sony A900 | 20 mm | ISO 200 | f8 | 1/160s | Fill flash



A stable tripod is a vital part of every wildlife photographer's setup

How to Succeed at Wildlife Photography

The following steps make up a workflow that will enable you to get better results more quickly.

Dry runs

Read the user manuals for your camera, lenses and accessories thoroughly. The better you know your gear, the more effectively you will be able to use it and the fewer time-consuming errors you will make when you are on a shoot. Try out all your camera's settings before you leave home and you will save yourself a lot of frustration when you start shooting for real. The more successful you are from the start, the more motivated you will be to continue experimenting.

Study your subject

If you have a pet, you have a model that you can practice with whenever you wish. Photographers often find that their dog, cat or canary enjoys the attention. A nearby duck pond or a zoo is also a great place to get out and practice capturing animal images. The more you practice, the faster you will be able to react to different situations. Successful wildlife photography depends a lot on simple diligence and practice.

Don't forget composition

While practicing your technical skills and learning how animals behave, it is all too easy to forget that a good photo is usually the result of a well-planned composition. A technically perfect image is worthless if it is poorly composed. Every aspect of your photos has to hit the spot if you want people to appreciate and remember your work.

Divide composition into two distinct phases. The first involves your 'photographic eye' that discovers a subject, analyzes it, forms an initial composition in your mind's eye and tells your brain that it wishes to capture it in a photo. The ability to find great subjects is

borne largely of artistic talent and is virtually impossible to learn. The second phase of creating a composition involves organizing the various elements within the frame. Anyone can learn how to use light, shade, colors and shapes to form a pleasing image. Don't be afraid to use books and magazines to give you ideas, or consider taking a course with an experienced photographer to brush up on your compositional skills.

In the wild

If you have followed the steps outlined in the preceding paragraphs, you are sure to have your first few successful wildlife photos 'in the bag'. If this is the case and your appetite is whetted, you are ready to expand your horizons beyond your own garden or the local zoo. The next obvious step is to begin photographing animals in their natural surroundings. This step requires you to develop what is probably a wildlife photographer's most important skill, namely an understanding of the behavioral patterns of your subjects. You must know instinctively how they are likely to behave under all sorts of circumstances. The better you know your subjects, the better your images will become.

TV documentaries, books and specialty periodicals are all great sources of information when it comes to bringing your knowledge of animal behavior up to speed. If you take your observations seriously, you will reach a point at which you can often predict what your subject is going to do next. This specialized knowledge will help you to decide whether your chosen viewpoint and perspective are likely to produce the results you are looking for and whether it is worth continuing to wait for the right opportunity to arise. Over time, your own inbuilt library of experiences will help you to avoid dangerous situations and dull days with no tangible results. You will also be able to organize your time more effectively and maximize your yield of usable photos. Studying zoology or behavioral biology is more useful to budding wildlife photographers than studying photography! This is the route I took, and it definitely helped me to get where I am today.

Zoos and Wildlife Parks

The enclosures in zoos and wildlife parks often consist of unsightly, functional buildings made of concrete. These present wildlife photographers with challenges that they don't have to face in the wild. You can avoid capturing these non-photogenic surroundings either by shooting at a tight crop to show only the subject or a selected part of its anatomy, or by selecting a suitably large aperture to blur the background. In

some cases using flash to light the foreground or the subject increases the contrast between the subject and the background, making the background detail less obtrusive in the finished image.

Challenges in zoo photography include the windows and fences that you often come between you and your subjects. To photograph through chain-link fencing, select a lens with a long focal length, remove the

lens hood and rest the front element or protective filter directly on the fence. This way, the narrow angle of view prevents the blurred slanting lines of the fencing from appearing within the frame and spoiling your composition. If you want to use flash to photograph an animal behind a fence, you have to be careful not to project shadows of the fencing onto your subject. The best solution here is to use your flash off-camera (triggered using either a cable or radio-controlled release) and affix it or hold it as close to the fence as possible. Photographing through glass involves similar challenges. As when shooting through fences, remove the lens hood, clean the glass of the enclosure as much as possible from the outside and rest the front of your lens directly on the glass before releasing the shutter.

Animals in captivity are often most interesting at or near feeding time, when their instincts and natural aggression take over their otherwise rather passive existence. Some animals have particularly close relationships to certain keepers, so it is worth keeping an eye out for more 'affectionate' moments, as these often make great photographs. When searching for interesting and unusual photo opportunities at the zoo, keep in mind that while some animals are close to their keepers, others would surely attack at the slightest opportunity.



This meerkat was photographed at the Hannover Adventure Zoo. The lighting conditions allowed a low ISO value, a short exposure time and a small aperture. The camera-to-subject distance of about two meters resulted in a completely blurred background, even though the lens was stopped right down. At a greater distance, a larger aperture would have been necessary to achieve the same amount of background blur.

Full-frame DSLR | 235 mm | ISO 100 | f10 | 1/200 s



This photo of a male drill was captured through a thick, dirty pane of glass at the Hannover Adventure Zoo. Because he remained very still, it was possible to shoot using a relatively long exposure time. The tight crop eliminated the unsightly concrete walls of the enclosure in the background.

Full-frame DSLR | 400 mm | ISO 100 | f8 | 1/80 s

A Question of Perspective



Eye to eye with a young baboon

Canon EOS 60D | 300mm | ISO 100 | f8 | 1/20s

One of the most important aspects of composition in animal photos is the viewpoint you choose and the perspective that results. You can shoot from standing or sitting positions, lying down, using a tripod or from above while holding the camera with outstretched arms. Capturing a single subject

in all these various ways will produce a set of photos with a wide range of different effects, some of which can be quite extreme. The viewpoint alone can make the difference between first and last place in a competition. Before releasing the shutter, you must consider the effect an image will have. Choosing a

perspective is much easier for stationary subjects or ones whose movements are easy to control or predict, such as architecture, landscapes, fashion, industrial subjects, product shots or portraits. In this respect, wildlife photographers have little or no control over the situations they are photographing.

Eye to Eye

Generally speaking, photographing animal and human subjects at eye level produces pleasing images with a natural feel. If you are photographing children or small animals, you should get down to their level, and if you are working with large subjects, you need to raise your viewpoint accordingly. This doesn't mean that you have to shoot all your animal photos this way, although many subjects will benefit from an unusual viewpoint. The following sections describe some of the better-known variations you can try, the effects they have and what to watch out for when shooting.

Worm's-eye View

The perspective created by capturing a subject from a very low viewpoint is often called a 'worm's-eye' view, for obvious reasons. This is a great technique to use if you want to make a subject appear larger or more powerful than it actually is. The picture of an elephant reproduced below was captured using a super-wide-angle lens from a worm's-eye viewpoint, making this splendid animal appear even larger and more impressive than it did in real life.

Bird's-eye View

Shooting from a slightly raised viewpoint is a great way to add a feeling of depth to landscape photos but is seldom effective when photographing animals. Photos shot from directly above communicate no feeling of depth at all, making the arrangement of the content and the composition all the more important. The viewer's attention should automatically be steered toward the most important details. In the photo of the zebras on the next page, the unusual perspective is immediately obvious but you will probably only discover the rising diagonal formed by the animals themselves at a second glance.



Photographed from a worm's-eye viewpoint, this elephant has a towering, otherworldly presence

Canon EOS 5D | 17 mm | ISO 200 | f5.6 | 1/80 s



These zebras were captured from a hot-air balloon over the Masai Mara nature reserve in Kenya

Scan of a slide captured using an analog SLR





This photo of crocodiles was taken from a bridge in Kruger National Park in South Africa. The three subjects form an imaginary triangle that guides the viewer's eye around the frame.

Canon EOS 60D | 75 mm | ISO 200 | f11 | 1/125 s

The Effect of Different Perspectives

We have already seen how the choice of viewpoint can influence the message a photo communicates. The photo of the meerkats below clearly demonstrates why photo-graphing small animals from above is not a good idea. The subject looks smaller than it really is and generates a feeling of condescension in the viewer.

This trick is often used deliberately in advertising to make a product appear substandard or inferior to the one being promoted.

The photo of the marine iguana on the right creates a much more pleasing and professional impression than the one below, which was obviously shot from the 'wrong' viewpoint.



Photographed from a raised viewpoint, these meerkats appear even smaller than they really are

Canon EOS 1D Mark II | 400mm | ISO 100 | f10 | 1/200s



The eye-level composition makes this marine iguana look more formidable than it would have had it been photographed from above

Canon EOS 1D Mark II | 100mm | ISO 200 | f6.3 | 1/40s

Motion Blur and Panning Effects

Unintentional blur can spoil an image, but it is important to differentiate between blur caused by camera shake and that which results from the subject moving during the exposure when selecting your exposure time. The best way to reduce the risk of camera shake is to use a solid tripod – a piece of equipment that Benny Rebel describes as “my most important accessory”.

Choosing the Right Exposure Time

If you don't have a tripod with you or the situation makes it impossible to use one, a good rule of thumb for preventing unwanted blur is to make sure that the exposure time you select is at least equal to the focal length you are shooting at – i.e., for a 100mm lens, use 1/100s or shorter. If you apply this rule rigorously, you are guaranteed to produce fewer blurred images.

You also have to estimate the speed at which your subject is moving if you want to avoid or deliberately include a degree of motion blur in your image. This is a skill that can only be perfected through experience and practice.

If you don't want to include motion blur in an image, you have to shoot using short

exposure times, but again, only experience will teach you precisely how fast a walking, trotting or running cheetah will actually move. You also have to take other factors – such as the focal length of the lens you are using – into account. The longer your lens, the shorter the exposure time has to be in order to prevent blur.

As an example, Rebel suggests the following guidelines for photographing a cheetah: 1/500-1/750 s will enable you to keep a slowly walking animal sharp when using a 500mm lens. If a cheetah is running, you need to use at least 1/1600 s and, if it is involved in a chase, you have to ratchet your exposure time right up to 1/3000 or 1/4000 s. On the other hand, if the animal is resting, you can get away with exposure times as slow as 1/50 s if you are shooting at ground level from a tripod. The numbers mentioned here all apply to a full-frame camera, but it is often possible to use longer exposure times for cameras with smaller sensors. Medium-format cameras require even shorter exposure times if you want to avoid producing blurred images.

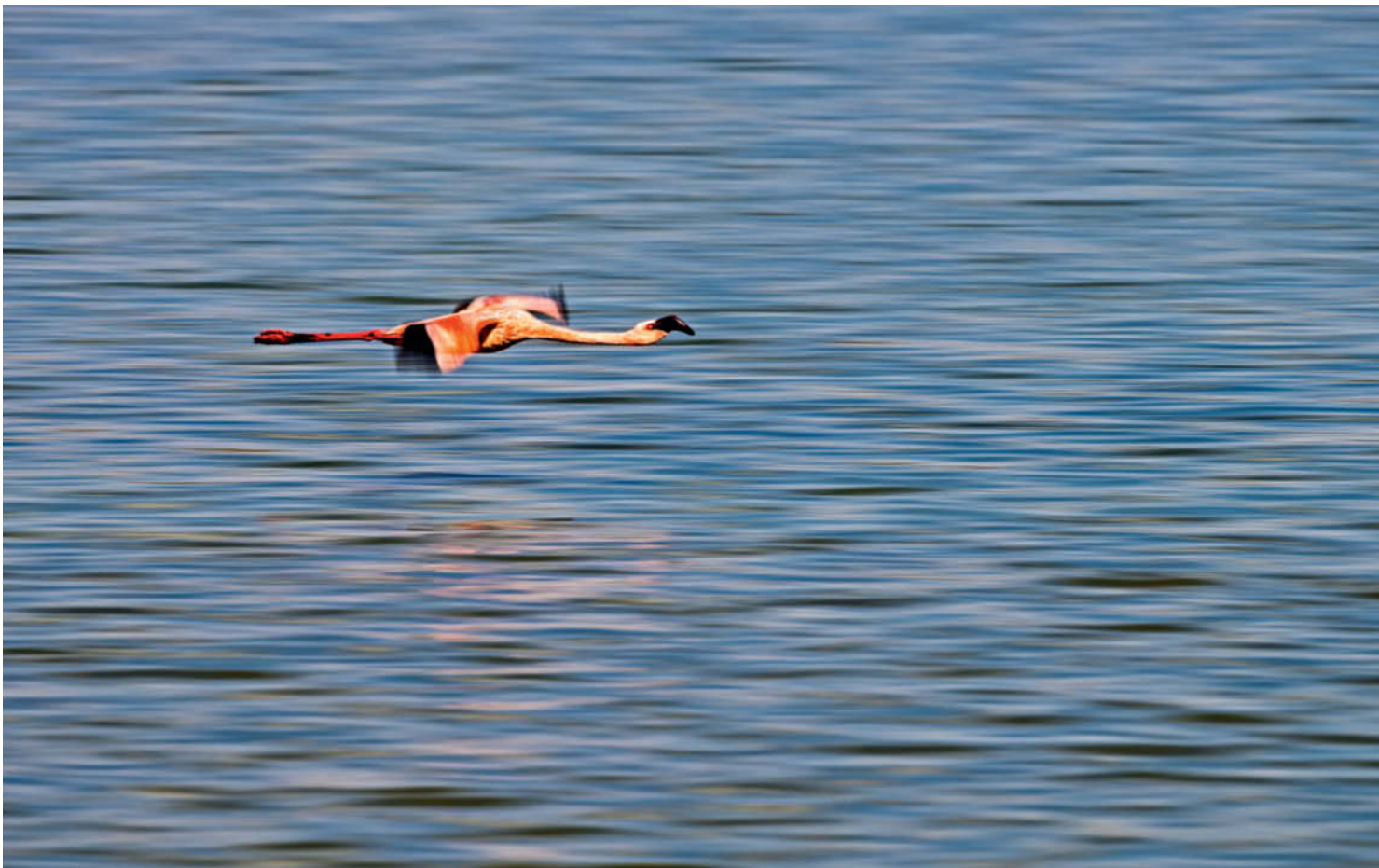
Selecting ISO Sensitivity

You might be forgiven for thinking that you should simply select a short exposure time and leave the rest to the camera. This would

definitely prevent unwanted blur. However, at very short exposure times, the high ISO values required to expose the frame correctly artificially increase the sensitivity of the sensor, which reduces overall image quality. Noise artifacts, too, begin to appear at high ISO levels, especially in cameras with smaller sensors. Put simply, this means that you always have to strike a compromise between the shortest possible exposure time (to prevent unwanted blur) and the lowest possible ISO setting (to prevent unwanted noise and retain image quality).

The image below was captured using a long exposure time and the camera was moved to track the flight of the flamingo. The tricky aspect of this shot was keeping the bird's head and body in sharp focus while allowing the rest of the frame to blur to an extent that makes it appear interesting and dynamic to the viewer.

Sony A99 | 500mm | ISO 50 | f10 | 1/80 s

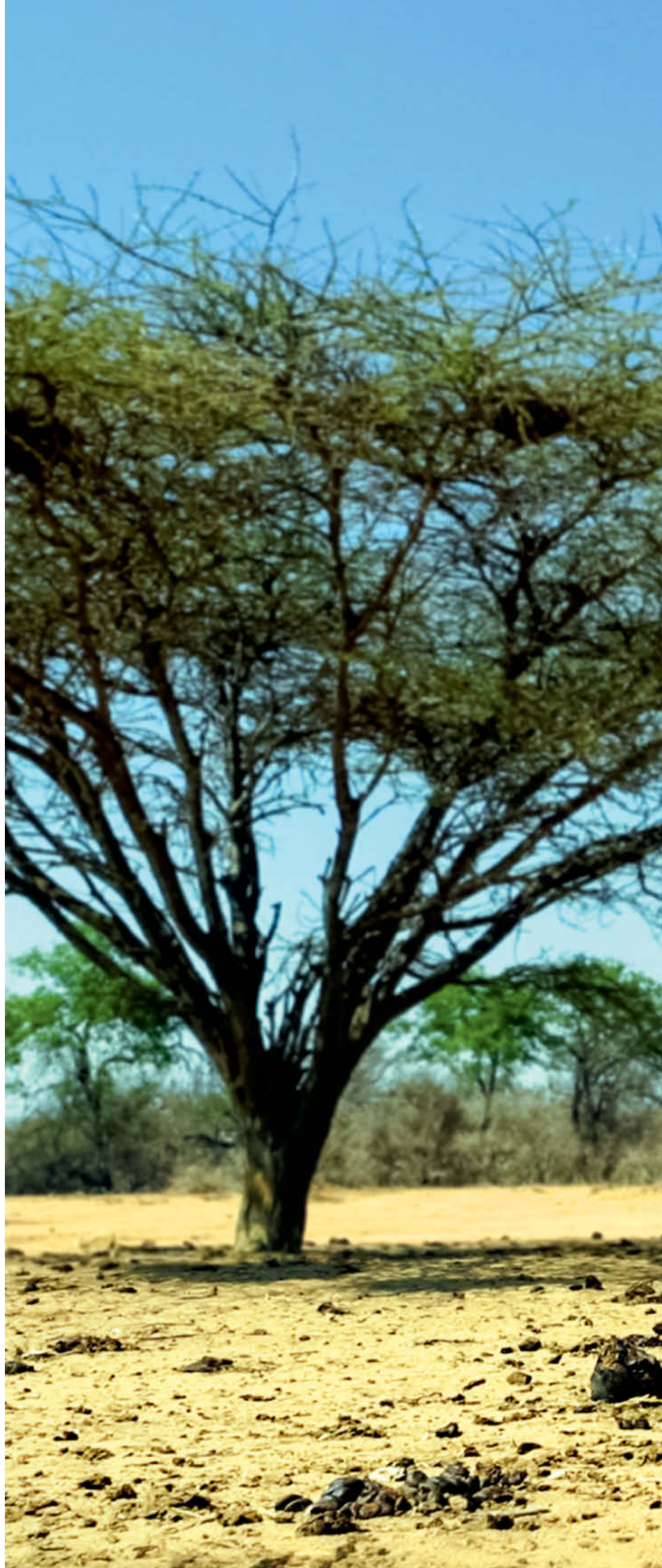


Wide-angle Wildlife

Your choice of lens has a significant effect on the composition and feel of the images you capture. When he was starting out as a wildlife photographer, Benny Rebel noticed that even though wide-angle and super-wide-angle lenses produce some of the most eye-catching effects, there were very few wide-angle images of wild animals in circulation. One obvious reason for this is the danger involved in getting close to wild animals, but Rebel has perfected techniques that have enabled him to capture images of lions, leopards, elephants, crocodiles and many other wild animals from as close as just a few centimeters away. He admits "I've often risked my life to get spectacular results." However, careful preparation and extensive knowledge of the behavioral patterns of his subjects have always enabled him to finish his shoots unscathed. Rebel works exclusively with the very best guides in the national parks he visits, who also help to protect him while he works. "Without my own intimate knowledge of my subjects and the help of the local guides and biologists, I probably wouldn't be here any more."

Rebel's unique mix of technical skill and behavioral observations has enabled him to capture exceptional wide-angle wildlife images of a kind that no-one else dares to shoot. These images have since become world famous and have paved the way for Rebel's career on the international wildlife photography scene.

Wide-angle lenses have three major characteristics: they emphasize the foreground, they have great depth of field and they distort vertical lines the moment you tilt the camera even slightly upward or downward. The depth of field is extreme, even at wide apertures, and increases further the more you stop the aperture down. The image on the right was captured using a 14mm lens. The emphasis on the foreground is obvious.

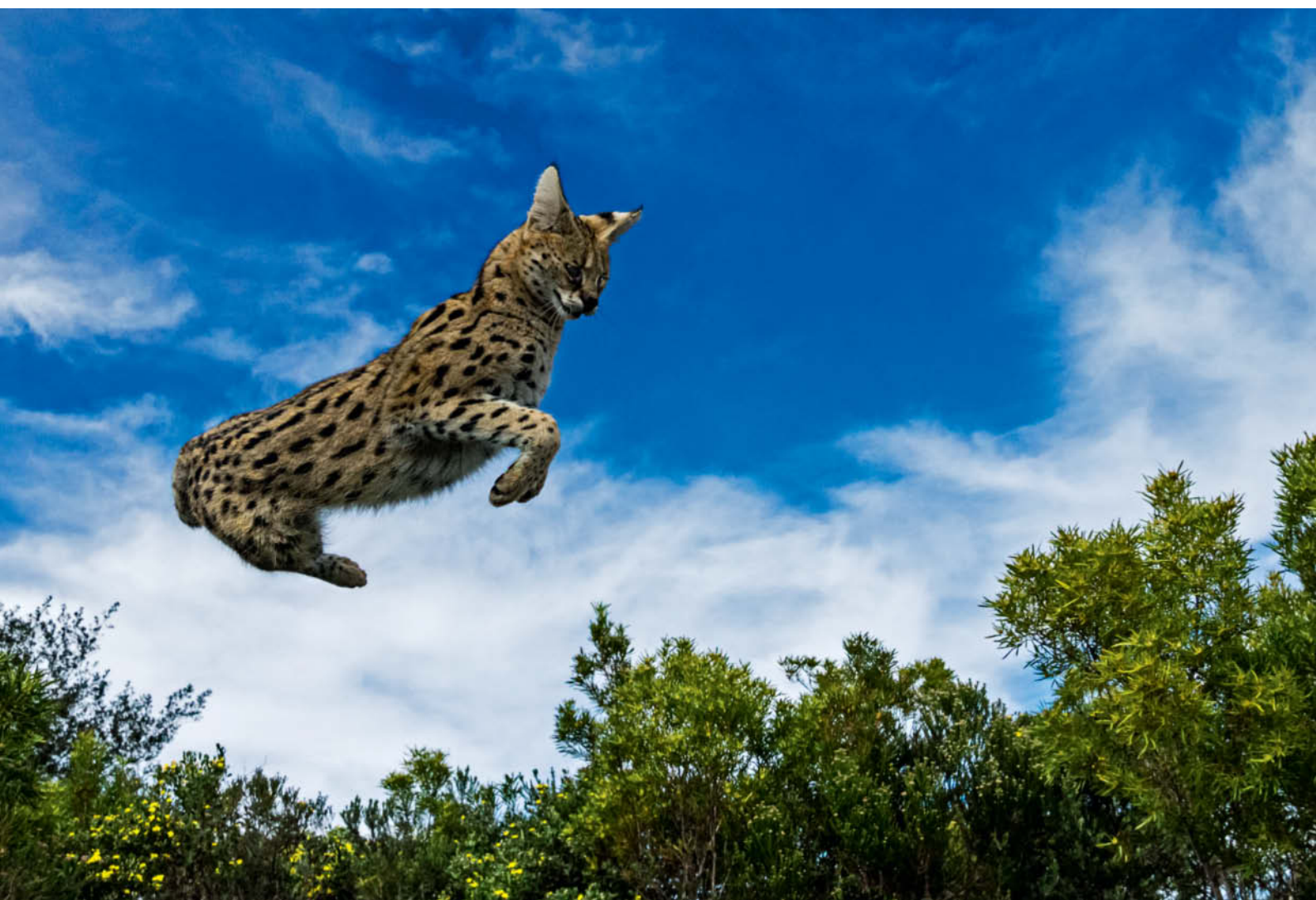


This female rhinoceros and her baby were photographed at ground level from just a few yards away in a wildlife reserve in South Africa

Canon EOS 60D | 14 mm | ISO 200 | f8 | 1/500 s



Animals in Action



An African serval in mid-pounce

Sony SLT-A77V | 16 mm | ISO 800 | f4.5 | 1/6400 s

To capture animals in action, you need a fast camera, short exposure times, quick reactions and plenty of light. The photo above was captured using an ultra-short exposure time of 1/6400s that froze the serval's movement as it pounced. For shots like this, it is essential to keep the entire subject within the field of focus. Rebel used a 16mm lens set to f4.5, deliberately using the great depth of field offered by the wide-angle lens to keep the serval in focus as it pounced in focus.

The challenges involved in capturing a shot like this are making sure that you are in the right place at the right time and that you react quickly at the crucial moment – in this case, just as the serval began its leap. When a

creature like a serval is hunting, it moves like a rocket and it can be difficult to see the subject through the viewfinder at all, especially if you are concentrating on your shooting parameters and releasing the shutter too.

Shooting in Backlight

For a shot like the one above, captured at close range with backlight from the sky, it is best to activate all the available autofocus points your camera offers and shoot in continuous servo AF mode using a very short exposure time.

To prevent the subject from turning out too dark, you need to overexpose by about one full f-stop when shooting against a bright

background. You have to rely on your camera to focus fast enough and shoot at a sufficiently rapid burst rate. If all these factors come together, you can end up capturing shots like the one reproduced here. Because action situations require the use of very short exposure times, you will often have to increase your ISO setting to compensate for the relatively small amount of ambient light. This photo was captured at ISO 800 – a value that many modern DSLRs can handle without running the risk of producing low-quality images or too many unwanted artifacts.

Action photos are exciting to shoot and present the ultimate challenge to both your own skills and the speed and reliability of your equipment. (pen) **ct**



Sony SLT-A77V | 280 mm | ISO 100 | f5.6 | 1/1000 s

These two images of a zebra come from the Ngorongoro Crater in Tanzania. The zebra was busy rolling in the dirt and short exposure times made it possible to freeze the action completely.



Sony SLT-A77V | 300 mm | ISO 125 | f/8.0 | 1/500 s



Sascha Steinhoff

35mm and medium-format

Film Scanner Test

In the days before DSLRs became affordable for the masses, film and slide scanners were the favorite toys of many technically-minded photographers, with high-quality film scanners offering image quality surpassing that produced by even the best flatbed scanners. While Nikon, Canon and other major camera manufacturers have since opted out of the scanner business to concentrate on developing their DSLRs, lesser-known manufacturers are introducing new models into the market. We checked out some of the more interesting offerings in detail.

Around the turn of the century, anyone who wanted to digitize analog slides or negatives used a dedicated desktop film scanner. While not as versatile as flatbed scanners, these produce much higher quality scans and are still the tool of choice for demanding photographers who wish to digitize large quantities of analog images.

Our Test Candidates

Until about 10 years ago, Canon, Minolta and Nikon regularly updated and improved their ranges of film scanners, but from that point on, they completely neglected the scanner market. The last generation of Nikon COOLSCAN V, 5000 and 9000 models set new standards when they were introduced in 2003 and sell on the used market today for up to five times their original price.

Lesser-known scanner manufacturers such as Plustek, reflecta (available in the US under the Pacific Image brand) and BRAUN have recognized the opportunity this gap in the market presents and recently hiked the prices of their scanner products. This article takes a detailed look at the best of the current crop of devices.

The reflecta ProScan 7200 and Plustek Optic Film 8200i Ai are pure 35mm scanners and, at around US\$300, are positioned at the more affordable end of the market. The reflecta DigitDia 6000 (which is in fact a rebadged BRAUN Multimag Slidescan 6000) is a more expensive 35mm model that scores with its additional slide magazine scanning capability. The reflecta MF 5000/BRAUN FS120 medium-format models cost about US\$1,500, while the Plustek OpticFilm 120 (at around US\$2,000) is the most expensive model we tested. We also included the Epson V750 in our test to represent the flatbed scanner market, and ran the same tests using a Nikon COOLSCAN 5000 as an (unrivaled) reference machine. The Nikon was the clear market leader 10 years ago and was relatively affordable at its introductory price of around US\$1,100. One of the main aims of our test



Image: Nikon

The Nikon COOLSCAN 5000 went out of production years ago but is still considered to be the best 35mm (i.e., full-frame) desktop scanner around – if you can find one at a price you can afford!

was to find out how today's devices compare with this highly respected 'oldie'.

Software and Test Conditions

Alongside the hardware, the software you use has a significant effect on the quality of the results you can achieve. In order to produce consistent test conditions, we used the *SilverFast 8* scan software with all of our test candidates – a package that is included with the Plustek OpticFilm 8200i Ai and OpticFilm 120 and the Epson V750 anyway. This software is an acknowledged market leader and enabled us to achieve the maximum possible scan quality during our test.

We used E6 and Kodachrome slides to test each device's ability to reproduce the rich, vibrant colors that negative-based images

simply cannot rival. The limitations of a scanner become immediately obvious in scans of slides. To help you judge the results for yourself, we have included our original high-resolution scans on the free DVD enclosed with this issue. Our results are only valid for the actual devices we tested and do not account for any variations in build quality that may occur in the same models purchased elsewhere. In other words, this test represents a random sample, although we did give each manufacturer the opportunity to provide us with a replacement device in the case of obvious defects.

Scanners aren't always quiet, and the Nikon COOLSCAN 5000 produced irritating saw-like noises that could annoy heavy users. In contrast, the Plustek 8200i Ai was extremely easy on the ears.

FILM SCANNER TEST RESULTS

Scanner	Theoretical maximum resolution [spi] better >	Real resolution at maximum setting [spi] better >	Real resolution at half resolution setting [spi] better >	Non-calibrated IT8 color deviation [ΔE] better <	Calibrated IT8 color deviation [ΔE] better <	Signal-to-noise ratio at D=2.9 better >
Epson V750 Pro	6400	2314	1725	3.6	4.1	3.9
Nikon COOLSCAN 5000	4000	3872	1725	9.4	2.1	0.9
Plustek OpticFilm 8200i Ai	7200	3251	2299	5.7	2.4	1.6
reflecta ProScan 7200	3600	2597	1725	5.3	2.5	0.7
reflecta DigitDia 6000	5000	2896	2048	4.4	2.5	0.2
Plustek OpticFilm 120	5300	3251	2048	5.1	2.1	1.6
reflecta MF5000	3200	2580	1290	5.1	3	0.4



The Epson Perfection V750 Pro is not of the same high quality as the other devices in our test but comes with a range of adapters and is capable of scanning up to twenty-four 35mm frames in one pass

Regarding handling, the Plustek OpticFilm 8200i Ai and the reflecta ProScan 7200 and MF5000 models all use designs that require the user to feed the originals through the device by hand, which makes using them quite laborious. The reflecta DigitDia 6000 and the Nikon COOLSCAN are the only models that can be used to effectively scan entire magazines of slides, although to do so, the Nikon requires the SF210 adapter which was available separately while the machine was

still being actively marketed and now costs as much as US\$900 second hand. The Epson V750 can digitize 24 slides in one pass and the Plustek OpticFilm 120 has an adapter for 12.

Epson Perfection V750 Pro

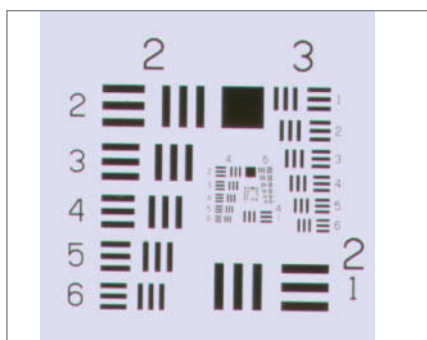
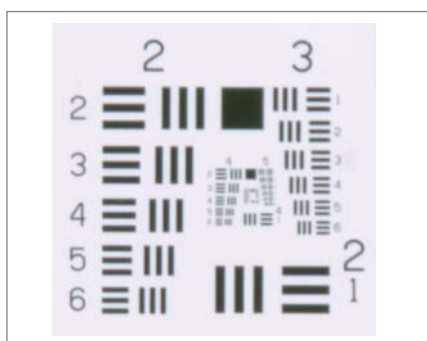
The Epson V750 was the only flatbed scanner we tested and, thanks to its large transparency unit, can even scan large-format slides and negatives, whereas cheaper scanners can only scan a small portion of the document table's area in transparency mode. If you wish to scan large-format material or larger numbers of smaller images, the V750 (or the slightly less capable V700) will be your tool of choice. In spite of its bulky body, the V750 requires the use of a separate AC adapter.

The Epson has been around for a few years now and uses a cold-cathode scan lamp rather than the LEDs used by most contemporary machines. This produces pleasant, slightly softer results but means that you have to wait

for the lamp to warm up before you can actually begin scanning. The IR channel is scanned after the RGB channel, which also takes extra time and results in scan times of up to four minutes for a scan of a 35mm slide with automatic iSRD dust and scratch removal. This is about average for the models in our test field.

The Epson's nominal resolution of 6400 spi (samples per inch) is a purely marketing-based number that bears little relation to the real-world results it produces, which show resolution that is about a third as dense as the specifications would have us believe. Simply scanning using a halved optical resolution value doesn't help, as this just reduces the already low effective resolution. In our scan of a USAF test target, some of the bars looked washed out at halved resolution. We found the best way to use the V750 is to scan at 6400 spi and rescale the finished scans during post-processing.

The *SilverFast* dust and scratch removal tools worked well and the only side effect was very slight softness in the finished scans. The Epson tends to reproduce colors on the gaudy side, which is a welcome feature when scanning colorful subjects such as a bowl of fruit. The downside of this tendency is that skin tones tend to look rather red, and a more neutral cast would be better for portraits. In the median color deviation (ΔE) stakes, the Epson came second to last. As far as sharpness and detail reproduction are concerned, the Epson's flatbed construction means that it cannot rival the quality of even the much cheaper reflecta ProScan 7200, which has



The Epson produced scans with only a third of its nominal 6400 spi scan resolution (above left). The reflecta ProScan 7200 has a lower nominal resolution of 3600 spi but produces much more detailed scans (below left).



The Plustek OpticFilm 8200i Ai isn't particularly easy to use but has a full set of features

3600spi delivers effective resolution of 2299spi. If you want to produce maximum detail while retaining reasonable file sizes, you will have to scale full-size scans appropriately later on.

The 8200i was the slowest of our test models, taking almost 10 minutes for a single 35mm slide with iSRD dust and scratch removal. Our Haswell i7-based test system has plenty of RAM but was still working at full capacity for long stretches while applying scratch removal. A faster processor would certainly improve the situation.

On the plus side, the Plustek hardly vibrates at all and is quiet enough for genuine desktop use. The slide adapter's click-to-close mechanism is fine for plastic slide frames but a little too rough for card-framed slides. The hardware-based dust and scratch removal functionality is the real let-down in the Plustek system and regularly missed most of the dust particles in our originals while producing additional softness in the resulting scans. The Nikon's software-based approach to iSRD produces much better results.

If you take the time to calibrate it properly, the 8200i produces decent colors. In our test, its color deviation value (ΔE) lagged only slightly behind that of the Nikon, although in practice, the Nikon's colors are more vibrant. The imprecise manual feed makes it impossible to align slides properly and we often had to make several pre-scans before we were able to produce truly frame-filling results.

Due to its poor scratch removal functionality, it is difficult to recommend the Plustek for E6 and C41-based scans. Its slow speed is another reason to think twice before making a purchase.

broader dynamic range and produces much better results for demanding subjects such as dark-colored clothing.

The Epson's trump card is its ability to scan large-format originals, and there are no real alternatives for this kind of usage at this price level. Dedicated film scanners are definitely the better option when it comes to producing high-quality scan files from 35mm slides and other film-based originals. If you're looking for a flatbed scanner to scan opaque originals but need a transparency unit for 35mm originals only, you will be better off purchasing two devices. For example, a reflecta ProScan 7200 for about US\$300 and a value flatbed unit such as the Canon CanoScan 9000F for about US\$200 cost less than the Epson and give you better transparency scans into the bargain. However, if you take the 'bundle' route, you will have to purchase software separately. *SilverFast 8* costs about US\$400, while *VueScan* comes in at US\$80 for a full version with lifetime upgrades.

Plustek OpticFilm 8200i Ai

The Plustek OpticFilm 8200i comes in Ai (US\$480) and SE (US\$300) versions, the more expensive of which includes *SilverFast 8*. The 8100 value version lacks an infrared channel and costs around US\$250.

On paper, the 8200i's nominal resolution of 7200spi is the best in our test, although we measured real-world resolution of just 3251spi. You can only reach the given values if you are prepared to work with extremely large files – for example, a 48-bit TIFF of a 35mm slide can be as large as 400 MB. Working with a nominal resolution of

The OpticFilm 8200i's dust and scratch removal tools performed very poorly. In this example, most of the artifacts remained visible while the image itself became noticeably less sharp.





The reflecta ProScan 7200 (available in the US as the Pacific Image Prime Film XE) is the cheapest scanner we tested and produced results that matched its price

The reflecta ProScan 7200 (above) removes dust and scratches much more effectively than its rival, the Plustek 8200i (below)

reflecta ProScan 7200

This value scanner is not at all pretty but scans RGB and IR channels in one pass, making it one of the faster models we tested. The '7200' in its name is misleading and the real nominal resolution on offer is a more modest (but usable) 3600spi. On the other hand, this limitation produces reasonably sized files and fewer processing bottlenecks. Overall, this model produced scans with about two thirds of its nominal resolution, which is a good result.

If you halve the scan resolution, nominal and visual resolution are almost identical and perfectly adequate for scans of 35mm snapshots shot using analog compact cameras. The 3600spi setting is only really worth considering if the original was captured using high-end equipment. Note that the measurable resolution produced by non-autofocus scanners (i.e., all of our test models) is a hit-and-miss affair that depends on the thickness of a slide's frame. Whether a particular region of a slide ends up in the zone of sharp focus is impossible to determine in advance.

As far as scan speed is concerned, the Nikon is the only model that can convincingly beat the ProScan 7200, which is generally too noisy and produces too many vibrations for desktop use. The slide adapters provided are decidedly low-tech but perfectly adequate for the job.

The scans of the USAF target were nice and sharp but suffered from serious chromatic aberration. The dust and scratch removal system worked very well. The combination of IR and RGB scans in a single pass generally appears to produce better results. Repeat scans not only take more time but are also subject to mechanical imprecision that can produce unwanted offset between passes and lower-quality corrections. Color reproduction, while not quite as good as that of the more expensive MF5000 or Plustek OpricFilm120 models, is nevertheless acceptably neutral.

Overall, the 7200 is clearly a better option than the similarly priced Plustek 8200i and offers a useful feature set at a reasonable price. However, we recommend replacing the *CyberView X* software included with the package with *VueScan* or *SilverFast* if you want to get the best possible results.

reflecta DigitDia 6000

The reflecta DigitDia 6000 is the only scanner we tested that is capable of batch processing entire magazines of slides. According to reflecta and BRAUN, the DigitDia 6000 is a rebadged version of the BRAUN SlideScan 6000 and the only slight difference between the two is the design of the supplied magazine. The supplied manual left us with a lot of unanswered questions but better instructions are available online.

Although the DigitDia 6000 is designed to batch process entire magazines, you shouldn't leave it completely unattended while it does its thing, as slides get stuck now and again and require manual intervention. However, it is still the easiest way to digitize your slides. During our test, each scan of a 35mm slide took about five minutes, including iSRD. This makes it one of the slower models we tested, in spite of its combined IR and RGB scan technology. The final results showed about half of the nominal resolution and the device vibrated strongly when set to full resolution, making it less than ideal for desktop use.

We encountered a series of hardware malfunctions during our test and ended up trying out a total of three different machines. The BRAUN version refused to work at all after just a few scans and we ended up using the first of our two reflecta models to make most of our measurements. This particular machine was mechanically reliable but its color reproduction left a lot to be desired. Its poor average deviation value (ΔE) measured 12.2 before calibration and was still below par (13.3) thereafter. The results also showed significant artifacts and banding in their color gradients.

The manufacturer sent us a replacement device which then proceeded to score top marks for color reproduction and showed virtually no banding or other artifacts. Nevertheless, The results from the Nikon COOLSCAN 5000 boasted rich, vibrant colors that were streets ahead of the DigitDia's rather bland-looking scans. In this case, our subjective findings were backed up by the histograms.



If you want to purchase a new scanner to batch process magazines of slides, there are no real alternatives to the reflecta DigitDia 6000/BRAUN SlideScan 6000



Extreme variations in quality: two different reflecta DigitDia 6000s produced very different iSRD results. The first produced usable results with only a few visible artifacts, whereas the second failed completely when scanning Kodachrome material.



The Plustek OpticFilm 120 isn't yet the mature and reliable product it aims to be, but is nevertheless on the right track



Additionally, our second test machine produced massive iSRD errors when processing Kodachrome originals. Both devices produced acceptable results when processing E6 material, which is likely to be the purpose most users will put it to. Because they turned out so differently, we have included both sets of scans on this issue's free DVD.

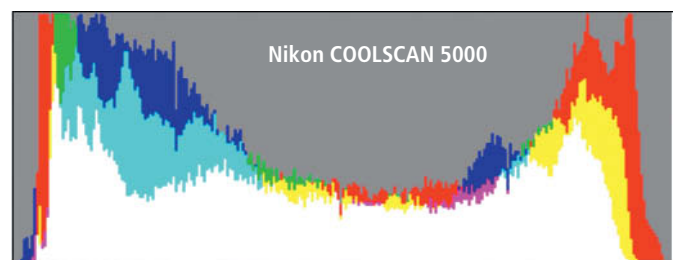
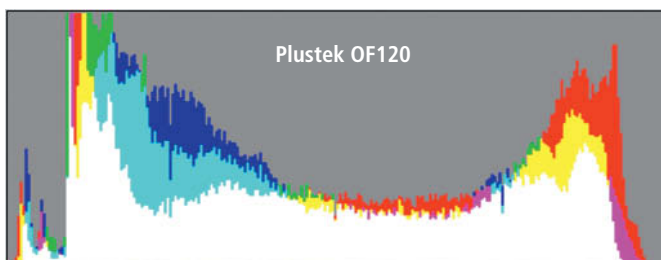
All in all, this model does its job but at a price that doesn't sit very well when you consider the quality and reliability of the results.

Plustek OpticFilm 120

Introduced in 2013, the Plustek OpticFilm 120 is the first high-end medium-format scanner to hit the market since the Nikon COOLSCAN 9000 went out of production. The specifications, supposedly high-end lens and definitely high-end price of around US\$2,000 make it clear that this device is aimed squarely at the upper end of the market.

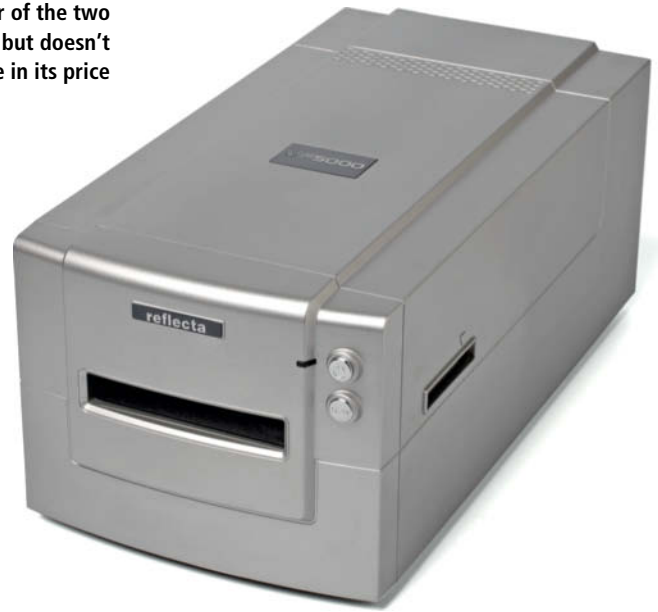
The first batch of machines to hit the market didn't work well at all and some reputable scan services withdrew the

OpticFilm 120 from their offerings. Our test also produced some anomalies that you wouldn't necessarily expect from a scanner in this price range. Our first attempt to install the Plustek driver ended up with Windows 8 not even booting, so to avoid negative interaction with other drivers, we did a clean Windows install, after which the scanner worked as intended. *SilverFast 8* (which is included with the package) is prone to occasional bugs and inconsistencies but performed adequately with the OpticFilm 120.



Comparing histograms shows clearly that the Nikon COOLSCAN 5000 coaxes much more color data out of an original than the Plustek OpticFilm 120

The reflecta MF5000 is the cheaper of the two medium-format models we tested but doesn't include quality software in its price



The noise this device produces isn't as irritating as the Nikon's saw-like sounds but we still recommend that you set it up a little distance from your normal working environment. Real resolution fell far short of the nominal value, measuring just 3300spi out of a theoretical value of 5300. Set to half resolution, the nominal and effective values of 2650 and 2048spi didn't deviate nearly as much.

An average iSRD scan time of 200 seconds for a 35mm slide puts the Plustek in the middle of our test field but scanning a

medium-format original at full resolution slowed down our i7-based test system significantly, taking 20 minutes for a single scan of a 6x6cm slide. Switching to half resolution made the process much faster.

The closure mechanism of the medium-format adapter bent our originals at most attempts, which is unacceptable if you want to produce high-quality scans. This was the only medium-format model we tested that has an automatic feed.

Scratch removal worked well too, although it occasionally made for a poorer-quality scan.

Color reproduction was fine, even if a direct visual comparison with the results produced by the COOLSCAN 5000 showed that the OpticFilm 120 can't really do justice to its high-end aspirations. At the end of the day, the OpticFilm 120 is a promising product that seems to have been released in a not-quite-market-ready state.

reflecta MF5000

The reflecta MF5000 is a rebadged BRAUN FS120 that is cheaper but not as highly



The red frame surrounding our preview scan (on the left) clearly deviates from the actual scan area (shown on the right). This offset makes it quite difficult to scan precisely with the MF5000.

Alternatives to Desktop Film Scanners

Due to a lack of real alternatives, many pro scan services still use desktop scanners. The next step up the technological ladder are virtual drum scanners, which start at around US\$16,000. These devices have no hardware-based dust and scratch removal functionality and the curved film holder technology they use makes them unsuitable for scanning large numbers of small originals. In 'real' drum scanners, the original is taped to a drum, which provides a moving apex for the scan unit to focus on. Drum scanners were always the preserve of specialist services or users on a large budget and are no longer being manufactured.

Lab-grade scanners such as those manufactured by Noritsu are too complex and expensive for home use because they are designed to produce very large numbers of JPEG scans very quickly and the results are difficult to edit effectively.

CMOS scanners that scan by capturing the original in a single shot (like a digital camera) rather than line for line do not produce scans of sufficient quality to make them worth considering as an alternative to a conventional scanner.

Other approaches, such as using lens adapters to photograph slides directly, usually produce relatively poor results. Even if you use a full-frame DSLR and a dedicated macro lens, most scan services produce better-quality results.

A quick look at the websites of most scan services reveals that they use desktop devices, usually from Nikon. Whether you make your scans at home or use a service provider, if you know which scanner is being used you will know in advance how good the results are likely to be. As in conventional digital photography, it is difficult to compensate for hardware or software shortcomings once the actual capture process has been completed.



Image: Hasselblad

Hasselblad's virtual drum scanners provide a high-quality alternative to conventional desktop scanners but start at a budget-busting US\$16,000

specified as the Plustek OpticFilm 120. It has no automatic feed mechanism and feeding originals manually is easier said than done. There are no perceptible click stops to help you correctly position the adapter and, although the originals don't actually move during the scan process, our results included a number of obvious cases of unplanned offset.

The medium-format adapter looks great and has a magnetic closure mechanism. Unfortunately, this doesn't fulfill its intended purpose and the mechanism causes even the flattest film to bend significantly. The tensioning mechanism is practically useless and, if you fill the medium-format adapter with three originals, you have to turn the adapter around by hand to scan the final one. *SilverFast* restarts every time you switch from medium-format to 35mm originals.

Like our other test models, the MF5000 has no autofocus functionality. Because we achieved a poor resolution value of 2048 spi, we rescanned our USAF target using the BRAUN FS120, which is essentially the same device. The BRAUN version recorded a visibly (and technically) much better resolution value of 2580 spi. We had to assume that the difference is due to normal variations in production tolerances and used the better value in our final results.

The MF5000's results are not as good as those produced by the more expensive Plustek and its dust and scratch removal functionality is only adequate. On the plus side, its relatively low resolution made it one of the fastest devices we tested for both 35mm and medium-format originals. Our biggest gripe is the lack of congruence between the scan frame shown on the monitor and the area that is actually scanned. If you want to avoid unintentionally cropping your scans, you have to set the device up to scan a larger area than is actually necessary.

The MF5000 is the only budget medium-format scanner currently available and could do with some refinement: the relatively poor quality of the medium-format adapter is particularly annoying and you need to invest in a copy of *SilverFast* (US\$400) or *VueScan Pro* (US\$80) if you want to make the most of its capabilities.

Conclusions

Our test left us feeling that scanner manufacturers are busily charging up-to-date prices for out-of-date technology. As far as we can tell, a decade has passed without any significant advances in 35mm scan technology and devices that represented the

lower end of the market 10 years ago appear to be the best that the current market has to offer. In a fast-disappearing market sector, there is little hope that new, better-quality film scanners will appear in the foreseeable future. This is an unsatisfactory situation for anyone who wants or needs to purchase a film scanner, although the models tested here can all produce more detailed results than most contemporary flatbed models.

The current scanner market works much like a centrally planned economy in which

consumers are forced choose from a limited range of goods, whether these fulfill their intended purpose or not. Real high-end alternatives are few and far between and cost the earth.

The best model for (non-batch) 35mm scans is the reflecta ProScan/Pacific Image 7200, which offers great value for money. The only option for scanning magazines of slides is the reflecta DigitDia 6000. If you wish to scan medium-format material, you should definitely consider using a flatbed

scanner instead of a poorly developed dedicated model. If money is no object, there is still nothing better than a new (extremely rare) or pre-owned (more common) Nikon COOLSCAN V/5000/9000. These are still the best scanners around and, even though they contain old technology, they are still just as fast as the younger competition. You will have to decide for yourself whether it is worth paying the sometimes ridiculous prices they now command. (pen)

FILM SCANNER DETAILS

	Flatbed	35mm				Medium-format	
Manufacturer	Epson	Nikon	Plustek	reflecta	reflecta ²	Plustek	reflecta ³
Model	V750 Pro	COOLSCAN 5000	OpticFilm 8200i Ai	ProScan 7200	DigitDia 6000	OpticFilm 120	MF5000
Type	Opaque and film scanner	Film scanner	Film scanner	Film scanner	Slide magazine scanner	Film scanner	Film scanner
URL	epson.com	nikon.com	plustek.com	reflecta.de/en	reflecta.de/en	plustek.com	reflecta.de/en
Introduced in	2006	2003	2012	2009	2012	2013	2011
Features							
Nominal resolution	6400 spi	4000 spi	7200 spi	3600 spi	5000 spi	5300 spi	3200 spi
Sensor	CCD	CCD	CCD	CCD	CCD	CCD	CCD
Internal color depth	48-bit	48-bit	48-bit	48-bit	48-bit	48 bit	48-bit
Light source	Cold cathode	LED	LED	LED	LED	LED	LED
Infrared scan	Separate	Combined	Separate	Combined	Combined	Separate	Combined
Autofocus	–	✓	–	–	–	–	–
Transparency scan area	207 mm × 257 mm	25.1 mm × 38 mm	25.4 mm × 36.8 mm	24.3 mm × 36.5 mm	37 mm × 37 mm	60 mm × 120 mm	57 mm × 140 mm
Flatbed scan area	216 mm × 297 mm	–	–	–	–	–	–
Batch processing							
Automatic feed	–	✓	–	–	✓	✓	–
Max. # of 35mm strip-based scans	24	6 ¹⁾	–	–	–	12	–
Max. # of framed 35mm slide scans	12	1 ¹⁾	–	–	Magazine capacity	5	–
35mm scan duration at max. resolution							
Scan	1:56 min	0:52 min	4:55 min	1:10 min	2:48 min	1:40 min	1:12 min
Scan + IR	4:11 min	1:19 min	10:20 min	1:38 min	4:47 min	3:22 min	1:34 min
Scan + multiple exposure + IR	10:02 min	2:14 min	15:05 min	3:32 min	9:39 min	6:39 min	3:58 min
6×6-scan duration at max. resolution							
Scan	4:20 min	–	–	–	–	3:35 min	2:50 min
Scan + IR	10:40 min	–	–	–	–	19:30 min	3:43 min
Scan + multiple exposure + IR	21:05 min	–	–	–	–	33:31 min	9:35 min
Other details							
Interfaces	USB 2.0, FireWire	USB 2.0	USB 2.0	USB 2.0	USB 2.0	USB 2.0	USB 2.0
Included software	SilverFast Ai 6, MonacoEZcolor	Nikon Scan, Photoshop Elements 5.0	SilverFast Ai Studio 8, Plustek QuickScan, NewSoft Presto! PageManager 7.23	CyberView X	CyberView X 5.00, image processing software	SilverFast Ai Studio 8	CyberView X
Separate AC adapter	✓	–	✓	✓	✓	✓	✓
Dimensions (D × H × W)	503 mm × 152 mm × 308 mm	315 mm × 172 mm × 96 mm	272 mm × 119 mm × 120 mm	275 mm × 80 mm × 167 mm	300 mm × 125 mm × 290 mm	374 mm × 189 mm × 210 mm	320 mm × 160 mm × 165 mm
Weight	6 kg (13.2 lb)	3 kg (6.6 lb)	1.6 kg (3.5 lb)	1 kg (2.2 lb)	2.9 kg (6.4 lb)	5.7 kg (12.6 lb)	5.3 kg (11.7 lb)
Current approx. street price	US\$800	US\$3,000	US\$500	US\$280	US\$1,600	US\$2,000	US\$1,500
SilverFast Ai	Included	US\$400 extra	Included	US\$400 extra	US\$400 extra	included	US\$400 extra
VueScan Professional	US\$80 extra	US\$80 extra	US\$80 extra	US\$80 extra	US\$80 extra	US\$80 extra	US\$80 extra
Rankings							
Resolution	⊖	⊕⊕	⊕	○	○	⊕	○
Color rendition calibrated / uncalibrated	○ / ○	⊕ / ⊕⊕	⊕ / ⊖	○ / ⊖	⊕ / ○	⊕ / ⊖	⊕ / ⊖
Noise characteristics	⊕	⊖	⊕	⊖	○	⊖	⊖⊖
Scan speed	○	⊕⊕	⊖⊖	⊕	⊖	⊖	⊕
Handling / Features	⊕ / ⊕⊕	⊕ / ○ ⁵	⊖ / ⊕⊕	○ / ○	○ / ○	⊖ / ⊕⊕	○ / ○
¹ Rollfilm and bulk slide feeder adapters available for Nikon COOLSCAN ³ Rebadged BRAUN FS 120							
² Rebadged BRAUN Multimag Slidescan 6000 ⁴ Features ranking is for standard model with no extras							
⊕⊕ excellent ⊕ good ○ satisfactory ⊖ poor ⊖⊖ inadequate ✓ included – not included n/a not applicable							



Sascha Steinhoff

Scan Workshop

Tips and Tricks

Creating successful scans requires patience and specialized knowledge of scanning techniques as well as skill in correcting the resulting image files. It often takes a disproportionate amount of time to produce top-notch results. This article introduces efficient digitizing strategies that will help you find the right compromise between the amount of effort involved and the quality of your results.

How to Digitize Large Archives Efficiently

You need patience if you want to digitize your analog image archives using a conventional scanner that captures originals line by line. The following sections show you how to digitize your archives in a reasonable amount of time.

There are no tricks and workarounds to make a scanner work faster, so device speed is a universal bottleneck. An unsuitable computer can make a scanner even slower but even a super-computer cannot make it scan any faster. The fastest 35mm scanner we know of is the Nikon COOLSCAN 5000, which is now only available second-hand. Current models are often slower, as demonstrated by our test results on page 74.

Batch Processing

The time a scanner takes to make a single scan matters less if it is capable of batch processing, as you can, theoretically, leave it unattended while it works. Unfortunately, very few scanners offer genuinely useful batch processing functionality and most have manual feed mechanisms that require you to

move the film holder by hand after each scan. Reflecta and Braun offer magazine-based models (see page 67) and the Nikon COOLSCAN 5000 has an optional slide feeder that requires you to remove your slides from their original magazine.

While such bulk feed solutions can make processing large numbers of scans easier, we have found that even the best feeder mechanism jams every now and then. If you do leave your scanner unattended, be sure to check regularly that everything is running smoothly. Flatbed models like the Epson V750 have large transparency units that allow multiple scans but don't offer the same level of quality as dedicated film scanners.

The Right Computer for the Job

Many users run their scanners on an old computer. This approach works fine for most everyday scanning activities, but, if you wish to make high-quality scans of 35mm or medium-format originals, the computing power required can test the limits of even the most high-powered system. Generally speaking, the larger a scan file, the more resources you need to capture and process it. Individual files of several hundred megabytes are common for high-end slide

RECOMMENDED HARDWARE		
	35mm originals	Medium format
Operating system	32- or 64-bit	64-bit
Scanner software	32- or 64-bit	64-bit
CPU	i3 or i5 desktop CPU	i5 or i7 desktop CPU
RAM	4-8 GB	12-16 GB
Hard drive	SSD	SSD

scans, while high-resolution medium-format scan files can easily break the gigabyte barrier.

However, the size of a file (i.e., the sheer number of pixels it contains) is not the deciding factor. Even more important is the amount of detail captured in a scan (i.e., the effective resolution) and the corresponding amount of computing power required by dust and scratch removal algorithms to process the image. The table above gives an indication of the kind of system required to effectively process different types of original.

Software

The software you use significantly influences the speed at which you can work. When scanning 35mm slides and negatives, we prefer to use either the scanner manufacturer's proprietary software or *VueScan* from Hamrick software or *SilverFast* from LaserSoft. The best way to find out which software works best with your particular device and the type of material you are scanning is to try it out. For this article, we tested two scanners using different software packages and discovered significant differences in scan speeds. See the table on the next page for more details.

Scan Resolution

To achieve the best possible scan quality, you need to set your equipment to scan at maximum optical resolution. However, scanning medium- or large-format originals at maximum resolution produces extremely large files that slow down even the most powerful computer. If you are in a hurry, you will find that setting resolution to half its



Image: Epson

At present, the Epson Perfection V700/V750 Pro is the only available A4 scanner with a transparency unit large enough to scan multiple rows of originals. The second-hand market offers more choices, including similar models from Canon and Mikrotek.

maximum doubles the scanning speed and usually still produces acceptable results. However, you should take care not to use resolutions below 2000 spi (samples per inch).

Processing Finished Scans

Software that performs automatic image processing during the scan procedure reduces scan times but may produce irreversible errors in the finished scans. It is

always preferable to edit scans in a separate step once the raw scan has been made. The only exception is dust and scratch removal, which requires a lot of computing power. Scanner software is not capable of multi-tasking and performs one scan after another, so the scanner itself is likely to remain inactive for long periods while the software does its work.

It is more efficient to use *VueScan* or *SilverFast* and scan to a RAW format rather

than TIFF. If you take this approach, you can save the infrared channel with the scan data and perform dust and scratch removal later on a version of the scan file that is saved on your hard drive. These filters can be applied as a batch process to large numbers of scans – a process that you can safely start and leave to run overnight. This functionality is included in the pro version of *VueScan* but you will have to purchase the HDR version if you want to do the same thing using *SilverFast*.

Selecting Originals

The best way to save time when scanning is not to purchase a high-end scanner or a fast computer but instead to concentrate on selecting appropriate originals. Not every slide or negative is worth scanning, and most magazines or strips of film contain out-of-focus or otherwise substandard images. Using a light table and a loupe to thoroughly sort through your archives will save a considerable amount of time when it comes to digitizing them.

SCAN TIMES FOR VARIOUS SOFTWARE PACKAGES						
Scanner	Nikon COOLSCAN 5000			Epson V750 Pro		
Software	SilverFast	VueScan	Nikon Scan	SilverFast	VueScan	Epson Scan
At maximum resolution¹	4000 spi			6400 spi		
Scan	0:52 min	0:31 min	0:22 min	1:56 min	1:25 min	1:56 min
Scan + scratch removal	1:19 min	0:31 min	0:40 min	4:11 min	4:40 min	4:04 min
Scan + multiple exposure + scratch removal	2:14 min	1:17 min	–	10:02 min	7:40 min	–
At half maximum resolution¹	2000 spi			3200 spi		
Scan	0:26 min	0:27 min	0:20 min	1:04 min	0:57 min	1:02 min
Scan + scratch removal	0:35 min	0:29 min	0:25 min	2:21 min	2:20 min	3:54 min
Scan + multiple exposure + scratch removal	1:03 min	1:11 min	–	5:10 min	5:02 min	–

¹ For a 24 × 36 mm 48-bit TIFF scan

Optimizing Scan Resolution

You have to keep an eye on multiple resolution values when making scans. The following sections explain what these values are and how to select the most appropriate ones for a particular job.

The subject of optimizing scan resolution is surrounded by many myths, due largely to persistently incorrect use of units in many discussions. Terms such as dpi, ppi and spi are often used indiscriminately, creating much confusion among photographers. But never fear – this will all be explained in the next few pages.

Absolute or Relative Resolution?

The resolution of a digital image can be expressed in absolute or relative terms. The maximum size of a digital image is limited by the size of the camera’s sensor and the appropriateness of the lens used to capture it. For example, the Canon EOS 5D Mark III has a

24 × 36mm (full-frame) sensor that measures 3840 × 5760 pixels. Multiplying these fairly large numbers gives us an overall sensor resolution value of 22 megapixels.

Expressed in terms relative to its size (in inches), the resolution of the Canon’s sensor is 4064 pixels per inch (ppi), although expressing resolution this way is extremely unorthodox. If we assume that the sensor’s area is fully utilized by lenses with appropriate geometries, the absolute resolution value remains constant.

Things are more complicated in the scanner world because scanners are used with different-sized originals and utilize various technologies. Many scanners use a moving sensor to capture originals line by line. The size of the image file produced depends on the distance the sensor has to travel, and it is

therefore not just the size of the sensor, but rather the combination of the scan resolution and the size of the original, that determines the size of a scan file (see the table on the next page for more details).

dpi, ppi and spi

A useful approach when creating scans is to consider the relative resolution per inch viewed in relation to the size of the original. For example, a common scan resolution for film-based originals is 4000 spi (samples per inch), which is the correct unit for expressing scanner input resolution and is close to the value we calculated for our full-frame Canon DSLR. Unfortunately, the term spi is seldom used and is often incorrectly replaced by the

terms dpi and ppi. The term dpi stands for 'dots per inch' and actually describes the output resolution of an image that is to be printed, whereas ppi (pixels per inch) describes the resolution of an image when viewed on a monitor. These definitions explain why values for dpi, ppi and spi resolution differ.

Specialized scanner software like *VueScan* enables you to specify both input and output resolution. When using such software, it is essential to have a correct understanding of these different resolution units in order to distinguish between the relative resolution of the original and that of the output area. In practical terms, this means that a single image file can have several different resolutions.

Lets look at an example: if we scan a 24×36mm slide at 4000spi, we end up with a file that measures 3780×5669 pixels. If we print this file at 300 dpi, we end up with a print that measures 32×48 cm (12.6×18.9 inches). Reproduced at 72 ppi on a monitor, the same image would cover an area of 133×200 cm (52.3×78.7 inches), so it is essential to use the correct units if you want to avoid misunderstandings.

Actual and Effective Resolution

The units we have examined so far all relate to the number of pixels in a scan. However, whether the nominal visual resolution is the same as the actual density of visual data contained in the image file depends on a number of factors. The effective resolution of a scanner is significantly lower than the nominal (optical) resolution specified by the manufacturer, and the same is true for many digital cameras. Whether in a camera or a scanner, if the nominal and actual resolution values diverge too far, the resulting image file will be disproportionately large. When creating scans, it is essential to keep an eye on the real (i.e., effective) resolution produced by the resolution setting you have selected, as this determines the amount of data and detail you can extract from your original.

SCAN RESOLUTION, FILES SIZES AND PRINT SIZES				
Relative resolution	Absolute dimensions	Absolute resolution	48-bit TIFF file size	Print size at 300 dpi
24×36mm slide				
1000 spi	945 × 1417 pixels	1.3 megapixels	7.66MB	8 × 12 cm
2000 spi	1890 × 2835 pixels	5.4 megapixels	30.65MB	16 × 24 cm
3000 spi	2835 × 4252 pixels	12.1 megapixels	68.9MB	24 × 36 cm
4000 spi	3780 × 5669 pixels	21.4 megapixels	122.61MB	32 × 48 cm
5000 spi	4724 × 7087 pixels	33.5 megapixels	191.57MB	40 × 60 cm
7200 spi	6803 × 10 205 pixels	69.4 megapixels	397.25MB	57.6 × 86.4 cm
6×6cm medium-format slide				
1000 spi	2362 × 2362 pixels	5.6 megapixels	31.93MB	20 × 20 cm
2000 spi	4724 × 4724 pixels	22.3 megapixels	127.72MB	40 × 40 cm
3000 spi	7087 × 7087 pixels	50.2 megapixels	287.36MB	60 × 60 cm
4000 spi	9449 × 9449 pixels	89.3 megapixels	510.87MB	80 × 80 cm
5000 spi	11 811 × 11 811 pixels	139.5 megapixels	798.23MB	100 × 100 cm
7200 spi	17 008 × 17 008 pixels	289.3 megapixels	1655.20MB	144 × 144 cm
13×18cm large-format slide				
1000 spi	5118 × 7087 pixels	36.3 megapixels	207.54MB	43.3 × 60 cm
2000 spi	10 236 × 14 173 pixels	145.1 megapixels	830.16MB	86.7 × 120 cm
3000 spi	15 354 × 21 260 pixels	326.4 megapixels	1.82 GB	130 × 180 cm
4000 spi	20 472 × 28 346 pixels	580.3 megapixels	3.24 GB	173.3 × 240 cm
5000 spi	25 291 × 35 433 pixels	906.8 megapixels	5.07 GB	214.1 × 300 cm
7200 spi	36 850 × 51 024 pixels	1.8802 gigapixels	10.51 GB	312 × 432 cm

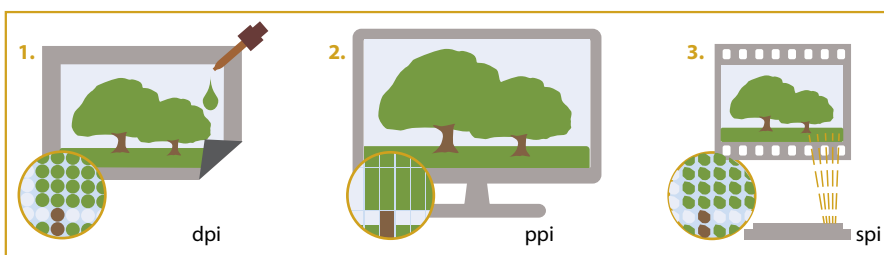
Data Density in an Original

Even the best scanner cannot help you if your original contains too little visual data or the scanner itself has problems sampling it. To avoid these issues, keep your originals as flat as possible (i.e., be sure that the entire surface lies within the scanner's plane of focus). Flat originals are particularly important if your scanner has autofocus functionality, because this type of scanner often has a very shallow field of focus.

The actual density of the visual data stored in a film-based original is difficult to determine. Unlike a digital image, an analog original is made up of randomly distributed film grain rather than easily countable pixels. Film resolution is expressed in terms of lines per millimeter. As a reference, Kodachrome 25 (which has a very low sensitivity value and extremely fine grain) should, under ideal conditions, be able to resolve about 100 lines per millimeter.

Due to the variety of processes available, scanning experts disagree as to whether it makes sense to translate such analog resolution values into digital equivalents. Depending on graininess, 35mm originals have an equivalent digital resolution of about 10-30 megapixels. However, due to limitations in camera optics and the vagaries of shooting conditions, these maximum values are rarely achieved in real-world situations.

At the end of the day, no matter how thoroughly you do your research, it is still difficult to determine the optimum resolution for your scans. Our experience has shown that an effective resolution of 2000 spi is sufficient for scanning everyday snapshots, whereas values of 4000 spi or more only make sense if the original was carefully captured using fine-grain film and high-end equipment. You can usually use lower values for medium- and large-format originals, as these have much larger surface areas and therefore contain much more detail to begin with.



Printers (1.) produce dots of ink and their resolutions are therefore expressed in terms of dots per inch (dpi). Monitors reproduce images using pixels (2.), so their resolutions are expressed in pixels per inch (ppi). Scanners (3.) sample an image (as opposed to capturing it in one go like a camera), so scanner resolutions are stated in terms of samples per inch (spi).

Removing Dust and Scratches

There is no such thing as an analog original that is completely free of dust and scratches. High-quality scanners tend to reproduce any unwanted markings in a slide or negative with frightening clarity. In order to save you hours of manual correction on the resulting scans, most scanners and scanner software packages offer automatic dust and scratch removal functionality.

Analog originals have a charm all their own but they also contain unwanted image artifacts in the form of dust damage and scratches. The surfaces of slide and negative films are highly sensitive to scratches and the problems begin in the camera, where the mechanical winding mechanism can produce scratches and pockmarks before the film is even exposed. Development and handling by the photographer are also critical stages in the life of a strip of film, and mounted slides are better protected from scratching than negatives. Unfortunately, even the cleanest home or office isn't as dust-free as a real clean room and it is rare that a film-based original is completely free of dust.

Back in the days of analog photography, a reasonable amount of dust and scratch artifacts was considered normal and didn't usually bother anyone. 35mm originals are so small that the reduction in sharpness caused by enlarging or projecting them often reduces the visibility of dust and scratches too. In contrast, dust and scratches are an inescapable issue when you are digitizing analog images, although the degree to which scanned artifacts mar a scan depends very much on the type and quality of the scanner you use.

Light Sources

Cold-cathode lamps were the standard light source in most scanners until quite recently. Some current models, such as the Epson Perfection Pro V750, are still based on this type of technology, which produces softer, less concentrated light than the LEDs used in most contemporary scanners and produces scans in which dust artifacts, scratches and film grain are less pronounced.

Infrared Scratch Detection

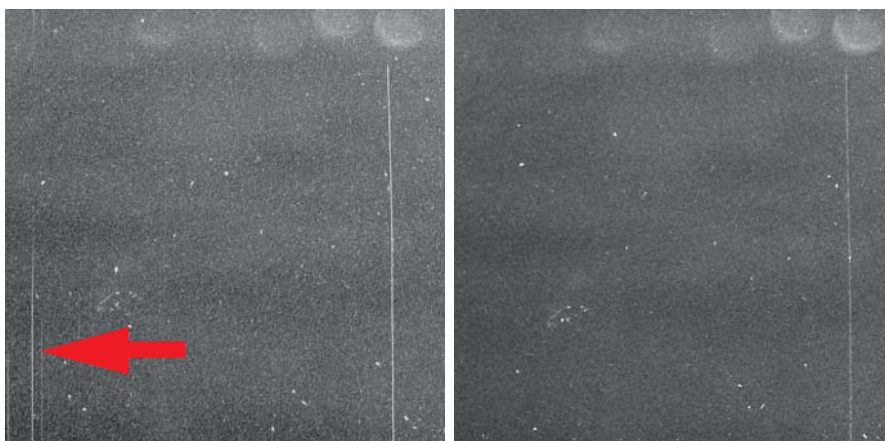
Every artifact correction process needs to be able to distinguish precisely between image detail and unwanted artifacts, but most of the current crop of purely software-based processes do not produce consistently satisfactory results. The best available dust and scratch correction processes are hardware-based, and most film (and some flatbed) scanners are equipped with appropriate functionality. The technique involves capturing a 16-bit infrared channel in addition to the conventional 48-bit RGB scan. Models such as the Reflecta MF 5000 and the Nikon COOLSCAN 5000 digitize the RGB and infrared channels simultaneously in a single

pass, which is not only faster but also more precise than performing two separate scans. This is due to the potential physical offset between scans, which can spoil the corrections produced by the tool's algorithm (for more details, see our scanner hardware test on page 62).

Comparing Correction Algorithms

The correction algorithms available today are either proprietary manufacturers' own or device-independent third-party solutions. Scanner manufacturers have developed their own solutions to avoid having to pay license fees to third-party providers. Canon's process is called FARE, Reflecta's is called Magic Touch and Epson uses a technology called Easy Photo Fix. Processes like these are more likely to be found in devices aimed at the value end of the market.

Device-independent technologies, such as Kodak's Digital ICE are generally found only in high-end devices. Digital ICE, the industry standard technology for many years, is no longer under active development. A 'black box' solution that licensees cannot customize, it is known for its extremely thorough



The 'hard' LED light used by the Nikon COOLSCAN captures all the patterns in the film grain and scratches in the film's emulsion in high definition (left). In comparison, the Microtek ArtixScan 120 (right) scans using a cold-cathode lamp that produces a softer overall effect with less noticeable scratches.



The Nikon COOLSCAN 5000's iSRD functionality worked very well with E6 slides (left), producing nice clean results. In contrast, the Plustek 8200i's iSRD tool produced only rudimentary improvements (right), possibly due to a poorly adjusted infrared channel.

approach but also for a degree of softness in the scans it produces. Software manufacturers like Hamrick and LaserSoft prefer to use their own solutions – *VueScan* has Infrared Clean and *SilverFast* uses iSRD. If the scanner provides precise infrared data, both processes have a gentler effect than Digital ICE. iSRD also offers extended configuration options such as masks and fine-tunable sensitivity settings.

iSRD and Infrared Clean both offer full RAW scanning support and, as previously mentioned, the resulting 64-bit format (48-bit RGB + 16-bit infrared) makes it possible to perform dust and scratch removal after the scan itself has been captured.

Scanning Black-and-white and Kodachrome Originals

Black-and-white film contains silver, which reflects infrared light, making IR dust and scratch removal completely impractical. While the IR process does remove scratches, it

produces so many additional artifacts that the resulting scans are unusable. Chromogenic monochrome films such as Ilford's XP2 and Kodak BW400CN, which are developed using the standardized C-41 color development process, are the only exception to this rule.

Kodachrome color slide film has a structure similar to that of traditional monochrome film.

It is no longer available and was developed using the proprietary K-14 process rather than the more widely used E6 slide chemistry. Conventional dust and scratch removal technology can work with Kodachrome originals, although fine details often fall victim to the process. This is still the case for more recent versions of Infrared Clean and iSRD.



At its lowest setting, *VueScan's* Infrared Clean option overlooks many obvious scratches (left). The scratches and artifacts that it successfully identified are marked in red. The highest setting (right) removes more scratches but also detects additional 'artifacts' where none are actually present.

Nikon COOLSCAN 5000



Nikon COOLSCAN 5000 with iSRD



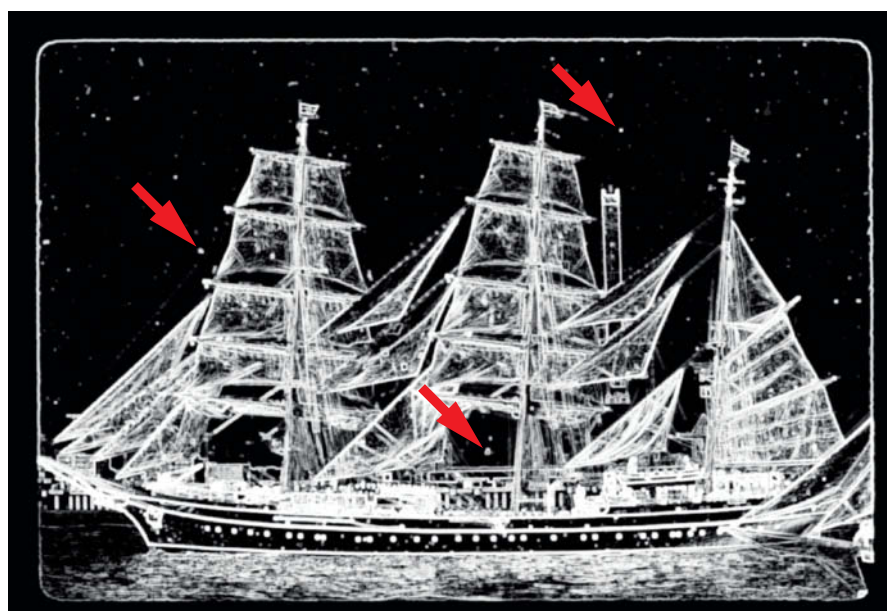
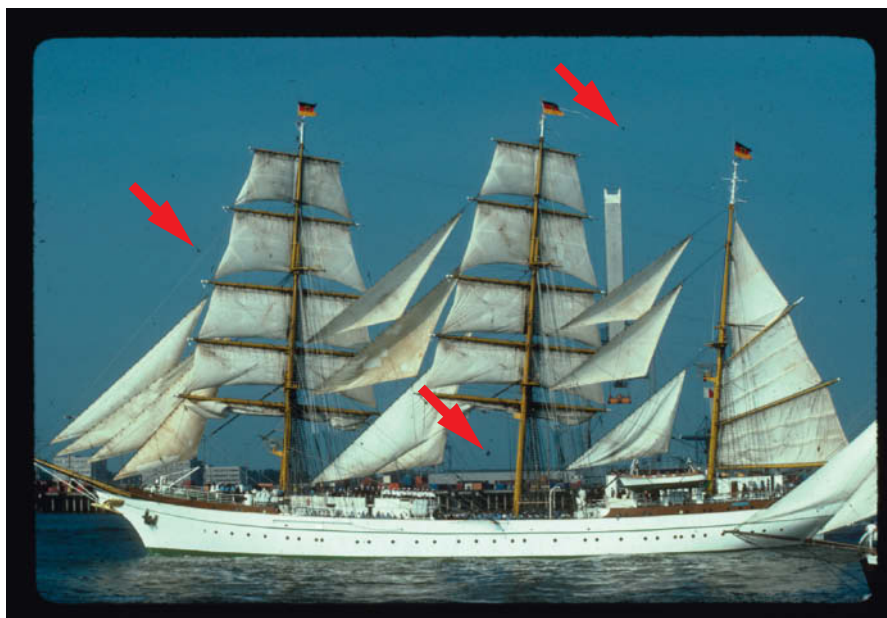
Plustek 8200i



Reflecta ProScan 7200



Dust and other unwanted specks are clearly visible in the scan made without iSRD (far left). Activating iSRD removes dust artifacts but it also alters details. In our example, a border has been created around the ship's portholes (second from left). The Plustek version of iSRD failed completely (second from right), mistakenly eradicating some of the portholes. The Reflecta 7200 scanner (far right) produced much more subtle correction artifacts than the Plustek, although zooming in reveals some new artifacts too.



The only scanner that ever incorporated a dedicated Kodachrome dust and scratch removal process was the now-discontinued medium-format Nikon COOLSCAN 9000 model, which used a customized version of Digital ICE specially licensed by Kodak. Dust and scratch removal for Kodachrome originals is still a process laced with pitfalls and is not directly supported by any of the devices profiled in our scanner test (see page 62).

Software-based Scan Correction

Purely software-based dust and scratch removal processes are not especially reliable. This applies just as much to LaserSoft's dedicated iSRD technology as it does to the *Photoshop* Dust and Scratches tool and Polaroid's Dust and Scratch Removal plug-in. If you have to rely on software, it is better to use *Photoshop's* many stamp and healing tools or *Lightroom's* Adjustment Brush in combination with the *Visualize Spots* option, which makes it much easier to identify individual blemishes. Manual corrections are always much more time-consuming than automatic infrared correction processes.

The standard *Lightroom* view (above right) makes it difficult to identify individual dust specks. Activating the *Visualize Spots* option makes specks much easier to see and simpler to remove.

IT8 Calibration

Like other optical devices, scanners are subject to variations in manufacturing tolerances and deviations in color reproduction. The IT8 set of standards is designed to unify color reproduction in a variety of graphic technologies. The following sections explain how these standards work and detail some of their limitations.

IT8 is a set of American National Standards Institute (ANSI) standards for color communications and control. The IT8.7 and 8.7/1 standards define a color transmission target for input scanner calibration.

Calibration or Profile Creation?

The colors reproduced by a scanner almost always deviate to some degree from the desired result. To measure this deviation effectively, we need a slide of a standardized IT8 target and an associated reference file that precisely defines which color in the target corresponds to which measured value. Using a process called 'profiling', scanner software packages like *VueScan* and *SilverFast* scan an IT8 target slide and compare the sampled colors with appropriate reference values. The differences between these pairs of values are saved in a device-specific ICC profile.

This profile can then be used to automatically correct any color deviations that occur during subsequent scans. The *SilverFast* status display reveals that the software regularly calibrates the scanner based on preset values or those contained in a custom profile. This process runs in the background and cannot be influenced by the user.

Once again, terminology can be confusing: people often use the term 'scanner calibration' when they actually mean profile creation. The terms 'calibration' and 'profiling' are therefore largely synonymous and the following sections use them interchangeably.

Limits to Calibration

Calibration is generally only useful if you are scanning slides and, although it does not harm when scanning negatives, it doesn't guarantee that you will end up with authentic colors. This is because color negatives contain inverted colors and are coated with an orange-colored protective layer. Transforming color negatives into positive images is not a precisely defined science, and there are no definitive profiles available for making scans of negatives.

Calibration for negatives is also subject to fluctuations. Ideally, the substrate for the IT8 target should be made of the same material as that of the film you wish to scan. Manufacturers of IT8 targets such as

Coloraid (colorreference.de) and LaserSoft (silverfast.com/show/it8-targets/en.html) offer targets for various types of film including Fuji Provia, Fuji Velvia and Kodak Ektachrome. LaserSoft even has some Kodachrome targets in stock.

Scan results always benefit from some kind of calibration. Uncalibrated Nikon film scanners, for example, are notorious for the green color casts they produce, but these can be reliably counteracted using IT8 calibration techniques.

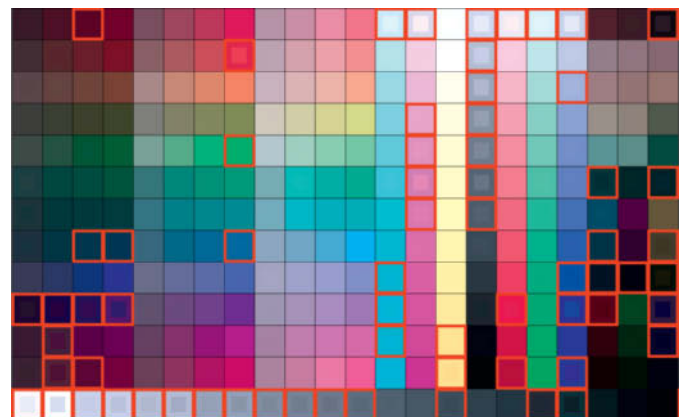
The effectiveness of calibration has its limits and, in spite of all the options available, it is usually a waste of time and effort to calibrate a low-quality scanner, as it will still produce color errors. By the same token, it is not worth purchasing expensive scan software with built-in calibration functionality for use with a cheap scanner. Software alone is not capable of ironing out all the inconsistencies involved in the scanning process.

Color Longevity

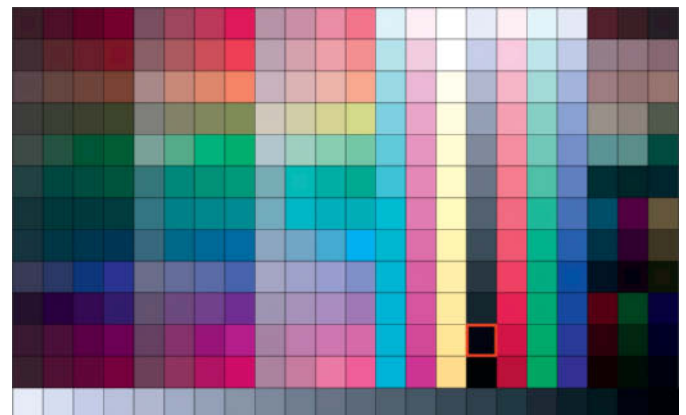
Once you have acquired a high-quality scanner and calibrated it properly, you have laid the basic foundations for creating scans that contain authentic colors. The only remaining proviso is that the original itself contains correct colors. Because the various chemical layers in a slide age at different rates, older slides often have unwanted color casts that are then scanned along with the image details. The only really effective way to remove color casts from scan files is to use image processing software.

Many scanner software packages therefore include automatic color restoration functionality designed to negate the visual effects caused by aging originals. These tools can be quite effective and are definitely worth trying out.

As you can see, successful calibration depends on a multitude of factors. Our tests show that scanning using a custom IT8 profile will produce much better results than scanning with a non-calibrated device. If you are investing in a high-quality scanner, it is certainly worth spending a little more on an appropriate target and high-quality scanner software in order to get the best out of your original material and your hardware. (pen) **ct**



In spite of using an IT8 color profile, the first test scan we made using a Reflecta DigitDia 6000 contained extreme color deviations (indicated by the outlined squares in the image above)



Calibration worked much better using a second machine of the same type, proving that manufacturing tolerances are still an important factor when it comes to creating accurate scans

Dmitri Popov

Mobile RAW Processing

Manage and edit photos on the go

Tablet and smartphone-based RAW editing has come a long way since its early days and now offers a true lightweight processing option when you are out and about. This article introduces the best of the current crop of Android and iOS RAW processing apps.





RawDroid is perfect for browsing and previewing RAW files on an Android device. The app can handle external storage and can import image files directly from a connected camera.

The ability to organize and process RAW files on an Android or iOS device is a real boon to enthusiasts and professional photographers alike. Why carry a regular laptop when you can pack a thin, light Android tablet or iPad instead? Most of the current Android and iOS devices have sufficient power to handle demanding tasks such as RAW file processing with aplomb. More importantly, there are plenty of reasonably priced and highly capable RAW processing apps available for both Android and iOS. In this article, we take a look at some Android and iOS apps that can help you to organize and process RAW files on your mobile platform of choice.

When it comes to transferring RAW files from a camera to an Android device, you have several options at your disposal. If your Android device supports 'USB host' mode, you

can connect your camera directly to your tablet or smartphone using an OTG (On-The-Go) USB cable, which costs just pennies on eBay. Instead of the camera, you can then connect a card reader to your device and transfer RAW files directly from the memory card. If you happen to use an Eye-Fi SD card, the Eye-Fi Android app enables you to transfer photos from your camera to your Android device via a wireless network. Better still, if you enable and configure Direct Mode, you can use the app to pull photos from the camera via a direct wireless connection. Keep in mind, though, that only the Eye-Fi Pro X2 card supports RAW file transfer. On iOS, you have two options for transferring RAW files from the camera to the device: you can either use the Apple Camera Connection Kit, or you can opt for the Eye-Fi SD card/iOS app combo.

Powerful Tools for Mobile Photographers

Obviously, an Android or iOS device in combination with one of the apps covered in this article won't replace a regular machine running a fully-featured RAW processing application such as Adobe Lightroom, Apple Aperture or digiKam. Not yet, at least! But when you are on the move, a mobile device loaded with a RAW management and processing app can come in handy in many situations. Android in particular is a great platform for working with RAW files – install RawDroid and Photo Mate, and you can organize and preview your files as well as performing some quick processing steps wherever you happen to be.

RAW APPS FOR ANDROID AND IOS		
Name	Details	Price ¹
Android		
RawDroid	RAW image browser that can handle a wide range of RAW formats and offers tools for tagging, rating, and labeling	Free
RawVision	RAW image browser that supports Eye-Fi SD cards. Features a no-frills editor which can be used for basic RAW processing.	US\$5.43
Photo Mate	Fully-featured app for organizing and processing RAW files. Highlights include support for network shares, powerful filtering options, and a wide range of editing tools, including curves.	US\$6.99 / US\$9.49 (R2)
iOS		
PhotoRaw	RAW editor with basic processing tools. Can transfer processed photos directly to Adobe Photoshop.	Free (lite version) / US\$9.99
piRAWnha	RAW processing app that features several tools not found in PhotoRaw, including tagging, denoising and presets	US\$9.99

¹ Prices correct at the time of writing

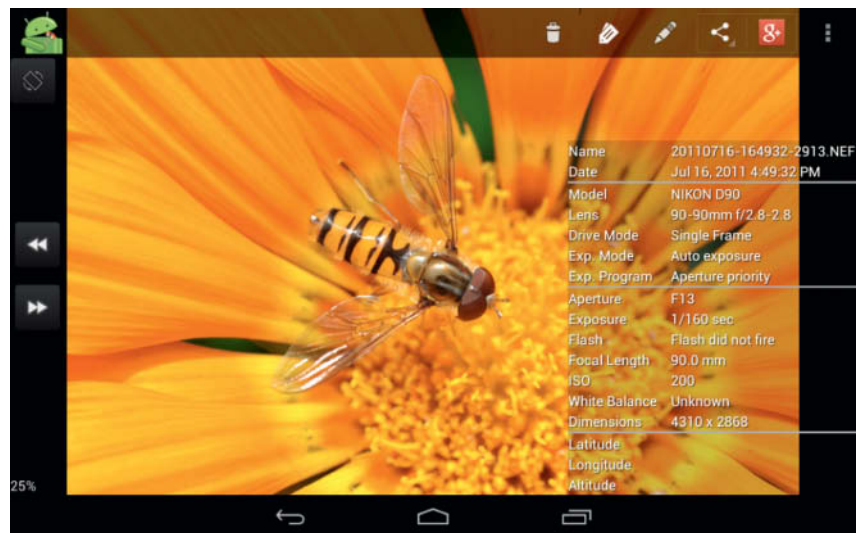
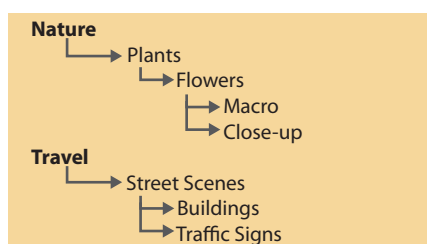
RawDroid (Android)

Even if you prefer to use a regular desktop machine or laptop for serious RAW processing, you might still want to use an Android device for previewing, tagging and organizing your RAW files when you are out and about. *RawDroid* is a great app that offers all the essential tools for efficiently managing RAW files. It supports more than 500 camera models and all major RAW formats, including NEF, ARW, CRW, RAW and many others besides. No matter what camera you use, there is a good chance that *RawDroid* can handle your RAW files.

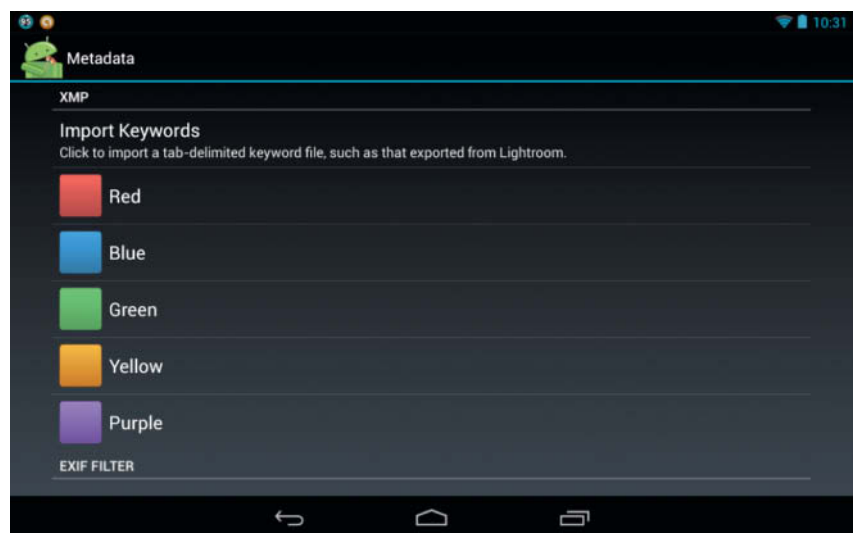
The app is not overloaded with features, making it relatively simple to master. If you point it to a directory containing RAW files, the app automatically generates thumbnails and displays them as a gallery. To preview a RAW file in full-screen mode, simply tap on its thumbnail. You can pan and zoom images too, and the app also displays a file's key Exif metadata tags. Although it doesn't offer any editing tools, *RawDroid* enables you to open the current file in an external editor by tapping on the 'Edit' button in the main toolbar. You can also edit basic metadata, including tags, ratings and color labels. To make tagging more efficient, the 'Reuse' button allows you to apply previously used color labels, ratings and tags to the file you are currently viewing.

Quick and Easy Labeling

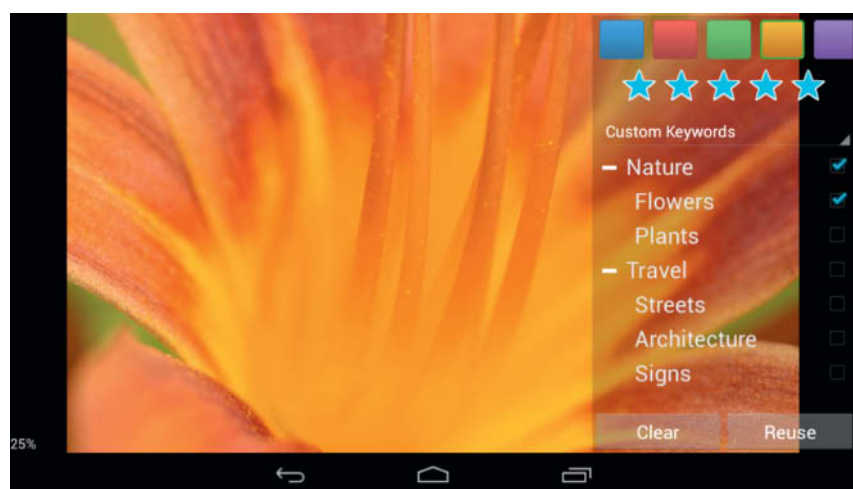
As well as enabling you to add tags manually, *RawDroid* can also import existing tags and handle keyword files exported from Adobe *Lightroom*. To export keywords from *Lightroom*, use the Metadata > Export Keywords command in the Library module. Move the generated file to the Android device, open *RawDroid*, tap the 'Menu' button and choose Settings. Switch to the Metadata section, tap 'Import Keywords' and select your imported keyword file. You should then be able to see your imported tags in the metadata editing pane. If you don't use *Lightroom*, you can create a keyword file manually using the following format:



You can view basic Exif data in full-screen mode, where you can also zoom and pan using gestures



If you use *Lightroom* as your main RAW processing application, *RawDroid* allows you to import existing keywords from a file generated by *Lightroom*



RawDroid lets you assign color labels, ratings and keywords to the current RAW file. This data is saved in a *Lightroom*-compatible XMP sidecar file.

The color labels, ratings and keywords assigned to RAW files in *RawDroid* are saved in 'sidecar' files that can be imported into *Lightroom* or any other RAW processing application that supports the XMP format.

Although *RawDroid* is not designed for processing RAW files, the app allows you to extract their embedded JPG images. To do this, select the desired files, tap

the 'Menu button' and choose Export Thumbnails.

Last but not least, *RawDroid* features batch renaming functionality that you can use to give RAW files descriptive names. To use this feature, simply select the files you want to rename, tap the 'Edit' button in the main menu, select your desired renaming option and specify a custom name.

Conclusions

Although it is fairly light on features, *RawDroid* is great for quickly organizing RAW files and tweaking their metadata when you are on the move. It is perfect for sifting through your files and selecting the ones you wish to process further on your home-based machine. It is also ideal for tagging images and adding ratings in your spare time.

RawVision (Android)

In addition to RAW browsing, preview and management functionality, *RawVision* includes some useful additional features. In its tablet version, the program features a two-pane interface – the left pane is used to navigate through directories, while the right pane lists the RAW and other supported files (JPG, PNG and MOV) contained in the currently selected folder. The Favorites feature lets you bookmark frequently used folders for faster access and, using the dedicated buttons on the main toolbar, you can view images as icons or thumbnails of varying sizes and sort images alphabetically or by date.

Provided the functionality is supported by your particular Android device, *RawVision* can import RAW files directly from your camera or card reader via a USB connection. Moreover, it also supports Eye-Fi SD cards, so you can easily transfer photos from your camera to the app via a wireless connection. To enable this feature, you need to obtain an upload key that

corresponds to your Eye-Fi card. Instructions on how to do this are available online.

To view a RAW file in full-screen mode, long-tap it and choose the Show Full Screen command. You can then view the file's histogram along with its basic Exif metadata and use pinch gestures to zoom in and out. The app includes color label and rating functionality but doesn't have a keywording feature. Any metadata you add is saved in a separate XMP sidecar file which can be imported into *Lightroom* or any other compatible RAW processing application.

RawVision allows you to open files for editing in an external application or using its

own built-in editor. To use this feature, long-tap a file and select the Edit Photo command. As well as basic Crop, Orientation, Brightness, Contrast and Saturation tools, the app provides some other, more or less useful features such as Stickers and Enhance. The Blemish and Whiten tools are great for removing artifacts and performing light on-the-go retouching. The Effects tool can be used to apply retro-style filters. The basic filter set is free, and you can purchase additional filters as necessary. Remember that the editor built into *RawVision* only edits the extracted JPEG versions of your files, not the RAW files themselves.

***RawVision* offers several useful features, including the ability to bookmark often-used folders and sorting tools**





Full-screen mode in *RawVision* displays a histogram and basic Exif data. In this view, you can also assign color labels and rating to the current RAW file. Metadata is saved in a separate XMP sidecar file.

Conclusions

RawVision is a highly capable RAW viewing and management tool but has some shortcomings. It doesn't support tagging and can be slightly cumbersome in use. For example, you can view basic Exif data in the full-screen view, but if you need to see all of a file's Exif tags, you have to return to the main interface, long-tap on the photo and then select the View Exif command. Additionally, while you can rename RAW files individually, *RawVision* doesn't support batch renaming. On the positive side, the app comes with a built-in editor and a set of useful tools, and can be used with Eye-Fi cards for direct wireless file transfers.

Photo Mate (Android)

While both *RawDroid* and *RawVision* can extract embedded JPG images from RAW files, neither of these apps can edit RAW image data. This is where *Photo Mate* comes into play. The app is based on the excellent (and mature) ddraw library and is capable of handling practically all popular RAW formats. The app is available in standard and professional versions and also offers the optional Photo Mate RAW Extension for direct viewing and manipulation of RAW files. Once installed, the extension can be enabled in the Preferences > Extensions section of the app.

The Preferences section also contains settings for enabling and tweaking the File Filtering options. For example, if you want to configure *Photo Mate* to display only RAW files of a certain type (e.g., only NEF and CR2), you can do so by specifying the desired file extensions under the *Filter File by File Type* option. If you plan to use the filtering feature on a regular basis, you should enable the *Show Filter Bar* option for faster access to the filtering options.

Photo Mate offers tools for both managing and processing RAW files. When you launch the app, it automatically opens the browser interface, which allows you to navigate to the

directories that contain RAW files. The app can import RAW files from a camera connected to the device and can also access

and browse Windows network shares. This feature is especially useful for accessing RAW files stored on a file server without having to

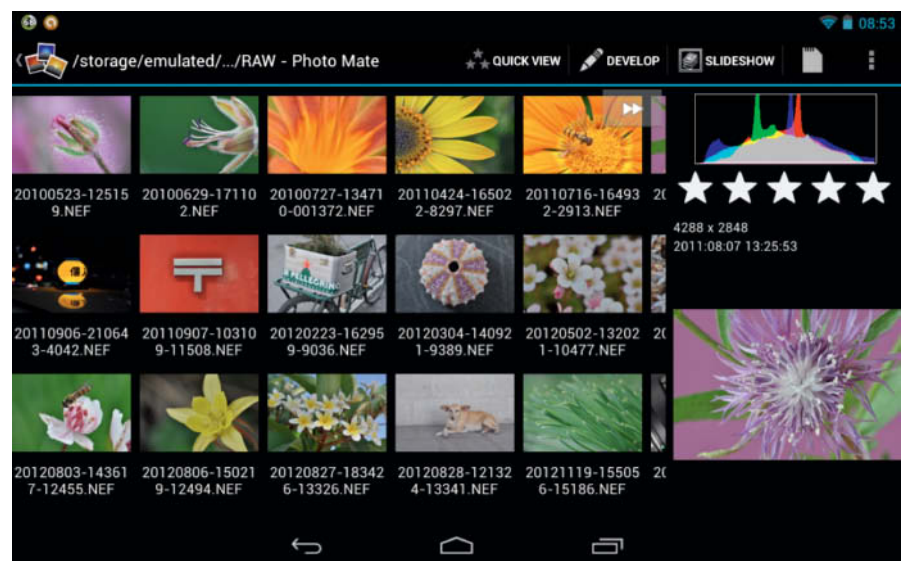
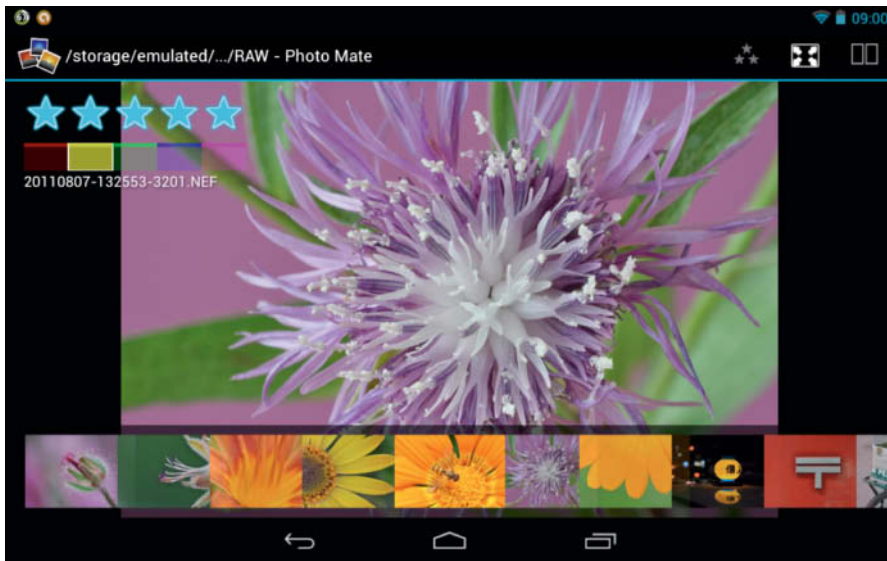


Photo Mate is a powerful, feature-rich Android app for managing and processing RAW files



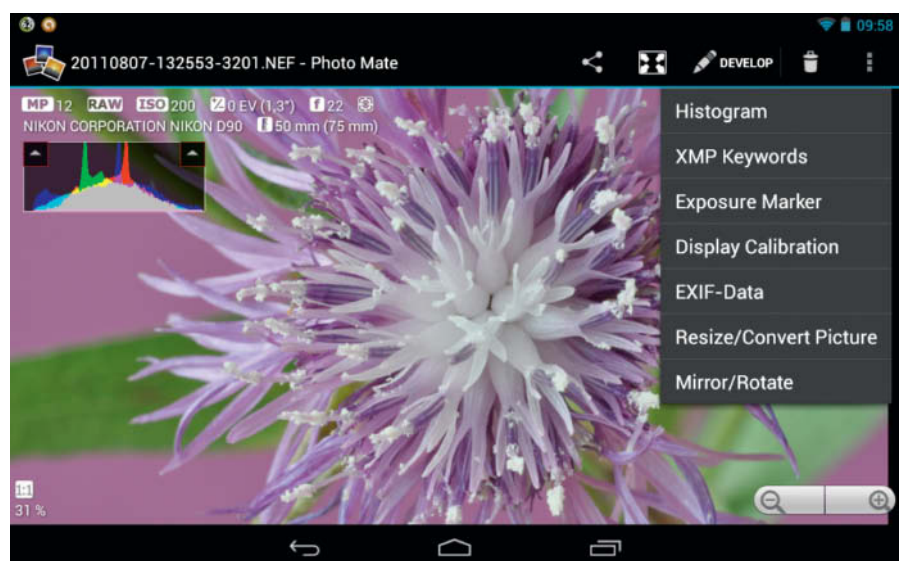
In Quick View mode, you can quickly rate and label RAW files. The app saves tag data in an XMP sidecar file that is compatible with many regular RAW processing applications.

transfer them to your Android device. To switch to network mode, tap the 'Menu' button and select Network. You should then see a list of the shares available on your local network. To access shares outside the local network, use the 'Add Server' button to specify the required server connection details.

In addition to the regular thumbnail view, the RAW file browser features a 'Quick View' mode that offers several handy features of its own. The scrollable strip at the bottom of the screen lets you quickly jump to the desired file, while the floating palette in the upper left-hand corner can be used to assign ratings and a color label to the currently active file. Like *RawDroid* and *RawVision*, *Photo Mate* stores this data in a separate sidecar file that is compatible with desktop RAW processing applications. Split View is another useful feature and enables you to view two photos side by side. To enable Split View, select the first photo, press the 'Split View' button in the main toolbar and then select a second photo. You can then use swipe gestures to flick through the photos in the right- and left-hand panes.

Back in the regular browser, you can view a large thumbnail of a RAW file along with its histogram and rating in the right-hand sidebar, while tapping the sidebar thumbnail opens a file in full-screen mode. The 'Menu' button in full-screen mode reveals several useful features, including a

variable histogram and full Exif metadata. The Exposure Marker feature enables the under- and overexposure indicators that you can also activate by tapping the triangles in the upper corners of the histogram window. Tapping the XMP Keywords command lets you add keywords to the current file.



The full-screen view displays basic Exif and histogram data, while the 'Menu' button gives access to several other features, including XMP Keywords, Exposure Marker and full Exif metadata

The Develop section of the app is devoted to RAW image processing. The available tools include white balance, brightness, exposure and saturation adjustments, and handling is generally self-explanatory. Alongside these standard tools, there are a couple of features that deserve special mention. The Curves tool lets you adjust the RGB curve as well as the curves for the individual red, green and blue channels. You can also save your adjustments as a template that you can then apply to subsequent images, saving you a lot of work if you want to apply the same settings to multiple files.

Photo Mate supports RAW file export to the ubiquitous JPG format as well as to TIFF and PNG. If you opt to save a file to JPG, you can specify the desired output quality and copy the file's Exif data if required. The export section also lets you define renaming rules for saved files and even apply a watermark.

Conclusions

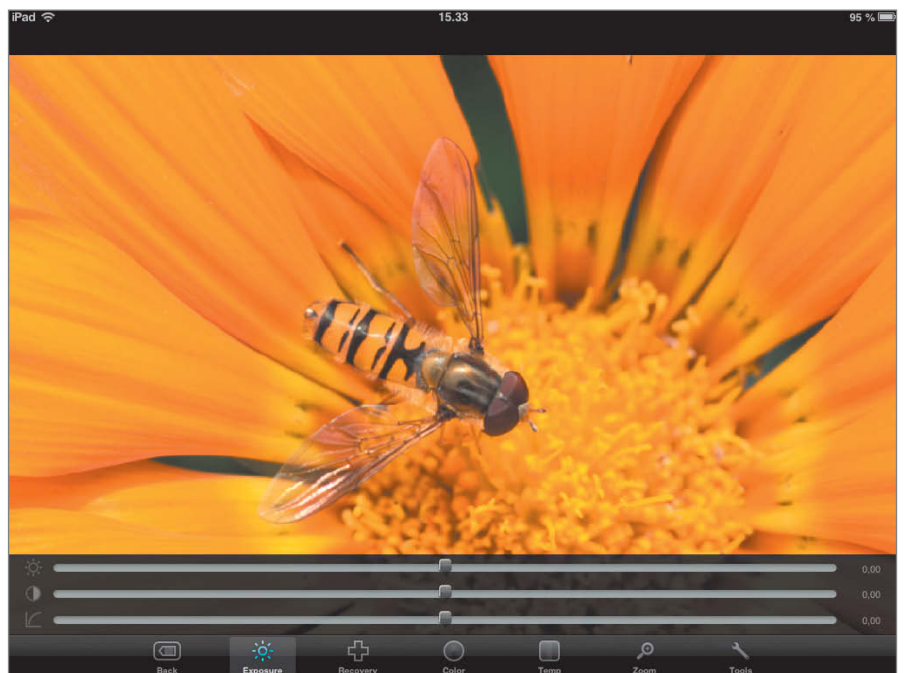
Photo Mate is by far the best mobile app currently available for managing and processing RAW files. Support for network shares, powerful filtering capabilities, a comprehensive set of RAW processing tools (including curves) and a raft of other features make it a must-have application for any photographer looking to use an Android device for working with RAW image files.

PhotoRaw (iOS)

Photographers who use iOS-based devices also have a range of third-party RAW processing apps to choose from. *PhotoRaw* is designed for fast image processing on the go but does not include any image organization or management features. The app supports a wide range of cameras, but bear in mind that you won't be able to import RAW files via the Apple Camera Connection Kit unless your camera model is supported by iOS too.

You can import RAW files into *PhotoRaw* from other apps, import images from *Photo Album*, transfer images using the file sharing functionality in iTunes or load RAW files from an Eye-Fi SD card. During import, the app automatically demosaics each RAW file, converts it to RGB and sharpens it using user-specified settings. It uses virtual memory to handle large files so there is, theoretically, no limit to the size of the RAW files you can process. In practice, importing large RAW files can take a very long time, which can be impractical. You can browse imported RAW files and view Exif metadata in the Library section, but there is no tagging, rating or labeling functionality available.

PhotoRaw offers a set of basic processing tools and the clear, simple interface offers tabs called Exposure, Recovery, Color, Temperature and Tools. Each tab reveals sliders for adjusting specific values – for example, the Exposure tab features exposure, contrast and brightness sliders, while the Color tab contains sliders for tweaking hue and saturation settings. The interface also features Zoom and Tools tabs. The Zoom tool has buttons for zooming to a number of preset levels and, although there is no conventional crop tool, the app exports the



***PhotoRaw* is a no-frills RAW editor that enables you to tweak basic settings such as exposure, hue, saturation and white balance using simple sliders**

currently visible image area (i.e., the current zoom view). In other words, to crop an image, all you have to do is zoom or pan to your desired crop and export your file. This is an interesting and intuitive approach, but doesn't allow you to crop to a specific aspect ratio.

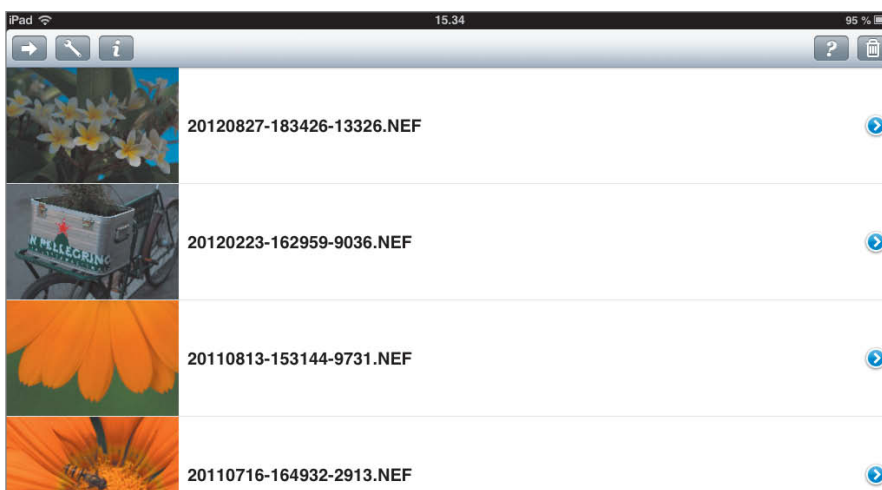
The Tools tab provides buttons for rotating images, resetting all settings and

exporting the edited file. *PhotoRaw* also allows you to transfer processed RAW files to *Photoshop* for further processing – for details, see the online user manual at sites.google.com/site/iphotoraw/user-manual/transferring-images-to-photoshop.

Conclusions

PhotoRaw is designed for performing quick basic RAW image editing within a simple and reliable user interface. It has no file management features and doesn't include advanced functions such as batch processing, denoising, renaming or develop presets, making it fine for performing quick tweaks on the go but too limited for serious RAW processing.

***PhotoRaw* doesn't support tagging or rating, but you can view Exif metadata in the Library view**



piRAWnha (iOS)

In many ways, *piRAWnha* is similar to *PhotoRaw*, although it does include some useful additional features too. It has a rudimentary album browser for locating and opening RAW files and, more importantly, is capable of assigning keywords and ratings to the current file and saving them in an XMP sidecar file.

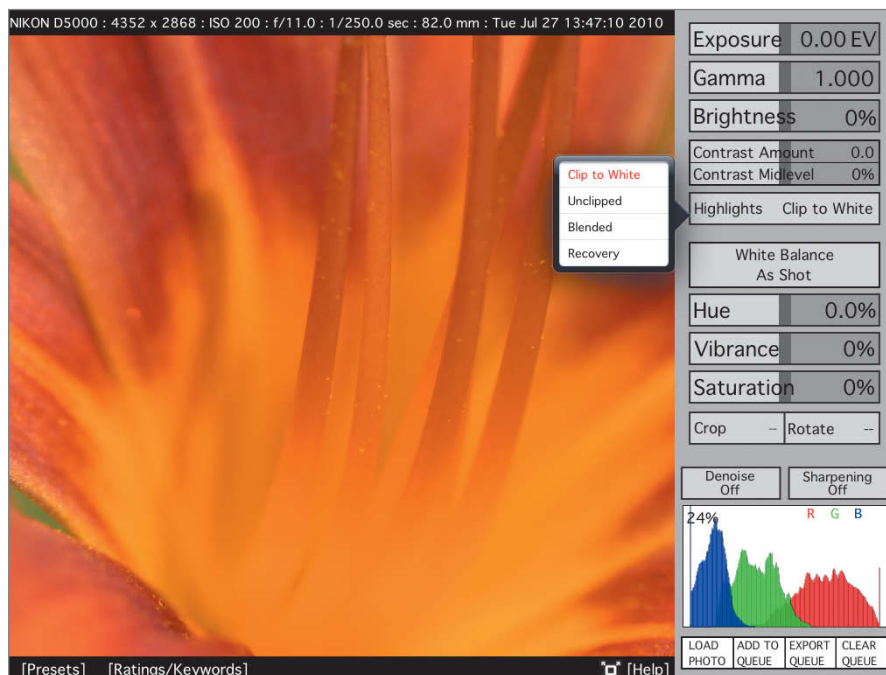
The app provides access to all its editing tools through a single window, so you don't have to switch between sections to access the various features. The editing tools are grouped in a toolbar, where you will also find sliders for tweaking basic settings such as exposure, brightness, contrast, saturation and others. The Highlights tool specifies how the app handles bright image areas using methods called Unclipped, Blended or Recovery. The latter attempts to recover lost details in overexposed areas using neutral tone overlays. The 'White Balance' button offers Automatic, Neutral and Eyedropper options and there is a dedicated crop tool that you can use to crop images to standard aspect ratios. The app's main toolbar features a histogram along with denoising

and sharpening tools. The denoising tool is not particularly sophisticated and simply lets you set its strength on a scale from 1 to 10. The sharpening feature is slightly more advanced, offering various options including Unsoften, Portrait, Low, Medium and High.

The 'Ratings/Keywords' button allows you to assign keywords and ratings to the current image, and all adjustments you make can be saved as presets using the dedicated 'Presets' button. This function is a real time-saver when you need to process multiple photos using the same set of adjustments.

Conclusions

piRAWnha offers several useful features that *PhotoRaw* lacks, including tagging and rating, denoising, highlight handling and presets. Of the two, *piRAWnha* is probably the better option for iOS users, although its toolset is still fairly limited compared to those on offer in some of the Android apps out there. (sea)



piRAWnha, too, focuses solely on RAW editing but has a more comprehensive toolset than *PhotoRaw*



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Sascha Steinhoff

Keeping it Quiet

The art of noise-free photography

Although photography is a purely visual medium, the devices used to capture photos produce a variety of sounds. A reflex mirror falling back into place after an exposure or spring-loaded aperture blades and mechanical shutters scything through the light path are often sufficiently loud to scare off sensitive subjects. This article investigates the sources of camera noise and explores how to reduce their effects to a minimum.



There is a world of difference between the construction of a simple pinhole camera and the mass of complex electromechanical components that make up modern DSLRs and mirrorless system cameras. While a box with a hole in it is capable of capturing a photo without producing noise, a modern camera can hardly be expected to do the same.

Silent Mode: Good or Bad?

Some cameras have a built-in 'silent' mode, although completely noiseless photography is not always an advantage. For example, the mute function in an iPhone not only switches off the camera sounds but also the the phone module's ring tone. Shooting silently using a small, easy-to-use camera phone is open to misuse and is frowned

upon in some societies, which is why Apple's firmware for the Japanese market doesn't allow the user to switch off the camera shutter sound. Of course, it is simple to work around this restriction using a quick hack or by installing a custom app, but it is nevertheless a deterrent. Some Android devices, too, require root access to switch off the camera sounds.

Uses for Silent Shooting

Alongside more dubious applications, there are many genuine uses for quiet cameras. For example, if you are photographing animals in the wild or you are capturing photos in a church or a theater. At classical music concerts, even a really quiet camera can be a source of irritation for performers and audience alike. Generally, a quiet camera is

more flexible than one that generates noise. Of course, it is up to you if you want to use a quiet camera to capture images of others without them knowing, and the same can be said of other specialized equipment such as a telephoto lens.

Where Loud Cameras Are Forbidden

Owners of quiet cameras are prepared for most situations, whereas a noisy camera can close many doors to you before you even begin to shoot. In the analog age, many US American courts only allowed photographers to use Leica rangefinder cameras in the courtroom. These cameras are mirrorless and have cloth focal plane shutters that were among the quietest available at the time. In spite of massive technological progress, the

myth of the 'quiet Leica' lives on. In 2009, the city of Cape May in New Jersey legislated that only cameras as quiet as a (non-specified) Leica rangefinder are authorized for use at its district council meetings. Even if this particular ruling is not completely in step with technological progress, it demonstrates clearly that not all cameras can be used in every situation.

In the course of the tests we made for this article, we found that always switching to silent mode is not a good idea, as photographers and subjects often expect audible feedback as part of the image capture process. It often causes misunderstandings if the photographer can be seen to be pressing the shutter button but the camera produces no sound.

Sound as a Purchase Criterion

Now that ever-increasing numbers of megapixels no longer boost camera sales, the noise a camera generates has become an important criterion for many photographers when it comes to acquiring a new camera. Pentax has been paying close attention to shutter noise for many years and only introduces cameras that have a soft and unobtrusive sound. Canon and Nikon, too, have been building 'quiet' shooting modes into their cameras for a number of years. Full-frame cameras have larger, noisier mirrors, but Nikon's latest model, the D810, has a newly developed shutter that is designed to be quieter than all its predecessors.

Our Test Cameras

For this article, we tested a range of DSLRs and system cameras in a variety of shooting modes. Among the models with mechanical shutters, the results ranged from serious clatter in the Canon EOS 5D Mark III to the subtle and discreet sound of the Pentax Q7. In earlier times, cameras used in noise-critical situations were often damped using air-filled 'blimps' that surrounded the entire camera/lens setup. These are large, cumbersome devices that make the camera much more difficult to operate effectively. Nowadays, technology provides the answers and, as long as you use the right camera, allows you to shoot silently without the use of clunky accessories.

Silent Movies

Virtually all cameras work silently in video mode and video footage is created from a series of individual frames that are extracted from a continuous stream of bits and bytes. Since the introduction of the 4K video standard, individual video frames have sufficient resolution for standalone printing, although the strong compression algorithms used to keep video files down to a manageable size mean they are still not as detailed as stills shot using dedicated technology. Extracting individual frames from a video file is nevertheless a useful way to capture images silently if your camera produces too much noise in stills mode.



You can extract high-resolution stills from the video footage captured using a 4K-capable camera like the Panasonic Lumix DMC-GH4

Sources of Camera Noise

Many components of a modern camera represent potential sources of noise. The following sections detail where noise is created and explain how to recognize a potentially loud camera before you make a purchase.

Generally speaking, most components of a camera are either electronic or mechanical, and all mechanical components produce a certain level of noise. Electronic components, too, can produce noise of their own under certain circumstances.

Of Cloth and Focal Planes

The mechanical focal plane shutter built into most DSLRs and high-quality system cameras is one of the most significant sources of noise in a modern camera. A focal plane shutter consists of two curtains that completely cover the sensor (or film) when closed and prevent light from reaching the capture medium. Releasing the shutter causes the front curtain to reveal the sensor before the rear curtain closes to interrupt the flow of photons. Most focal plane shutters consist of multiple blades made of a light but rigid material such as aluminum, titanium or Kevlar that give a shutter its characteristic clatter – a sound that

is extremely difficult to deaden. The sound produced by the cloth shutters built into many early Leicas and SLRs is much less obtrusive. The problem with cloth shutters is that they are comparatively heavy and cannot be used to shoot shutter speeds of faster than about 1/500 s. The photographic industry made the switch from cloth to metal-bladed shutters in the 1980s and simultaneously began the change from mechanically to more precise electronically controlled shutter mechanisms. Early shutters of this type are often incorrectly referred to as 'electronic shutters' and are in fact mechanical shutters with electronic control. Whether a shutter is electronically or mechanically controlled plays

no role in the amount of noise it produces while operating.

Between-the-lens Shutters

Between-the-lens shutters are built into the lens rather than the camera body, making it possible to completely alter the sound of a camera just by swapping out the lens. Between-the-lens shutters open and close in much the same way as an iris aperture, although an aperture allows some light through even when it is closed all the way down whereas a between-the-lens shutter is completely light tight when closed.

Between-the-lens shutters are very common in medium- and large-format cameras, although a few unusual compact system models such as the Pentax Q-series cameras also employ this technology. Between-the-lens shutters create a similar level of noise to focal plane shutters and the larger the lens, the greater the mass of the shutter blades that have to be moved during each exposure and the more noise they

produce. Between-the-lens shutters are not used in APS-C and full-frame cameras, where focal plane shutters are the technology of choice.

Electronic Shutters

In contrast to the types of shutter described above, 'real' electronic shutters are genuinely silent. However, for technical reasons they are of limited use in digital cameras. An electronic shutter works by altering the way in which the image data collected by the sensor is read out and involves no additional moving parts.

Such a shutter is an elegant (and cheap) way to make photographic exposures without the use of mechanical aids and makes it possible to shoot using exposure times as short as 1/16 000s. Another advantage of this approach is that flash synchronization works at all exposure times. On the downside, electronic shutter technology permanently exposes the sensor to incoming photons, thus exacerbating unwanted effects such as blooming and smearing that are caused by



Image: Nikon

An electronic shutter has no moving parts and functions by altering the way the signals captured by the sensor are read out. The image here shows the sensor from a Nikon D4s.

excess light hitting the photoreceptors in the sensor. Interrupting the light path mechanically is still the best way to avoid these types of issues and gives the sensor's photoreceptors adequate opportunity to discharge between shots. Most electronic shutters use the relatively clunky 'rolling shutter' technology that reads out image data line by line and often produces distortion in moving subjects. One way to work around this issue would be to use a sensor with much faster readout times, but this technology is not yet ready for mass production. In contrast, focal plane shutters produce little or no visible distortion in moving subjects.

'Global shutter' technology that reads and processes the data captured by the entire sensor in one go is being developed but is still not fast or reliable enough for general use. In short, the disadvantages of electronic shutters outweigh the advantages, and they are currently only found in smartphone cameras or cheaper, mass-market compact and system cameras in which mechanical shutters are too bulky or expensive. Most mid-market and high-quality cameras use mechanical shutters to optimize overall image quality.

Hybrid Shutters

Combining electronic and mechanical shutter technology gives us the best of both worlds and enables the camera to control the shutter in a variety of ways.

One approach involves switching in the electronic shutter whenever the mechanical shutter reaches the limits of its performance. This makes it possible to use ultra-short exposure times and extremely fast burst shooting rates, even in cheap cameras. For example, the mechanical shutter built into the Samsung NX30 can shoot at speeds of up to



At rest, the blades of a focal plane shutter completely cover the sensor (left). The shutter is only completely open during flash sync or long exposures (right).



Between-the-lens shutters are built into the lens and interrupt the light path at rest (left). Releasing the shutter opens the shutter completely, so, unlike in focal plane models, all available exposure times are suitable for flash synchronization.





Image: Nikon

Early Nikon AF lenses didn't have built-in motors and relied on a drive shaft built into the camera body for focusing. Many current Nikon cameras still have this technology built in for use with legacy lenses.

1/6000s, whereas its electronic shutter can shoot at 1/8000s and enables burst shooting at up to 30 frames per second (fps). However, because the electronic shutter cannot be used at all shutter speeds, this approach is not particularly useful when it comes to reducing camera noise.

Some cameras can use the entire range of exposure times with their electronic shutters – an approach that is useful when quiet operation takes priority over image quality. The Nikon D4s, for example, uses a purely electronic shutter in its 'SL' (Silent) live view mode. Because the mirror remains static, SL live view mode can be used to shoot truly silently, which adds a useful tool to the feature set of the otherwise fairly noisy D4s. We are not aware of any other DSLR that currently offers this feature.

Hybrid shutters that combine an electronic front shutter curtain with a mechanical rear curtain are more common. Sony and Canon use this Electronic First Curtain Shutter (EFC) technology in a number of their current models. DSLRs such as the Sony SLT-A99 and the Canon EOS 5D Mark III offer dedicated 'silent' shooting modes for use with EFC. The Canon EOS M uses an electronic first shutter curtain as standard.

Moving Mirrors, Semi-transparent Mirrors and Mirrorless Cameras

The complex optical viewfinders built into most DSLRs project the image entering the lens via a mirror and a glass pentaprism into

the viewfinder eyepiece. To free the light path to the sensor during an exposure, the camera has to physically move the mirror upward before opening the shutter. The viewfinder remains dark while the mirror is raised and only shows an image once it has returned to its initial position.

Alongside the mechanical shutter, the movements of the mirror are the most significant source of noise in most DSLRs. Most camera also have a secondary mirror located behind the main mirror that is used to aid exposure and autofocus metering. This too has to be moved before the shutter can open and contributes to the overall noise level.

The larger the sensor, the larger the mirror and the more noise it will make when it moves in and out of position. A moving mirror is also a significant hindrance to fast burst shooting rates. To combat this issue, Sony introduced the world's first DSLR with a semi-transparent mirror, the SLT-A55, in 2010 ('SLT' stands for Single Lens Translucent). In SLT cameras, the mirror remains in place at all times and allows 70 per cent of the incoming light through to the sensor while using the remaining 30 per cent for focusing. SLT cameras have an electronic viewfinder that draws its image data directly from the main sensor. These cameras produce similar levels of noise to their mirrorless system camera cousins. The newer Sony Alpha a7R has no mirror at all, and it is likely that mirrorless models will completely replace models with mirrors in the medium term. Their unusual designs mean that both the SLT and mirrorless Alpha models produce much less noise than their conventionally designed counterparts.

The Aperture Diaphragm

The aperture diaphragm regulates the amount of light reaching the sensor or film. Modern DSLRs have automatic diaphragms that remain fully open until the shutter is released, thus providing the brightest possible viewfinder image. Closing and re-opening the aperture during an exposure creates noise too, although it is much less significant than the sounds produced by the shutter and the mirror. The role played by aperture noise will depend on the lens you use and your shooting style. The more you shoot at wide apertures, the less aperture noise will effect your work.

Autofocus Noise

Autofocus mechanisms are designed to move varying numbers of glass lens elements in a split second and are seldom silent. The level



Image: Nikon

Powerful flash guns like the Nikon Speedlight SB-910 produce audible sounds while charging and discharging

of noise focusing produces depends a lot on the specific camera and lens you use. The autofocus motors in early Nikon AF-capable SLRs were built into the camera body and were connected to the lens via a mechanical drive shaft. This design is predestined to produce a lot of noise, and the longer the lens, the larger the lens elements involved and louder the system becomes. A vintage NIKKOR 80-200mm f2.8 produces a noise that is roughly equivalent to that of an electric pepper mill. Because focusing involves moving parts, it can never be completely silent. Autofocus motors built into the lens itself are generally much quieter, and modern ultrasonic motors focus even large lenses extremely quietly. Canon was the first major manufacturer to introduce ultrasonic focus motors, but all the other majors have since followed suit. However, there are still many early Nikon and Pentax lenses in circulation based on older, shaft-driven AF systems.

High-quality lenses with built-in AF motors are usually quiet enough to use in most situations, although the sound levels involved vary according to the specific combination of camera and lens in use. If your camera has appropriate functionality, you can always switch autofocus off and focus manually in critical situations.

Image Stabilizers

Optical image stabilizers are now a standard feature in most mid-range and high-end cameras. Stabilizers enable you to shoot using longer exposure times than normal and to shoot shake-free in low light. Image stabilizers are extremely practical in indoor situations in churches or concert halls, for example, but also produce noise of their own. One of the

two major types of stabilizer is the in-lens type popularized by Canon's IS (Image Stabilizer) system. This system uses moving elements within the lens to compensate for unwanted camera movements and can also be found in Nikon's VR (Vibration Reduction), Sigma's OS (Optical Stabilizer) and Panasonic's OIS (Optical Image Stabilizer) systems. These produce comparatively little noise, although you can often hear a slight hum if hold your ear close to the lens while it is doing its thing. Some lenses, such as the Canon EF-S 55-250mm f/4-5.6 IS, are known for their loud stabilizing mechanisms, although Canon has changed things for the better in the later EF-S 55-250mm f/4-5.6 IS STM model, in which the AF motor and the stabilizer are much quieter than those used in the predecessor model.

The other type of stabilizer in broad use is the in-camera type developed by Konica-Minolta that compensates for unwanted camera movements by moving the image sensor. The advantage of this approach is that it doesn't require specially-designed lenses. Sony has now taken over Konica-Minolta and markets the system under the SteadyShot Inside (SSI) and Super SteadyShot (SSS) labels. The Olympus Image Stabilization (IS), Pentax Shake Reduction (SR) and Ricoh Vibration Correction systems are all based on similar technology. Like in-lens stabilizers, in-camera stabilizers usually produce negligible amounts of noise. There are, of course, exceptions and, following its introduction in 2012, the Olympus OMD EM-5 received a fair amount of negative feedback due to the clearly audible hum produced by its 5-way stabilizer. Olympus reacted quickly to criticism and soon introduced a firmware update that largely eliminated the issue. The Olympus system can also be set up to switch in only when the shutter is released, making stabilizer noise a non-issue if you are prepared to do without a perfectly stable live view monitor image. Some Canon telephoto zooms have a similar function that is designed primarily to preserve battery power. Once again, the equipment you use and the situation at hand will determine whether the noise levels your gear produces are acceptable or not.

Film Transport and Rewind

These are significant sources of noise in analog cameras. Because there is no film involved, digital cameras are generally quieter than their analog counterparts. If you want to shoot quietly using film, make sure that you use a camera without motorized film transport. Built-in or add-on winders and

motor drives produce significant noise, and things get worse if your camera is one that automatically rewinds the film following the last exposure on the roll. Rewinding is loud and takes a comparatively long time to complete. If you are unlucky enough to shoot the last frame of a roll just as the bride and groom say "I do", the resulting noise might just ruin the entire wedding ceremony! If in doubt, always use a manual-transport camera in critical situations. This is not only quieter, but you can also decide yourself when to wind or rewind.

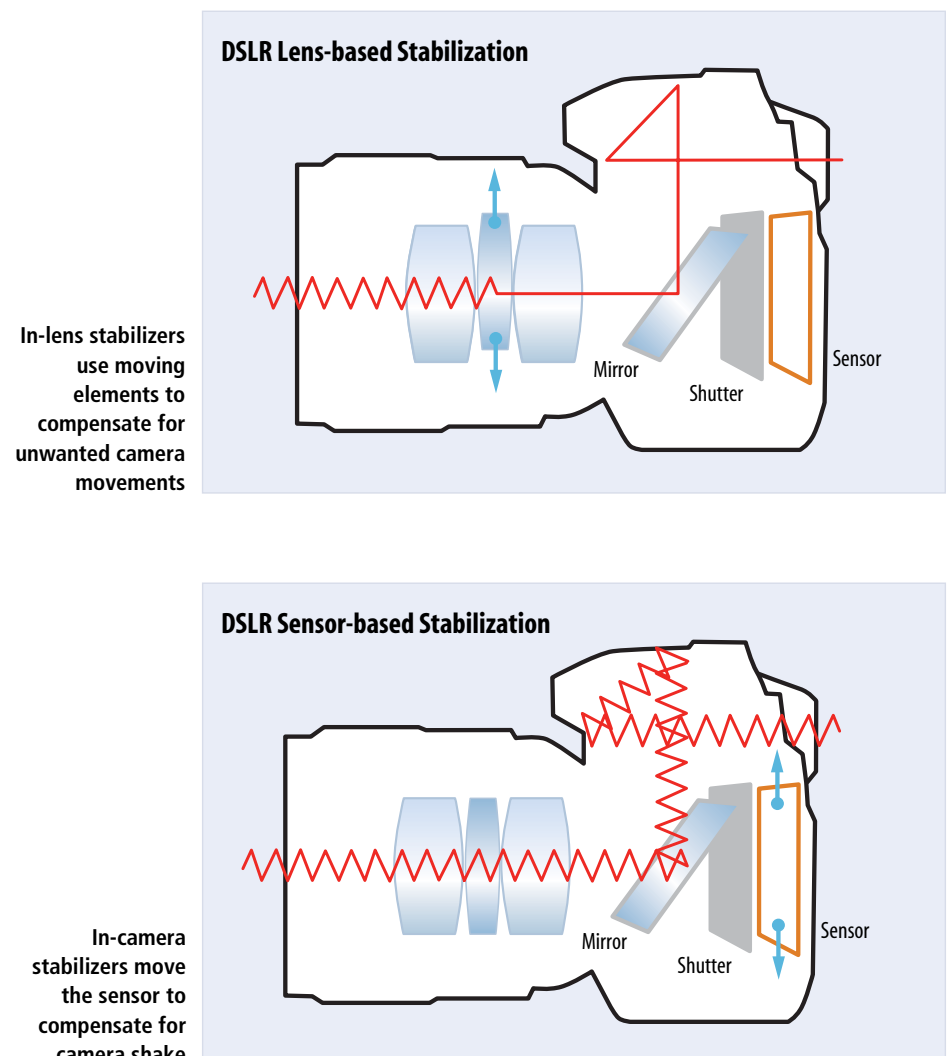
Flash

The sources of noise we have described so far all result from the movement of mechanical components. But don't be fooled, electronic components can produce noise too. A camera's circuitry and firmware is usually silent, but flash is anything but. Flash

discharge is always audible and the more powerful the flash, the louder the noise. Flash guns also produce an audible white while they recharge. Reducing flash power reduces the volume of the discharge sound and the recharge time that follows. You can compensate for reduced flash power by increasing your ISO setting, although it is usually better to shoot without flash if you can.

Conclusions

Virtually every process performed by a camera produces some form of noise, even if aperture, focus and stabilizer noise are not particularly prevalent. Most individual functions can be switched off and today's high-ISO cameras can often handle low-light situations without flash. The following pages demonstrate just how effective 'quiet' and 'silent' shooting modes can be.



All About 'Quiet' Modes

Many cameras are quite loud when used with their default settings. Dedicated 'quiet' modes can reduce noise levels, although the way cameras are built means that there are limits to how effective these can be.

Used with its factory settings, just about any mass-produced camera produces a fair amount of noise while shooting. Manufacturers combat these noise levels using dedicated 'quiet' or 'silent' shooting modes. The names of these modes vary from manufacturer to manufacturer and from camera to camera but don't be fooled by the 'silent' or 'super silent' labels – the potential for reducing camera noise by adjusting device configuration is relatively limited.

Digital cameras can generally be divided into two groups: those that have mechanical shutters and/or mirrors that produce real noise and mirrorless models with electronic shutters that produce synthetic camera noise via their loudspeakers in order to avoid confusing the photographer and the subject. Such synthetic sounds can usually be switched off via the camera's firmware. The following sections describe the various ways in which the level of sound produced by mechanical shutters can be reduced.

DSLRs in Quiet Mode

To understand how 'quiet' mode can reduce the amount of noise a camera produces, it is important to understand how the shutter release mechanism normally works. The basic process involves raising the mirror, opening and closing the shutter and lowering the mirror back into its original position. Normally, all these movements take place within a very short space of time and agglomerate to produce a single loud noise.

The most common way to reduce the level of noise is to lengthen the intervals between the individual movements so that they don't all create sound at once. This is how most DSLR quiet modes work and is an effective way to produce audibly (and measurably) less noise. Some cameras also have modes in which only the actions that are necessary to make an exposure take place when the shutter button is pressed, while the actions required to set the camera up for the next shot – such as lowering the mirror – only take place once the shutter button is released.

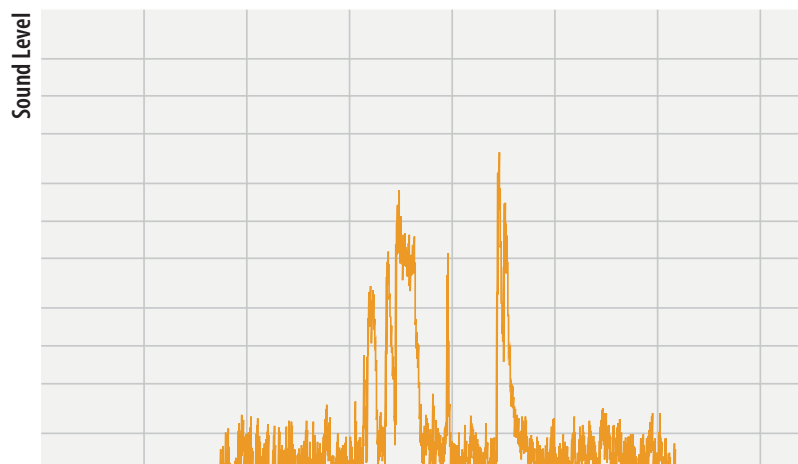
Such functionality helps you to control the amount of noise produced during an exposure and enables you to choose the moment at which the mirror is lowered. This method is, of course, only really useful for single shots and cannot be used to shoot sequences of images.

Effective Noise Reduction

The techniques described so far redistribute noise to make it less obtrusive but don't actually eliminate it. A more effective approach is to avoid producing noise in the first place. This is, of course, difficult to achieve in DSLRs that have multiple moving

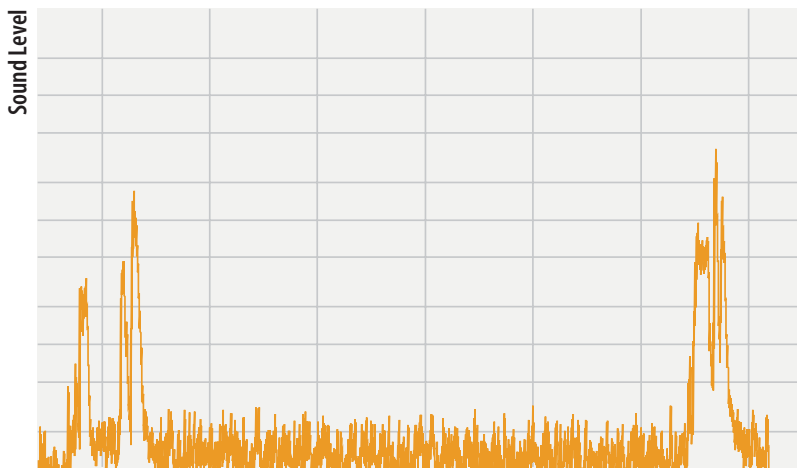
parts. One way to reduce the noise these movements make is to move the mirror more slowly or simply leave it in its raised position, as is the case in live view mode. The downside of this approach is that the real-time optical viewfinder image is no longer available. In live view mode, a DSLR works like a mirrorless system camera and can no longer use its (faster) phase-detection autofocus system and dedicated AF sensors. Instead, the camera has to make do with the slower contrast-based AF system that live view offers. Mirrorless cameras are faced with the same issues, and phase-detection AF is not usually possible in conjunction with conventional sensors. To combat this

Canon EOS 5D Mark III in Live View Mode 1



In Live View Mode 1, the pause between the movement of the mirror and the shutter opening and closing is really short

Canon EOS 5D Mark III in Live View Mode 2



In Live View Mode 2, the mirror is only lowered when you release the shutter button

limitation, Canon, Nikon, Fujifilm, Samsung and Sony have all released cameras with hybrid autofocus that combine features of both phase-detection and contrast-based systems. These cameras have built-in phase-detection sensors in the image capture sensor. This new technology hasn't yet completely superseded conventional contrast-based AF – Sony's A7, for example has hybrid AF, while the higher-resolution A7R still uses a purely contrast-based system. Phase-detection AF used to be considered the better (and usually faster) system for all cameras, although this now only really applies to DSLRs that can focus faster in normal mode than they can using live view. Among today's mirrorless models, which always work in live view mode, there are now many models available with really fast contrast-based and hybrid AF systems.

In spite of these limitations, using live view is a great way to reduce the levels of noise produced by a conventional DSLR, although the deciding factor is whether the camera controls its shutter electronically or mechanically. Live view alone is no guarantee of a quiet shoot.

Double Shutter Noise in Live View Mode

A purely mechanical shutter produces more noise in live view mode than it does in normal use. This is because it is already open during live viewing and has to be closed before opening and closing to make the exposure. To cap it all, it opens again after the exposure in order to continue live viewing. In other words, live view eliminates mirror noise but produces twice as much shutter noise instead. This also means that shutter lag increases and that the mechanical components involved wear out twice as fast. Because they eliminate the need to close the shutter before firing it, cameras with purely electronic first shutter curtain functionality are usually quieter and faster than conventional models. This approach is used in the mirrorless Canon EOS M, which functions in permanent live view mode anyway. Some DSLRs, such as the Sony SLT-A77 and A99 models offer the option of switching in an electronic front shutter curtain, although the rear curtain remains mechanical.

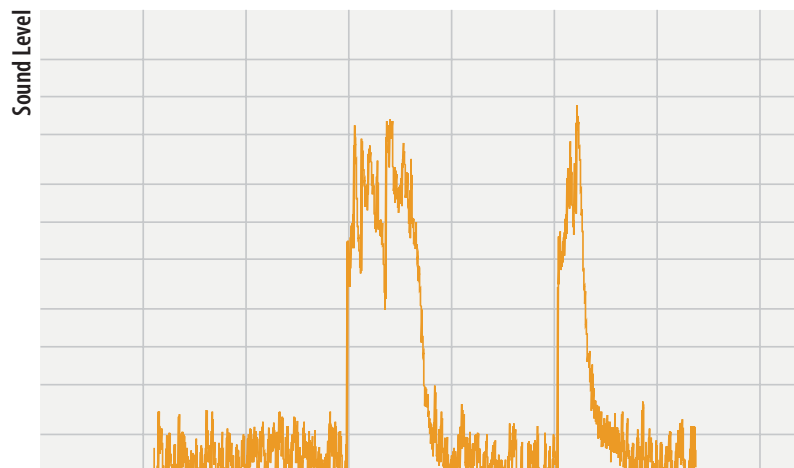
The only truly silent shutters are ones with electronic front and rear curtains like the one found in the Nikon 1 J4 entry-level system camera. DSLRs have either hybrid or purely

mechanical shutters. Technically speaking, hybrid shutters can be switched to work in purely electronic mode, although this is not a common feature. The Nikon D4s is an exception and is capable of capturing images for which the only sound is the one produced by pressing the shutter button. You still have to find the best moment to start and end live view mode, as even the best quiet mode cannot completely eliminate mirror noise. At the end of the day, using live view is a practical way to reduce camera noise, preferably in combination with one or two electronically controlled shutter curtains.

No Universal Remedy

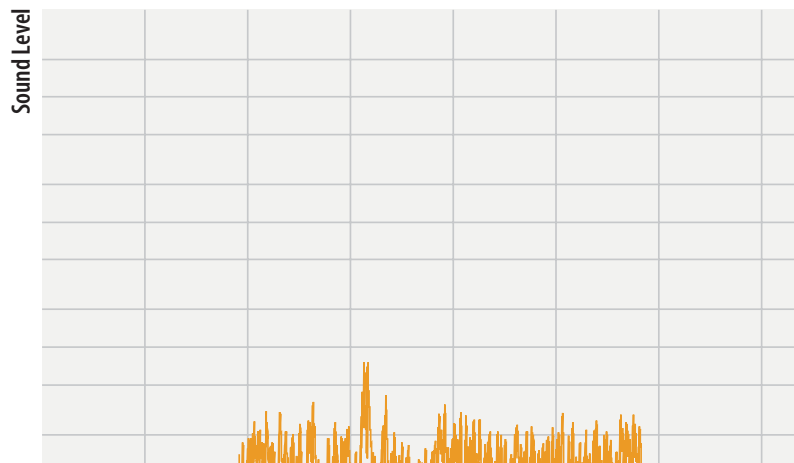
A technically refined quiet mode can certainly help to reduce overall shooting noise, but limits the camera's functionality. A mechanical shutter generally produces images of higher quality than a hybrid or purely electronic shutter. The best approach is to choose a camera that is as quiet as possible when used with its default settings – quiet mode is then a bonus that you can switch in as necessary. We tested the noise produced by a wide range of cameras in a variety of modes – read on to find out how they fared.

Nikon D4s in 'normal' live view mode



The mechanical shutter in the Nikon D4s produces significant noise in 'normal' live view mode

Nikon D4s in SL live view mode



In Silent (SL) live view mode, the D4s uses only its electronic shutter and is thus practically silent

Camera Noise Test

In theory, mirrorless system cameras always produce less noise than DSLRs, although our tests show that this is not always the case. We discovered both extremely loud and surprisingly quiet models in both categories.

The varying sound levels produced by cameras are the subject of heated discussion in many online forums. ‘Loudness’ is a term used in psychoacoustics and is highly subjective and, unlike the sound levels we measured at a constant distance, it cannot be measured objectively. Alongside the actual

level of noise, other factors such as the ‘rawness’ or ‘sharpness’ of a sound also play a role in how it is perceived. Such values can be measured but cannot be evaluated objectively.

Even the loudest of our test cameras produced peak values that are lower than that

How We Tested

We used a soundproof room and measured the sound levels produced by our test cameras at a standardized distance of 50 cm (20 inches). The results are given in units of decibels (dB(A)) and represent the loudest peak measured for each device. We switched off all additional functionality, such as autofocus, image stabilizers and warning beeps before testing in order to eliminate discrepancies caused by different lenses. We set each camera to shoot at 1/125 s and f8. Some cameras with hybrid shutters – the Samsung NX30, for example – cannot perform this exposure time electronically and only use electronic shutter functionality for burst shooting or at exposure times of 1/6000 s or less. This type of shutter is of limited use when it comes to effectively reducing camera noise.

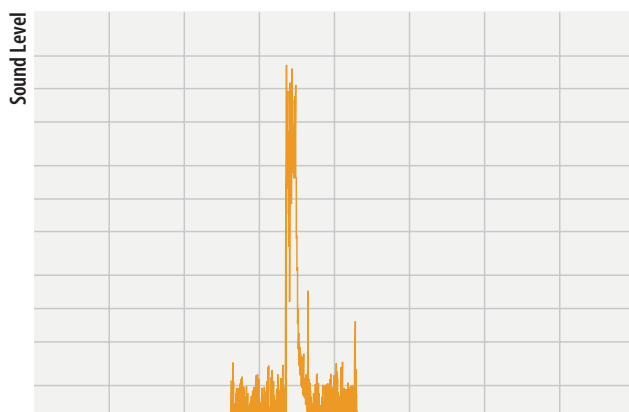
Measured and perceived sound levels can differ significantly, especially during continuous shooting. Although the actual level of noise produced in continuous mode is no higher than that of a single exposure, the noise is continuous and much more pervasive than that of a single shot, especially in fast full-frame cameras such as the Nikon D4s. Overall, peak values are more meaningful than average values when searching for a truly quiet camera.

We haven’t printed average values or results measured using the psychoacoustic ‘sone’ units that are used to describe how

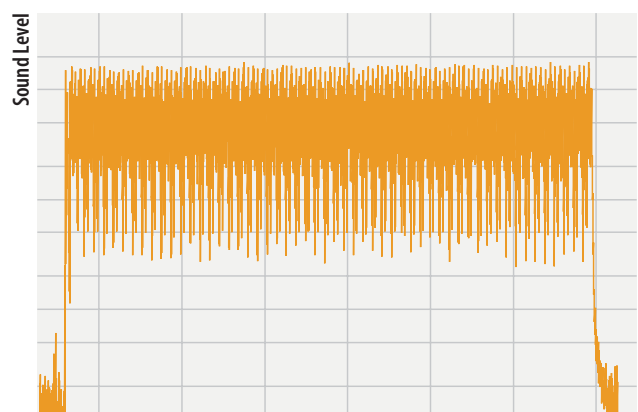
loud sound is perceived. The decibel (dB(A)) unit we use is purely technical and does not necessarily express the impression a sound makes on the listener, but can nevertheless be used to express pulse values extremely precisely. Sones are more useful for expressing the effect of averaged, continuous noise such as that produced by a lawnmower or a computer fan. For our purposes, measuring in dB(A) produced more meaningful, reproducible results. This is especially true for our measurements in quiet mode, in which there are obvious pauses between the movements of the mirror and the shutter. Even slight differences in the length of these pauses produced significant variations in the sone values we measured. Measuring peak dB(A) values proved to be more consistent and reliable.

Generally speaking, an increase of 10 dB(A) represents a doubling of the volume perceived by the listener. In reality, the sound level doubles with an increase of 6 dB(A) – a difference in values that most listeners perceive as significantly louder. In contrast, only specially trained audio technicians can perceive a difference in sound level of 3 dB(A). For this reason and due to normal deviations in measurement tolerances, we treated differences of 3 dB(A) and less as negligible.

Canon EOS-1D X, single exposure

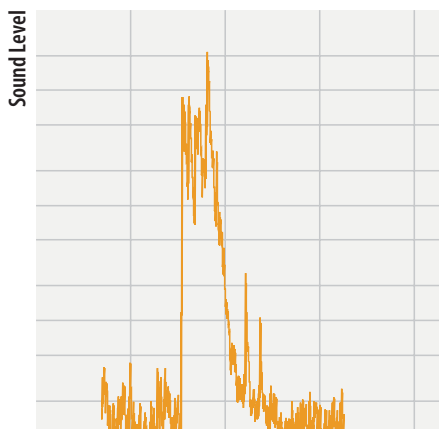


Canon EOS-1D X, continuous shooting

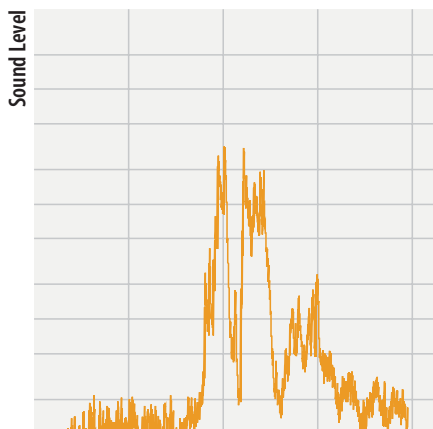


A sequence of images shot in continuous mode will appear to produce more noise, even if the actual sound level is the same as that produced by a single exposure

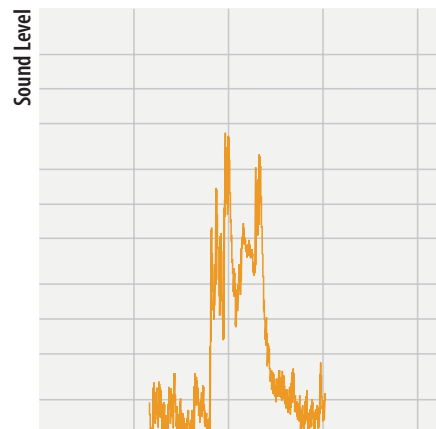
Nikon D4s, single exposure



Pentax K-3, single exposure



Olympus PEN E-P5, single exposure



In 'normal' mode, the Nikon D4s measures 68 dB(A), which is 14.4 dB(A) louder than the Pentax K-3. Although it is mirrorless, the Olympus PEN E-P5 is just as loud as the Pentax.

of a normal conversation, although the 'hard' metallic sound of the camera shutter being released in quiet surroundings is always perceived as louder than human speech.

Quality Clunks and Cheap Clatter

The variety of sounds produced by our test cameras was enormous and cannot be adequately described using peak measurements alone. To help you hear for yourself what we mean, we have included all of our test sound files on this issue's free DVD. In spite of its mechanical between-the-lens shutter system, the tiny Pentax Q produces a subtle sound like the beating of a moth's wings. The only cameras that are quieter than this are the ones with purely electronic shutters in which you can, ideally, only hear the sound made by pressing the shutter button. Most shutter buttons produce a sound that is quieter than 30 dB(A), which is negligible and can be ignored in all but the most critical situations. Although no camera is literally 'silent', the term can definitely be applied in a practical sense in many real-world photographic situations. The other end of the scale is represented by full-frame DSLRs with their large mirrors and mostly mechanical shutters.

The sounds we recorded ranged from loud, cheap-sounding clatter to well-damped high-end clunks. The pro-grade Nikon D4s and Canon EOS-1D X are the loudest of their

type, recording volumes of almost 70 dB(A). Generally, we found that the faster the burst shooting rate offered by a camera, the louder its shutter. This was especially true of the full-frame models we tested.

We also found that our subjective impressions of the noise levels our cameras produced often differed significantly from the values we recorded. This is at least partially due to the emotional aspect of the experiment – you are bound to expect a quieter and more pleasant sound from a high-end, retro-style camera like the Nikon Df than you are from a modern, plastic-bodied entry-level DSLR. How 'pleasant' a camera sound is cannot, of course, be measured empirically, although our measurements do prove unequivocally that the Nikon D610 is quieter than the Df. Similarly, the Leica M is often assumed to be quieter than it actually is, even though it is one of the loudest mirrorless models we tested.

Many Shooting Modes

Due to the wide variety of technologies employed in modern cameras, it is difficult to make a fair and objective comparison of the types and levels of noise they produce. Some cameras, like the Canon EOS M, have no quiet mode, while Canon's DSLRs have several different quiet modes to choose from. Electronic shutters are always quieter than mechanical ones but generally produce images of inferior quality. It is all too easy to

lose your way when comparing details, so it makes more sense to look at the issue of camera noise strictly from the user's point of view. We ended up measuring the noise produced by every single shooting mode we could find in each camera and used the quietest of these as our result. To keep things simple for you, we filtered the mass of data this generated and divided it into three categories.

The first is 'normal' mode, in which any camera can be used without any functional limitations. Where possible, we switched electronic shutter functionality off in favor of improved image quality and also deactivated any other 'quiet' functions.

The second value was measured using the dedicated 'quiet' modes offered by our test cameras. Because these modes limit camera functionality – either due to the use of electronic shutter technology or simply because they make the camera slower – most photographers don't use them as their default shooting mode. For this test, we didn't switch cameras with optical viewfinders to live view mode. Mirrorless cameras work in permanent live view mode anyway, and it makes no difference to the sound level a camera produces whether the image is viewed on the monitor or via a viewfinder. Our aim was to find out just how far we could reduce camera noise levels using all the configuration options offered by each model.

For our third test value, we switched on live view for all cameras with optical

viewfinders. Canon cameras have three different Live View modes that can all be combined with the various silent shooting modes. We tested all the available combinations for each camera and entered the quietest live view result in our table (see page 99). Compared to using an optical viewfinder, live view limits camera functionality but guarantees quieter operation due to the lack of mirror movement during the actual exposure.

Test Results in Normal Mode

Unsurprisingly, our mirrorless test models produced quieter results in normal mode, although we did come up with some surprises too. Pentax DSLRs produce levels of noise comparable with that of many mirrorless models in spite of their conventional mirror-based construction. Properly set up, full-frame DSLRs like the Nikon D810 and the Canon EOS 6D are quieter than many DSLRs with smaller sensors and mirrors. The increasing importance attached by manufacturers to quiet shooting is emphasized by the Nikon D810 with its completely new shutter, which produced a result of 57.5 dB(A). This puts it in the middle of our test field and compares favorably with its predecessor, the D800, which placed near the bottom with a value of 65.6 dB(A).

DSLR Beats Mirrorless

In quiet mode, our test results once again mirrored our expectations. Well set up mirrorless cameras with electronic shutters came out on top, with DSLRs and SLTs lagging behind. Interestingly, when comparing the results produced by cameras that have no dedicated quiet mode with those that do, the mirror-based Canon EOS 5D Mark III measured 48.9 dB(A) in quiet mode, compared with the Leica M's 53.4 dB(A) in normal mode. The Leica's lack of a dedicated quiet mode is an obvious disadvantage. The noise produced by the Nikon 1 V3 was reduced from 52.9 dB(A) in normal mode to a whisper-quiet 30.9 dB(A) in silent mode. Implemented effectively, dedicated silent modes can provide significant improvements in camera noise levels. Nevertheless, even the quietest DSLR cannot compete with a mirrorless camera with an electronic shutter. Noise reduction in DSLRs usually means redistributing the sounds it makes over a longer period of time, so, as long as the mirror has to be raised and the shutter opened, there will be little reduction in the overall level of noise produced.

Live View Saves the Day

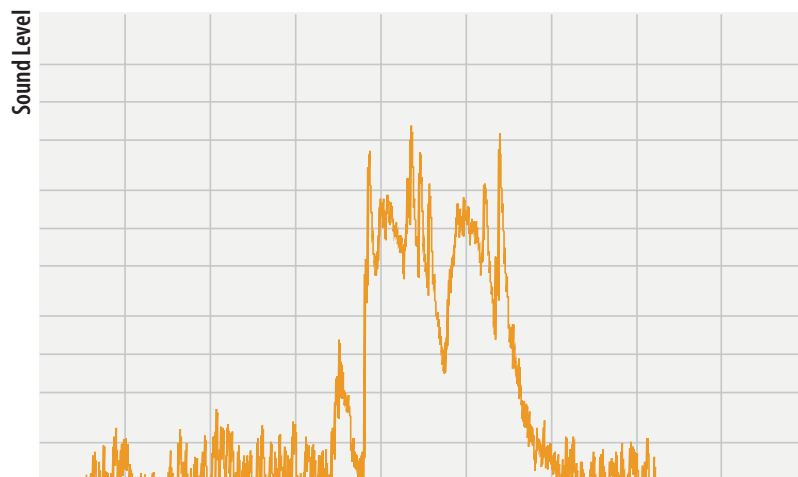
Most cameras with optical viewfinders offer live view as an option. As previously noted, it makes no difference to camera noise levels whether you use the monitor or the viewfinder to set up a shot. Well-balanced quiet functionality in live view mode can provide significant improvements, as demonstrated by Canon's EOS 5D Mark III and EOS 6D models. The differences between normal and quiet modes in most Nikon cameras are only slight, although the effectiveness of quiet mode varies from model to model and manufacturer to manufacturer. Remember that activating and deactivating live view produces noise too, and is often louder than a single shot captured in normal mode – at least on paper, so you need to consider carefully when to use live view.

Although the user manuals provide no obvious clues, Canon's quieter Live View modes appear to work in conjunction with electronic first shutter curtain functionality, which is why they produced comparatively good test results. In the D4s, Nikon has taken this approach an important step further and, in SL live view mode, delivers a truly quiet reading of 21.4 dB(A). In this mode, you really can only hear the sound of the shutter button being pressed and occasionally the movement of the aperture blades. Due to the lack of a mirror, the sound levels produced by normal and live view modes in the Leica M are identical.

Conclusions

The type of camera alone is not the deciding factor, and well-damped DSLRs like the

Sony A99, Electronic Front Curtain OFF



Sony A99, Electronic Front Curtain ON



With the Sony SLT-A99, you have the choice between electronic (left) and mechanical (right) front curtain functionality. Rear curtain operation is always mechanical in this camera.

Pentax K-3 and K-5 II are no louder than many mirrorless system cameras in everyday use. Nevertheless, if you want to shoot truly silently, even the best mechanical damping mechanisms won't help and you will have to use a camera with an electronic shutter. And even then, you have to make sure that other factors, such as the aperture blades, autofocus motors and image stabilizer don't spoil the fun. As long as electronic shutters involve compromises in image quality, photographers will continue to accept the noise their cameras produce in normal mode.

We would like to see more cameras adopting the approach taken by Nikon in the D4s, with an option for fully electronic shutter operation if the situation requires. Truly silent photography is still very much reserved for the cheaper camera segment, which is a shame.

The mechanical shutter built into the Nikon D4s can be switched off in favor of a purely electronic shutter that works silently, even in burst shooting mode

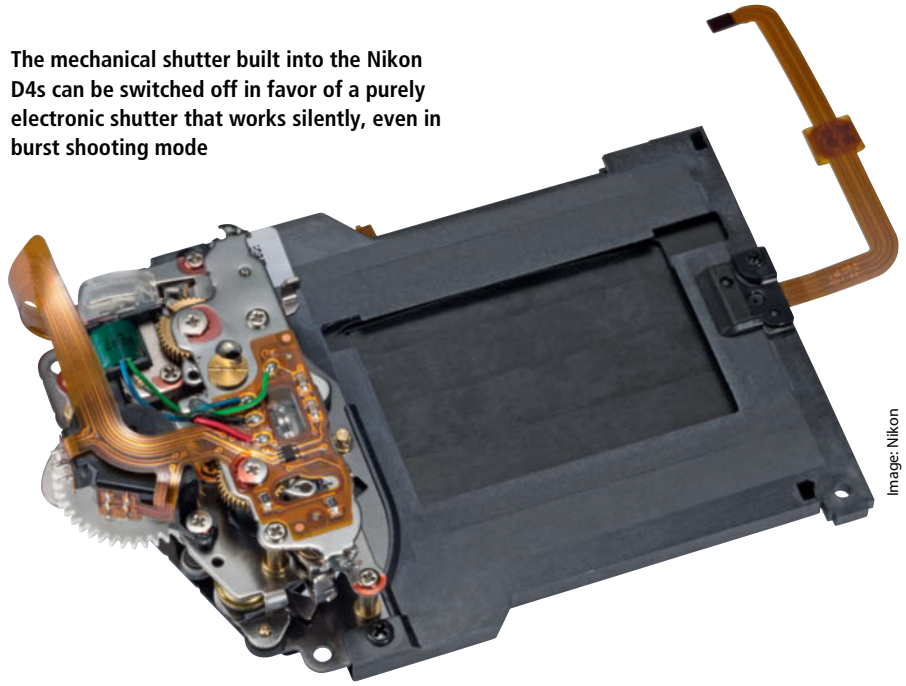


Image: Nikon

CAMERA SOUND LEVELS

Type	Model	Normal Mode	Quiet Mode	Live View
Mirrorless	Pentax Q7	38.7 dB(A)	34.4 dB(A)	–
Mirrorless	Pentax Q	43.1 dB(A)	29.7 dB(A)	–
Mirrorless	Leica T	47.1 dB(A)	–	–
Mirrorless	Olympus PEN E-P5	50.1 dB(A)	–	–
Mirrorless	Fujifilm X-E2	52.0 dB(A)	–	–
Mirrorless	Olympus OM-D E-M1	52.2 dB(A)	–	–
Mirrorless	Canon EOS M	52.3 dB(A)	–	–
DSLR	Pentax K-5 II	52.7 dB(A)	–	51.4 dB(A)
Mirrorless	Nikon 1 V3	52.9 dB(A)	30.9 dB(A)	–
Mirrorless	Leica M	53.4 dB(A)	–	54.1 dB(A)
DSLR	Pentax K-3	53.6 dB(A)	–	49.0 dB(A)
Mirrorless	Samsung NX30	54.0 dB(A)	–	–
SLT	Sony SLT-A58	54.1 dB(A)	52.2 dB(A)	–
FF DSLR	Canon EOS 6D	54.4 dB(A)	50.9 dB(A)	47.0 dB(A)
Mirrorless	Panasonic Lumix DMC-GX7	56.7 dB(A)	22.9 dB(A)	–
SLT	Sony SLT-A99	57.5 dB(A)	52.6 dB(A)	–
FF DSLR	Nikon D810	57.5 dB(A)	54.4 dB(A)	52.0 dB(A)
SLT	Sony SLT-A77 II	57.8 dB(A)	57.3 dB(A)	–
FF DSLR	Canon EOS 5D Mark III	58.3 dB(A)	48.9 dB(A)	48.1 dB(A)
FF DSLR	Canon EOS 5D	58.3 dB(A)	–	–
Mirrorless	Panasonic Lumix DMC-GH4	58.8 dB(A)	44.9 dB(A)	–
DSLR	Canon EOS 70D	59.3 dB(A)	55.1 dB(A)	50 dB(A)
FF DSLR	Nikon D610	60.1 dB(A)	58.6 dB(A)	57.7 dB(A)
Mirrorless	Sony Alpha A7	60.4 dB(A)	–	–
DSLR	Nikon D7100	61.4 dB(A)	57.2 dB(A)	58.8 dB(A)
VF-DSLR	Nikon Df	62.9 dB(A)	61.2 dB(A)	60.5 dB(A)
DSLR	Nikon D300	65.2 dB(A)	–	65.9 dB(A)
FF DSLR	Nikon D800	65.6 dB(A)	64.3 dB(A)	60.2 dB(A)
FF DSLR	Canon EOS-1D X	66.2 dB(A)	63.8 dB(A)	58.5 dB(A)
FF DSLR	Nikon D4s	68.0 dB(A)	63.2 dB(A)	21.4 dB(A)

– not available FF denotes Full-Frame

Normal Mode: All functions that reduce noise but which reduce the speed of operation or image quality were deactivated. Cameras with viewfinders were tested without switching on live view. System and synthetic shutter sounds were switched off where possible.

Quiet Mode: Tested with all available options for noise reduction switched on. Cameras with optical viewfinders were tested without live view. For the Pentax Q models, we used the quieter 5-15mm zoom lens instead of the comparatively loud 8.5mm standard lens.

Live View: Because switching to live view usually reduces camera functionality, this value was only measured for cameras with optical viewfinders. Where multiple live view modes were available, we chose the quietest.





Ralph Altmann

Color Corrections in Lab Mode

Many color corrections that are painstaking to perform in RGB mode are a lot easier to apply in Lab mode, mainly because the Lab model completely separates lightness and color data. Lab-based editing is faster and more precise than the RGB approach and makes corrections possible that the more familiar RGB mode simply does not allow. This article introduces some basic Lab techniques and explains how to use some common Lab-based editing tools. We also show you what goes on behind the scenes in the Lab process and give you some tips to help you perform your own experiments.

The Lab image mode included in *Photoshop* has led something of a wallflower existence since the introduction of Version 3 more than 20 years ago. This is quite unjustified as this mode includes tools that are often more powerful than the more conventional RGB tools found in *Photoshop* and *Lightroom*, thanks to the completely different way in which the Lab color model works (see the box on page 111), which makes comparing and manipulating colors much easier and more versatile. Lab is the reference color space for most color management systems and the paint and ink industries could not do without it, so it is surprising how few image editing programs support it.

Apart from *Photoshop*, the only other programs with Lab support that we found are *PhotoLine* and *Corel Photo-Paint*. We found it simpler to produce clean editing results once we had switched to Lab mode. For example, changes to brightness no longer influence colors and Hue/Saturation, Shadows/Highlights and Unsharp Mask adjustments all produce significantly fewer artifacts than their RGB counterparts. Mixed colors also have much smoother transitions. The downside of using Lab mode is that it offers fewer dedicated tools, and familiar tools such as Curves produce results that are much more difficult to interpret, especially when you are manipulating individual color channels. However, this is where Lab mode's strengths really come into play, enabling you to perform color and saturation adjustments that are difficult or impossible to duplicate in RGB mode.

Separating Color and Lightness Data

Working in Lab mode requires you to rethink your approach to color adjustments. Some settings are tricky to make and the Lab color space is simply not suitable for some types of adjustments. The fact that Lab separates color and lightness data makes it virtually impossible to use standard tools to make clean, selective adjustments to the brightness of individual colors. Most Lab tutorials use recoloring of entire objects or sharpening within the lightness channel to illustrate the strengths of the system. These obvious examples do not cover the entire range of options that Lab mode offers. In this article, we will show you some easy-to-learn techniques that are almost certain to be more powerful than those you usually use. Using these together with *Photoshop* Actions will give you complete control over the colors in your images and a much larger range of options than that provided by the

conventional RGB tools built into *Lightroom* and *Photoshop*.

The following pages introduce the basics of the Lab color model and the advantages and challenges involved in using it. We take a close look at the available tools and suggest workarounds for cases in which they don't provide all the necessary functionality. Starting on page 112, you will find three step-by-step tutorials that explain how to perform channel-by-channel color corrections and apply luminosity and saturation masks. To begin, we will take a look at how to use Lab mode to increase the functionality of a familiar tool whose limitations in RGB mode have probably annoyed you at some point in the past.

Altering Hue and Saturation

Because the data they encompass are distributed across three separate channels, hue and saturation adjustments applied in RGB mode always create tricky issues. The dedicated Hue/Saturation tool works particularly poorly when applied to dark or unsaturated colors, and attempts to strengthen such 'weak' colors often result in brighter colors burning out or losing consistency. The Saturation slider increases saturation proportionally, having a more marked effect on colors that are already saturated. Because this is usually the opposite of the effect we wish to achieve, *Photoshop* and *Photo-Paint* both offer a Vibrance slider designed to counteract oversaturation. Unfortunately, these sliders don't work in Lab mode. On the plus side, the Hue/Saturation tool benefits from the switch to Lab mode and only has to influence the two color channels a^* and b^* . These are highly robust and are difficult to oversaturate – a situation that is clearly illustrated by the a^* and b^* channel histograms, which usually only contain high, narrow peaks in the center and plenty of leeway for adjustment toward the right and left-hand ends of the curve. For cases in which even this is not sufficient, we will also show you how to use opacity settings to limit saturation.

Making Weak Colors More Vivid

If you wish to liven up an image plagued by weak or poorly defined colors, Lab should be your editing mode of choice. A significant increase in saturation for a particular color causes significant disruption in its complementary color (see the illustration on page 103 for an example). Lab mode can also be used to improve images with acceptable



levels of contrast, although this type of adjustment produces more subtle effects than the recoloring effects that Lab mode is famous for. Working in Lab mode often enables you to quickly produce excellent results that would require the painstaking use of additional masks in RGB mode.

The secret behind this capability is that the hue and saturation sliders directly affect the two Lab color channels, whereas they have much more complex effects when applied to the three color channels that make up the RGB color model. The effect is clearly demonstrated if we compare it with the effect produced by the Curves tool, which can be used to influence each channel separately (see page 106). Increases in saturation steepen the curves for the a^* and b^* channels, producing the same effect as increasing contrast by applying an identical alteration to the a^* and b^* curves. In this case, the curve (which remains a straight line throughout the exercise) is rotated about its center and leaves the gray tones in the center of the a^* and b^* curves unaltered.

This means that while the global or channel-based saturation sliders built into the Hue/Saturation tool can increase the strength of an existing color cast, it is impossible to create a new, unwanted one. Whites remain white and blacks black. Brightness, which is regulated by the separate L^* (lightness) channel remains constant too, as this it not influenced by the saturation slider. Lightness is regulated by the slider of the same name. We recommend leaving it alone in the (default) global mode, as adjusting it simply

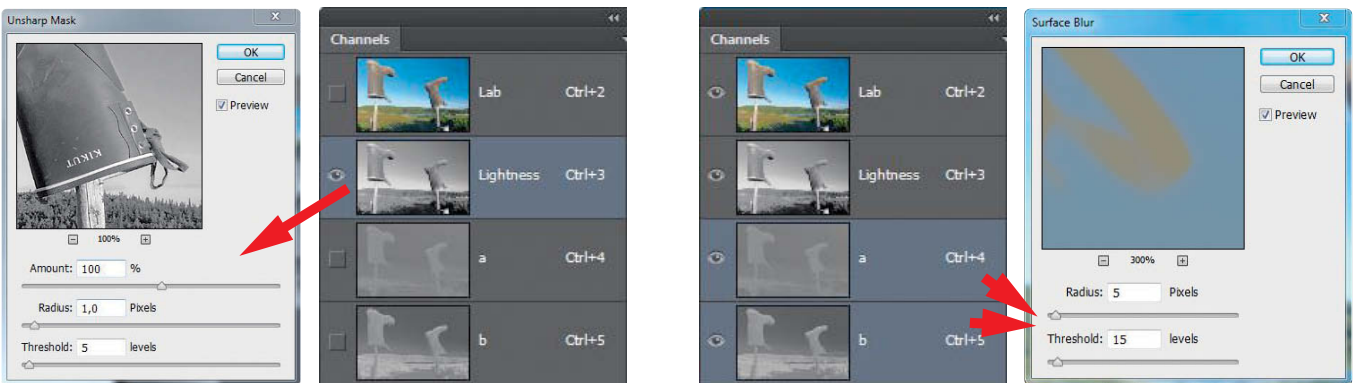
Lab mode makes it easier to tease finely differentiated colors from an image and to intensify their effects as you please



Many color editing tools are more effective if you convert your image to Lab mode before applying them. This example shows that applying the Shadows/Highlights tool (with its default settings) produces more pleasing detail and more natural-looking green tones.



Blurring the color channels is equivalent to selectively sharpening the lightness channel (below left) – an effect that also minimizes color noise (below right). Because it preserves edge detail, the *Photoshop* Surface Blur filter is more suitable than Gaussian Blur for this type of effect. Usefully, these filters can be applied to two separate channels simultaneously.

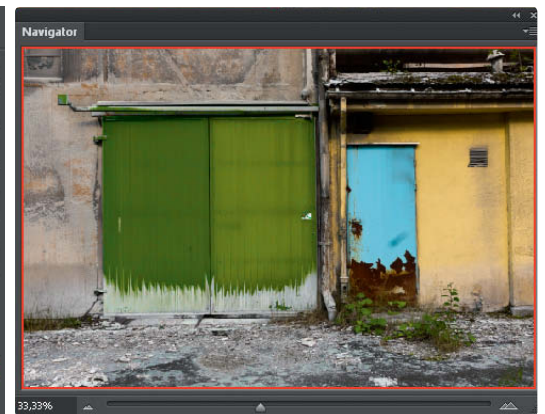
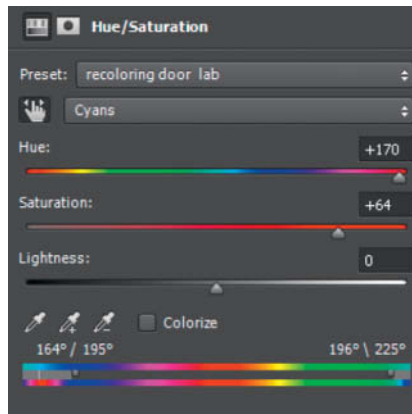


Because the original lightness is preserved, the result of increasing saturation for a selected yellow tone in Lab mode (center) is better defined and less exaggerated, but also darker than the equivalent RGB adjustment (right). Any adjustments to lightness then have to be made separately.



Recoloring the dark blue garage door in RGB mode produces a lot of unwanted artifacts and affects the color of the light blue door too. In Lab mode, both color ranges can be precisely selected using the adjustment sliders at the foot of the Hue/Saturation dialog.

The green version of the garage door on the right wasn't created deliberately, but rather by a *Photoshop* bug. The preview and navigator windows display false colors if you edit a 16-bit Lab file using a Hue/Saturation adjustment layer. The colors returned to normal once the layers had been merged.



makes an image look softer. It only really comes into play if you are working in *Photoshop's* RGB mode on a specifically selected color or color range. The tutorial on page 116 demonstrates how to use this tool in Lab mode, with a saturation mask, to brighten or darken selected colors. *PhotoLine's* Hue/Saturation dialog can be applied equally simply in RGB and Lab modes, while the *Photo-Paint* version isn't even available in Lab mode.

Editing Channels Separately

The Saturation slider adjusts saturation in proportion to the original value, which has the same effect as making the a^* and b^* curves shallower or steeper in equal amounts. In practice, this approach increases the risk of color clipping (i.e., maximizing color saturation), which produces washed-out detail that is just as irretrievable as burned out pixels. Additionally, you will often need to adjust the contrast between colors in a single

channel or using different settings for each. This can be done using the *Photoshop* Curves or *Photo-Paint* Tone Curve tools. As previously mentioned, the *Photo-Paint* Hue/Saturation tool is not available in Lab mode.

Curves tools are designed for adjusting color channels separately, although this capability causes color shifts and can only really be used in RGB mode to remove color casts. To adjust contrast or brightness in RGB mode, it is much more effective to adjust all three channels at once. The Lab color model doesn't have an equivalent 'all-channels' option, and both brightness and contrast are governed by the L^* channel. Adjustments to the L^* value have similar effects to adjustments made in RGB mode but, because even extreme adjustments have no discernible effect on hue and saturation, you can use it to create effects that are much more precisely targeted than those possible in RGB mode. The only way to achieve this degree of precision in RGB mode is either to set the blend mode of the layer (or adjustment layer)

you are editing to Luminosity and superimpose it on the original or apply the Fade command (from the Edit menu) to your effect in Luminosity mode.

The options for correcting colors in individual channels are virtually unlimited, although setting multiple anchor points on the curves in the tiny dialog window can be extremely fiddly, especially when you consider that the effect is limited to the narrow available tonal range illustrated by the small histogram displayed in the Curves dialog by *Photoshop* and *PhotoLine*. Most real-world images use less than half of the potential a^* and b^* tonal values, and a large part of the Lab color space is made up of imaginary colors that the human eye cannot actually tell apart from adjacent 'real' colors anyway. Where colors are too strongly amplified or clipped, the risk of producing imaginary colors increases (see the lower, positive yellow part of the b^* channel in the illustration on page 106 for an example). You can check whether this is the case on your

Software with Lab Capabilities

Of the Lab-capable software packages available today, *Photoshop* has built-in 8- and 16-bit Lab mode functionality, *PhotoLine* is capable of processing 8-, 16- and 32-bit Lab-mode images, but *Photo-Paint* can only process 8-bit files. 32-bit Lab files created in *PhotoLine* cannot be read or edited using any other program, and all three packages have their own particular limitations.

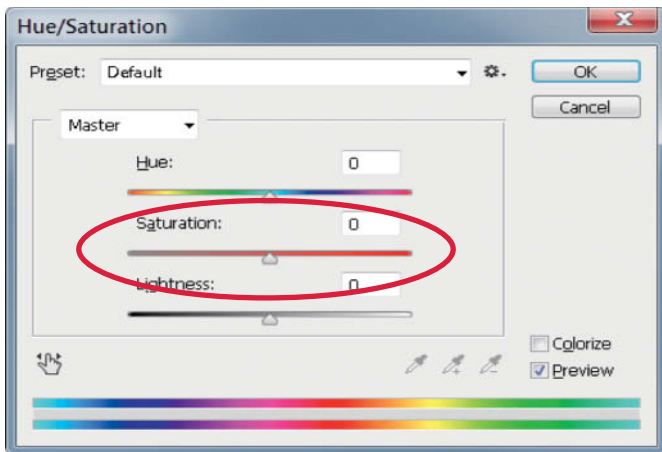
In **Photoshop**, various blend modes and important tools (Black & White, Exposure, Vibrance, Channel Mixer and others) are not available in Lab mode. The midtones slider for defining a neutral reference color and clipping warnings are missing in the Levels dialog. Most filters (including most sharpen and blur options) are available, but there are no Lens Correction options.

PhotoLine has a much more comprehensive range of Lab-mode functions than *Photoshop*. All the blend modes, the Channel Mixer and the Gray Mixer (equivalent to *Photoshop's* Black & White adjustment) are fully functional, but there are no equivalents to the Adobe Calculations and Apply Image commands. The range of Lab values is the same as that available in *Photoshop* and can be displayed in 8-bit or 32-bit float formats. We noticed that the neutral point was truly zero only for images with 8-bit color depth and shifted to 1 when they were converted to 16-bit. The color picker and the image data panel sometimes even displayed different values. Some dialogs include a white point eyedropper for making quick corrections to

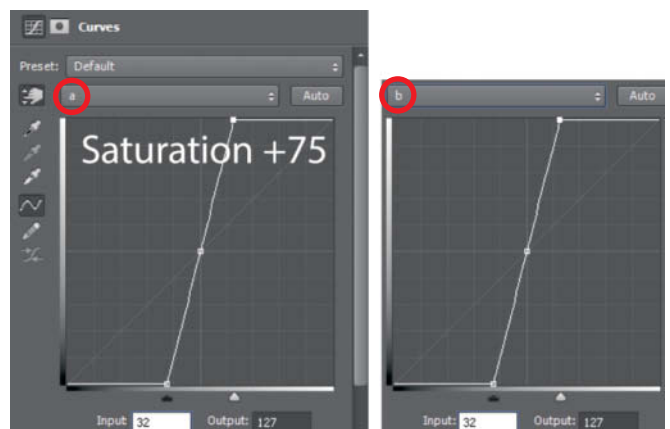
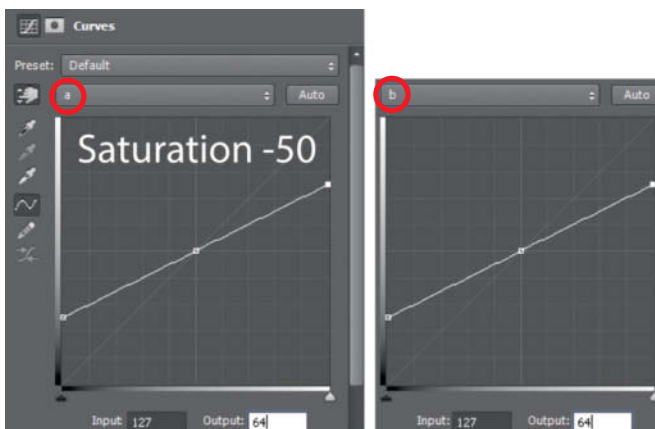
individual channels or all channels simultaneously. There is also a function that warns you when colors have extreme values. There is no gray point eyedropper.

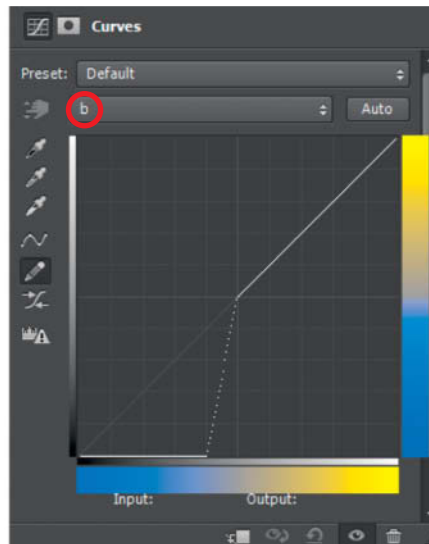
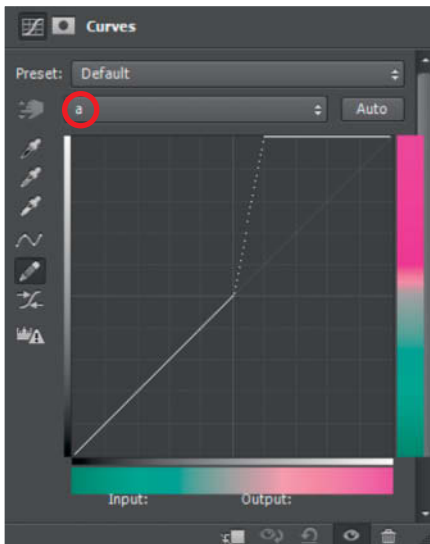
Corel **Photo-Paint** (available as part of the *CorelDraw Graphics Suite*) has the fewest Lab mode options and is of limited use in a Lab mode context due to the fact that it can only process 8-bit images. Some of the tools available in Lab mode – such as Color Balance and Brightness/Contrast/Intensity – actually work in RGB mode, thus limiting the scope of the color space they utilize. The Hue/Saturation tool is not available in Lab mode and there is no equivalent on offer. Due to the lack of a setting for a constant, the Channel Mixer cannot be used in Lab mode either. However, there is a Channel Calculations tool, although this can only be applied to the background layer. Oddly, the dialogs have differing scales of tonal values, sometimes from 0-255 and, in the case of the Contrast Enhancement tool, an extremely unusual range of -60 to +60.

Lightroom displays Lab images in TIFF or PSD format and can, optionally, display Lab tonal values (for non-Lab images too) in the histogram window. Lab-based images cannot, however, be exported or handed over to *Photoshop* in Lab mode and are automatically converted to RGB prior to further editing. In contrast, *Adobe Camera Raw* can edit Lab (TIFF) images and hand them over to *Photoshop* in their native format.



Adjusting the Saturation slider in the Hue/Saturation dialog is equivalent to rotating the a^* and b^* curves around their neutral center points. Reducing saturation makes the curve shallower (below left), while increasing it makes the curve steeper (below right). Such adjustments always adjust both color channels by exactly the same amount.





In the a* and b* channel curves, the areas to the right and left of the center point each represent a single color. In these examples, we used the Pencil tool to steepen only one half of each curve, thus increasing the saturation in the magenta and blue tones without affecting green or yellow.

monitor by selecting the monitor's native color space (or Adobe RGB) and using the Soft Proof or Gamut Warning tools. Imaginary colors will be forced back into the perceptible zone during conversion back to RGB, but overall color reproduction will be better if you make sure that your colors don't lie too far outside the RGB space in the first place. In other words, don't make the a* and b* curves steeper than is absolutely necessary.

Retaining Color Nuances

Adhering to this rule is also important when it comes to retaining the widest possible range of tones within in an image. a* and b* curves that are too steep destroy subtle nuances of color and, in extreme cases, leave only four

colors (albeit with differing lightness levels) with 'hard' transitions between them. The Saturation slider in the Hue/Saturation tool doesn't have this effect, and most tones remain intact even at extreme slider settings. On the other hand, reducing the number of tones increases contrast and can make some images look better.

The illustration at the top of the next page shows another effect that only occurs in Lab mode, namely: highly saturated highlights and shadows suddenly become colored. You cannot keep blacks black simply by reducing the lightness (L*) setting to zero, and the a*/b* values have to be close to zero too. You might be forgiven for thinking that imaginary colors that only exist within the Lab color space would be automatically corrected during

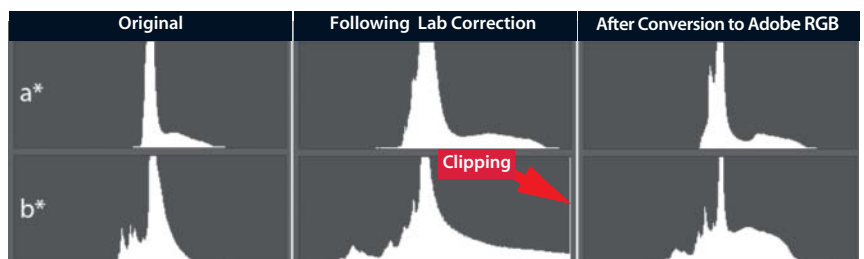
conversion to the RGB or CMYK color spaces. However, if the value in the L* channel is close to zero or 100%, all three of our test programs force the retention of black and white tones by retaining the existing color at the expense of lightness. Be sure to remove such unwanted color casts while you are still working in Lab mode, as they are virtually impossible to edit out later. Suitable methods are detailed below.

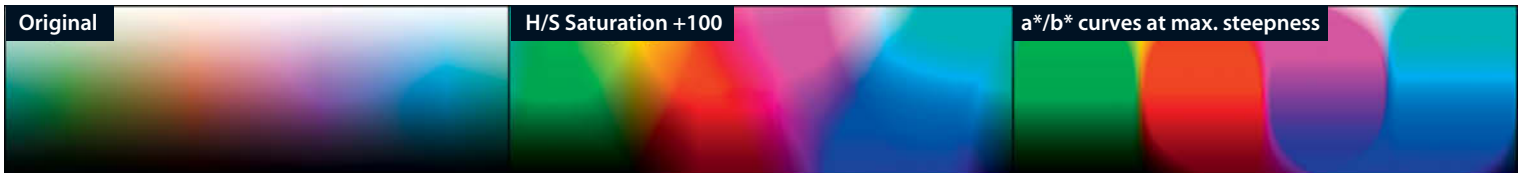
Retouching Burned-out Highlights

This strange effect can, however, be helpful when it comes to retouching burned-out highlights. All you have to do is paint over the areas concerned using an appropriate color



Following a Lab mode correction, the Gamut Warning tool (left) shows which colors lie outside the Adobe RGB color space. The histograms (below) clearly illustrate the expansion and contraction of the range of tonal values caused by converting an image to Lab mode and then back to RGB.





These illustrations demonstrate the effect on a rainbow gradient of maximizing Saturation in the Hue/Saturation dialog and the steepness of the a^* and b^* curves in the Curves dialog. The Curves treatment in particular destroys a lot of the tonal nuances between the main colors. For example, the yellow tones with medium lightness tend to red.

and the Color blend mode. Although they won't have any texture, the edited areas will nevertheless be much less obvious in the finished image. For editing techniques such as extreme sharpening that produce lots of extremely bright tones, this effect works like a kind of self-repair function. You might lose some texture, but you are sure to retain the color in the affected areas. Note that this technique only works effectively in Lab mode.

Using Opacity to Moderate Extreme Effects

The opacity slider is a great tool for reducing the strength of an effect without having to readjust your painstaking Curves settings (see the illustration at the top of page 108 for an example). Opacity settings can be applied directly to an adjustment layer but, if you have applied an effect to the main layer, you can use the Edit > Fade command to reduce its strength. Reducing opacity reduces the strength of an effect in proportion to its original strength, so the effects of highly saturated colors are reduced by a change in opacity. If you deliberately perform an exaggerated increase in saturation and counteract it by reducing opacity, the result will be a non-linear increase in saturation that is equivalent to the (theoretical) effect of adjusting the Vibrance setting in Lab mode. In other words, less highly saturated colors are strengthened and already highly saturated colors are prevented from becoming oversaturated.

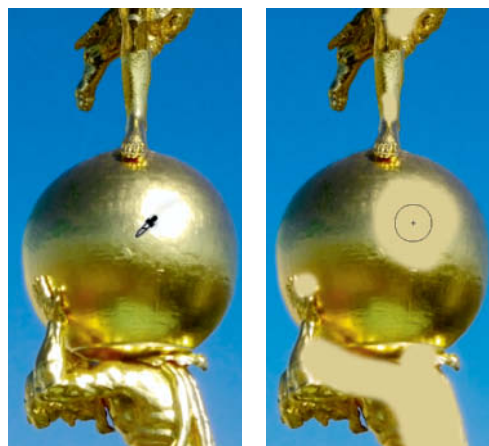
The opacity slider in the Layers panel alters opacity globally without taking the tones of the individual pixels into account. A much more powerful tool that enables you to adjust opacity according to the tones contained in each channel is hidden in the Blend If section of the Layer Style dialog (see page 109). The names given to this tool vary from program to program but the principle is always the same. The Upper 'This Layer' channel in the *Photoshop* version of the tool determines which color (or brightness) range will become transparent in the upper layer. With the image

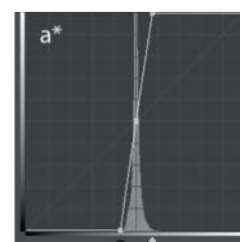
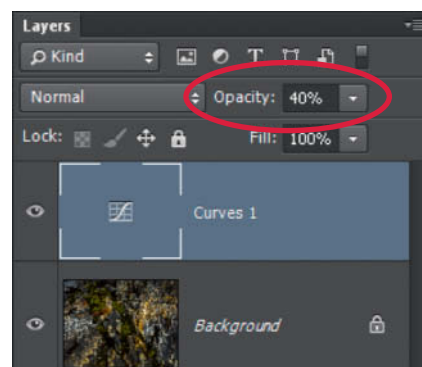
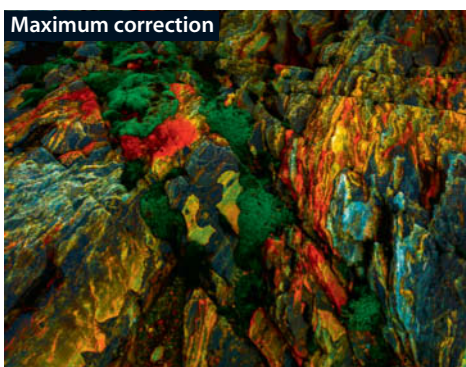
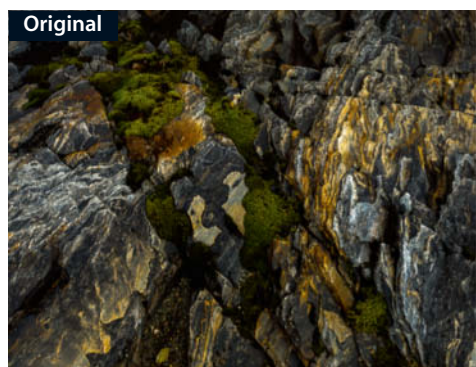
in its original state, nothing is transparent. If you shift the left-hand slider to the right, all of the pixels in the upper layer in your chosen channel that have low tonal values will become transparent (i.e., high negative values in the a^* and b^* Lab channels). Confusingly, *Photoshop* still uses 8-bit values in the Lab-based dialog, so the neutral 'zero' point actually has the value 128, while lower values stand for increasingly saturated green (a^*) and blue (b^*) tones or mixtures of the two. In effect, shifting the slider to the right masks the appropriate colors. If you press the Alt key while shifting the slider, it splits into two halves that you can then move separately. The space between the two halves becomes

a soft transition between the transparent and still-visible colors.

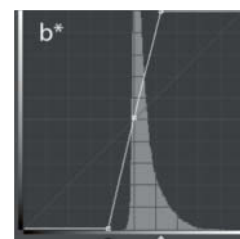
In the same manner, you can use the right-hand slider to make the highly saturated magenta and yellow tones present in the a^* and b^* channels of the upper layer transparent. Colors created by mixing green and yellow or magenta and blue can be adjusted by equivalent inverse movements of the sliders in the separate channels. For example, to make all the green and yellow tones transparent, shift the left-hand slider in the a^* channel and the right-hand slider in the b^* channel toward the center of the scale. The sliders in a single channel can 'cross over', which opens a 'window' in the less-saturated

To retouch this burned-out highlight, we sampled the gold color surrounding the affected area and used it to paint over the burned-out pixels on a separate layer. Setting the new layer to Color blending mode blended it perfectly with the existing layer. To finish up, we used a slight reduction in opacity to fine-tune the effect.





The extremely steep a^* and b^* curves produce highly saturated colors (above center) that can be modulated using the opacity setting. This effectively limits the increase in gradation of both channels, as illustrated by the response curve shown at bottom right. Lower a^* and b^* values to the left and right of the center point are affected more than higher values, thus preventing over-saturation.



areas of the upper layer. The tutorial on page 112 uses this effect to remove the weaker blue tones from selected details. In the affected areas, the unedited original shows through the edited areas of the upper layer.

The lower slider (called 'Underlying Layer' in the *Photoshop* dialog) has the opposite effect to that of the upper slider and is thus less intuitive. It masks parts of the upper layer while selectively showing parts of the lower one, regardless of the opacity of the upper layer. For example, if you select the Lightness channel and shift the lower left-hand slider toward the center of the scale, darker areas in the lower layer will shine through, regardless of their actual color. Conversely, shifting the right-hand slider toward the center emphasizes the brighter areas in the original. If your edits have produced any of the

ominous colored highlights and shadows described above, this technique is great for combating them – provided of course, that the highlight and shadow areas in the lower layer are neutrally colored in the first place.

These settings provide the criteria the software applies when creating the mask it uses to blend the two layers. If you only select some parts of the b^* channel, the upper layer will only become transparent where the criteria you have selected apply. For example, in the final image produced by our tutorial on page 112 (top right), instead of the details that we have brightened via the L^* channel, the darker original shows through for the masked blue-veiled details, which further increases the contrast in the result.

If this is not the effect you are aiming for, adjust the brightness in a separate step before

you adjust the colors – ideally on a separate layer, so that you can add a further layer for your color corrections and blending options. If, on the other hand, you only want to include certain channels from the upper layer in the blended image, uncheck the appropriate boxes in the Advanced Blending section of the *Photoshop* Layer Style dialog. None of the other options in this dialog are of any significance when editing photos.

Masking at the Click of a Button

Instead of using complex blending settings to force *Photoshop* to create its own internal processing mask, you can create your own mask using a dark-colored brush to paint in

the appropriate areas in the empty layer mask that image editing programs create with every new adjustment layer. The only proviso here is that the areas you wish to mask have simple outlines, which is often not the case in landscape images. Fortunately, the luminosity and saturation masks we need are often ready-made. They are hidden in the image itself and simply have to be brought to the fore. The L* channel in Lab mode is identical to a conventional RGB luminosity mask. Clicking on the L* channel in the Channels panel with the Ctrl key pressed loads the lightness data as a selection. If you then create a new adjustment layer or add a new layer mask to an existing layer, the layer mask will automatically be filled with the content of the luminosity mask.

Luminosity masks enable you to edit bright details separately from darker areas. However, because they tend to equalize local contrast, they are not particularly suitable for brightening over-dark shadows or increasing highlight detail. If you try to compensate for this effect by blurring the mask, halos usually result.

Increasing Saturation Selectively

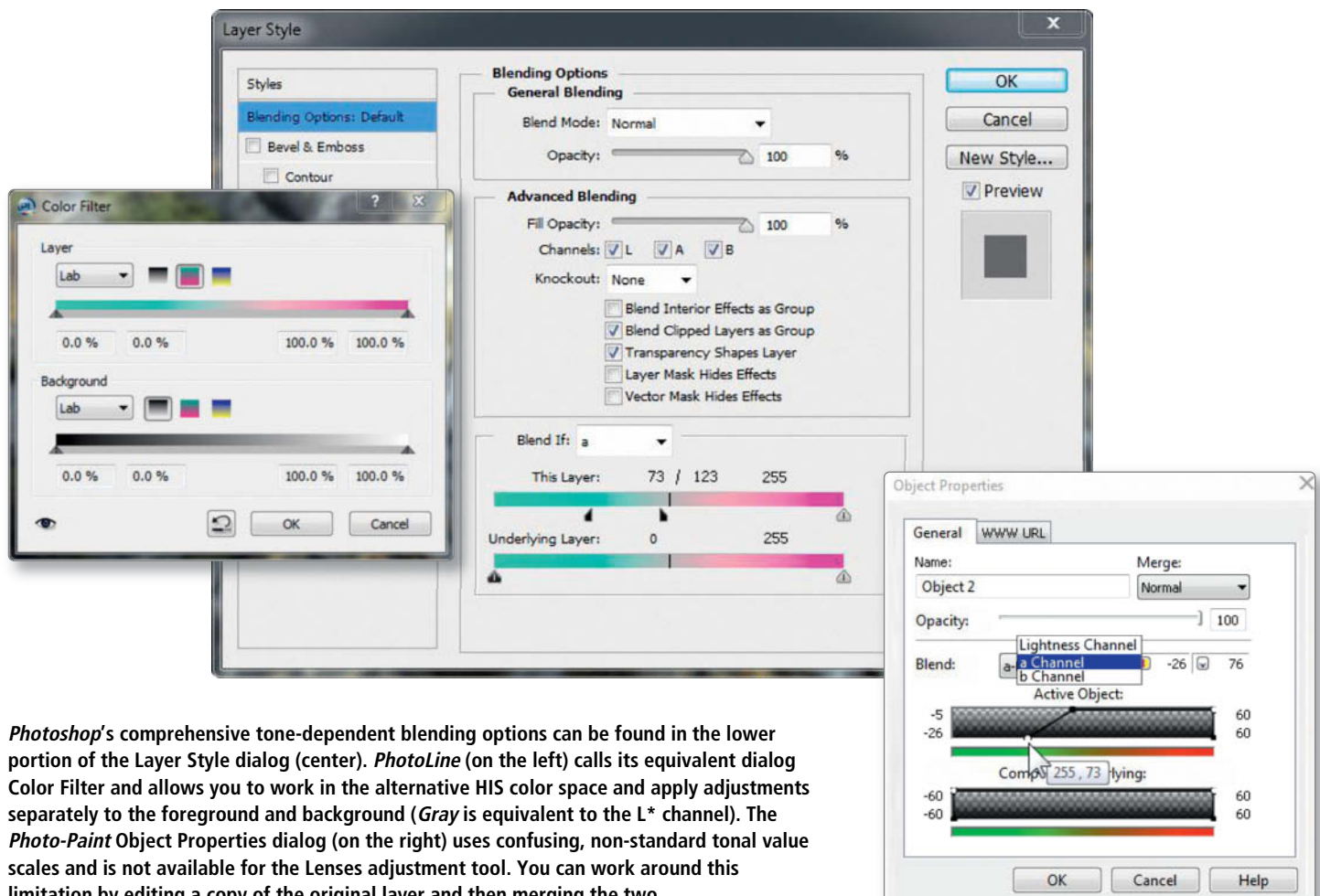
These considerations are not an issue when you adjust hue and saturation, and luminosity masks are a great tool for doing just that. Some tools – such as Color Balance – have built-in luminosity mask functionality governed by the Tone Balance options in the dialog window. The tutorial on page 116 explains how to use a luminosity mask to selectively increase saturation in dark image areas. Additionally, a luminosity mask with extremely high contrast can be used to remove just about any color cast from shadows and highlights. To do so in shadow areas, shift the right-hand slider toward the left until only the values between zero and 50 remain. Then invert the resulting mask and apply it to a Hue/Saturation adjustment layer with saturation set to zero. To remove a highlight cast, shift the left-hand slider an equivalent distance to the right and do not invert the mask before applying it.

Instead of using a luminosity mask – or the Shadows/Highlights tool with its built-in

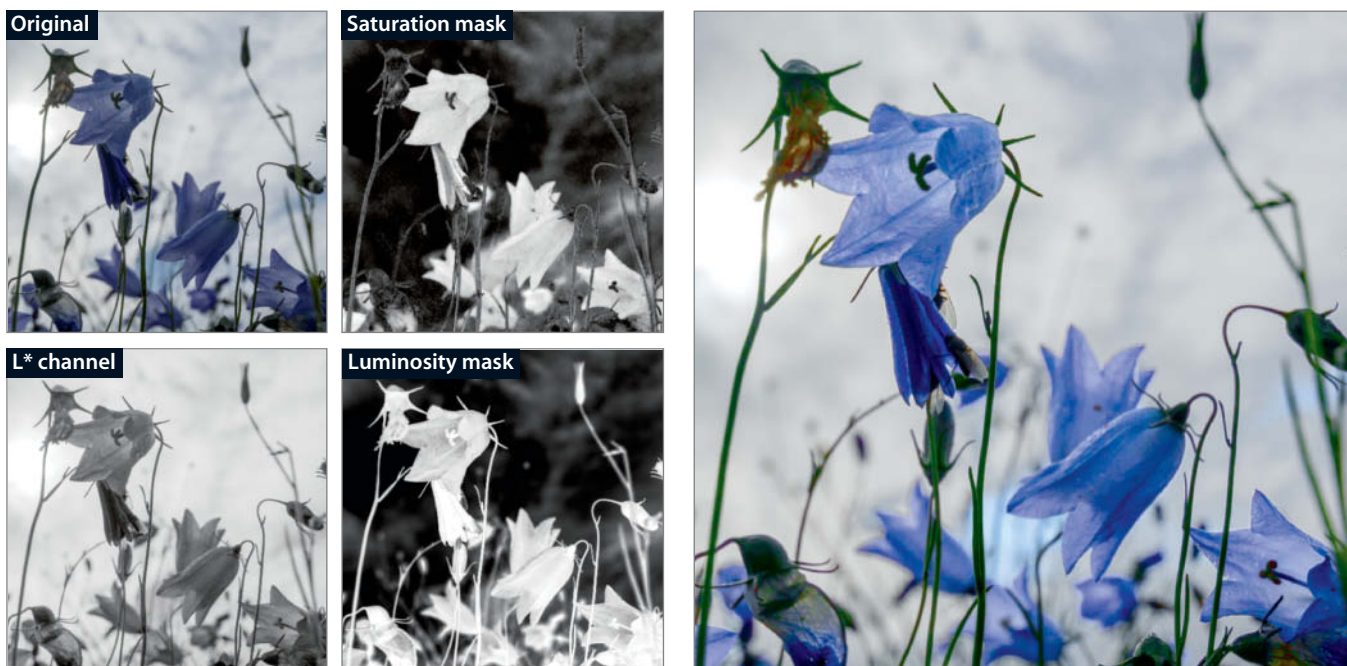
luminosity mask functionality – to brighten shadow colors, you can also try using a saturation mask to do the same job. As its name suggests, this type of mask mirrors the saturation levels of the individual pixels, regardless of their color or brightness. This enables you to treat highly saturated colors differently from less saturated ones, whether you wish to strengthen, weaken, selectively brighten or recolor them. The tutorial on page 118 uses a saturation adjustment layer to help the Hue/saturation tool adjust individual colors highly selectively.

Saturation Masks

Extracting saturation data from an image and transforming it into a mask is much more complex than performing the same task for luminosity values. Compared to the model posited by traditional color theory, *Photoshop* uses a heavily simplified method to define pixel saturation, for example in Saturation blend mode. In RGB mode, *Photoshop* considers saturation to be the difference between the highest and lowest



Photoshop's comprehensive tone-dependent blending options can be found in the lower portion of the Layer Style dialog (center). *PhotoLine* (on the left) calls its equivalent dialog Color Filter and allows you to work in the alternative HIS color space and apply adjustments separately to the foreground and background (Gray is equivalent to the L* channel). The *Photo-Paint* Object Properties dialog (on the right) uses confusing, non-standard tonal value scales and is not available for the Lenses adjustment tool. You can work around this limitation by editing a copy of the original layer and then merging the two.



A new approach to masking: we created the luminosity mask by inverting the Lightness channel and used it to increase saturation in the shadow areas. We used the saturation mask to brighten the shadows.

tonal values present in the image. In Lab mode, it takes an even simpler approach, selecting the greater of the two absolute a^* and b^* channel values. Unfortunately, *Photoshop* doesn't divulge the values it selects, while the saturation value it displays in the Info panel when you select the *HSB Color* option is a symbolic number that isn't actually applied anywhere. If you look at the HSB saturation value for any near-black tone you will find that it is often given as 100% and only switches to zero for really deep blacks.

Photoshop's Lab saturation value is much more useful and is much simpler to extract and transform into a saturation mask. The basic calculation is performed by the Image > Calculations command (a similar tool is available in *Photo-Paint* too). To simplify things further, we have included a *Photoshop* Action that covers all the necessary steps on this issue's free DVD.

In the newly created saturation mask, the lightness values are equivalent to saturation values. Black and dark gray represent neutral and less highly saturated areas, while lighter gray tones stand for 'normal' colors and white represents the highly saturated tones that probably lie outside the conventional RGB color space. When applied to an adjustment layer, the dark parts of the mask prevent your changes from affecting the layer below.

An increase in saturation therefore has less effect in areas where the colors are less saturated (i.e., where the mask is dark) and a stronger effect on areas that are more highly saturated. If you want to achieve the opposite effect (i.e., a disproportionate increase in saturation for less highly saturated colors), all you have to do is invert the mask before applying it. There are plenty of situations in which both methods are useful. An inverted mask is perfect for making soft, poorly differentiated colors more vibrant and contrasty, while soft colors are much more effective if they are placed on a neutral background – a situation in which a 'positive' (i.e., non-inverted) mask can be effectively used to strengthen the main colors in an image.

Conclusions

It is simply a myth that *Photoshop* performs its internal adjustments in Lab mode. In fact, it only uses Lab values to perform color space conversions.

Lab is a useful color model that has been largely neglected by Adobe and other manufacturers of image processing software. Many pro-level editing tricks are based on Lab and show just how much potential the system has. The downside of working in Lab mode is that it often involves complex processing

steps and there are no dedicated Lab-based tools available to make things simpler. Some of the more useful RGB tools (such as the Channel Mixer, the gray point eyedropper and various blend modes) are simply deactivated in Lab mode. It is nevertheless still worth taking the trouble to experiment with Lab mode color corrections and corrections to image brightness (see the comparison with the Shadows/Highlights tool on page 102). Don't forget to switch 8-bit images to 16-bit before converting them and only switch them back to 8-bit once you have converted them back to RGB. Even if you cannot immediately tell the difference, working with 16-bit colors gives you a useful margin for safety that you will probably only exceed if you overdo an adjustment to a detail such as a softly graded blue sky.

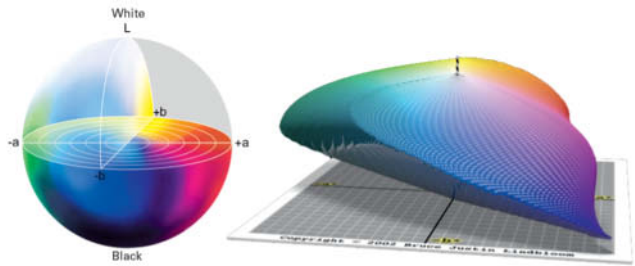
The full potential of Lab mode does not come to the fore until you begin to make adjustments to the individual color channels (see the tutorials on the following pages for more details). It is definitely worth the trouble, and the Lab-mode Curves tool is equal to just about any task you can throw at it. Lab forums describe some highly specialized tricks involving exotic blend modes or blending channels with themselves, but most of these only make the same kinds of adjustments that you make more conveniently using Curves. (pen)

Differences between the Lab and RGB Color Models

The CIE L*a*b* color model (usually referred to simply as 'Lab') defines colors using three main components or 'channels'. The three channels in the RGB model contain the primary colors red, blue and green at differing levels of brightness and mixes these to produce all other colors, including gray. In contrast, the Lab system separates the tonal and brightness components. The lightness (L*) channel determines only brightness, while the other two channels contain color information only for the four base colors green and magenta (in the a* channel) and blue and yellow (in the b* channel). The two pairs of complementary colors are represented by opposing ends of an axis and mixing them produces gray. The cooler green and blue tones have negative values, while the warmer yellow and magenta tones have positive values. The neutral white, gray and black tones lie on or near the zero point at the center of the axes. Mixing the main colors produces the secondary colors red (magenta + yellow), cyan (blue + green) and violet (magenta + blue). Mixing yellow and green produces a color very similar to that of a green lawn, due to the relatively large yellow component in the greens that occur in nature. For this color, the eyedropper tool would show negative a* values and positive b* values.

The values in the a* and b* channels can be mixed to produce all the tones contained in the color wheel and many more besides. The Lab model contains many more colors than any of the other conventional color spaces, some of which are 'imaginary'. The model defines all colors precisely and device-independently, making it perfect as a reference model when converting color data between the various RGB and CMYK color spaces. As long as you continue to work in the Lab space, you won't need to use ICC color profiles. The differences between varying color and lightness values within the lab model correspond closely to differences in color as perceived by the human eye. This is a significant advantage compared to other color models, which make it virtually impossible to predict the color that will result when a single parameter is altered.

Because all three RGB channels contain brightness and color data, it is usually possible to identify the subject of a photo by looking at any one of the three. In contrast, the L* channel is the only component of the Lab model in which the subject can be discerned, while the color channels generally look pale and

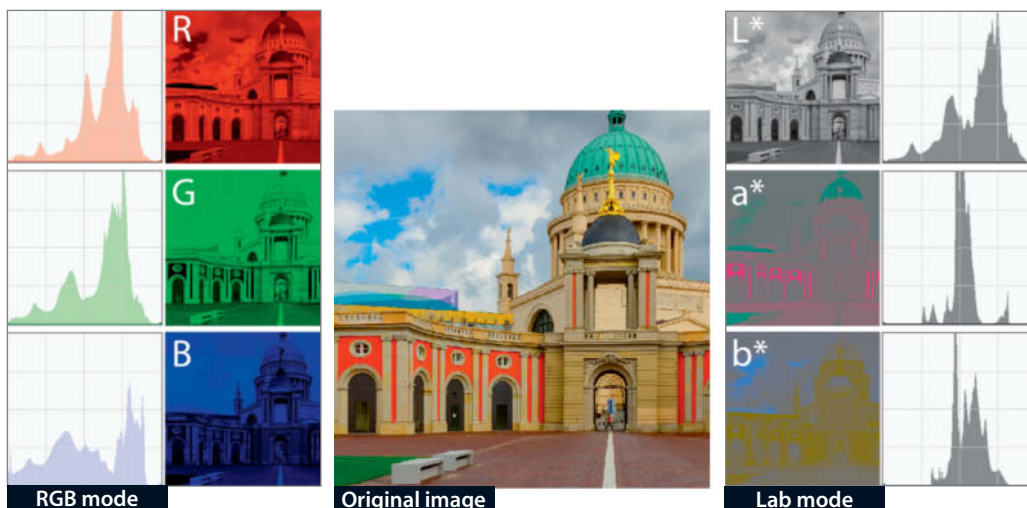


The Lab color model is often represented by a sphere (above left). Alternatively, it can be represented by a cube, similar to the RGB model, but one in which the zero points on the color axes lie in the center. Only a small proportion of the resulting coordinates represent visible (i.e., distinguishable) colors. The representation on the right is reproduced courtesy of www.bruceindgren.com.

washed-out. Medium gray represents areas with no color content, and the more color a pixel contains, the brighter (positive) or darker (negative) the gray will become. Pure black or white tones are extremely rare, as they represent colors outside the visible color space. A narrow range of values in any of the RGB channels or in the L* channel requires correction, whereas this is the norm in the a* and b* channels of the Lab model (see the histograms below). Because this represents poor utilization of the available colors, we recommend converting your images to 16-bit color depth before you edit them in Lab mode.

For *Lightroom* users, outputting 16-bit images with a ProPhoto profile will give you the best possible results, while *Adobe Camera Raw* can even export images directly into the Lab color space. Here too, we recommend that you convert your images back to RGB in 16-bit format and switch them back to 8-bit color later on if necessary.

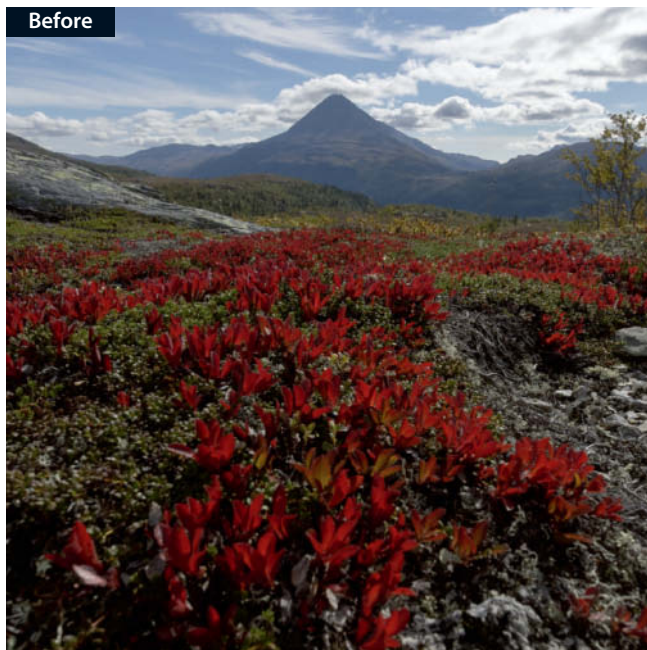
Lab values are unusual too: the L* channel is usually expressed in values from 0-100% and the color channels from -128 to +127. Zero is therefore not located precisely in the center of the axis but is nevertheless defined as 'neutral'. This is because software uses 8-bit values (i.e., 0-255), so Lab zero is represented by the 8-bit value 128.



One image, two different systems. These illustrations show the RGB and Lab-mode channels and histograms for the image in the center. These are the values that are displayed if you activate the *Show Channels in Color* option in *Photoshop's* preferences.

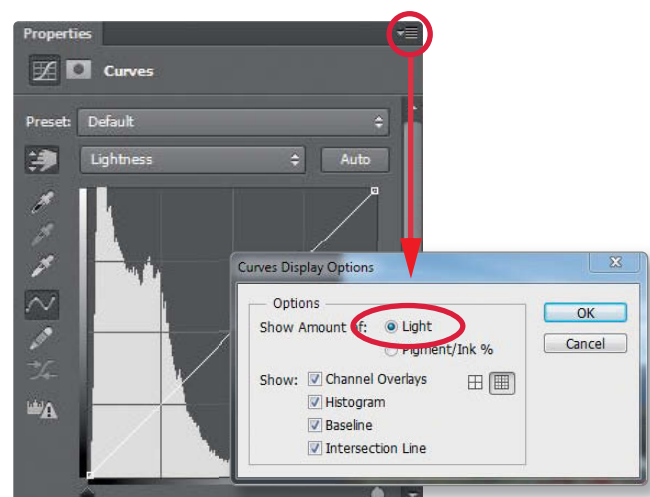
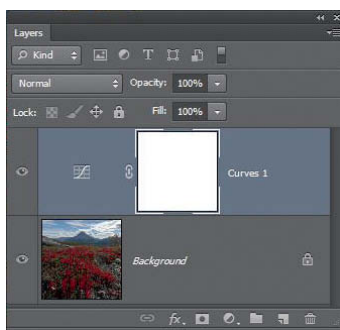
Adjusting Color and Lightness Separately

The original image of Gaustatoppen, a mountain near Rjukan in Norway, is too dark and the red of the backlit leaves, intensified by the first frosts of the year, is almost completely lost. My memory of the sky was of a much more intense blue too. This tutorial demonstrates how to correct first the lightness and then the colors, and then, where they are too intense, how to modulate these adjustments selectively using advanced blending options.

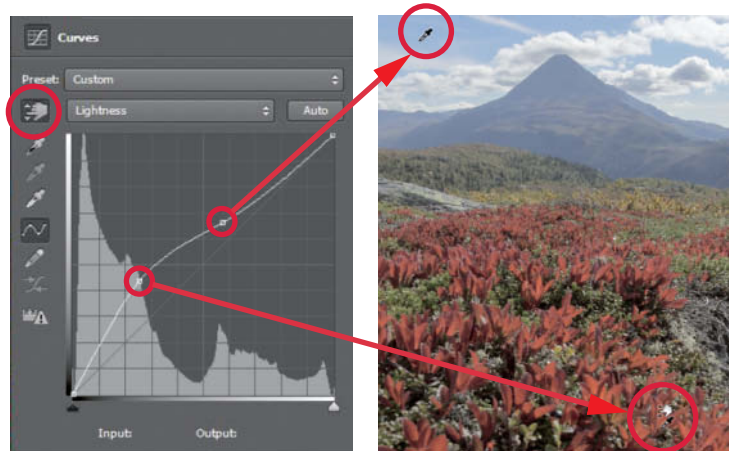


1 Create a new adjustment layer: Selecting the Layer > New Adjustment Layer > Curves command creates a new layer and automatically creates a new layer mask that we do not require for this step. The Properties panel (Window> Properties) will now display the new curve as a straight line stretching from bottom left to top right, as well as a histogram of the Lightness channel

To give yourself maximum control, open the Channels panel too. You don't have to select the Lightness channel manually because it is already selected in the Properties panel. If the gradient beneath the histogram runs from white to black instead of black to white, select the *Light* option in the Curves Display Options dialog to reverse it.

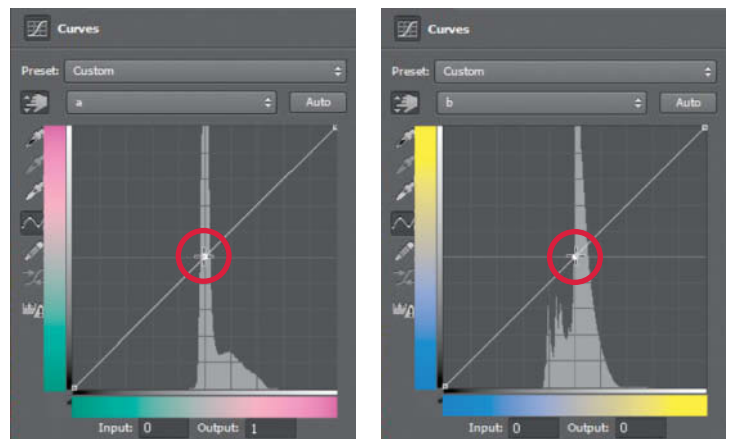


2 | Correct Lightness in the L* channel: Select the On-image Adjustment tool in the Curves dialog and use it to select the area you wish to brighten. In our case, this is the red foliage in the foreground. Drag the cursor upward with the mouse button pressed until you reach the correct brightness level. This automatically creates a new point on the curve and positions it to correspond to your adjustment. Because this adjustment brightened the sky too much, we added a corresponding opposite adjustment to darken it again. Neither *PhotoLine* nor *Photo-Paint* allows you to directly adjust the lightness curve. Instead, you have to set a point using a Ctrl-click and then drag it in a separate step. This adjustment makes midtones a little pale, but we will compensate for this later on.

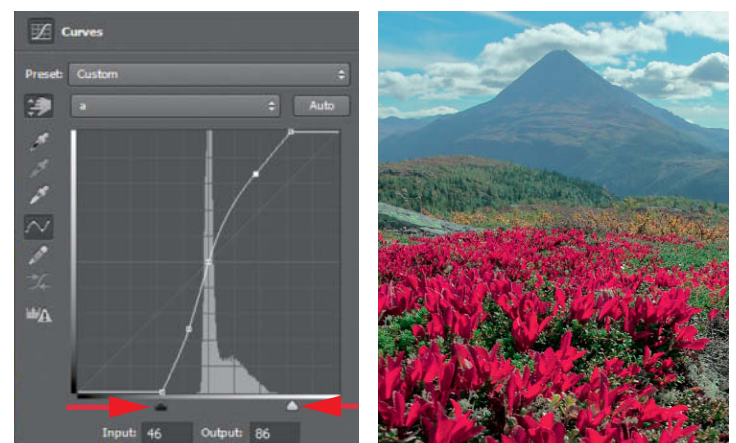


3 | Set neutral points: Switch to the a* channel in the Curves dialog. This channel governs the green and red components in the image colors. In the *Photoshop* dialog, you simply have to remember which colors lie where on the scale, but we have painted them in in the illustration to help you see what you are doing. The way we set up the Curves display options, green and blue are at the lower end of the curve, while red and yellow are at the top. To avoid creating unwanted color casts later on, we created a 'neutral' point by clicking the center of the curve. This point should lie precisely at the 0/0 coordinates, which you can enter manually if necessary.

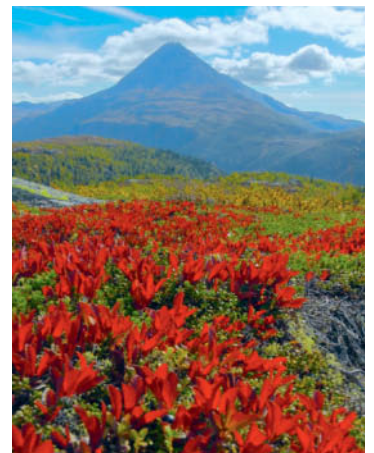
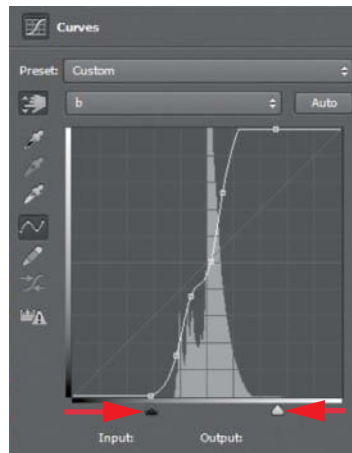
Do the same for the b* channel. You will only need to shift the center points of the a* and b* channels if you need to remove a global color cast. Using the gray point eyedropper would be a lot easier but it is not available in Lab mode. In our case, we had to click twice on the same point in the image using the On-image Adjustment tool to create points that we were then able to shift manually. If you need to remove a strong color cast, it is preferable to adjust it in advance of other corrections using the Color Balance tool.



4 | Strengthen the green and red tones: Always begin your corrections with the main color – in our case, the red tones. Switch back to the a* channel and shift the triangular sliders toward the ends of the histogram axis to increase saturation in the red and green tones. To give the red foliage an extra kick, we then clicked on it and dragged the point thus created a little higher to emphasize the effect of the color. The neutral point we set earlier protects the less saturated colors. However, dragging the 'red' point also altered the shape of the lower portion of the curve, making it steeper and thus increasing saturation in the green tones – in this case, an effect that made the image look better overall.



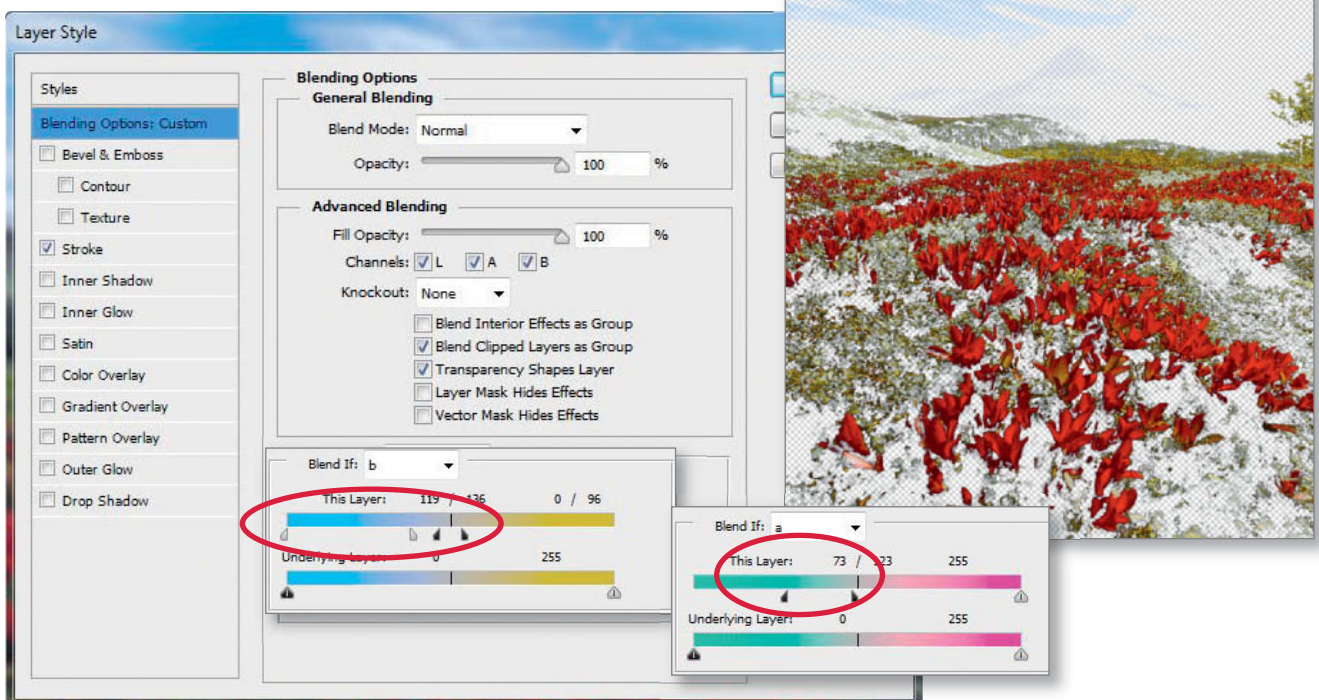
5 Intensify the blue and yellow tones: Because the a* channel affects magenta rather than red tones, the foliage has too strong a magenta component. To compensate, add some yellow by making the upper part of the b* channel curve slightly steeper. This strengthens the yellow and green components (greens in nature have a stronger yellow component than most people are aware of). Steepening the lower portion of the curve helps to strengthen the blue of the sky. To prevent the blues in the mountain from being strengthened too, we added a kink to the lower part of the b* curve. We will remove the rest of the unwanted blue cast in the next step. Make sure that you only select the main color in a channel when using the On-image Adjustment tool. In other words, only adjust green and red tones using the a* channel and blues and yellows in the b* channel. If you don't follow this rule, you will adjust less prevalent intermediate tones and create unpredictable and unwanted side-effects.



6 Mask the blue cast: Instead of trying to get rid of the unwanted blue cast, we decided to simply let the original image show through in the affected areas. Clicking on the blank part of a layer entry in the Layers panel opens the Layer Style dialog, where you will find the sliders shown in the illustration below. Select the b* channel for the Blend If option and shift the right-hand slider into the left-hand half of the scale and the left-hand slider to the center. This opens a 'window' in the less saturated blue tones of the corrected image (in our case, the adjustment layer), allowing the original image to show through.

The more highly saturated blue sky remains unaltered. Dragging the two halves of the sliders apart (with the Alt key pressed) softens the transitions between the masked and unmasked areas.

To finish up, we shifted the left-hand slider in the a* channel to attenuate the effect of the more dominant, highly saturated green tones. The adjustments we made in the previous steps now have a less exaggerated effect. The checkered areas in the illustration below show exactly where the adjustment layer is transparent, which is where the colors in the original image show through.

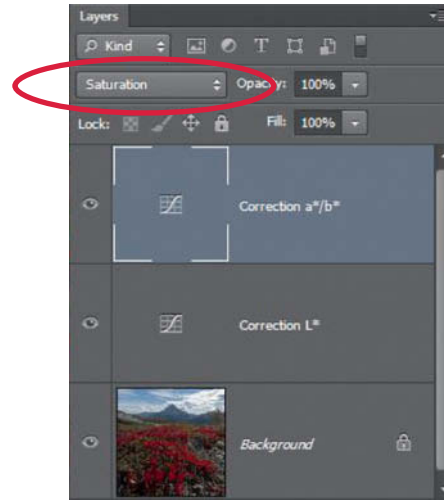


Expert Advice

How to protect specific tones: Because they alter the proportions of the a^* and b^* values of the pixels, all the adjustments that you make to the individual channels not only alter the saturation but also the tone of the colors involved. This effect was demonstrated in Step 4 above, in which the increase in saturation made the red tone cooler.

If you don't want to rely exclusively on your instincts to correct such effects, set the blend mode of your adjustment layer to Saturation. This ensures that your adjustment affects saturation only while retaining the existing lightness and tonal values on the layer beneath.

If you take this approach, you then have to correct lightness on a separate layer set to Normal blend mode. The illustration on the right shows how the Layers panel should look when making this type of adjustment.



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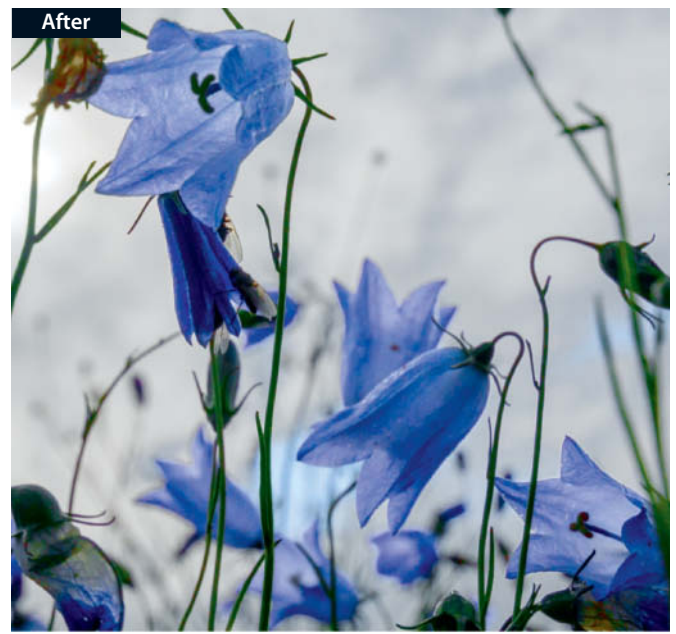
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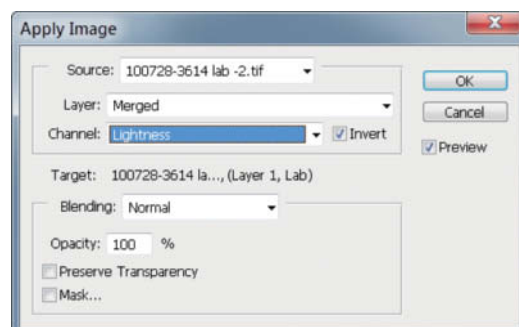
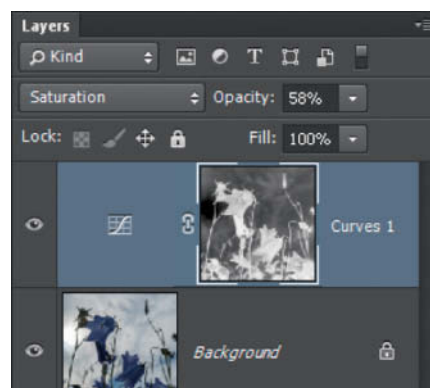
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Creating and Applying Luminosity Masks

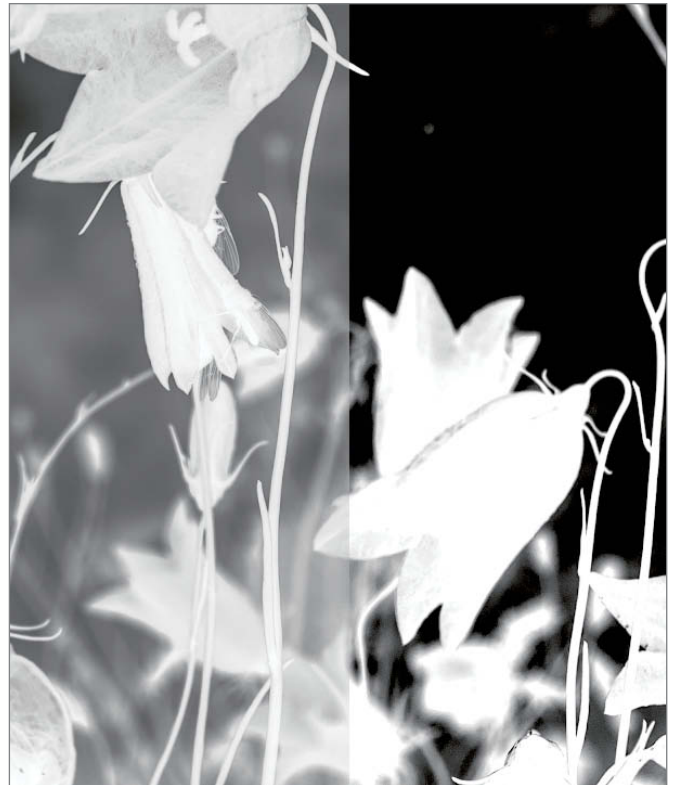
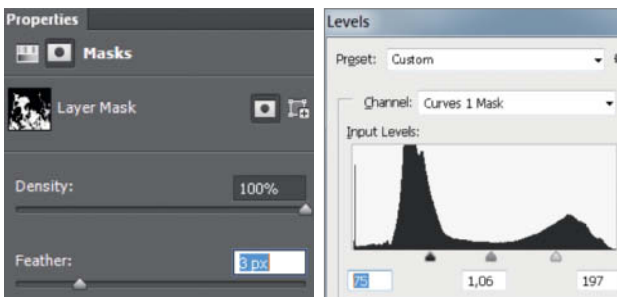
This backlit photo of a patch of bluebells is much too bleak. The shadows need to be brightened and the blue tones strengthened to produce an effect that looks like the original scene. To enhance the colors, we will use a luminosity mask created using data extracted from the L* (lightness) channel. There are various ways to do this; the following steps demonstrate how to use *Photoshop's* tools (the process is very similar in *PhotoLine* and *Photo-Paint*). To speed up your experiments, this issue's free DVD includes a *Photoshop* Action that you can apply to the layer mask of a selected adjustment layer of your own.



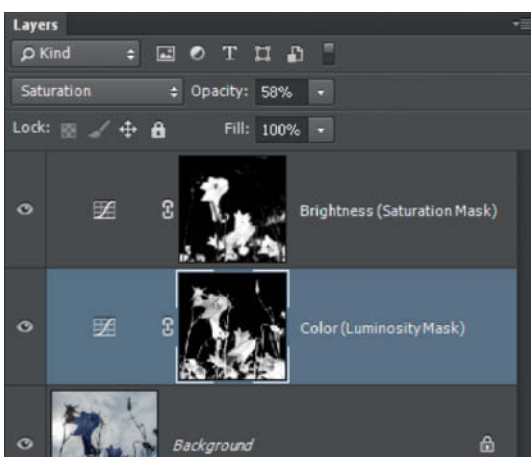
- 1 Create a luminosity mask:** Create a new Curves adjustment layer using the Layer > New Adjustment Layer > Curves command and perform your adjustments – for example, an increase in saturation like the one described on the preceding pages. For this exercise, you can start with settings that are more exaggerated than they really need to be. Select the layer mask by clicking once on its thumbnail and then open the Calculations dialog using the Image > Calculations command. Select the Lightness channel in the Source section. Now check the *Invert* option to create the mask effect we are aiming for. Select Normal blend mode. Other blend modes can be useful if you want to merge the source channel with an existing layer mask.



- 2 Adjust the luminosity mask:** To be really effective, our new mask requires much higher contrast. We usually use the Levels tool (Ctrl+L) to make this kind of adjustment. In the Levels dialog, drag the left- and right-hand sliders toward the center of the scale until the shadows are deep black and the highlights bright white. Keep an eye on the preview image – the optimum setting is when the effect is strongest in the darker areas of the image but doesn't produce any harsh transitions. If you are using a luminosity mask to correct colors alone, you won't necessarily have to add an additional feather effect, although it won't do any harm if you do. You can adjust the Feather setting in the Masks view of the Properties panel, where you can also invert the mask if you haven't already done so.

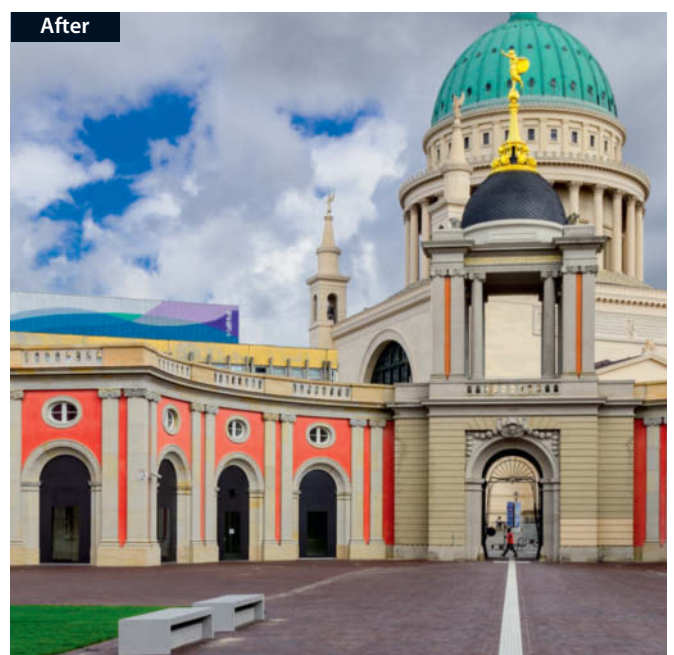
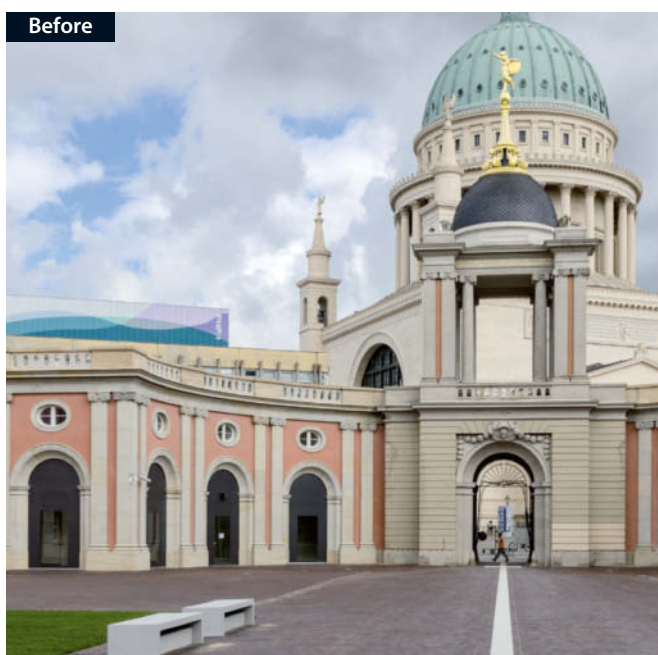


- 3 Fine-tuning:** If the effect is too weak, reduce the Density setting in the Properties panel to allow the effect to show through more in the black areas of the mask. If your effect is too strong, reduce the opacity of the adjustment layer. Both of these steps can also be performed during the final brightening of the shadows, which is easiest to perform via the L* channel in the Curves dialog. However, this often causes a loss of detail resolution and a luminosity mask is not really the right tool for the job. We prefer to use a saturation mask on a separate adjustment layer to make this type of adjustment. Read on to find out how.

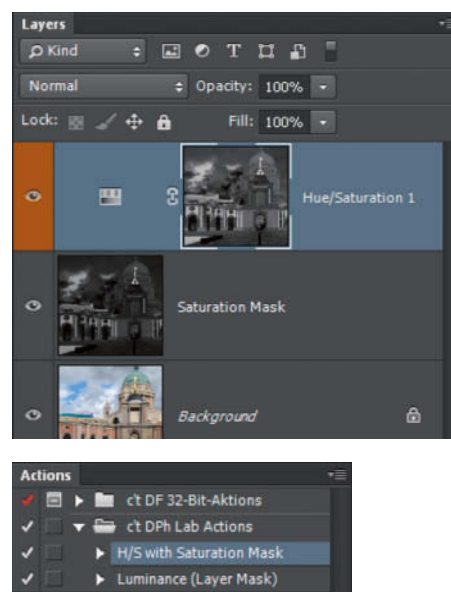


Using a Saturation Mask to Enhance Colors

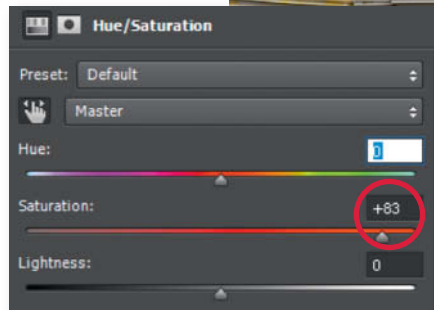
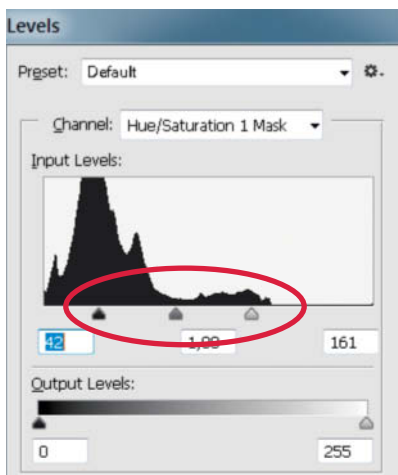
This photo of Fortuna Gate and St. Nikolai's Church in Potsdam was captured on a cloudy day with a few sunny spells. Unfortunately, we didn't manage to catch one of the sunny moments, so we decided to use Lab mode to help us pep up the dull colors instead. This time, we used the standard Hue/Saturation tool to make the main adjustment and an additional saturation mask to fine-tune the result. The tool is only of limited use in Lab mode without the use of a mask. As well as increasing saturation, we wanted to selectively brighten some of the colors – an ideal task for the Hue/Saturation tool. The original image and Actions for creating the saturation mask in *Photoshop*, *PhotoLine* and *Photo-Paint* are included on this issue's free DVD.



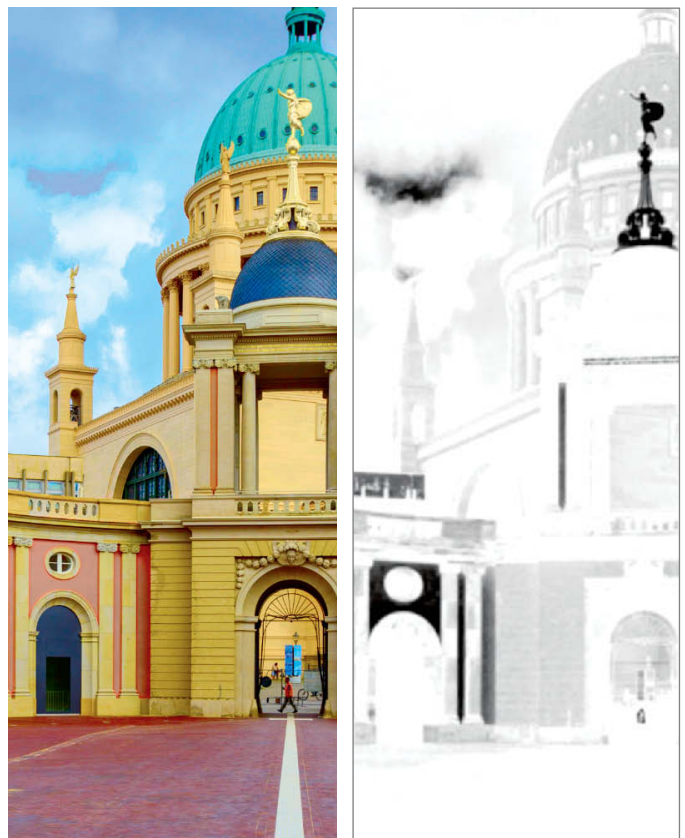
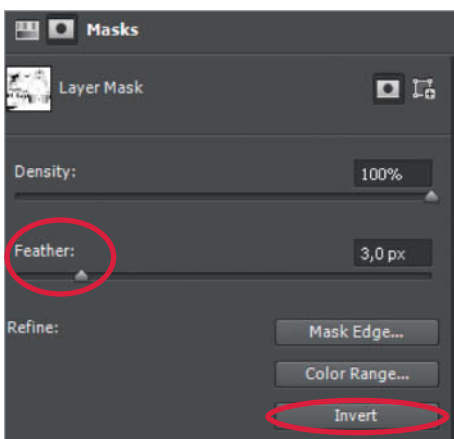
- 1 Create an adjustment layer with a saturation mask:** Run our action to create the mask. Now select the image layer in the Layers panel and restart the Action. If there is already an adjustment layer present (for example, for a previous Levels adjustment), select it. Any necessary color corrections will be automatically included in the saturation mask and corrections to lightness are discarded anyway. Our Action creates a Hue/Saturation adjustment layer and loads the saturation mask into the new layer's layer mask. The saturation mask is also inserted into a separate (hidden) layer in the form of a grayscale image. This layer can be used for further adjustments or simply deleted.



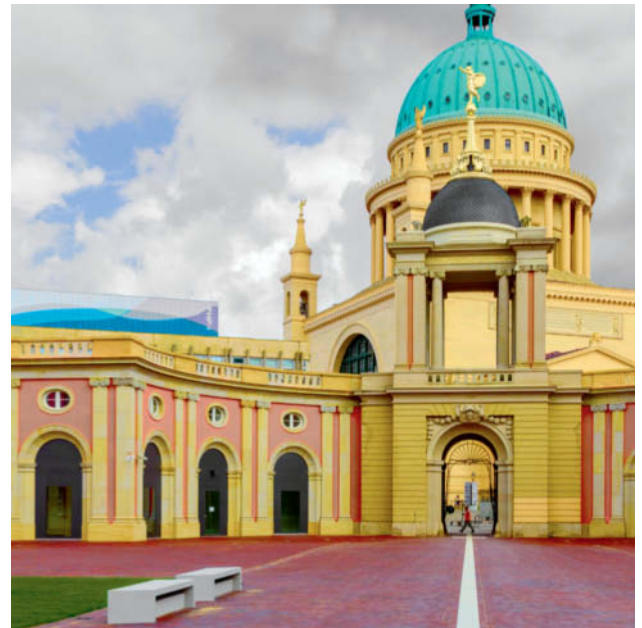
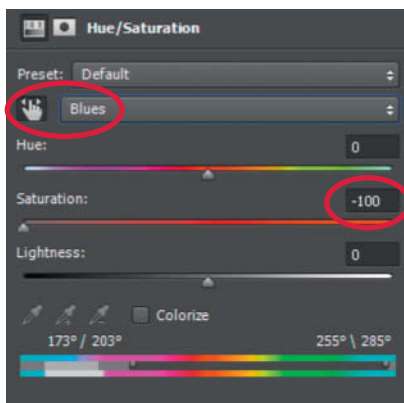
- 2 Adjust contrast in the mask:** In their original state, the dark areas of the saturation mask cover the less saturated image areas. You can make the effect more visible by significantly increasing the saturation setting in the adjustment layer. If the result is still too global, increase contrast in the mask as described in the previous tutorial – for example, using a Levels adjustment.



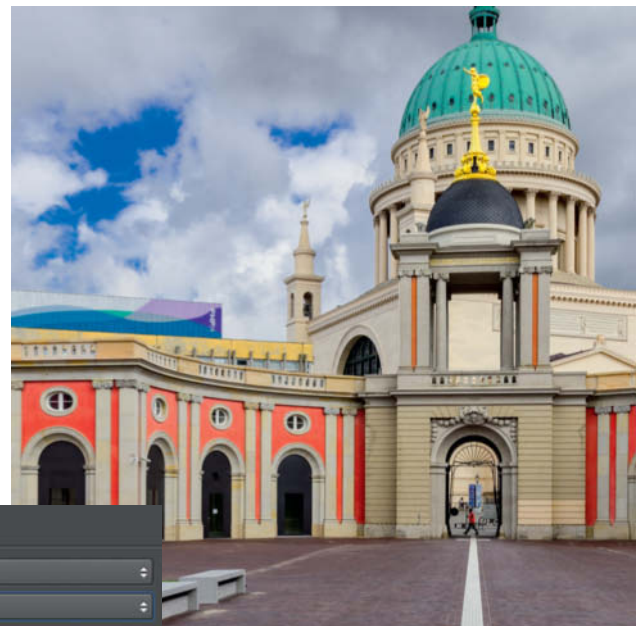
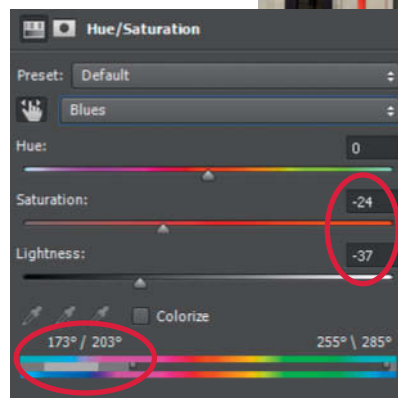
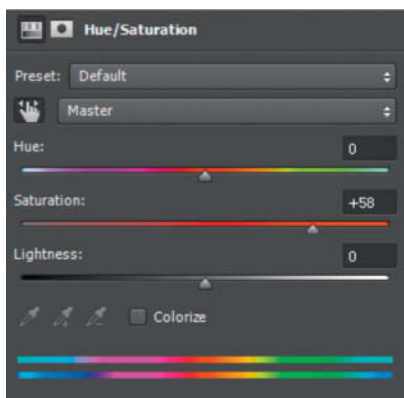
- 3 Blur and invert the mask:** Saturation masks are extracted from the a* and b* color channels, where noise artifacts are recorded. This and the fact that the color channels usually have coarser resolution makes it a good idea to add a Feather effect to the mask. If you adjust this attribute via the Properties panel, you can re-adjust it at any stage, whereas changes made using dedicated tools such as Gaussian Blur are irreversible. Clicking the 'Invert' button in the Properties dialog inverts the effect of the mask and influences the less highly saturated image areas. Using this approach makes every color cast, however slight, extremely conspicuous – in our case, the effect is especially obvious in the clouds.



- 4 Adjust saturation selectively:** This is where the individual color channels in the Hue/Saturation dialog come into play. Clicking the sky with the On-image Adjustment tool selects the Blues adjustment dialog, where you can selectively reduce saturation. As intended, the mask limits the effect of the adjustment to the neutral image areas, while the gap in the clouds and the blue façade in the background remain unaffected. Instead of increasing global saturation and then reducing it for individual colors, you can also take the inverse approach: increase saturation for individual colors and leave the global Saturation slider alone.



- 5 Give your colors real punch:** The tone-in-tone approach to color adjustment described above is not suitable for all types of images, and some require a cooler look with a clear separation of obvious colors from the less highly saturated areas. To achieve this type of effect, we return to the non-inverted mask in Step 2. So far, we have left the Lightness slider in the Hue/Saturation dialog alone, and this is still the best approach in 'global' mode. However, the slider can be used to effectively brighten or darken preselected colors. The patch of bright blue sky that shows through the clouds is an ideal detail for this kind of adjustment – especially considering that this was how we remembered the scene. Note that adjustments made using the Lightness slider in the Hue/Saturation dialog only work if made using a non-inverted saturation mask. Other approaches (in *Photoshop's* Lab mode, at least) simply produce ugly specks of color. In contrast, the results produced by the equivalent sliders in *PhotoLine* are easier to control.



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Martina Mettner

How to Make a Splash in **Fine Art Photography**

"And that's supposed to be art?" is a comment often made by visitors viewing photographs in museums and galleries around the world. The criteria used to judge the quality of photographic art are vague at best, and it is often simply an artist's name or reputation that decides the outcome in the battle for acceptance within the art establishment. Unpublished photographers who have not studied art or enjoyed the benefits of a scholarship find it almost impossible to break into the market. In this article, photography consultant Martina Mettner outlines the questions you have to ask yourself if you want to take a shot at stardom in the hazardous world of fine art photography.

Anyone who takes a lot of photos has considered the ins and outs of staging an exhibition at some point – usually spurred on by the wish to have their work accepted as art and possibly also to profit from the high prices often commanded by contemporary photographic artists. However, before you spend a lot of time and money pursuing this dream, it might help to review your motivations and take a closer look at how the market for fine art photography works.

How We Perceive Images

What are our expectations when we look at photographs? Often we simply feel strongly about an image or accept it as a genuine ‘work of art’. However, if you were to ask everyone you know to list the photographs that mean the most to them, you almost certainly wouldn’t end up with a list of famous images by well-known photographers, but rather a mixed bag of personal **memories** or **souvenirs**. The first thing most untrained viewers ask themselves when they see a photo is whether they know the person or place depicted. Recognition is the dominant force and the subject itself is usually only a metaphor for what it represents to the viewer. If this were not the case, women wouldn’t take the trouble to tear up photos of men who disappoint them. Because perception depends more on what is being presented than how, performing visual checks, noting the photographic techniques involved or even summarizing the content of an image is way beyond most people’s needs on this fairly superficial level.

The next level of perception is where we find **symbolic images** that show subjects that are easy to interpret and enable the viewer to immediately (and ideally, subconsciously) understand the message they are designed to transport. Illustrations in magazines work this way, as does advertising – the latter to the point of deliberate deception. Travel brochures

always show empty, sunny beaches and crystal-clear oceans, even if there is barely room to move on the beach in the vacation season. The same images find their way into winter catalogs, even though we know that winter at our chosen destination will look rather different.

Decorative images form a further category. These are sometimes atmospheric but generally show meaningless landscapes, urban scenes or isolated details that the photographer hopes people will want to hang on their walls at home. There is nothing to be said against printing such images in calendars, but things become more critical when people begin to mistake images that exist purely to match their sofa cushions for art. When I say ‘critical’, I don’t mean for the owners of the

images in question, but rather for all those who overvalue their vacation snaps to the point at which they call them art and think they can make a living selling them online.

The creators and purchasers of purely decorative photos seem to favor colorful, attractive and often blurred subjects that actually stem from a kind of pre-photographic reality, even if they are not immediately recognizable as such. Such images are often considered ‘quaint’, but generally have nothing much to do with photography or art. Apart from pleasing colors, the main thing that people seem to like about them is that they can interpret them however they wish. And that is the whole point of their existence. In this case, the image represents a kind of blank screen or mandala that engenders a



Photo: Dr. Martina Westner

What do we expect when we look at a photograph? Untrained viewers often ask themselves whether they know the person or place in the picture. Recognition of known subjects is the dominant force in souvenir-style photos.

feeling of deep thought in viewers, even if they aren't really looking at what they are seeing and are really only fantasizing. The result is a kind of motif-fueled reverie that is definitely relaxing for the mind. Art, on the other hand, is designed to excite our senses and has exactly the opposite effect.

What Makes a Great Photograph?

A photograph that 'works' doesn't allow us to interpret it however we want. Instead, it 'speaks' to our inner self and forces us to 'read' its message and participate in the experience it depicts. It is possible to explain why such a photograph works, but something remains that cannot be articulated – and that's exactly how it should be.

We experience a truly artistic photograph with our entire being, in a way that is perhaps similar to the feelings engendered by flirting. This is because a photograph that works on an artistic level bares part of the photographer's soul. If viewers are sufficiently open-minded and 'on the same wavelength' as the artist, they will experience the same emotion and will feel the need to have the photograph close by and to look at it time and again.

As in other fields of human endeavor, only a few contemporary artists produce work that is in high demand and can be priced

Image: Deichtorhallen Hamburg

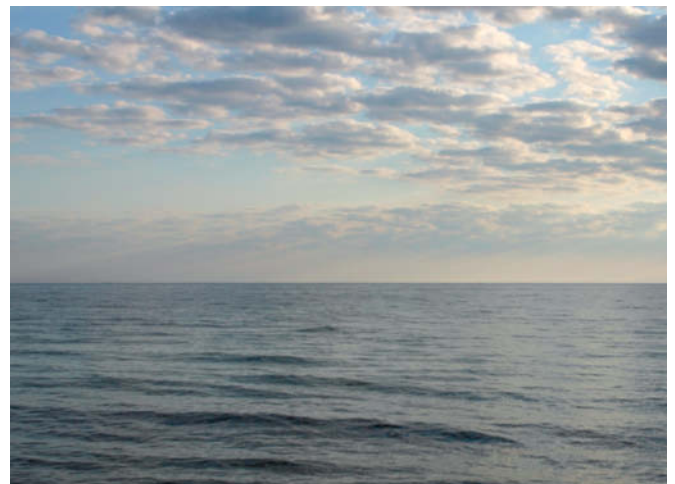


What makes a photograph work? The most expensive images are indeed sometimes the most artistic.



Photo: Thomas Hoffmann

Symbolic images like the one on the left are designed to convey a simple message. Such images are often found in magazine adverts and travel brochures and suggest that this is where you really want to be.



'Quaint' or 'picturesque' photos rarely have any artistic value and usually serve to promote a kind of motif-fueled reverie in the viewer. This may be relaxing, but is not what art is all about.

accordingly. The most expensive artists are not necessarily the best, but this is currently the case with stars like Andreas Gursky, Thomas Demand and Taryn Simon. These innovative artists are constantly pushing the envelope. They reflect on current social and political issues and are fully aware of both the potential and the limits of the medium.

However, this doesn't necessarily mean that their work is universally moving. Art demands that the artist and the viewer engage with the work, which is virtually impossible for a photograph that can only be viewed in the form of a small, low-resolution image file on a website. Especially in the case

of artists who work in large formats, online 'thumbnails' should serve not as a substitute but instead as an incentive to go and look at the real thing.

Online and catalog images of large artworks can be misleading in positive and negative ways. For example, the only way to appreciate the scale and mass of detail in Andreas Gursky's images is to view them hung on a gallery wall. The experience of walking along next to one of these monumental works simply cannot be replicated artificially. But seeing art live can be disappointing too, even in the case of students of Bernd & Hilla Becher, and images

that appear promising in print or on a monitor don't always live up to our expectations in the flesh. As elsewhere in life, size isn't everything.

A Typology of Perception

Why should photographers consider the effect their images have at all? For a start, thinking this way often helps an artist to judge the direction in which a work is headed. They also need to develop insight into how their work might be seen by others. Someone who **reads a meaning into** an image has visual predilections that differ strongly from those of someone who wishes to let an image



Image: art KARLSRUHE/Jürgen Rösner

Context is crucial, and you are much more likely to be able to sell your work if you manage to display it in a gallery or at an international show such as *art KARLSRUHE*. In these situations, even quite commercial images are more likely to be perceived as art.

Image courtesy of the Getty Open Content Program



A purely documentary approach often produces great photographs, and great art transcends time and short-lived trends. The image above is one of Eugène Atget's famous images of late 19th and early 20th century Paris, created as visual notes for the painters of the time. The secret of their allure lies in the way Atget worked, combining concentration and stamina with unpretentious compositions and modern elements such as the centrally positioned tree shown here. *Luxembourg Gardens* was captured in 1902 and measures 90×64.54 cm (35.4×25.4 inches).

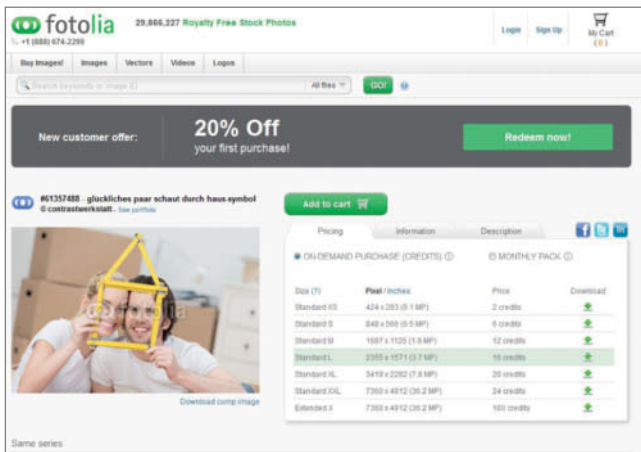
communicate its message for itself. Having your portfolio rejected often has to do with 'soft' factors such as your personal appearance or the contents of your resumé and doesn't necessarily reflect the quality of your work. **Contextualizers** are a third type of viewer who tend to concentrate on a factor that photographers often underestimate – the 'story'. The less obvious the criteria used to assess the quality of an image, the more the market demands that the story behind the artist is at least as interesting as the one that led to the creation of the work. This is

where the place you studied, who you studied under, where you were born, prizes and scholarships you have won and books you have published play a role in the overall acceptance of your work.

Before you seriously consider exhibiting your work in public, you need to ask yourself whether it is actually capable of making the experience of conceiving and producing it tangible to the viewer. This requires stamina, consideration and a continual process of rigorous selection among the images you have available. If you are successful, the

images you end up presenting will automatically impress even untrained viewers with their immediate and uncompromising content. Such works are sure to stand the test of time and outlive short-term visual trends.

Many renowned photographers still name Eugène Atget as one of their most important sources of inspiration, even though Atget himself was reputed to be a grumpy oddball who spent his time wandering around Paris and its environs with an outdated camera capturing documentary images that served mainly as visual notes for the painters of the



time. The secret of Atget's success lay in his concentration, single-mindedness and stamina, and in the completely unpretentious nature of the images he produced. A purely documentary approach to photography often produces compelling and timeless results. The great thing about this approach is that anyone can work this way (with the emphasis of course on the parochial meaning of the word 'work'). You needn't study art or photography in order to capture simple studies of landscapes, towns or people, although it certainly helps if you have studied something. The crucial factors to the success of such an undertaking are patience and a passion for the subject. Even if you initially receive little or no recognition for your work, your photographs are sure to become more valuable over time – a bonus that today's conceptual photographic art cannot reckon with.

Simple, matter-of-fact photography of this type is obviously not as simple to pursue as many people assume – otherwise, the genre would be much more popular. Contemporary 'art' photography has much more to do with advertising imagery and is currently experiencing a simplification of its content that tends toward either highly symbolic images or poster-style work. Expressed in musical terms, if documentary photography represents jazz (i.e., endless variations on standards), symbolic photography represents pop music – an almost generic approach that is immediately accessible, easily consumable and requires no previous knowledge of the genre, even if its quality does vary. Symbolic images can be found everywhere where visual information needs to be understood quickly and easily. Microstock agencies and their universally applicable images represent the current 'state of the art' in the genre. However, just because such photos are easy to consume

Symbolic images, which are understood immediately, are successfully marketed by a myriad of microstock agencies. 'Easy to consume' does not mean 'easy to make', however, and many such images require a lot of preparation. Nevertheless, they are not usually regarded as art.

own knowledge of the context or simply by fantasizing. To continue our music analogy, this brings us neatly to the type of photo that I associate with musicals, which give an impression of high culture although they are designed purely with consumability in mind. By the same token, equivalent 'musical'-style images attempt to convey an air of painterliness while also being pleasing and easily accessible. Embodying strong emotions packaged as simple stereotypes, these require great skill and hard work to create and the results are always highly commercial.

The Market for Art

Art is a product with a price governed by the law of supply and demand. To keep prices high, supply has to be limited and demand appropriately fueled. For those who make a profit from other people's art – international auctioneers, for example – it is only worthwhile to deal in works that cost US\$100,000 or more. The next level down is the mid-price national or regional art market, which offers a more realistic platform for photographers who want to sell their work.

doesn't mean that they are easy to create. High-quality symbolic images that are part of a documentary film or article often involve a lot of preparation and hard work, but are nevertheless rarely viewed as art.

Symbolic images allow the viewer to read more into them than their content initially conveys, either with the help of the viewer's

The screenshot shows the Findartinfo.com website displaying an art auction result for Andreas Gursky. The page includes a navigation menu on the left, a search bar, and a main content area with a table of auctioned pieces. The table lists various artworks with their dates, titles, sizes, mediums, and prices.

Date	Title	Size (HxWxD)	Medium	Price
10-06-14	Singapore II	13.4 x 10.6 in	Print	17,741 USD
30-05-14	Rattingen	12.4 x 19.4 in	Print	Unsold
30-05-14	Singapore II	13.4 x 10.6 in	Print	20,328 USD
28-05-14	Supernova No. 3	11 x 8.2 in	Print	11,088 USD
28-05-14	Fotograf	17.9 x 23.9 in	Print	8,500 USD
14-05-14	Love Parade	25.6 x 61.9 in	Print	161,000 USD
12-04-14	Cheops	33.1 x 23.4 in	Offset	Unsold
07-04-14	Teneriffa	15.4 x 19.3 in	Print	40,656 USD
01-04-14	Paris, Centre Pompidou	40 x 76.4 in	Print	Unsold
29-03-14	Cheops 2005 (mönchehaus Museum Goslar 2008)	33.1 x 23.4 in	Offset	Unsold
27-03-14	Fifa World Cup	38.2 x 26 in	Linoleum	163 USD
26-03-14	Centre Georges Pompidou	22.1 x 28.3 in	C-print	11,264 USD
13-02-14	Singapore Börse 2	51.9 x 92.8 in	Print	397,345 USD
13-02-14	Dubai World I	112.2 x 79.1 in	Print	554,645 USD
10-02-14	Ocean IV	134.3 x 98 in	Print	554,645 USD
27-11-13	Unknown	6.7 x 15.9 in	Photograph	Unsold
14-11-13	Jockey, Hechingen	65 x 83 in	Print	62,500 USD
12-11-13	Dresden	78.5 x 62.2 in	Print	137,000 USD
19-10-13	Victoria Versicherung (victoria Insurance)	9.4 x 7 in	Unknown	22,529 USD
18-10-13	Union Rave	50 x 94.1 in	Unknown	259,708 USD
18-10-13	Bundestag (parliament)	93.5 x 65 in	Print	377,683 USD
17-10-13	Paris, Montparnasse	58.7 x 139.4 in	C-print	2,429,133 USD
17-10-13	Chicago Mercantile Exchange	71 x 96 in	C-print	Unsold

Like that of any other product, the price of art is governed by the law of supply and demand. To ensure that prices remain high, supply has to be limited and demand appropriately fueled. For those whose aim it is to make money with other people's art – international auctioneers, for example – it only makes commercial sense to deal in works that cost US\$100,000 or more. Andreas Gursky is one of the 'lucky few' who consistently break this barrier.

How to price your work

1. Don't set your prices too high to begin with. You can always increase your prices later, but cutting prices is guaranteed to alienate anyone who has already purchased your work. Many buyers view art as an investment and like to see rising prices. Prices increase if a museum purchases one of your prints or if two or three of an edition of five prints have already been sold.
2. How much would you pay for an image of similar quality and size? If you think you would prefer to create one yourself rather than pay, you will find it difficult to find a buyer, regardless of the price you set.
3. In the case of unknown artists, buyers are prepared to pay more for works that are technically complex or that have a distinctly personal style.
4. Remember to include the cost of printing and presenting your work and don't forget to add any regional sales and value added taxes. Depending on the size and format of your work, prices starting at US\$1,200-1,500 are the kind of level you should aim for when you are starting out.
5. The context is crucial, and your chances of making a sale increase significantly if you manage to display your work in a gallery or at an international show where everything on show is considered to be art. It is extremely difficult to sell work exhibited in stores, cafés and restaurants, regardless of the price.
6. Make plenty of effort to drum up public interest for your exhibition, and make sure you get some coverage in magazines and blogs. This is sure to increase your market value.



Photo: Nov 13, 2013 © Jérémie Bouillon/Paris Photo

Simply being good at what you do won't get you recognized. Any renowned photographer who has ever exhibited or sold high-end work is sure to have had a well-known patron and, even before the rise of social media, a working network of fans, sponsors and promoters. There is no way around these factors and there are a number of such unspoken barriers to entry into the art market that many young artists are simply not aware of.

However, prices below around US\$3,000 make no commercial sense for gallery owners, especially for those who also exhibit at art fairs. Below this level, there is an enormous supply of photographic art in a market that offers virtually no demand.

The recent phenomenon of deliberately limiting the number of prints in an edition has developed in the wake of the increasing commercialization of the art market. Most 20th-century photographers simply made an enlargement every time somebody wanted one, which happened seldom enough as it was.

Increasing Prices

One of the major exceptions to this rule is Ansel Adams' famous image *Moonrise, Hernandez, New Mexico, 1941*, which the artist printed more than 1,000 times and sold at often sky-high prices. In 1971, a print of the image sold for US\$150. In 1976, the same print sold for US\$2,000 and in April 1981, the German magazine *Stern* published a story called 'The Moon Was Worth It' about the then most expensive photo in the world, which had recently sold for US\$71,500. Since then, Adams' image has embodied the paradigm for the increasing prices commanded by contemporary photographic art.

One of the pioneers of the concept of limited supply was gallery owner Harry Lunn, who also represented Ansel Adams. Adams was elderly but in excellent health and continued to produce exceptional work, which made it difficult to communicate the idea of artistic rarity to potential buyers. Lunn nevertheless managed to get Adams to sign a contract that forbade him to produce any additional prints of his most famous works after December 31, 1979. He sweetened the deal with a major order for prints, including several of the famous *Moonrise*.

Gallery owners earn a significant portion of their income from collectors, but even though the number of collectors specializing in photography and the number of large corporations that collect art have grown in recent years, there are still not as many serious collectors around as many aspiring photographers seem to think.

Toward the end of the 20th century, editions of 50-100 prints were the rule, although many of these remained unsold. To promote the concept of 'vintage' prints (i.e. prints made shortly after the image is captured), artists felt obliged to print entire editions at once. Unfortunately, there were rarely enough buyers around at one time and many prints ended up gathering dust in the artists' or gallery owners' cupboards and drawers.

Five ideas to help you get started

1. The more you know about the contemporary photography scene and the recent history of photographic art, the better you will be able to judge whether your images are 'state of the art'. Be warned, this particular quality has less to do with technique than it does with your attitude. You must have original ideas and an unfaltering desire to express them.

If you can, visit the *Paris Photo* shows in Paris or Los Angeles, *Fotofest* in Houston or one of the European summer photo festivals such as *Rencontres Arles* in France

or *Photoespaña* in Madrid to get a feel for the scene.

2. Start out with projects that will be of interest to people in your local area. This makes it much easier to set up your first exhibition and gain experience.

3. Write your own press releases and, if you can, publish a catalog. Here too, it makes sense to limit your print run. It is preferable to offer 100 signed copies than to print 1,000 copies and end up with 800 gathering dust at home.

4. Once you have two or three projects under your belt, take these along to some portfolio reviews to get some feedback on your work and get yourself better known. Take part in competitions that suit your style of photography and, most importantly, try to get published in magazines and blogs. They don't usually pay well (if at all), but hey, you want to be famous, right?

5. Continuity is key. The earlier you begin and the longer you produce interesting and engaging work, the better known you will become.

Limited Editions

Nowadays, successful artists rarely offer more than five copies of large-format works, 10 copies of medium-format works or 100 copies of smaller works for sale. But even limited

editions aren't always sold out and only the 'big names' can be sure of shifting everything they produce. Limited editions are something of a two-edged sword for photographers – on the one hand, they ensure higher prices from the start, but on the other, they only

guarantee turnover for established artists. If a particular image becomes successful, the artist has to stand back and watch while its price increases with each sale to a new collector. Ethically, a limited edition obliges the artist not to produce any further copies of



Photo: Dr. Martina Meitner

Julie Blackmon's staged color photographs in the style of classical paintings address the twin themes of childhood and family relationships. These familiar themes are presented in such an unusual way that the art market simply laps them up – at prices from US\$3,500 to US\$12,000. This photo was seen at the Robert Mann Gallery booth at the 2011 *Paris Photo* show.

What is art?

c't Digital Photography: *You have very strict criteria – you don't class many objects that other people find visually pleasing as art.*

Dr. Martina Mettner: The difference between art and a purely decorative artifact is huge, and that difference is what I try to define. I have to be 'strict' to make my point clearly. In this respect, I'm often misunderstood and people think that I want to stop them from photographing certain things. But nothing could be further from the truth – I simply suggest that they avoid capturing images of rust, derelict buildings, graphical subjects or water if they want to develop their style and produce powerful, truly meaningful work. And I don't mean candy colors either, but rather images that say something about the artist or the moment portrayed in the image and, ideally, engender new feelings in the viewer too.

c't: *Those are lofty ideals that most hobby photographers are unlikely to be able to fulfill.*

MM: Not a bit of it! I will never stop spurring artists on and encouraging them to test their own limits. Photographing within your own comfort zone is ultimately dissatisfying, whereas making the effort to research a new idea and transform a concept into photographic reality produces a long-lasting feeling of deep satisfaction and usually draws positive feedback too.

c't: *And that makes it art?*

MM: Is it important? I think the term 'art' is overused. Generally speaking, if people write about their own 'fine art' on their websites, you can be fairly sure that they are amateurs. Giving yourself such a label doesn't help you to become an artist or to sell your work. People completely overestimate the power of the market and most don't know anyone who has ever bought a photograph to hang on the wall at home. And most of them never bought a photograph themselves. Think about that for a moment.

c't: *How would you describe the images that these photographers call art?*



Photo: Carsten Buell

Dr. Martina Mettner being interviewed for c't Digital Photography

MM: Many try to imitate painters and there are just as many blurred or abstract images around that are based on the kind of art propagated in the Romantic period by the likes of Caspar David Friedrich. There are many other sources of inspiration available to today's photographers. Modern photography is becoming ever more sculptural and nowadays includes moving pictures too. Another aspect of photography that has become very popular in the United States is the creation of one-off pieces using old-school techniques such as platinum-based or wet-plate collodion printing.

c't: *So images that provoke what you call 'motif-fueled reverie' will never find a buyer?*

MM: Artists who market high-quality bland images cleverly can find buyers. After all, there are plenty of art enthusiasts who prefer an abstract blotch of color to a daily visual challenge. Some artists are even fortunate enough to be able to sell their own large-format dibond-mounted seascapes, even though the market is full of that kind of photo. What worries me is how many aspiring artists expect to be able to make a living from their work. I've been advising photographers for more than 10 years and have often come across ideas like these. I've even met artists who take on debt to stage an exhibition and never sell a single image. Because so many people seem prepared to let their livelihood depend on a pipe dream, I've made it my job to explain as clearly as possible the background and complex relationships that drive the market. Misplaced hopes can easily spoil all the fun that photography has to offer.

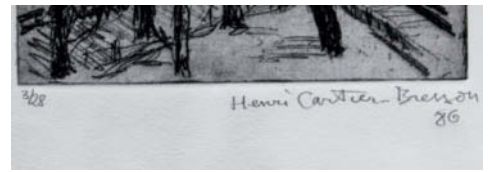


Photo: General view, Grand Palais, Nov 13, 2013 © Jérémie Bouillon/Paris Photo

The most important fine art photography gathering in the World is Paris Photo, held every November. Last year, 136 galleries exhibited and more than 55,000 people attended.

the same object, even if this is technically possible. The artist can only benefit indirectly from the inherent increase in market value that such success engenders.

Things have changed enormously since the times of Ansel Adams' *Moonrise*. For most of the 20th century, the assumption was that most artists would produce only one or two 'masterpieces' in the course of their life's work that were of collectible quality and priced accordingly. Today's market builds up artists as brands and benefits from the profitability of those brands. In other words, the potential loss of value imposed by a limited edition is more than compensated for by the sale of similar objects by the same artist.



A strictly limited number of prints helps to keep prices high. This practice has long been the rule for etchings sold on the traditional art market and is rapidly taking hold in the world of fine art photography. If a particular work becomes extremely expensive, the artist is duty bound to stick to the initial limit. Above: details of an etching and a photo, both by Henri Cartier-Bresson.

Artificial Fame

Only hopeless idealists still believe that the art market rewards purely artistic quality. The market is more about profit than art, and you can only generate profit if you invest in the smallest possible number of high-value artists. Individual 'stars' can only exist if the majority of productive artists are prevented from participating in the market. Sociologist Richard Sennett describes the principle thus: "If 500 people are famous, no one is, and so to find someone you can call a recognizable personality, a person who stands out, at least 490 must be pushed into the background. This is not benign neglect. Those 490 must be



Gallery owner Robert Morat (Hamburg and Berlin) and Cai Wagner (Berlin), both of whom receive about 20 requests per week from artists seeking representation. Most gallery owners have 15 or fewer artists on their books at any one time.

Photo: Dr. Martina Mettner



Photo: art KARLSRUHE/Jürgen Rösner

High-profile art fairs like *artKARLSRUHE* are showing increasing numbers of photographic exhibits alongside more traditional paintings and sculptures. A fortunate few get to exhibit their work in a one-artist show .



Photo: Book signing, Sophie Calle at Xavier Barral's booth, Nov 14, 2013, ©Marc Domage/Paris Photo

positively unrewarded in the same measure the 10 are rewarded."

In Germany, for example, there are about 60,000 working artists registered with the state-subsidized artists' social security system and many more who are either not registered or are foreigners hoping to make it big in Berlin, Hamburg or one of the other major cities. The artists who participate in the system have an average annual income of about US\$15,000. A reasonably successful advertising photographer earns more than that in a month.

Who Will Get to Be One of the Fortunate Few?

Every year, universities and art schools release a new generation of hopeful graduates out into the world, although it is estimated that only two per cent of graduates actually end up

Sophie Calle, whose name is a valuable brand, signing books at the *Paris Photo* show.



making a living from their art. The reality of the matter is that most artists depend on a 'day job' to make ends meet. In fact, most active artists haven't actually cottoned on to the most basic principle of the art market, namely: a work only has value if it is rare and everyone wants to own it. In this respect, the contemporary art market embodies capitalism in its purest form and its machinations are much more closely related to the way stock markets work than most of its participants care to admit. Part of the marketing strategy is to uphold the illusion that the products being sold have intrinsic cultural value.

Many famous examples from the past and present prove that, in order to become sufficiently well-known to exhibit and sell their work, photographic artists need a prominent patron and a well-oiled network of fans and promoters. Nowadays, you have to add social media to the mix too. Without this foundation, no-one will succeed in the fine art photography world.

You will have little or no chance of making it if you are not prepared to take the plunge and actively drum up interest for your work. You have to spend money travelling to art fairs and publishing books. Ideally, you should be photogenic, or if you are not, perhaps you can develop an image as an 'enfant terrible'. If

Photo: Dr. Martina Mettner



you cannot fulfill some or all of these criteria, you probably won't even find a gallery that is prepared to represent you.

Author and curator Piroshka Dossi says that the art market appears to be open, autonomous and free. However, in reality, many informal barriers to entry exist that are just as effective as the formal barriers to entry that exist in other markets. Many artists, especially younger ones, are simply not aware of these obstacles and believe that artistic talent and continual hard work are all that counts. After a first few faltering steps on the hard floor of the market, the dream of pursuing art as a self-perpetuating life form quickly proves itself to be a grave misapprehension.

Even if an artist has a deal with a gallery, regular shows are not guaranteed. Artist Nobuyoshi Araki is an exception to this rule, selling everything he produces. The Taka Ishii Gallery in Tokyo has represented him for 20 years and puts on a solo exhibition of his work every year to mark his birthday.

A major barrier to success is the lack of clarity in the criteria by which art is judged. An artist who has already won a major prize is sure to win another and will just as surely attract gallery owners and buyers. The 'stable' an artist comes from is important too. Artists who have studied at well-known institutions under famous tutors are more likely to be accepted by the establishment and will have better contacts too.

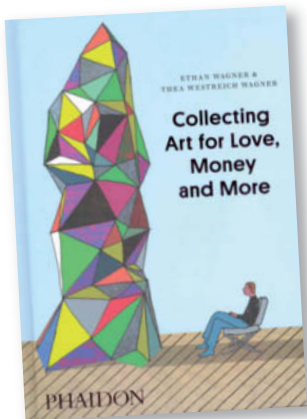
Success Breeds Success

But let's return to the 10 'fortunate ones' described earlier by Richard Sennett. Because art is no longer easily definable, artists who have 'made it' have really hit the jackpot and can enjoy the privilege of having all their future work automatically accepted as 'art'. Established photographers

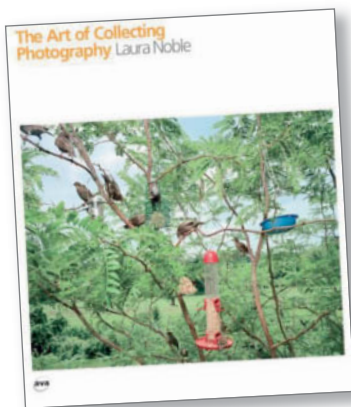
like Andreas Gursky, Wolfgang Tillmans, William Eggleston and Nan Goldin can assume that anything they produce will be exhibited and that they will find publishers for any project they launch. But don't be fooled – not just anyone can make it big with photos of reflections in water or of their own discarded clothing. You have to bring your own inspiration to the party and you need to keep an eye on the overarching aim of transcending reality rather than just imitating the work of others.

Julie Blackmon enjoys great success with her color photographs shot in the style of classical paintings that explore the twin themes of childhood and relationships within families. Blackmon's images sell for US\$3,500-12,000 and are proof that you don't have to live in New York to build a successful career as an artist. The prerequisite is, of course, that you offer a product that is somehow familiar yet sufficiently challenging to garner interest in the market. Referencing well-known classical works of art is a clever but well-worn idea and anyone presenting a homage to Caspar David Friedrich, Edward Hopper or Vermeer is obviously trying to force a way into the art market. Whether tactics like this can work in the long term remains to be seen. At the end of the day, 'the market' is always looking for the next big thing, so it is questionable whether a long-term strategy is any use to an artist anyway.

Recommended Reading



Ethan Wagner, Thea Westreich Wagner
Collecting Art for Love, Money and More
 208 Pages
 Hardcover, 9.9×7 inches
 Published by Phaidon Press
 ISBN 978-0-71484-977-5
 US\$25



Laura Noble
The Art of Collecting Photography
 256 Pages
 Hardcover, 12×9.8 inches
 Published by AVA
 ISBN 978-2-88479-028-4
 US\$9.99



Piroshka Dossi
Art Price and Value: Contemporary Art and the Market
 144 pages
 Paperback, 10.2×7.2 inches
 Published by Silvana
 ISBN 978-8-83661-240-6
 US\$60

Working with Galleries

The high prices currently commanded by a few photographers should not be interpreted as a sign that photography as a genre is universally accepted. In this highly opaque market, the highest valuations go to the few living artists everyone already knows. And no-one knows how long the hype will last. Cindy Sherman, Richard Prince, Jeff Wall and Gilbert & George are not so much photographers as artists who work with photographic media. On a more traditional level, Andreas Gursky, Hiroshi Sugimoto, Thomas Struth, William Eggleston and Robert Frank can all generate a seven-figure annual turnover. On the other hand, if I remember correctly, renowned American gallery owner Harry Lunn once said, "The only good photographer is a dead photographer", and Ansel Adams, Irving Penn, Richard Avedon, Robert Mapplethorpe, Edward Weston and Helmut Newton prove his point by generating enormous sums for the galleries that represent their estates.

A gallery owner is first and foremost a salesperson – a fact that artists often forget. Berlin gallery owner Cai Wagner says that the type of communication fostered by the art world and other creative industries “contributes strongly to the blurring of the borders between the private and working lives of those involved.” Many gallery owners also have an idealistic standpoint and work hard to foster and support their own protégés. Staging and marketing an exhibition is only part of the story. A lot of hard work also goes into introducing artists to collectors and institutions, and it costs a great deal of money to generate a presence at art fairs and shows. Wagner says, “The cost of developing an artist is hard to calculate but often runs into hundreds of thousands of dollars.”

The Importance of Gallery Owners

Gallery owners play an important role in the art market and are often in a position to bestow credibility on an artist simply by agreeing to represent them. But a presence at a gallery is by no means a ticket to the easy life. A photographer has to contribute to his or her public image by appearing at openings, talking to potential buyers, touring shows and, ideally, finding a second gallery or organizing an exhibition somewhere abroad. Most importantly, an artist who wishes to succeed has to deliver a continuous stream of high-quality work. Prices only increase if an artist is known to produce consistently exciting work over a number of years. Gallery owner Robert Morat always assesses the artists themselves very carefully, as well as their work, and decides for himself whether they have the tenacity required to make it in the marketplace. Talent alone isn't enough – an aspiring artist has to have a strong character too.

Like most gallery owners, Morat receives about 20 requests a week from artists seeking representation. However, a gallery can only effectively represent a limited number of artists – usually less than 15.

Many photographers find themselves turning their backs on a market that makes heavy demands in return for uncertain rewards. Some give up voluntarily while others are forced out of the system. Even if you have a deal with a gallery and constantly produce new work, you are not guaranteed regular exhibitions to back it up. Check out any gallery's website to see how frequently its artists get to exhibit. The fact that the Taka Ishii Gallery in Tokyo put on its 20th solo

show for Nobuyoshi Araki in the 20th year of its existence is unique in the gallery world and indicates the fantastic level of demand Araki enjoys.

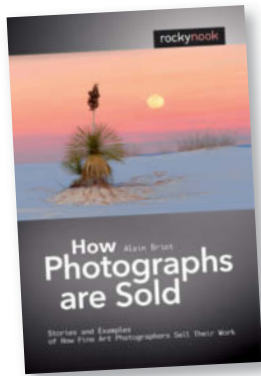
The Bottom Line

An artist who has studied photography and has worked long and hard on a project that

has won some kind of prize is probably a worthwhile investment. But make sure you sell your work at a price that you can live off. Never price yourself too low.

Nevertheless, anyone (of any age) who has put a lot of thought into their work can achieve success in the art world. All you have to do is create something that other people want to own. (jr) **ct**

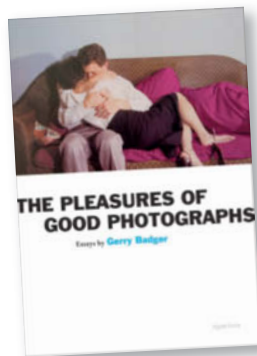
Recommended Reading



Alain Briot
How Photographs are Sold: Stories and Examples of How Fine Art Photographers Sell Their Work
 192 pages
 Paperback, 8.9×6.6 inches
 Published by Rocky Nook
 ISBN 978-1-93395-293-2
 US\$36.95

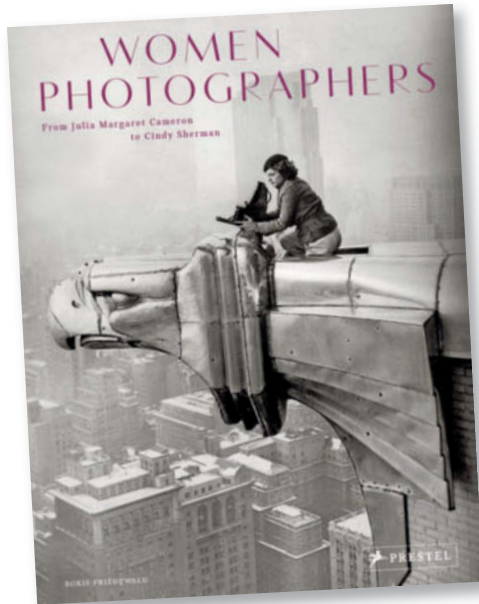


Gerry Badger
The Genius of Photography: How Photography Has Changed Our Lives
 256 pages
 Paperback, 8.9×11.4 inches
 Quadrille Publishing Ltd
 ISBN 978-1-84400-609-0
 US\$20



Gerry Badger
The Pleasures of Good Photographs
 256 pages
 Paperback, 8.5×6.2 inches
 Published by Aperture
 ISBN 978-1-59711-139-3
 US\$22

Book Reviews



Women Photographers From Julia Margaret Cameron to Cindy Sherman

By Boris Friedewald
Published by Prestel
Hardcover, 240 pages
10.9 × 8.6 × 0.9 inches,
200 color illustrations
ISBN: 978-3-7913-4814-8
US\$39.95

The Other View Through the Viewfinder

Great women photographers of the last two hundred years

Is there such a thing as specifically female photography? This book offers a rare opportunity to get to grips with the idea. Within its pages, Boris Friedewald introduces 55 of the most important female photographers of the last two centuries, dedicating multiple pages to the life and work of each. The diverse subject matter covered by these artists includes photojournalism, documentary work, fine art and portrait photography.

The oeuvre covered by this wonderful book really does span two centuries, from the work of Anna Atkins (1799-1871), who published the world's first photographically illustrated book, to Shirana Shahbazi, who was born in 1974. Within this time span, we encounter such great names as Eve Arnold, Nan Goldin, Candida Höfer, Cindy Sherman, Dorothea Lange and Gertrude Käsebier.

The author puts a strong emphasis on the biographies of his subjects, and these are all fascinating stories. He leaves it to the reader to interpret the photos, and his own analysis very much takes a back seat. The reasoning behind the selection of these particular photographers as 'greats' is not explained and gives the reader space to interpret this and the question of whether 'feminine photography' exists at all.

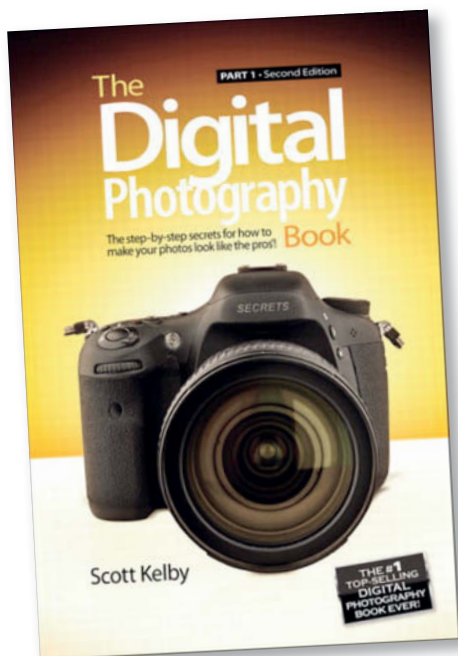
Friedewald does address the idea that some of these projects could never have been tackled by men. Sarah Moon, for example, tells of the intimate woman-to-woman dialog that develops during a photo session, while Gisèle Freund stresses that some of her images – for example of 'Evita' Peron – could never have been captured by men. Zanele Muholi's photographs of lesbians would never have come into being in the presence of men.

With this volume, Prestel has published an important book, and the only real gripe is that the author limited himself to portraying only 55 artists. This is a great selection, even though you will search in vain for names like Diane Arbus, Sophie Calle, Gabo and Annie Griffiths, among many others. But what better reason could there be to start work on Volume 2? (jr)



Image: Viviane Sassen for Carven (2012)

Viviane Sassen, who was born in 1972, has made a name for herself in the world of fashion photography with her unusually artistic work



The Digital Photography Book, Part 1 (2nd Edition)

By Scott Kelby
 Published by Peachpit Press
 264 pages
 9 × 6.1 inches, Paperback
 US\$24.99
 ISBN: 978-0321934949

Scott Kelby's Photo Recipes

180 Ways to Create Great Images

Digital photography promises quick results but offers no patent remedy for disappointed beginners and keen amateurs who long to produce photos like the pros. Enter Scott Kelby and his down-to-earth approach.

An experienced photographer and the author of more than 50 best-selling books on photography and digital imaging, Kelby dedicates this book to the practical aspects of taking great photos.

His easy style turns what sounds like a tough lesson into an entertaining read. Instead of offering a reference book full of theory, he gives us concrete tips on how to produce specific results. The answer to the question "How do I produce a blurred background?" is a simple and unequivocal "Select an aperture of f2.8 or larger", while his tips on sports photography include "Bring your credit card", and one of his tips on photography in general is to stop reading books on photography!

Whether or not you choose to follow his advice, Kelby has an answer to just about any photographic question that comes his way, and this is what makes this book so useful, especially for beginners. Although creativity takes something of a back seat, the information presented here will help everyone get better results right from the start.

The book is divided into easy-to-digest chapters on various types of subjects, with landscapes coming out on top as far as page space is concerned. There is also a 22-page guide to wedding photography based on Kelby's own experience as an event photographer, as well as sections on shooting panoramas, portraits, sunsets, nature, travel and macro scenes.

This book doesn't put the techniques it describes within a larger photographic context, but instead delivers a rock-solid guide on how to produce satisfying images that will, in turn, give you a foundation on which to build your own photographic style. (tho)

A whole chapter is dedicated to explaining just how Kelby creates his own best images

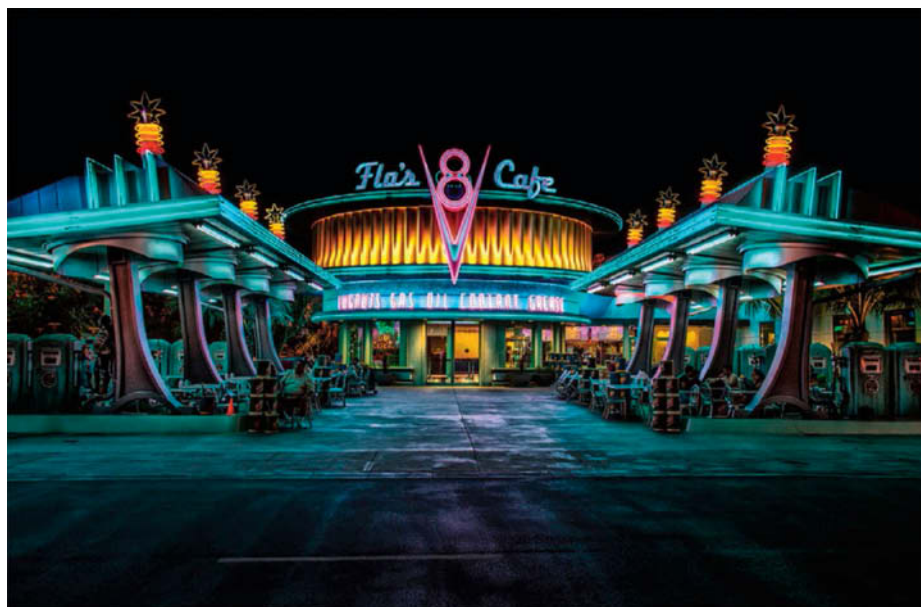


Image: Scott Kelby, Peachpit Press

Coming up in Issue 18

● ● ● ● ● available from December 18



Photo: Torsten Andreas Hoffmann

Workshop Travel Photography

■ Guidebooks usually only recommend that you visit well-known palaces, museums and other points of interest. Such places often have little or nothing to do with the real life of the people in the country you are visiting. In this article, pro photographer Torsten Andreas Hoffmann explains how to create an authentic portrait of a location without resorting to well-worn photographic clichés.

Standard Lens Test

■ Standard lenses are bright, cost relatively little and deliver excellent image quality. Many photographers swear by their 'good old 50mm'. We test a range of standard lenses, from value kit models to high-end third-party glass, and give you the low-down on just what they are capable of.



Image: Sigma

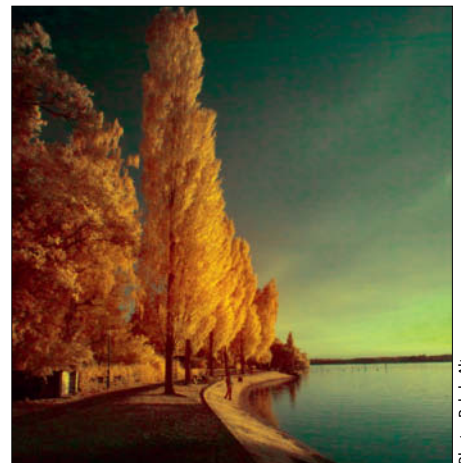


Photo: Ralph Altmann

Infrared Photography

■ Infrared photography literally shows the world in a different light, producing images with unusual colors and extreme, fascinating contrast. We take a look at how to capture infrared images and give you tips on how to give your own subjects that unique infrared look.

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Issue 17

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DVD Production: Klaus Ditzte, Nicole Tiemann

Published by

Heise Zeitschriften Verlag GmbH & Co. KG
P.O. Box 61 04 07, 30604 Hannover
Germany

Publishers: Christian Heise, Ansgar Heise, Christian Persson

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U.S. Distribution Service: George Clark (george@clarkgroup.bz)

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Toll Free: 855.748.4105
Direct: 818.286.3122
CTDCS@magserv.com

In cooperation with

Rocky Nook, Inc.
802 East Cota St., 3rd Floor
Santa Barbara, CA 93103
U.S.A.

Subscription Service: For orders and all other issues please contact CTDCS@magserv.com

Subscription Price (one year/two years)
US\$49.95/US\$94.90
ctd.magserv.com

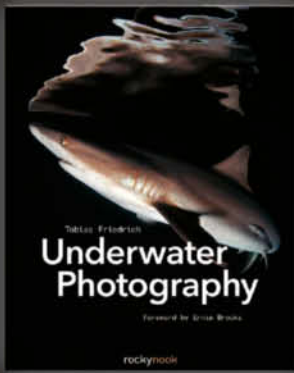
Suggested Retail Price (single issue):
USA US\$14.99 Canada CAN\$14.99
Delivery is free worldwide.

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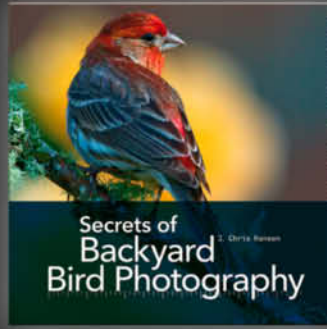
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Printed in Germany
by Dierichs Druck + Media GmbH & Co. KG, Kassel
Distributed in the USA and Canada by CMG,
155 Village Blvd., 3rd Floor, Princeton, NJ 08540
Distributed outside of the U.S.A. and Canada
by COMAG Specialist, Tavistock Road, West Drayton,
Middlesex UB7 7QE, UK



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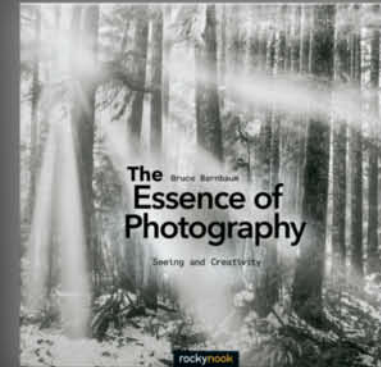
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