

Free DVD
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Street Photography • GIMP Add-ons • Chromatic Aberrations • Image Databases

ct Digital Photography

The in-depth quarterly for the photo enthusiast

Creative Corner

Scanner Close-ups

Cheaper than a macro lens!

Street Photography

Up close and personal

Free DVD

Six Video Tutorials

Sample Images

Full Version Software

Extensive Tests

Invisible Watermarks

Discrete image identification

High-end Camera Test

Nikon D800 vs. Canon 5D Mark III
plus Olympus OM-D, Nikon D4, Pentax K-01

Better Photos

Photoshop CS6

New features, Our favorites

GIMP Add-ons

RAW development with plug-ins and scripts

Eliminate Color Smears

Tools for removing chromatic aberrations



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PLUS MUCH MORE



Our cover model was slightly puzzled when she saw the custom filmstrips that our styling team had created for this issue's shoot. They symbolize our title story on image database software, and we turned them into a spectacular piece of headwear for the occasion. In the article itself, our test team gives you the low-down on Aperture, Lightroom, Picasa and others, and fills you in on some of the surprises they experienced when using them to organize complex collections of images.

Have you ever spotted a street scene that you just have to capture, but you are not sure whether you will be allowed to publish the results? Where does street photography end and portrait photography begin? This issue's workshop will get your documentary juices running and gives you important shooting tips and a series of step-by-step guided shoots to help you hone your technique.

There is an enormous range of free and commercial image processing products available on today's market, and it can be tricky to decide which to use. Some programs are indispensable, while others are better off in the trash. This issue's chromatic aberration workshop tells you all about how these bothersome artifacts are caused and tests the best programs for removing them seamlessly and professionally.

As always, open source fans get their money's worth too, and we show you how to use free add-ons to extend GIMP's capabilities and turn it into a full-blooded RAW converter and processor.

Have fun with this issue of your favorite photo magazine. If you want to meet us in person, we will be at Photokina in Cologne, Germany (September 18-23, Hall 04.1, Booth G038) and at PhotoPlus in New York (October 24-27, Booth 4). See you there!



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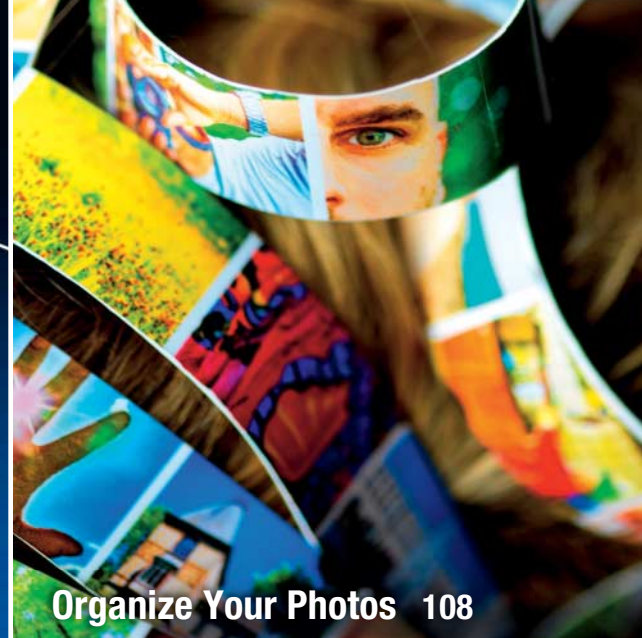
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Readers' Letters

Keep Up the Good Work

Unlike many of the other printed media, your publication leaves no stone unturned and all information is supported with technical facts and dedicates as many pages as necessary to fulfilling the assignment. Complemented by the lack of pages of useless advertising, it is more of a manual/technical journal. Since discovering *c't Digital Photography* I do not buy any other photography publication. The information will be valid for many years and should form reference material for any serious amateur or professional photographer. Keep up the good work!

Glen Ward



have discovered that using these lenses on a modern DSL camera evokes strong memories of my father. Not only is the article informative and evocative, but Stefan Arand is also an excellent wordsmith.

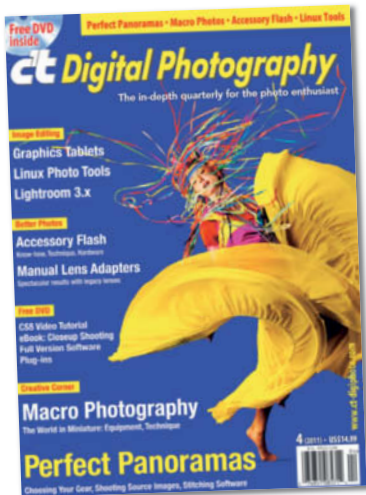
Elliot B. Siegel

c't Digital Photography is available digitally in iPad and zinio formats, and the zinio reader is available for various platforms, including Android. Check out our website at www.ct-digiphoto.com/subscription for more details.

Disappointing Issue

We have just received issue 8 here and I must say I'm disappointed. You seem to be going the same as other magazines, with the inclusion of how you do everything Photoshop. I do not use that product and if I did there are so many mags that cover it I would buy one of them. Please stay with the way the first issues were, they were great.

Robert Broadhead



Comparable with the Very Best

Spring Issue is superb. Comparable in all respects with the very best, if not better than many of the very top drawer photomags. I particularly appreciated the cover – a breakaway from some in the past when some were downright hoakie, and the first to present an image of a mirrorless digital in a way that makes it worthy of adult consideration.

Nathan Caplan

We are sorry to hear that Issue 8 didn't fulfill your expectations, even though it included articles on the open source Gallery software package and a range of non-Adobe slideshow and color management software products. It is an important part of our philosophy to cover a wide range of manufacturers and products. Our article on GIMP plug-ins in this issue continues the trend, and there's plenty more open source goodness in the pipeline – we hope you find something you like in the mix. Thanks for your comments and keep reading!

Tremendous Value

When I first read the magazine two quarters ago I was astounded by how every article was about something I was interested in. I would say most magazines provide 30% relevant content, but practically every page of your magazine has articles that I am deeply interested in and caters well to both an amateur and professional audience. Combined with the provided software, I think your magazine presents tremendous value. I'm so glad I've found such a great read. The back issues were exactly what I was looking for. Please keep up the great work! Is there any possibility of Android and/or PDF versions?

Balraj Jassal

Manual Lens Adapters

Issue 4 (2011) of *c't Digital Photography* had an excellent article by Stefan Arand concerning manual lens adapters. I have three lenses, circa 1953, which my father used on his Exacta camera. These are: a 135mm f/2.8 Steinheil (Munich), a P. Angenieux (Paris) F35 1:2.5 and a Xenon 50mm f/1.9. It took me almost a year to find an Exacta internal mount lens for my Four Thirds Olympus E3. The photograph here was taken using the adapter and shows the 185-year-old Fort Snelling (on the Mississippi River) and an Alaskan Husky. I appreciate the article and



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DVD Highlights

Highlights of this issue's free DVD include an exclusive set of Adobe CS6 video tutorials, sample and test images from the articles and tests in the magazine and a free full version of the *Inpaint 3* photo restoration software. Our free software selection also includes many of the GIMP add-ons described in the article on page 102.



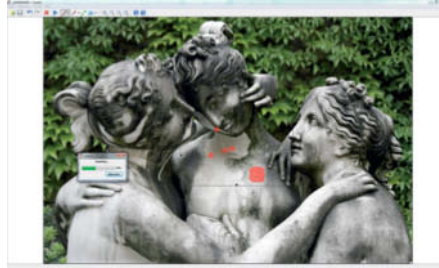
Using Flash Creatively

Video tutorials: In this series of FotoTV video tutorials, we show you how to use accessory flash to produce backgrounds for location portraits and give you the low-down on Photoshop Actions and file formats.

Portrait photos are all about people, and the background should only play a secondary role. It is simple to select an appropriate background in a studio environment, but things get more tricky on location, where you often have no choice in the matter. Dirk Waechter shows you how to use bounce flash, wide apertures and color filters to produce defocused backgrounds that remain unobtrusive and keep the viewer's attention pinned to the subject.

Following on from the 'backgrounds' tutorial, Kate Breuer uses two separate videos to explain how to use Photoshop Actions to automate processing steps that you use regularly. She uses the insertion of watermarks as an example to demonstrate how much time you can save using Actions, and goes on to explain how to use complex Actions to perform color shifts.

In the final section of this series of FotoTV tutorials, Karsten Franke introduces the various file formats used by Photoshop. He discusses the attributes of standard image file formats such as TIFF, PSD and JPG, as well as more specialized EPS and PDF printing formats. He also provides a short introduction to vector and Web formats. (tho)



Inpaint 3

Full version software: Tiny details can ruin an otherwise successful photo. Inpaint enables you to remove unwanted objects, scratches and text using just a few simple clicks.

Many photos would be a lot better if it wasn't for that pesky trash can, street lamp, power line or tourist that got in the way! Inpaint offers a quick, easy solution that invisibly blends erased areas with their surroundings using intelligently generated textures pulled from the surrounding image data. The program makes fiddling around with clone tools a thing of the past.

All you have to do is mark the area you want to get rid of using a brush or a magic wand like the one found in Photoshop. The software reinterpolates the image without the unwanted object and uses pixels from the surrounding areas to create new image areas in the resulting 'hole'. The results are astonishingly good, especially in images with evenly colored backgrounds – for example, a beach scene can be easily relieved of an unwanted umbrella. The program only begins to reach its limits when removing large objects or multiple details.

To use the software's full functionality, you have to register your copy from within the user interface. You will then receive an e-mail newsletter and a special offer giving you a 25 percent discount on version 4 of the program. (tho)



Adobe CS6 Video Workshops

Video workshop: These videos show you how to make successful selections and create masks, give you tips on cleaning up your images and explain how to integrate Adobe Bridge into your everyday digital photo workflow.

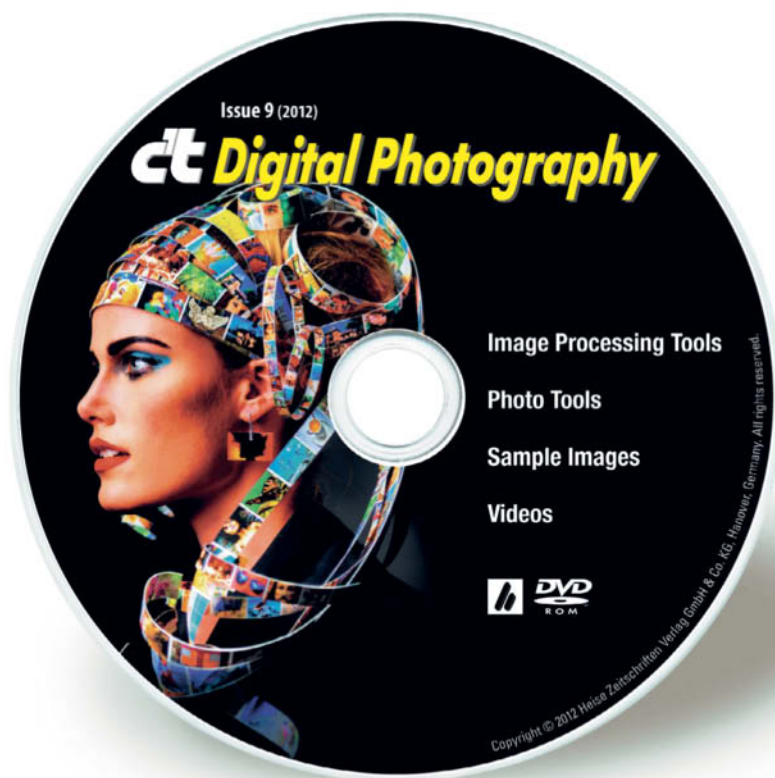
In this workshop, video2brain trainer Tim Grey dedicates more than two hours to three specific areas of image management and processing using Adobe's Creative Suite 6.

Image processing in Photoshop often requires you to make precision selections before you can begin to make adjustments to selected image areas. The first part of this three-part workshop is dedicated to selections and layer masks. Grey shows you how flexible the Color Range tool can be when making selections and how to make quick selections using the individual color channels.

The second part of this series goes into detail on the tools you can use to correct various image errors. In addition to specific tasks, such as removing unwanted artifacts or brightening teeth in a portrait, Tim Grey also shows you how to combine tools and how to reduce the effects of chromatic aberrations.

The final section introduces image management and simple editing using Adobe Bridge, covering important topics such as keywording, image optimization and file export.

The full versions of all these videos are available for purchase at www.video2brain.com for US\$34.99 each. (tho)



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Portfolio

Jason Lee

Children often come up with really creative ideas, so when Dad is a professional photographer who can turn those ideas into images, the results are guaranteed to get everyone smiling.





Not only children dream
about throwing a pie in
someone's face!



Sticking baby sister to the wall with gaffer tape. What makes this image surreal is that the girl on the wall seems quite happy about the situation and her big sister appears to have had no trouble getting her up there in the first place. These subtle impossibilities give the image its own special charm.

Kayla removes her sister's tooth with a pair of pliers, while Kristin throws a pie in her sister's face or sticks her to the wall with gaffer tape – and the strange thing is, the girls seem to be enjoying every moment of these parental nightmares!

The creator of these offbeat images is Kayla and Kristin's father, professional wedding photographer Jason Lee. He began taking

unusual photos of his daughters in 2006 when his mother became ill and wasn't able to see her grandchildren for fear of catching the infections that kids often carry.

Like others of their age, Jason's lively girls come up with crazy ideas but, instead of ignoring them, he simply decided to shift them up a gear and capture the results with his camera. The resulting images show his kids



Simple everyday events suddenly become unpredictable when a creative photographer gets to capture them his own way. This is what happens when a child sneezes a little more forcefully than usual.

doing things that are either forbidden or impossible, or both. In contrast to the antics of some fairy-tale rascals like Max & Moritz, these girls seem to be enjoying every second of rough and tumble rather than getting told off for their troubles. It seems completely natural to plant your sister and water her to make her grow! The combination of innocent child's play and bizarre scenarios is what makes these images special.

Jason leaves nothing to chance in his compositions and he carefully sets up the lighting and props in each scene before beginning a shoot. This way, the girls only have to stay still for a maximum of two minutes. Of course, they are rewarded for their

efforts and having Dad play the fool behind the camera helps to get them laughing when the shutter clicks.

Most of the photos shown here were taken using Canon EOS 5D and 5D Mark II cameras and a range of Canon lenses (although Jason has now switched to using a Nikon D700). He used a Canon Speedlite 580 EX flash equipped with a PocketWizard remote transceiver, Photogenic 640 w/s strobes and a range of reflectors and softboxes for lighting. *Photoshop* and *Lightroom* are his tools of choice for post-processing.

When we asked Jason how he manages to make his photos so different from other people's, he told us that he likes to think

outside the box and develop his own ideas while still listening to feedback from others. He also says that it is essential to write his ideas down as they occur. His unique approach and his obvious love for his kids is the basic recipe that makes these images so wonderful.

(jr)

Links

www.flickr.com/photos/jwlphotography
www.jwlphotography.com
<http://kristinandkayla.blogspot.com>



This ought to be a painful experience, but in Jason Lee's world, removing a milk tooth with a pair of pliers seems to be a lot of fun



A baby sister has to be watered if she is to grow. Some of these photos have a highly cartoon-like quality.

Supergirl helping with the domestic chores. We found ourselves wondering if Jason Lee has ever heard of Pippi Longstocking ...



On her third birthday, Kayla proudly wears the candles that Kristin has just lit on her head

In his blog, Jason warns, "Do not try this at home ..."





Making speech bubbles is
easy – all you have to do is
drink a little delicious
liquid soap and talk away







Dr. Klaus Peeck

SLR and System Camera Test

This year saw the introduction of a whole slew of new high-end cameras, and we tested seven models that represent the pinnacle of the speed, resolution and image quality that is now available. The Canon EOS 5D Mark III and Nikon's D4 and D800 models are all high-spec full-frame cameras with slightly different target markets. The Pentax K-01, with its SLR lens mount, and Sony's A57, with its semi-transparent mirror, are less showy but nevertheless score points for innovation. The Olympus OM-D E-M5, with its unrivalled focusing speed, leads the pack in the Four Thirds segment, while the Sigma SD1 Merrill, with its multi-layer Foveon sensor, is the most exotic of this issue's test candidates and proves that you don't necessarily need a full-frame camera to capture ultra-high-resolution digital images.

The top dogs among the latest high-resolution cameras to hit the market are the 22-megapixel Canon EOS 5D Mark III, and the Nikon D800 and Sigma SD1 models, with their record-breaking 36 and 46-megapixel sensors.

Sigma SD1 Merrill

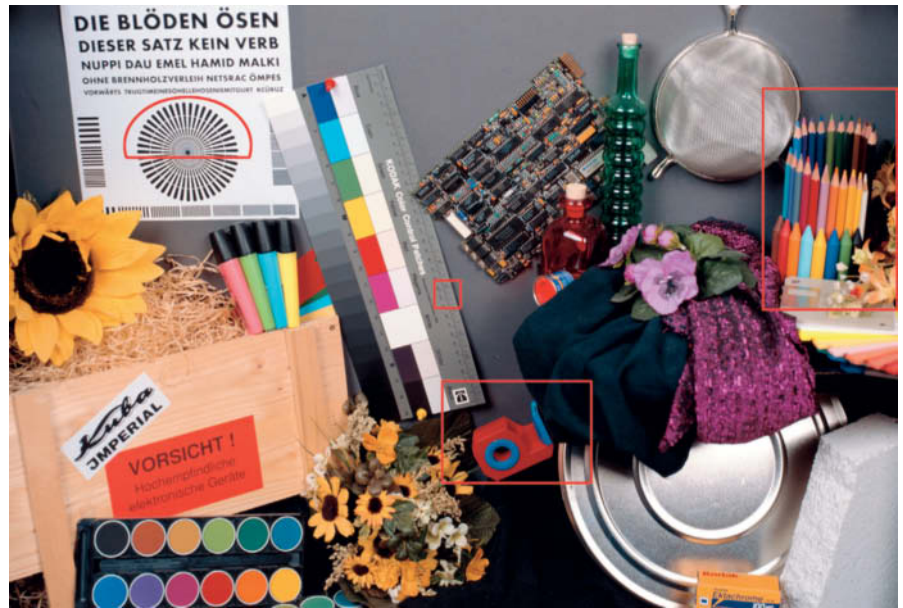
Let's start by putting the Sigma numbers straight. The manufacturer arrives at the massive 46-megapixel figure by counting the pixels on all three of the sensor's light-sensitive layers. These capture light separately from each of the three primary colors (red, green and blue), instead of using a 'Bayer Pattern' grid of color filters to colorize the monochrome light that reaches a conventional image sensor. This technique provides the camera with 'real' color values for all three color channels for each individual pixel, thus increasing the effective resolution and reducing the incidence of moiré effects. Unlike conventional sensors, which interpolate color data from the information contained in neighboring pixels, the Foveon sensor doesn't require the use of a low pass filter – a component that reduces the amount of incident light that reaches conventional sensors.

The resulting images measure 'only' 4704 × 136 pixels (i.e., 14.8 megapixels) but, because they are not interpolated, they have extremely high effective resolution. Our test results (measured at optimum aperture) back up this theoretical advantage.

However, the SD1 also has its drawbacks, and exhibits extremely long save times, especially for sequences of RAW images. This a real disadvantage, as the camera's JPEG engine is not particularly effective, and produces obvious color errors, reduced dynamic range and burned out highlights, making RAW the format that most photographers will choose. Here too, Sigma's clumsy and non-user-friendly *Photo Pro* RAW conversion software detracts from the otherwise speedy nature of the digital photographic medium.

High ISO values are another weakness. The SD1 produces obvious color errors in monotone image areas at ISO 200 and above, making this value the upper limit for viewing monitor images at 100% magnification. Color errors spread to gray areas above ISO 800, and higher values produce marbling effects. Above ISO 3200, the camera produces muddy luminance noise and horizontal banding.

All in all, the SD1 is a highly specialized camera with a limited target market, and will appeal mostly to enthusiasts who are prepared to accept its shooting limitations in



The c't test shot contains a number of serious technical challenges as well as some random objects that were selected for their high recognition value. The details mentioned in the test results are outlined in red.

order to get the most out of its extraordinarily high resolution and moiré-free images.

Prospective buyers should also be aware that the SD1's feature set is relatively modest for a camera that costs US\$2,300. Its monitor is bright and can be viewed from a wide range of angles, but has only 460,000 dots of resolution and no live view. The camera lacks a separate control panel display, and autofocus and burst shooting rates are very slow. There is no video mode at all.

If you are prepared to accept these limitations, you will be rewarded with a well-built camera with good handling and the potential to shoot extremely sharp images. The range of Sigma lenses is enormous, but you should use only the best of these if you want to use this unusual camera's potential to the full.

Nikon D800

The same is true for the D800, Nikon's new 36-megapixel full-frame monster. Unlike the Sigma's 'divided-by-three' resolution, the Nikon delivers genuine 36-megapixel resolution and 2,546 line pairs measured over the height of the image frame, presenting our lab technicians with a real challenge. Our tests produced a value of 2,150 lp/h under ideal wide-aperture conditions, which equates to 88 percent of its theoretical maximum resolution, and our test images confirmed our expectations with regard to detail. Having said that, you need

to use the best possible lenses and plan your shoots carefully to make the most of the camera's potential.

The Nikon sensor's high pixel density produces more noise than its lower-resolution competitors, and cannot compete in terms of maximum contrast above ISO 400. With the exception of the Sigma, the D800 produces less satisfactory signal-to-noise and visual noise results than all other cameras in our test at virtually all levels up to ISO 6400. Nevertheless, the D800 produces great visual results, with clean, well-defined images, minimal roughness in monotone areas and clear edges all the way up to ISO 800, providing good image quality at 100% magnification. Image quality begins to deteriorate at ISO 3200, with increasing luminance and color noise and reduced texture and detail rendition showing up in our test images. Resolution values start to lose ground at this point too, and noise begins to increase appreciably at ISO 6400. In real-world situations outside our clinical lab conditions, the D800 produces convincing, reliable results straight out of the box.

The D800's clear, bright viewfinder displays 100 percent of the frame at 0.7x magnification, and is directly comparable with those built into the Canon and the Nikon D4. The monitor comes with a reflective but removable protector and has a slightly larger (3.2-inch) diagonal than its predecessor. The monitors in all four pro and semi-pro models in our test are fixed, and the D800 is the only camera in this test with a built-in USB 3.0 port.

The camera's large magnesium body is well insulated against dust and moisture and is pleasant to hold. It responds promptly to all command input. The overall look and feel of its controls are typical of Nikon's high-end products, with a wide range of dedicated buttons and dials. There is no main mode dial and the setup menu is extremely long. The information display offers only a few direct settings. Its high resolution slows the camera down in continuous shooting mode, and we achieved just 4 fps (for a maximum of 10 JPEG or RAW images) during our test. Autofocus is very good, except in live view mode, which uses the slower, contrast-based AF system.

Canon EOS 5D Mark III

Slow contrast-based live view autofocus is also the Achilles heel of the latest version of Canon's EOS 5D. However, you can switch to phase detection AF in live view mode. This approach requires the mirror to be raised and lowered but otherwise works very well.

The Mark III boasts a new AF module inherited from the EOS-1D X, with 41 cross and five dual-cross sensors among its total of 61. The module represents the pinnacle of current AF technology and provides fast, precise autofocus, even in unfavorable lighting conditions, although the D800's system is still slightly faster overall. The Canon, however, can shoot 20 RAW frames at 5.7 fps in continuous mode or endless JPEG sequences that are only limited by the capacity of your memory card.

The Mark III's 22-megapixel sensor produced test resolution values inferior to those of the Sigma but retained almost 90-percent resolution over the entire range up

to ISO 3200 while delivering consistently high contrast. The Canon sensor's large pixels deliver excellent noise characteristics, with a fantastic signal-to-noise value of 101 at ISO 100 and visual noise characteristics that beat those of all the other test candidates. The Canon test images are virtually noise-free and have great detail definition up to ISO 1600, only beginning to drop off at ISO 6400 and above. Adequate full-screen viewing is even possible with images shot at ISO 12800.

The Mark III also includes some ergonomic improvements. The power switch is now located next to the (now lockable) mode dial. A depth of field preview button has been added to the lens throat and there is an additional multi-function button located next to the shutter release. The 'Quick Control' button on the right of the monitor gives you instant access to all the shooting functions listed on the Quick Control screen, and the live view lever can be switched between video and photo modes. The new 'Rating' button helps you grade your images for selection later on.

Some production batches of the camera were affected by a light leak problem that caused light from the 3.2-inch (3:2) monitor to affect the results produced by the camera's light meter in dark shooting situations. If you are unlucky enough to have one of these cameras, Canon customer service will block the leak for you if you send your camera in.

Nikon D4: Fast and Professional

Two and a half years have passed since the introduction of the D3S, and Nikon has now presented us with its latest full-frame pro

model DSLR. This camera sports a 16-megapixel sensor (up from 12 megapixels in the predecessor model), and offers continuous shooting of up to 50 RAW or JPEG frames at 10 fps. It supports the rare but fast (and expensive) XQD memory card format and also has a conventional CF card slot. It also has a new, multi-function 91,000-pixel RGB sensor that takes care of exposure metering, subject tracking, highlight analysis, and even face recognition. The shutter module is designed to last for at least 400,000 shoot cycles and ISO sensitivity can be pushed up to 204,800. Other new hardware features include a new 22 Wh battery, two joystick-style multi-selectors and a number of backlit control buttons on the top and rear of the camera body.

The weatherproof magnesium body weighs 1.3 kg (nearly three pounds) and our 24-70mm f/2.8 test zoom added a further kilogram (2.2 pounds). In addition to a wealth of dedicated controls, the camera has a built-in portrait-format grip with its own shutter release, main dial and sub-selector for quick menu access.

The 51 AF sensors include 15 cross sensors, and Nikon has increased the light sensitivity of the central sensor and the 10 sensors surrounding it to the equivalent of f8, which makes darker lenses and teleconverters a usable AF option for the first time. We measured an AF speed of 0.24 s at 30 lux and 0.26 s at 1000 lux, making this camera the best in this test. As expected, live view contrast-based AF was much slower, and cannot be substituted for phase-detection AF the way it can in the EOS.

The camera has the same virtually silent 'Quiet' live view release mode as the D800.



Differing degrees of monitor freedom. From left to right: the Canon EOS 5D Mark III with its fixed monitor, the Sony SLT-A57's tilt/rotatable model and the up/down tilt of the Olympus OM-D E-M5.

This works by leaving the shutter constantly open and the mirror raised, but can produce inferior quality images.

The D4 delivers constant resolution of between 85 and 88 percent of its theoretical maximum all the way from ISO 100 to ISO 3200. Maximum contrast is good up to ISO 3200 and still acceptable all the way up to ISO 12800. Its signal-to-noise results are, surprisingly, not as good as those of the D800 or the Canon up to ISO 1600, and visual noise is much more prevalent between ISO 800 and ISO 3200 than it is in the Canon, in spite of the greater pixel density. However, these lab test values made no significant difference in our visual test, and the test images showed only slight increases in roughness up to ISO 1600 (the generally accepted limit for 1:1 viewing on a computer monitor) and retained crisp edges throughout. In fact, we were able to view our test images at full-screen size at up to ISO 6400 with no obvious drop-off in image quality. Outdoor image quality was consistently good, and the slight tendency to underexposure that we noticed in our lab test shots no longer played a role. The Nikon JPEG engine produces reliable results that can be used straight out of the camera. The camera has a built-in Ethernet connector and an optional wireless transmitter is available for

downloading images and controlling various camera functions remotely (in up to 16 cameras at once) using an iPhone or an iPad.

A Hybrid, a New Camera with a Legacy Lens Mount and an Updated Classic

With regard to price, size and features, the other three cameras in this issue's test are aimed more at the mid-range market.

Sony SLT-A57

The Alpha series A57, which succeeds the A55V, has a stationary, semi-translucent mirror that allows about two thirds of the incident light through to the image sensor and diverts the remaining third to the phase detection AF sensors. This system provides a continuous live view image on the camera monitor, or – if it is activated by the built-in proximity detector – in the electronic viewfinder. This also means that the camera can adjust focus in photo and video modes quickly and continuously.

In our photo test, the camera produced focus times that were comparable with those of the Canon. Because the mirror doesn't have to be raised between shots, the Sony is also

capable of high continuous shooting rates of up to 8 fps. The camera's buffer can handle 20 full-resolution JPEGs or 20 RAW images per sequence.

The A57 offers an extended ISO range up to 16000 and increased continuous shooting speeds. The new body is larger, handles better than its predecessor and has space for a more powerful battery. The monitor can be tilted and swiveled, unfortunately around its mounting point on the bottom edge of the body. Handling is otherwise very good, the main menu is clearly set out and the functions that are directly accessible via the MENU button and on-screen icons make a useful addition to the user interface. Unlike the A55V, this model doesn't have a built-in GPS module.

The electronic viewfinder has been enhanced and now has 1.4 million dots and provides a much sharper image than its predecessor. However, the color sequence technology used to produce the viewfinder image switches each color channel on at high frequency and tends to produce unwanted flashing effects when you switch quickly between the monitor and viewfinder views.

The camera's mid-range 16-megapixel APS-C image sensor produces unsatisfactory noise characteristics. While the built-in noise

SLR AND SYSTEM CAMERAS: TEST RESULTS, PART 1

	Sensor Resolution [lp/h]	Relative center resolution (ISO 100, wide-angle)	Center Resolution (ISO 100) [lp/h]	Center Resolution (ISO 400) [lp/h]	Center Resolution (ISO 1600) [lp/h]	Center Resolution (ISO 3200) [lp/h]	Center Resolution (ISO 6400) [lp/h]	Center Resolution (ISO 12800) [lp/h]	Center Resolution (ISO 25600) [lp/h]	Contrast range/subject range, ISO 100 [in f-stops]
	better >	better >	better >	better >	better >	better >	better >	better >	better >	better >
Canon EOS 5D Mark III with EF 50mm f/2.5	1920	91	1751	1707	1704	1681	1576	1489	–	9.7
Nikon D4 with AF-S 105mm f/2.8	1640	88	1449	1417	1404	1397	1328	1282	1191	10.0
Nikon D800 with AF-S 105mm f/2.8	2456	88	2150	2017	1879	1770	1741	1679	1492	10.0
Olympus OM-D E-M5 with M.Zuiko 17mm f/2.8	1728	100 ¹	1728 ¹	1691	1521	1555	1494	1386	1070	11.3 ¹
Pentax K-01 SMC-D FA 100mm f/2.8	1632	86	1408	1338	1365	1275	1233	1163	1064	10.0
Sigma SD1 Merrill with 70mm f/2.8 EX	1568	120 ²	1882	1882	1882	1882	1882	–	–	9.3
Sony SLT-A57 with Sony SAL 50mm f/2.8	1632	86	1399	1400	1393	1376	1178	1114	–	9.3

Resolution was determined visually in units of vertical line pairs [lp/h]. The larger the value, the sharper the image. The logarithmic density, D, represents the camera's dynamic range in terms of the ratio between the brightness of the subject and the corresponding recorded tonal values. Higher values are better. Real subject range represents the range of tonal values contained in an 8-bit rendition of a test image.

SLR AND SYSTEM CAMERAS: TEST RESULTS, PART 2

	Signal-to-noise ratio [S/Nx] ISO 100	Signal-to-noise ratio [S/Nx] ISO 400	Signal-to-noise ratio [S/Nx] ISO 1600	Signal-to-noise ratio [S/Nx] ISO 3200	Signal-to-noise ratio [S/Nx] ISO 6400	Signal-to-noise ratio [S/Nx] ISO 12800	Signal-to-noise ratio [S/Nx] ISO 25600	Visual noise OECF20 ISO 100	Visual noise OECF20 ISO 400	Visual noise OECF20 ISO 1600
	better >	better >	better >	better >	better >	better >	better >	< better	< better	< better
Canon EOS 5D Mark III with EF 50mm f/2.5	101.0	55.0	58.0	46.0	32.0	31.0	–	0.7	1.2	1.2
Nikon D4 with AF-S 105mm f/2.8	79.0	53.0	36.0	37.0	32.0	27.0	28.0	1.0	1.3	1.8
Nikon D800 with AF-S 105mm f/2.8	83.0	55.0	38.0	32.0	26.0	23.0	20.0	0.8	1.3	2.0
Olympus OM-D E-M5 with M.Zuiko 17mm f/2.8	69.0 ¹	56.0	48.0	40.0	29.0	21.0	16.0	1.0 ¹	1.3	1.6
Pentax K-01 with SMC-D FA 100mm f/2.8	75.0	62.0	44.0	43.0	31.0	21.0	15.0	0.9	1.1	1.6
Sigma SD1 Merrill with 70mm f/2.8 EX	51.0	64.0	34.0	11.0	6.0	–	–	1.0	1.0	1.8
Sony SLT-A57 with Sony SAL 50mm f/2.8	62.0	62.0	50.0	37.0	31.0	23.0	–	1.1	1.2	1.6

Higher signal-to-noise ratio values indicate better image reproduction with less unwanted noise. 'Visual noise' is a physiologically-based judgement of how 'irritating' certain image noise artifacts appear to the viewer. The values are calculated based on the intensity, frequency and color of the perceived noise artifact. Values below 0.8 represent virtually noise-free images, values below 2 low-noise reproduction, while values between 2 and 3 represent visible but acceptable noise levels. Values above 3 represent disruptive noise levels. Values of 5 and above represent extreme, unacceptable noise.

reduction circuitry keeps the signal-to-noise ratio low, it increases visual noise over the entire ISO range as a result. Visual tests resulted in even more noise than our lab tests led us to expect, with an obvious drop-off in texture sharpness and detail rendition at ISO 400 and upward, and complete disappearance of some textures above ISO 800. Severe luminance noise appears and edges begin to blur above ISO 1600, and additional increases in ISO value produce intense loss of detail and additional color noise. Adequate 100% views can no longer be produced above ISO 200, and even full-screen images show a lot of weakness above ISO 800. For less 'clinical' outdoor shots, these values all move up one step, with textures reproduced adequately up to ISO 400 and other details up to ISO 800.

Pentax K-01

The philosophy behind this camera seems to involve taking an SLR body, removing the mirror box and viewfinder while retaining the full-frame lens mount and adding a sensor shift CMOS sensor with ultrasonic dust-off for continuous live view shooting. The whole package is then fitted into a heavy aluminum 'designer' body. The result is the K-01 – the

first system camera to offer a mount for an existing range of legacy (and current) SLR lenses. In principle, this is a great idea, but does mean that the flange depth (i.e., the distance between the rear lens element and the image sensor) has to have SLR dimensions, making the camera body much more bulky than many of its competitors. The camera's 16-megapixel sensor positions it between the Pentax K-30 and the much cheaper 12-megapixel K-r SLRs.

The menu system will be familiar to Pentax users. It is quite colorful, but easy to navigate using the main dial, or 'E-dial', as Pentax calls it. You can also change various settings directly on the monitor using the INFO button. The monitor is fixed, but bright and detailed. There is no optional accessory viewfinder available.

The lack of a mirror box also means that the camera does not have phase-detection autofocus sensors and has to rely on contrast-based AF performed via the image sensor. This produces audible focus seek, especially in low light, and we measured focus times of up to 1.7s in our lab tests! On the plus side, the 81-sensor AF system is flexible and can be set to use a single AF area with variable size and position. The K-01 delivered 4.7 fps sequences for 16 shots in the lab, while real-world tests

produced shorter sequences at up to 6 fps. The shutter is relatively loud, especially when you consider that it has no mirror that has to be raised and lowered.

For an APS-C camera, the K-01's noise levels are good up to ISO 3200, and maximum contrast remains pleasantly high up to ISO 1600. White balance and dynamic range results were some of the best we measured in this test. Starting at a very good value of 86 percent at ISO 100, resolution for our test lens decreased quickly with increasing ISO values. Visually, our test images were fine up to ISO 400, but began to show coarse luminance noise above ISO 800, the threshold value for satisfactory 100% viewing. Edge detail began to fray and additional color artifacts began to appear above ISO 1600. This is also the usable limit for full-screen viewing, and obvious sharpness and texture drop-off sets in thereafter. The pancake test lens produced obvious fringing effects down to f11, but delivered very good detail and sharpness when stopped right down.

Olympus OM-D E-M5

Physically, the new Olympus flagship camera represents an update of the company's classic OM series analog SLR cameras, though its lens mount breaks with tradition. The E-M5 makes no technological compromises, offering a very small weather-sealed body, a 16-megapixel Four Thirds format LiveMOS sensor and a standard kit zoom with optional motorized zoom. It also has extremely advanced five-axis image stabilization built in.

The camera is almost completely customizable, and has an 86-line setup menu to prove it! However, some of the buttons are a little too small for reliable operation and the vertically tiltable OLED monitor has only rudimentary touch-screen functionality that makes everyday shooting a somewhat menu-driven process. The 1.4-million-dot viewfinder is sharp and switches on automatically when needed using a proximity sensor. Olympus doesn't use color sequence technology to generate the viewfinder image, making it more pleasant to use than the Sony.

The E-M5 focuses extremely quickly (0.22s in bright light) and left the rest of our test models standing in low light too, in spite of its contrast-based AF system. Continuous shooting of up to 8.5 fps in JPEG and RAW mode was second only to the D4, although sequences max out at 15 shots. 'Live bulb' mode is an exciting innovation that updates the monitor display in real time to reflect changes to the image data captured during long exposures.

Contrast range/subject range, ISO 400 [in f-stops]	Contrast range/subject range, ISO 1600 [in f-stops]	Contrast range/subject range, ISO 3200 [in f-stops]	Contrast range/subject range, ISO 6400 [in f-stops]	Contrast range/subject range, ISO 12 800 [in f-stops]	Contrast range/subject range, ISO 25 600 [in f-stops]	Real subject range [# of tonal values]	Color Checker SG (Δ E) ISO 100
9.3	9.7	9.3	8.7	8.7	—	255	12.2
9.7	9.3	9.0	8.7	8.0	7.3	252	9.8
9.0	8.7	8.3	7.7	7.0	7.0	255	9.0
11.3	9.7	9.0	8.3	7.3	6.7	254	9.4 ¹
10.0	9.0	8.3	8.0	7.0	6.0	256	6.5
11.7	10.0	9.0	7.0	—	—	255	12.3
9.7	9.3	8.7	8.0	7.3	7.0	256	9.3

¹ Measured at ISO 200 minimum sensitivity setting ² The unique architecture of the three-layer Sigma Foveon sensor makes measured resolution values greater than 100% possible. The measurable limit of 120 % was exceeded at all ISO values.

Visual noise OECF20 ISO 3200	Visual noise OECF20 ISO 6400	Visual noise OECF20 ISO 12 800	Visual noise OECF20 ISO 25 600	Startup time [s]	Shutter lag (wide-angle) at >1000 lx in LiveView [s] ²	Shutter lag (wide-angle) at >1000 lx [s] ²	Shutter lag (wide-angle) at 30 lx [s] ²
1.5	2.2	2.3	—	0.5	1.8	0.3	0.5
1.9	2.3	2.7	3.2	0.2	0.9	0.3	0.2
2.4	3.1	3.8	4.9	0.2	0.9	0.2	0.3
1.9	2.5	3.6	5.0	1.8	0.2	—	0.3
1.8	2.5	3.7	5.8	1.7	0.8	—	1.7
4.0	8.1	—	—	3.0	—	1.2	1.6
2.3	2.6	3.7	—	0.8	—	0.3	0.4

¹ Measured at ISO 200 minimum sensitivity setting ² Measured with the following lenses: Canon EF 24-70mm f/2.8, Nikon AF-S 24-70mm f/2.8, Olympus M.Zuiko 12-50mm F/3.5-6.3, Pentax SMC-DA 18-55mm f/3.5-5.6, Sigma EX 17-50mm f/2.8. Sony SLT-A57 measured using a Zeiss Vario-Sonnar 24-70mm f/2.8.



The Pentax K-01 is hardly any slimmer than an APS-C SLR, even though it has no mirror. On the plus side, it is compatible with all Pentax K-mount lenses. The Olympus OM-D E-M5 with its much smaller Micro Four Thirds body is shown on the right.

Our test results showed particularly high maximum contrast at ISO 800, and relatively constant values right up to ISO 3200, although these drop off quickly at higher values. The same observations apply to the camera's noise characteristics. Automatic noise reduction causes only slight impairments up to ISO 800, whereas higher values up to ISO 3200 produce a loss of detail and texture as well as frayed edges and color noise that make images useful for full-screen viewing only.

At optimum ISO values, the OM-D produces sharp, balanced images across the entire zoom range.

Video Functionality

With the exception of the Sigma, all of our test cameras conform to current market expectations by shooting Full HD video at 30 full frames per second using H.264 compression. The Sony even offers 50 fps shooting in AVCHD 2.0 format. Both Nikon models are capable of directly outputting uncompressed video footage to external recording media via an HDMI port and without artificial clip length limitations.

Along with the Canon, the two Nikons (with their extremely flexible handling and settings) are aimed at professional film-makers who appreciate the extra creative options provided by the full-frame sensor format. All of our test cameras produced high-quality video footage that was generally of comparable quality to the still images produced by each. The Pentax produced slightly oversaturated video colors and

distinct wobble effects due to its less effective vibration reduction system.

The optional motorized zoom built into the Olympus kit lens is smooth and quiet – ideal for shooting zoomed video shots. Of all our test lenses, it was the best suited to video applications, although they all produced juddery or noisy focusing results and some fairly coarse exposure adjustments. If you are looking for a camera with video work in mind, make sure that the lens you select has appropriate characteristics or, better still, aim high and shoot your clips using fixed focal lengths and apertures, and fixed or manual focus settings.

Conclusions

Our test cameras represent a fair cross-section of the current crop of mid-range to high-end SLR and mirrorless models. They are all capable of producing great results under appropriate conditions, but the best all-round models show their true colors when conditions are less than optimal.

The most flexible and capable of the seven cameras tested here are the two Nikons and the Canon, representing the current cream of the crop in a long tradition of high-end camera manufacturing. The Nikon D800, with its 36-megapixel sensor has made the leap into medium-format resolution territory while retaining a relatively compact body with great handling. The downside of all this technological progress is the US\$3,000 price for the camera body and the necessary investment in high-end lenses if you want to get the most out of the sensor's capabilities. If

you don't feel you have to squeeze every last drop of detail out of your subjects, it is cheaper to go the Canon route. Lenses that get the best out of the 5D Mark III's 22-megapixel sensor are easier to find, while the volume of data remains manageable and the relatively large pixel pitch enables useful combinations of high continuous shooting rates and low noise at high ISO values.

Pro documentary and sports photographers will most likely go for the large, robust and super-fast Nikon D4. The camera's autofocus system adapts well to small apertures, making it eminently usable with long lenses and teleconverters. We were slightly disappointed by its sub-optimum noise characteristics, especially in view of its relatively low-resolution 16-megapixel sensor.

The Sony cheapest SLR in our test (US\$650 body only) was the SLT-A57, which displays similar noise-related shortcomings. On the plus side, its static, semi-transparent mirror enables fast continuous shooting and fast, reliable focus tracking in photo and video modes.

The Olympus OM-D E-M5 offers similar focus speed and accuracy in a mirrorless retro design that pays homage to the OM series of SLR cameras introduced more than 40 years ago – all in a small, weather-resistant package kitted out with an ultra-modern 16-megapixel image sensor. The power and sheer functionality of the Olympus catapult it right to the top of the current heap of Micro Four Third cameras. But quality has its price, and you can get a high-end SLR for the same US\$1,300 price as the Olympus kit – it just won't be as slim, stylish and retro ... (pen)



Canon EOS 5D Mark III

Full-frame, low-noise SLR with 22-megapixel image sensor. Great handling and flexible user interface. Full HD video.

Good: Full-frame CMOS sensor with moderate resolution. Large, weatherproof magnesium body with great handling. Various dedicated controls, joystick-style multi-controller, two main dials and 'Quick Control' button for making settings directly. Typically clear EOS main menu with scroll-free item lists. Clear, bright viewfinder with 100-percent view. Sharp, high-resolution, live view monitor with wide angle of view and effective anti-glare coating. Backlit LCD info panel on the top of the body. Very fast 61-area phase-detection AF with cross and dual-cross sensors, which is still very good in low light and optional for live view focusing. Lens-dependent MF override. Fast continuous shooting, fast startup time and fast data saves. Useful 'silent' shooting mode. Dual CF/SD card slot. Powerful

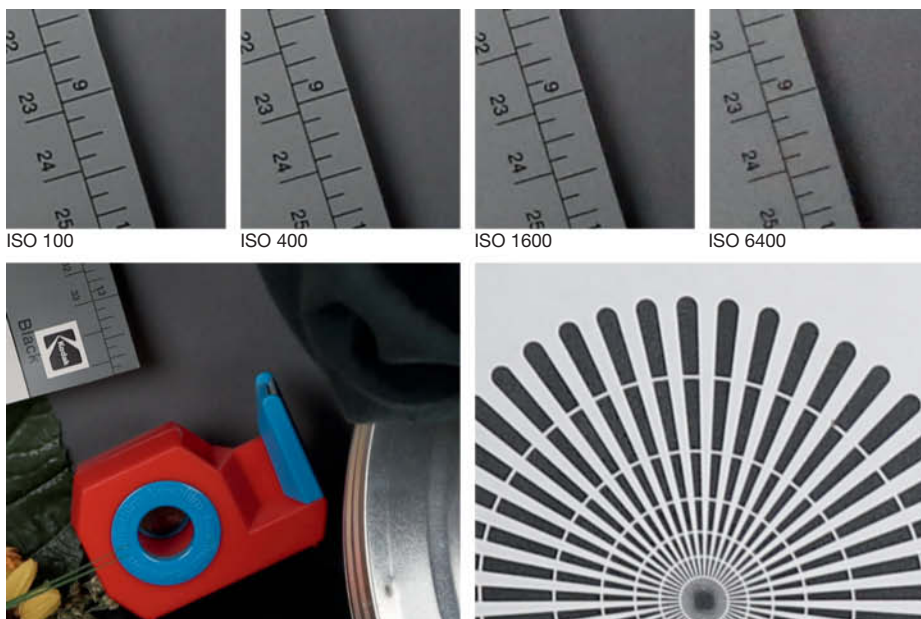
battery with continuous charge status display. Full HD video mode with many manual settings. Microphone and headphone connectors.

Not so good: Fixed monitor with anti-glare coating that tends to smear and is difficult to clean. Slow contrast-based AF in live view mode. No AF assist lamp. No built-in flash. Limited self-timer functionality. Lockable mode dial relatively small.

Test results: High maximum contrast up to ISO 3200 with best results at ISO 800. Results still acceptable at ISO 12 800. Average ColorChecker color rendition. Very high signal-to-noise ratio at ISO 100, still good up to ISO 3200. Visual noise low up to ISO 3200 and satisfactory up to ISO 12 800. Resolution balanced up to ISO 3200 and still satisfactory up to 12 800. Fast 'endless' JPEG continuous shooting. Fast startup and normal AF. Live view AF very slow.

Image quality: Bright, neutral colors, very slight green tint in daylight lab test. Good sharpness and detail at small apertures. Balanced exposure, although somewhat contrasty. Slight banding on our line chart, otherwise very few moirés and virtually no fringing. Very clean images at ISO 100, and virtually no change at ISO 200 and ISO 400. Very slight edge fraying at ISO 800. Loss of detail begins at ISO 1600. Obvious loss of edge and texture detail at ISO 3200 (the practical limit for effective 1:1 viewing). Texture and detail obviously weaker, and some noise in monotone areas above ISO 6400. ISO 12 800 limit for effective full-screen viewing.

Outdoor shots with neutral colors. Good sharpness and detail rendition except at extreme wide angles. Balanced exposure and very good noise characteristics (see test shots below and on this issue's free DVD).





Nikon D4

Very large, pro-grade SLR with 16-megapixel full-frame sensor and 10-fps continuous shooting. ISO sensitivity can be pushed up to 204800. Full HD video with many user-controllable settings.

Good: Extremely robust, weatherproof magnesium body with built-in portrait mode grip. Many dedicated controls, two joystick-style selectors, four control dials. Some backlit buttons on camera back. Sharp, high-resolution, 3.2-inch monitor with large angle of view. Two backlit LCD info panels. Very bright 100% viewfinder with eyepiece blind. Very fast, precise 51-area selective single point AF that works very well in low light. Lens-dependent AF override. Very fast (10 fps) continuous shooting. Shutter certified for 400,000 exposures. Fast startup and negligible shutter lag. Fast data saves. Extremely configurable. Flexible self-timer, multiple white balance presets. Powerful battery and two-battery charger. Headphone and microphone connectors.

Not so good: 16-megapixel resolution. Monitor fixed and without anti-glare coating and protective cover. No AF assist lamp. Compatibility problems with some CF cards. Additional XQD card slot not particularly useful. Drive mode selection ring locks and is difficult to use. Small, imprecise 8-way multi-selector. Too few direct settings via INFO screen. Extremely long custom settings menu.

Test results: High maximum contrast up to ISO 3200, satisfactory up to ISO 12800 with good white balance but reduced dynamic range. Very good signal-to-noise ratio up to ISO 800, drop-off thereafter. Visual noise behavior similar and good up to ISO 3200. Consistently high relative resolution up to ISO 3200, only begins to deteriorate above ISO 12800. Fast continuous shooting with long sequences in JPEG and RAW modes. Very fast startup and autofocus. Contrast-based AF in live view mode slow.

Image quality: Excellent daylight color rendition, with only the orange test sticker looking slightly salmon-colored. Good, balanced sharpness and great detail for a 16-megapixel sensor. Very slight tendency to underexposure. Grayscale wedges less convincing above level 17. Only slight banding in our line chart, otherwise very few moirés. Great noise characteristics, unchanging between ISO 100 and ISO 400. Some noise artifacts above ISO 800, increasing slightly above ISO 1600, but with no visible edge deterioration. Luminance noise begins to appear at ISO 3200, but edges still sharp. Some loss of detail, edge sharpness and texture above ISO 6400 (the limit for usable full-screen views). Images begin to look washed out thereafter with increasing incidence of artifacts. No discernible fringing.

Outdoor image quality very good, with excellent color rendition, sharpness and detail rendition, even at wide apertures. Balanced exposure. Noise characteristics very good, as in our studio test shots. No discernible fringing.



ISO 100



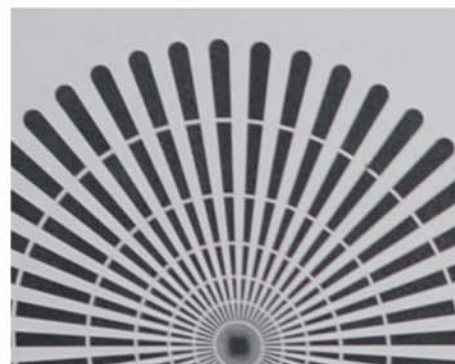
ISO 400



ISO 1600



ISO 6400





Nikon D800

Full-featured, 36-megapixel full-frame camera with a relatively compact body and unlimited length Full HD video recording to internal media or external devices.

Good: Extremely high resolution when used with high-end lenses. Extremely robust, weatherproof magnesium body with great handling. Main dial and multi-selector with better handling and more precise than those built into the D4. Extremely configurable. Large, bright, high-resolution monitor with wide angle of view and transparent protective cover. Large, backlit control panel display. Very bright 100% viewfinder with built-in blind. Very fast, precise 51-area selective single point AF that works very well in low light. Lens-dependent AF override. Fast startup and virtually no shutter lag. Fast data save times. Relatively quiet, dampable mirror. Flexible self-timer and multiple white balance presets. Built-in wireless flash control. 1/250 s X-Sync. CF/SD dual card slot. Powerful battery. USB 3.0

connector. Full HD video. Headphone and microphone connectors.

Not so good: Fixed monitor with no anti-glare coating. AF assist lamp vignettted at close subject distances. Unclear compatibility with some (current) CF card types. No central control dial (typical Nikon design), handling can take some getting used to. Direct access to only non-critical functions via INFO screen. Extremely long custom settings menu. Average continuous shooting rates. Loose rubber battery contact cap on camera bottom.

Test results: Maximum contrast high at ISO 100, satisfactory at ISO 3200 but dropping off thereafter. Excellent white balance. Very good signal-to-noise ratio at ISO 100, still okay up to ISO 800, thereafter dropping off steadily and poor at ISO 6400. Visual noise values similar. Resolution good at ISO 100, but only satisfactory between ISO 200 and 1600, and poor for higher values. Average continuous shooting speed. Very fast startup and negligible AF lag. Live view AF slow.

Image quality: Just missed an 'excellent' rating under lab conditions. Very slight yellow/green tint. Obvious color shift in our orange test sticker. Very good central sharpness, good overall sharpness at small apertures. Excellent detail rendition but slight tendency to underexposure. Slight banding on our line chart and some moirés in the center of the Siemens star, otherwise no obvious artifacts. Well-compensated fringing. Virtually no noise at ISO 100 and 200, increasing slightly at ISO 400, edges nevertheless intact up to ISO 800, which is the limit for 100% viewing. Obvious luminance and color noise at ISO 1600, but detail still acceptable. Loss of detail and texture above ISO 3200, significant luminance noise and loss of texture at ISO 6400 and above.

Outdoor images with very good color rendition, sharpness and detail rendition. Very good exposure. Noise characteristics like those observed under test conditions. Chromatic aberrations well compensated.



ISO 100



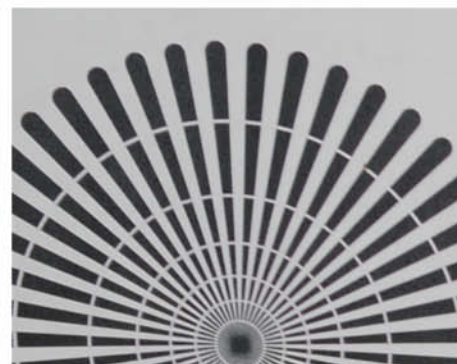
ISO 400



ISO 1600



ISO 6400





Olympus OM-D E-M5

Compact Four Thirds format system camera with SLR look and feel. Very fast AF, great electronic viewfinder, kit lens with built-in (optional) motorized zoom.

Good: Compact dust and moisture-sealed magnesium body with good overall handling. Sensor shift image stabilization. High-quality vertically tiltable OLED monitor. Infrared proximity sensor for switching to electronic viewfinder, which doesn't use color sequence technology and is easy to view. Icon-driven Quick Task menu at edge of monitor. Fast, precise (contrast-based) AF in all lighting conditions. Bright AF assist lamp. Manual focus override. Fast continuous shooting with little shutter noise. Custom limitable auto ISO. Manual white balance with two preset memories. Extremely configurable via an 86-line custom settings menu. Compact accessory flash included. Optional two-piece battery grip.

Not so good: Body almost too small, with some connectors only accessible when the monitor is tilted. Too few dedicated controls. Arrow

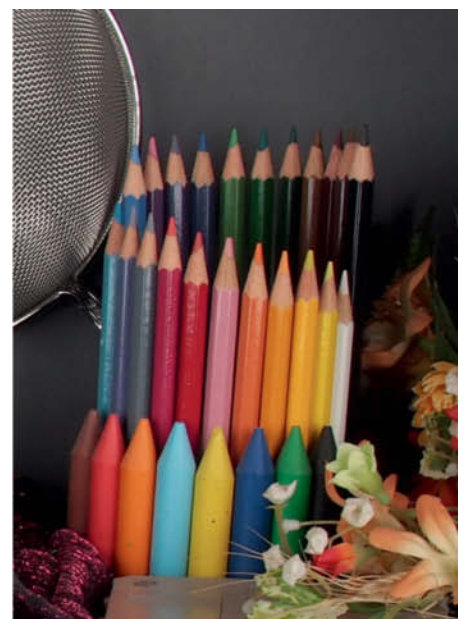
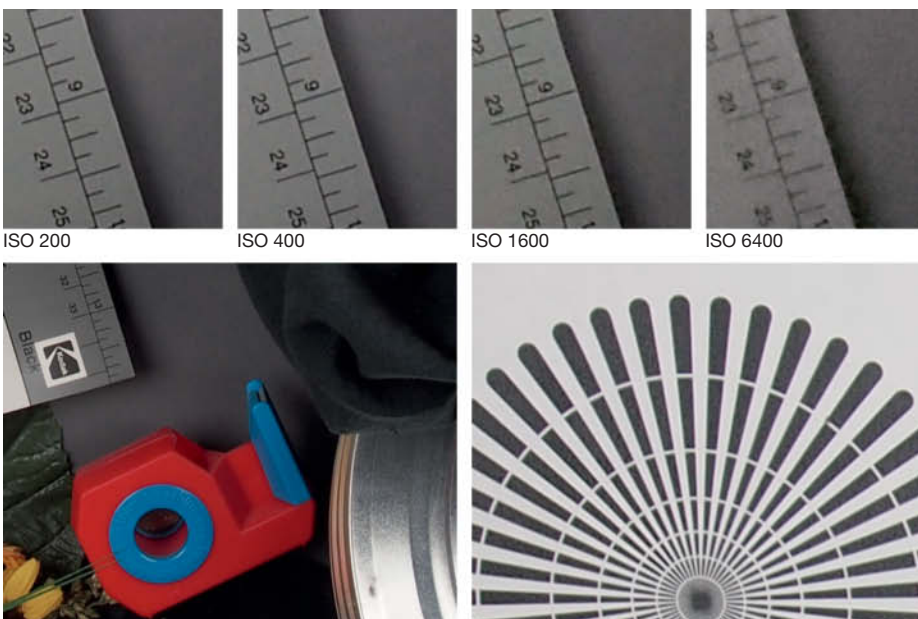
buttons too small, delay before button action becomes continuous too short. Playback and Fn1 buttons too small and difficult to use. Touchscreen functionality rudimentary. OLED screen green-tinged when viewed at an angle. No separate LED control panel. Simple self-timer. Tripod thread non-central. Moderate battery capacity with no continuous status display. High purchase price.

Test results: Maximum contrast from ISO 200 to 800 very good, dropping off slightly toward ISO 6400 and significantly above ISO 12800. Very good white balance. Signal-to-noise ratio and visual noise very good at ISO 800 and still good all the way up to ISO 3200. Very good resolution right up the ISO scale. Fast, relatively long sequences, moderate startup time and very little shutter lag for a contrast-based AF system.

Image quality: Very good color rendition under lab conditions in daylight. Orange test sticker slightly salmon-colored. Good, evenly distributed sharpness and, for a 16-megapixel

sensor, very good detail rendition. Balanced exposure with well-defined grayscale wedges. Only slight banding on our line chart, otherwise no significant moirés. Slight fringing on the text chart and our sieve. Very clean images at ISO 200, with some noise and slight loss of detail in gray tones at ISO 400. Obvious loss of detail, texture and sharpness at ISO 800 (the limit for 100% viewing). Loss of edge definition, appearance of color noise artifacts and significant loss of texture at ISO 1600, increasing toward ISO 3200 with additional color noise in our test sticker. ISO 3200 the limit for full-screen viewing. Images washed out and with significant data loss at ISO 6400 and above.

Outdoor images well exposed with good color rendition, good sharpness and very good detail rendition, even at wide-angle settings and wide apertures. Noise characteristics the same as under lab conditions up to ISO 800 (fine for 100% viewing). Loss of texture thereafter. Obvious blur and loss of detail above ISO 3200.





Pentax K-01

Bulky mirrorless system camera with legacy-compatible Pentax K lens mount.

Good: APS-C CMOS sensor with moderate 16-megapixel resolution and ultrasonic dust-off. Sensor shift image stabilization inactive when self-timer in use. Robust metal body with large main switch, mode dial and 'E-dial' (settings dial). Configurable function buttons. High-resolution 3-inch monitor with a wide angle of view. Clear, scroll-free, tab-driven menu system. Direct settings via INFO screen icons. Comprehensive data display. 81-area AF works well in low light. Effective green assist lamp. Manual focus with variable monitor image zoom. Interval timer shooting mode. User adjustable auto ISO limits. Built-in flash powerful, with good positioning and fast recycle times. Powerful, high-capacity battery. Card slot not too close to the tripod thread.

Not so good: Heavy, bulky 'designer' body too smooth, making handling tricky. Soft rubber caps on side connectors and card slot don't close firmly, and sometimes open during

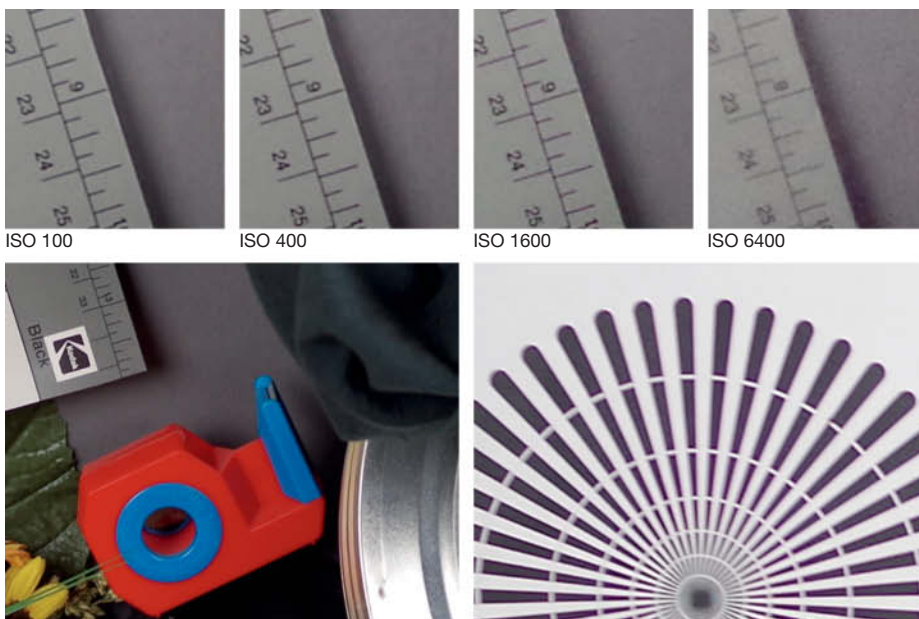
one-handed operation. Function buttons precise but too small and flat. Static monitor with no anti-glare coating. No optional viewfinder. AF loud and slow with pancake test lens in photo and video modes. Loud focal plane shutter. Short sequences in continuous mode. AF only possible in video mode by pressing separate button. 32 kHz audio recording. High purchase price.

Test results: Consistently high maximum contrast up to ISO 1600, satisfactory up to ISO 6400 and dropping off quickly thereafter. Very good white balance and ColorChecker results. Good signal-to-noise ratio up to ISO 400, okay up to ISO 3200 but deteriorating thereafter. Visual noise values similar. Resolution only good at ISO 100, but satisfactory up to ISO 1600 (rapid fall-off at higher values). Fairly fast JPEG sequences, slow RAW sequences, but both 'endless'. Average startup time and typically slow contrast-based AF, especially in low light.

Image quality: Bright, intense, slightly warm colors under lab conditions in daylight. Orange

test sticker appears bright red. Good but unreliable sharpness and detail definition at small apertures. Very few moirés. Balanced but variable exposure. Fringing well compensated only at f11 and beyond. Very clean images at ISO 100, slight noise at ISO 200. ISO 400 similar but slightly weaker looking. More obvious noise and imprecise edge detail at ISO 800 (limit for 100% viewing). Frayed edge detail and color artifacts at ISO 1600 (limit for full-screen viewing). Also loss of detail and texture and heavy smoothing due to automatic noise reduction. Sharpness and texture rapidly deteriorating at ISO 3200 and above. Images washed out at ISO 6400 and with significant green/magenta color noise thereafter.

Outdoor images comparable, with good color rendition and slightly variable exposure. Good sharpness and detail rendition at small apertures. Clean images up to ISO 400 with obvious fall-off at ISO 800. Obvious noise artifacts at ISO 1600 and dull images at higher values.





Sigma SD1 Merrill

High-end SLR with ultra-high-resolution, moiré-free APS-C Foveon sensor, modest feature set and massively reduced price.

Good: Three-layer sensor with no Bayer pattern microfilters or low pass filter, resulting in extremely high resolution for 14 (nominal) megapixels. Robust, dust-protected magnesium body with highly ergonomic battery grip. Many clearly arranged dedicated controls. Very good viewfinder image for an APS-C camera. Bright 3-inch monitor with wide angle of view. Clear main menu with scroll-free system of tabs and sub-tabs. 'Quick Set' button for fast access to major functions. 'Func' button for direct access to the Function Display. AF works well in low light. Quiet mirror, fast sequences, usable built-in flash with very short recycle time. Mains adapter with standard connector.

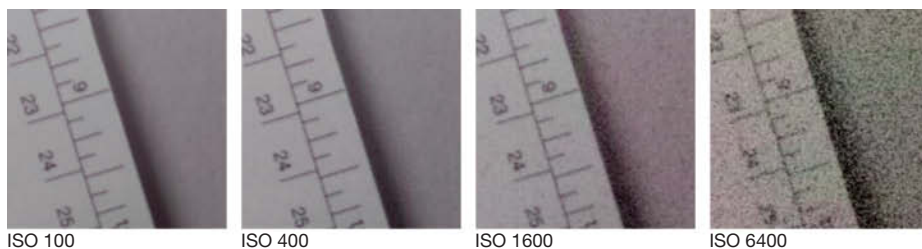
Not so good: Poor internal JPEG processing forces the use of RAW mode and PC-based image conversion, making photography a long-winded process. No live view, no control panel, no white balance fine-tuning, no HDMI

connector and no video mode. Eight-image sequences and long data save times that block other camera functions. Two main dials with many redundant features. Many settings only possible via inconvenient button/dial combinations. Relatively slow AF. AF assist lamp partially vignetted by lens barrel. Monitor resolution low for its 3-inch size. Dramatic price reduction of more than US\$6,000(!) compared with the technically almost identical 'non-Merrill' SD1. Original SD1 owners understandably upset!

Test results: Very good maximum contrast at ISO 400 and 800, with massive fall-off at ISO 6400. Average ColorChecker color rendition. Signal-to-noise ratio very high at ISO 400, falling off rapidly at ISO 1600 and above. Very poor visual noise performance at this level too. Exceptional resolution for a (nominally) 14-megapixel sensor, producing results that are off our normal test scale. Slow startup, slow AF and short sequences in continuous shooting mode.

Image quality: Poor JPEG color rendition under lab conditions in daylight. Pale images with obvious red color cast. Test sticker and marker pen orange-colored with color artifacts in red areas. General overexposure. Sharpness and detail rendition only really good between f8 and f11, otherwise with obvious blur. Hardly any moirés, except for a couple of double lines in our line chart. Little fringing. Little image noise at ISO 100, increasing slightly for monotone colors at ISO 200 (the limit for 100% viewing). Obvious color artifacts at ISO 400 (limit for full-screen viewing). Significant color noise artifacts at ISO 800, even in gray tones. Obvious color marbling at ISO 1600 and above. Practically unusable at ISO 3200 and above, with additional color noise and horizontal banding.

Outdoor images similar to lab tests with respect to color rendition and noise characteristics, but with excellent sharpness and detail rendition, even at wide apertures. Occasional chromatic aberrations.





Sony SLT-A57

High quality first-time user's APS-C SLR with fixed, semi-translucent mirror, fast continuous shooting and good continuous AF, even in Full HD video mode.

Good: CMOS sensor with moderately high 16-megapixel resolution. Well-made, relatively small plastic body. Sensor shift image stabilization and 10-fps sequences at full resolution. Simple handling with many shortcuts via the 4-way control button. Scroll-free, tab-driven menu system with icon-driven function menu for making settings directly. Sharp, high-resolution articulated monitor with wide angle of view. High-resolution electronic viewfinder with a choice of formats and automatic/manual brightness adjustment. Fast AF with dedicated sensors. Very good close-up flash. Powerful battery with percentage charge remaining display. Microphone connector. Built-in Sweep Panorama and Auto Portrait Framing functionality.

Not so good: Monitor attached to the bottom edge of the camera body, which makes it

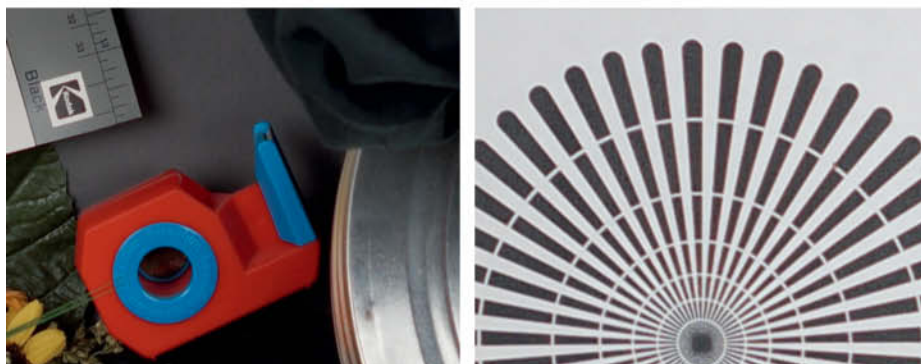
impossible to tilt the display when the camera is mounted on a tripod. No separate control panel in display. Viewfinder with annoying color sequence technology. Auto ISO limits fixed. Flash recycle time increases quickly for sequences of flash photos. Wireless flash control only with optional equipment. Shutter release too loud for a camera with no mirror movement.

Test results: High, balanced maximum contrast up to ISO 1600, falling off rapidly above ISO 6400. White balance very good. Noise characteristics very good up to ISO 800/1600, with obvious drop-off thereafter. Resolution consistently good up to ISO 3200, with obvious drop-off at higher values. Adequate sequence length, acceptable startup time and very little shutter lag.

Image quality: Neutral colors with a very slight yellow tinge, generally a little pale due to a tendency to overexpose under lab conditions in daylight. Orange test sticker stays orange. Central sharpness only good at apertures of f4.5 and smaller. Good images detail for a

16-megapixel sensor. Obvious banding on our line chart, but otherwise few moirés. Intense chromatic aberrations at wide apertures. Very clean images at ISO 100, with a slight loss of texture at ISO 200 (the limit for 100% viewing). Clear loss of texture, sharpness and detail at ISO 400. Blurred images with texture all but disappeared at ISO 800 (limit for full-screen viewing). Additional edge blur and significant luminance noise at and beyond ISO 1600, with obvious color noise cutting in above ISO 3200. Images milky and blurred above ISO 6400.

Outdoor shots with neutral colors but somewhat pale due to camera's tendency to overexpose. Very good overall sharpness and very good detail rendition at smaller apertures. Noise characteristics better than under lab conditions. Fine textures in shadow areas slightly lacking at ISO 400 and obviously deteriorating at ISO 800. Washed-out details at ISO 1600 and significant luminance noise at higher values. Serious fringing at wide apertures.



DSLR AND SYSTEM CAMERA OVERVIEW

Manufacturer and Model	Canon EOS 5D Mark III	Nikon D4	Nikon D800
URL	www.canon.com	www.nikon.com	www.nikon.com
Digitization			
Native resolutions (in pixels)	5760 × 3840, 3840 × 2560, 2880 × 1920, 1920 × 1280, 720 × 480	4928 × 3280, 3696 × 2456, 2464 × 1640 (36 × 24), 4096 × 2720, 3072 × 2040, 2048 × 1360 (30 × 20), 3200 × 2128, 2400 × 1592, 1600 × 1064 (24 × 16), 4096 × 3280, 3072 × 2456, 2048 × 1640 (30 × 24)	7360 × 4912, 5520 × 3680, 3680 × 2456 (36 × 24), 6144 × 4080, 4608 × 3056, 3072 × 2040 (30 × 20), 4800 × 3200, 3600 × 2400, 2400 × 1600 (24 × 16), 6144 × 4912, 4608 × 3680, 3072 × 2456 (30 × 24)
Sensor type, effective megapixels / Size / Self-cleaning	CMOS, 22 / Full-frame (36 mm × 24 mm) / ✓	CMOS, 16 / Full-frame (36 mm × 23.9 mm) / ✓	CMOS, 36 / Full-frame (35.9 mm × 24.0 mm) / ✓
Image format(s) / Compression rates / Video format	RAW, JPEG, RAW+JPEG / 2 / MPEG-4 H.264	RAW, TIFF, JPEG, RAW+JPEG / 3 / MPEG-4 H.264	RAW, TIFF, JPEG, RAW+JPEG / 3 / MPEG-4 H.264
Video: max. resolution [pixels], length, fps	Full HD 1080p, 29 min 59 s, 30	Full HD 1080p, 29 min 59 s, 30	Full HD 1080p, 29 min 59 s, 30
Memory card type / average file size ³	SD(HC/XC) + CF I / 11.5 MB	XQD + CF I / 11.8 MB	SD(HC/XC) + CF I / 23.4 MB
Features			
Crop factor (35mm equiv.) / Bayonet	- / Canon EF	- / Nikon F (AF)	- / Nikon F (AF)
ISO settings	Auto (with custom limits), (50) 100-25 600 (51 200, 102 400) in 1/3 or 1/1 increments	Auto (200-upper limit + longest exposure up to 1 s), (50) 100-12 800 (25 600-204 800) in 1/3, 1/2 or 1/1 increments	Auto (200-upper limit + longest exposure up to 1 s), (50) 100-6400 (25 600) in 1/3, 1/2 or 1/1 increments
Shutter speeds [s] / Default flash sync [s]	Bulb, 30–1/8000 / 1/200	Bulb, 30-1/8000 / 1/250	Bulb, 30-1/8000 / 1/250
Focusing / Image stabilizing	AF (one-shot, continuous, tracking, face-detection), MF / ✓ (in-lens)	AF (one-shot, continuous, tracking), MF / – (in-lens)	AF (one-shot, continuous, tracking), MF / – (in-lens)
AF areas / Focus assist lamp	61 (41 cross, 5 double cross sensors) or 1 (61 positions) or various combined areas / –	51 (15 cross sensors) or 1 (51 or 11 positions) or selected combinations (21 or 9) / –	51 (15 cross sensors) or 1 (51 or 11 positions) or selected combinations (21 or 9) / ✓ (white)
Metering: Matrix / Center-weighted / Spot	✓ (63 sectors) / ✓ / ✓	✓ (91,000 pixels) / ✓ (4 metering area sizes) / ✓	✓ (91,000 pixels) / ✓ (4 metering area sizes) / ✓
Programmed auto / Scene modes / Custom presets	✓ (with shift) / Subject recognition / ✓ (3 presets)	✓ (with shift) / – / ✓ (4 presets)	✓ (with shift) / – / ✓ (4 presets)
Exposure: Aperture priority / Shutter priority / Manual	✓ / ✓ / ✓	✓ / ✓ / ✓	✓ / ✓ / ✓
Exposure compensation [EV] / Depth-of-field preview	±5 EV in 1/3 or 1/1 increments / ✓	±5 EV in 1/3, 1/2 or 1/1 increments / ✓	±5 EV in 1/3, 1/2 or 1/1 increments / ✓
Bracketing: Exposure / WB / Focus / Interval timer / Sound	✓ / – / – / – / ✓ (16-bit, mono ² , 48 kHz)	✓ (highly configurable) / ✓ (+ D-Lighting bracketing) / – / ✓ (+ time-lapse) / ✓ (16-bit, mono ² , 48 kHz)	✓ (highly configurable) / ✓ (+ D-Lighting bracketing) / – / ✓ (+ time-lapse) / ✓ (16-bit, mono ² , 48 kHz)
Self-timer / Continuous shooting speed (JPEG/RAW) ⁶	12 or 2 s / 4.7 fps, 16 shots; 2.2 fps, until card full	20, 10, 5 or 2 s (1-9 shots, 0.5-3 s intervals) / 10.2 fps, 62 shots; 10.1 fps, 56 shots (11-1 fps selectable)	20, 10, 5 or 2 s (1-9 shots, 0.5-3 s intervals) / 4.0 fps, 100 shots; 4.0 fps, 100 shots (5-1 fps selectable)
White Balance: Auto + Man. / Presets / Fine-tuning	✓ / 6 / ✓ (and Kelvin)	2 auto + 4 man. / 12 / ✓ (and Kelvin)	2 auto + 4 man. / 12 / ✓ (and Kelvin)
Sharpness, Contrast, Saturation adjustable / Color spaces	✓ / sRGB, Adobe RGB	✓ (Fine-tuning) / sRGB, Adobe RGB	✓ (Fine-tuning) / sRGB, Adobe RGB
Viewfinder: Type / Magnification / Coverage / Eyepiece distance	Pentaprism / 0.71x / 100 % / 21 mm	Pentaprism / 0.7x / 100 % / 18 mm (with built-in blind)	Pentaprism / 0.7x / 100 % / 17 mm (with built-in blind)
Monitor: Diagonal / Resolution [dots] / No. of brightness settings	3.2" / 1,040,000 / 7	3.2" / 921,000 / 11 or automatic	3.2" / 921,000 / 11 or automatic
Live View / With AF using sensor / Dedicated sensors	✓ / ✓ / ✓	✓ (5-30 min. or unlimited) / ✓ / –	✓ (5-30 min. or unlimited) / ✓ / –
Body material / Control panel / Auto monitor rotation	Magnesium, weatherproof / ✓ (orange backlight) / –	Magnesium, weatherproof / 2 (blue backlight, EL) / –	Magnesium, weatherproof / ✓ (green backlight) / –
4-way selector / Multi selector / Command dials	✓ (mini joystick) / 1 / 2	✓ (8-way + center button and 2 joystick-style multi-selectors) / 1 / 4	✓ (8-way + center button) / 1 / 2
Flash guide number (ISO 100) / Charge time / Connector	- / – / ✓ (TTL shoe, X-Sync socket)	- / – / ✓ (TTL shoe, X-Sync socket)	12 / 4.4 s / ✓ (TTL shoe, X-Sync socket)
Playback			
Multiple [# of images] / Zoom / Histogram	9 or 4 / ✓ (up to 10x) / ✓ (with RGB)	72, 9 or 4 / ✓ / ✓ (with RGB)	72, 9 or 4 / ✓ / ✓ (with RGB)
Connectors / Dimensions			
Power source	Mains adapter (dummy battery), Li-Ion battery, battery grip	Mains adapter (dummy battery), Li-Ion battery	Mains adapter (dummy battery), Li-Ion battery, battery grip
Interfaces / A/V out / HDMI / Remote control	USB 2.0 / ✓ (proprietary, stereo mic IN, headphones) / ✓ (type C) / ✓ (IR or Cable)	USB 2.0, LAN, GPS IN / – (stereo mic IN, headphones) / ✓ (type C) / ✓ (Cable)	USB 3.0, GPS IN / – (stereo mic IN, headphones) / ✓ (type C) / ✓ (Cable)
Dimensions (W/H/D) / approx. weight ⁶ / Body only / With test lens	152 mm × 116 mm × 76 mm / 955 g, 1620 g	160 mm × 157 mm × 91 mm / 1340 g, 2260 g	146 mm × 123 mm × 82 mm / 995 g, 1910 g
What's in the Box			
Manual / User guide	Quick start guide, User manual	Quick start guide, User manual, Networking guide	Quick start guide, User manual
Accessories	Li-Ion battery LP-E6 (7.2 V, 1800 mAh, 13 Wh), charger, body cap, eyecup, shoulder strap, USB cable	Li-Ion battery EN-EL18 (10.8 V, 2000 mAh, 22 Wh), twin charger, body, eyepiece, battery chamber and flash shoe covers, shoulder strap, USB cable	Li-Ion battery EN-EL15 (7.0 V, 1900 mAh, 14 Wh), charger, body cap, flash shoe cover, transparent monitor cover, shoulder strap, USB cable
Optional accessories	Memory cards, mains adapter, IR or cable remote release, HDMI cable, bags, wireless transmitter, GPS module, EOS system accessories	Memory cards, mains adapter + battery chamber adapter, cable remote release, GPS receiver, WiFi adapter, HDMI cable, microphone, angle finder, Nikon system accessories	Memory cards, mains adapter + battery chamber adapter, cable remote release, GPS receiver, WiFi adapter, HDMI cable, microphone, angle finder, Nikon system accessories
Software			
Standalone software (Platform)	ImageBrowser EX 1.0, EOS Utility 2.11, Digital Photo Professional 3.11, PhotoStitch 3.1/3.2, Picture Style Editor 1.10 (Win/Mac)	Nikon ViewNX 2 (Win/Mac)	Nikon ViewNX 2 (Win/Mac)
Ratings			
Test images ¹ (c't test image shot in daylight)	Shot using an EF 24-105mm F/4L IS USM	Shot using an AF-S Nikkor 24-70mm f/2.8 G ED	Shot using an AF-S Nikkor 24-70mm f/2.8 G ED
Color rendition / Exposure	⊕⊕ / ⊕	⊕⊕ / ⊕	⊕⊕ / ⊕
Sharpness / Detail rendition	⊕ / ⊕⊕	⊕ / ⊕	⊕⊕ / ⊕⊕
Image noise / Other artifacts ²	⊕⊕ / ⊕	⊕⊕ / ⊕	⊕ / ⊕
Ease of use ⁴ / Printed manual	⊕⊕ / ⊕⊕	⊕ / ⊕⊕	⊕ / ⊕⊕
Feature set ^{4,5} / Included accessories ⁴	⊕⊕ / ○	⊕⊕ / ○	⊕⊕ / ○
RRP: Body only / With test lens (US\$)	3,500 / 4,450	6,000 / 7,890	3,000 / 4,890
¹ Judged by eye on a calibrated monitor (applies only to these cameras and therefore not comparable with earlier tests)			
² Artifacts, noise, moirés, axial and longitudinal chromatic aberrations			
³ Average value, measured using largest native image size and best JPEG quality			
⁴ Relative to similar class/price of camera			
⊕⊕ excellent ⊕ good ○ satisfactory ⊖ poor ⊕⊖ inadequate ✓ included – not included n/a not applicable			

Olympus OM-D E-M5	Pentax K-01	Sigma SD1 Merrill	Sony SLT-A57
www.olympus.com	www.pentax.com	www.sigmaphoto.com	www.sony.de
4608 × 3456, 2560 × 1920, 1024 × 768 (4:3, each adjustable to 3:2, 16:9, 1:1 or 3:4)	4928 × 3264, 4224 × 2816, 3456 × 2304, 2688 × 1792 (3:2, each adjustable to 4:3, 16:9 or 1:1)	4704 × 3136, 3264 × 2176, 2336 × 1568	4912 × 3264, 4912 × 2760 (16:9), 3568 × 2368, 3568 × 2000 (16:9), 2448 × 1624, 2448 × 1376 (16:9)
LiveMOS, 16 / Four Thirds (17.3 mm × 13.0 mm) / ✓	CMOS, 16 / APS-C (23.7 mm × 15.7 mm) / ✓	Foveon X3 CMOS, 14.8 / APS-C (23.5 mm × 15.7 mm) / – (Filter behind bayonet)	CMOS, 16 / APS-C (23.5 mm × 15.6 mm) / ✓
RAW, JPEG, RAW+JPEG / 2 (only at max. resolution) / MPEG-4 H.264 or MJPEG	RAW, JPEG, RAW+JPEG / 3 / MPEG-4 H.264	RAW, JPEG, RAW+JPEG / 3 / –	RAW, JPEG, RAW+JPEG / 2 / AVCHD 2.0 or MPEG-4 H.264
Full HD 1080p, approx. 29 min, 30	Full HD 1080p, approx. 16 min 20 s, 30	–	Full HD 1080p, approx. 29 min, 50
SD(HC/XC) incl. EyeFi / 7.3 MB	SD(HC/XC) / 6.9 MB	CF I / 7.3 MB	SD(HC/XC) or MS Duo / 6.9 MB
Approx. 2x / Micro Four Thirds (Four Thirds with Adapter)	Approx. 1.5x / Pentax KAF2	Approx. 1.5x / Sigma SA	Approx. 1.5x / Sony alpha, Minolta AF
Auto (with custom limits), 200-25 600 in 1/3 or 1/1 increments	Auto (with custom upper limit), 100-12 800 (25 600) in 1/1, 1/2 or 1/3 increments	Auto (100-800), 100-6400 in 1/1 increments	Auto (100-3200), 100-16 000 in 1/1 increments
Bulb, 60-1/4000 / 1/250	Bulb, 30-1/4000 / 1/180	Bulb, 30-1/8000 / 1/180	Bulb, 30-1/4000 / 1/160
AF (one-shot, touch-AF, continuous, tracking, face-detection), MF / ✓ (sensor shift)	AF (one-shot, tracking, face-detection), MF / ✓ (sensor shift)	AF (one-shot, continuous, tracking), MF / – (in-lens)	AF (one-shot, continuous, tracking, face-(re)detection), MF / ✓ (sensor shift)
35, 9 (15 positions) or 1 (35 positions) / ✓ (red)	81 or 1 (3 sizes, max. 81 positions) / ✓ (green)	11 (cross sensors) or 1 (11 positions) / ✓ (red/orange)	15 (cross sensors) or 13 (3 zones) or 1 (15 positions) / ✓ (rapid flash)
✓ (324 zones) / ✓ / ✓	✓ (1024 metering areas) / ✓ / ✓	✓ (77 segments) / ✓ / ✓	✓ (1200 zones) / ✓ / ✓
✓ (with shift) / 23 / ✓ (4 presets)	✓ (with shift) / 21 / –	✓ (with shift) / – / ✓ (3 presets)	✓ (with shift) / 9 / –
✓ / ✓ / ✓	✓ / ✓ / ✓	✓ / ✓ / ✓	✓ / ✓ / ✓
±3 EV in 1/3, 1/2 or 1/1 increments / – (via Fn2 configuration)	±3 EV in 1/3 or 1/2 increments / ✓ (green button)	±3 EV in 1/3 increments / ✓	±3 EV in 1/3 increments / ✓
✓ (+ ISO bracketing) / ✓ / – / – / ✓ (16-bit, stereo, 48 kHz)	✓ / – / – / ✓ / ✓ (16-bit, stereo, 32 kHz)	✓ / – / – / – / –	✓ / ✓ / – / – / ✓ (16-bit, stereo, 48 kHz)
10 or 2 s / 5.7 fps, until card full; 5.7 fps, 20 shots	10 or 2 s or smile-detection / 8.0 fps, 29 shots; 7.9 fps, 21 shots	10 or 2 s / 4.5 fps, 8 shots; 4.0 fps, 7 shots	12 or 2 s / 8.6 fps, 15 shots; 8.5 fps, 15 shots
✓ (man.: 2 presets) / 7 / ✓ (and Kelvin)	✓ / 10 / ✓ (and color temperature increase)	✓ / 6 / –	✓ / 9 / ✓ (and Kelvin)
✓ / sRGB, Adobe RGB	✓ / sRGB, Adobe RGB	✓ / sRGB, Adobe RGB	✓ / sRGB, Adobe RGB
Electronic (1.4 million pixels, IR sensor) / 1.15x / 100 % / 18 mm	– / – / – / –	Pentaprism / 0.95x / 98 % / 18 mm	Electronic (1.4 million pixels, color sequence tech., IR sensor) / 1.04x / 100 % / 25 mm
3.0" touchscreen (OLED), vertical two-way tilt / 610,000 / 5 (plus selectable color temperature)	3.0" / 921,000 / 13 (and auto brightness)	3.0" / 460,000 / 7	3.0", tilt/swivel, bottom-mounted / 921,600 / auto or 5
✓ / ✓ / –	✓ / ✓ / –	– / – / –	✓ / – / ✓
Magnesium, weatherproof / – / –	Aluminum / – / –	Magnesium, weatherproof / – / –	Plastic / – / –
✓ (5 buttons) / 1 / 2	✓ (5 buttons) / 1 / 1	✓ (5 buttons) / 2 / 2	✓ (+ main button) / 1 / 1
10 (ISO 200) ⁸ / 4.3 s / ✓ (TTL shoe)	12 / 3.2 s / ✓ (TTL shoe)	11 / 1.3 s / ✓ (TTL shoe)	10 / 2.4 s / ✓ (Sony/Minolta TTL shoe)
100, 25, 9 or 4 calendar / ✓ (up to 14x) / ✓ (with RGB)	9 / ✓ (up to 16x) / ✓ (with RGB)	9 / ✓ (up to 10x) / ✓ (with RGB)	9 or 4 / ✓ (up to 13.6x) / ✓ (with RGB)
Li-Ion battery, two-piece battery grip	Mains adapter (proprietary), Li-Ion battery	Mains adapter (standard socket), Li-Ion battery, battery grip	Mains adapter (proprietary), Li-Ion battery grip
USB 2.0 / ✓ / ✓ (type D) / ✓ (Cable)	USB 2.0 / ✓ / ✓ (type C) / ✓ (IR)	USB 2.0 / ✓ (proprietary) / – / ✓ (IR or Cable)	USB 2.0 / – / ✓ (type C) / ✓ (IR or Cable)
121 mm × 90 mm × 42 mm / 430 g, 645 g	121 mm × 79 mm × 59 mm / 555 g, 610 g	146 mm × 114 mm × 80 mm / 790 g, 1285 g	132 mm × 98 mm × 81 mm / 620 g, 790 g
Quick start guide, User manual (PDF only)	User manual	User manual	Quick start guide, User manual
Li-Ion battery BLN1 (7.6 V, 1220 mAh, 9.3 Wh), charger, body cap, FL-LM2 accessory flash, shoulder strap, USB and AV cables, kit lens(es), if applicable	Li-Ion battery D-LI90 (7.2 V, 1860 mAh, 14 Wh), charger with mains cord, body cap, flash shoe cover, shoulder strap, AV/USB cable, kit lens	Li-Ion battery BP-21 (7.4 V, 1500 mAh, 12 Wh), charger, body cap, eyecup, shoulder strap, USB cable, video cable	Li-Ion battery NP-FN500H (7.2 V, 1600 mAh, 11.8 Wh), charger, body cap, eyecup, shoulder strap, kit lens(es), if applicable
Memory cards, bags, accessory flash, interchangeable lenses, mains adapter, cable remote release, accessory microphone, Bluetooth module, HDMI cable, Olympus system accessories	Memory cards, mains adapter, IR remote release, HDMI cable, bags, GPS receiver, Pentax SLR system accessories	Memory cards, battery grip, mains adapter, cable or IR remote release, bags, Sigma system accessories	Memory cards, mains adapter, cable or IR remote release, USB and HDMI cables, bags, accessory microphone, Sony alpha system accessories
Olympus ib (Win), Olympus Viewer 2 (Win/Mac)	SILKYPIX Developer Studio 3.0 (Win/Mac)	SIGMA Photo Pro	Image Data Converter SR
Shot using an M.ZUIKO 12-50mmf/:3.5-6.3 EZ ED MSC	Shot using an SMC Pentax DA 40mm f/2.8 XS	Shot using a Sigma 70mm f/2.8 DG Macro EX	Shot using an SAL-50F18 50mm f/1.8
⊕ ⊕ / ⊕ ⊕	⊕ / ⊕ ⊕	⊖ / ⊙	⊕ ⊕ / ⊕
⊕ / ⊕	⊕ / ⊕	⊙ / ⊙	⊕ / ⊕ ⊕
⊙ / ⊕	⊕ / ⊙	⊕ ⊖ / ⊕	⊕ / ⊙
⊙ / ⊕	⊕ / ⊕ ⊕	⊕ / ⊕ ⊕	⊕ / k. A.
⊕ ⊕ / ⊙	⊙ / ⊙	⊕ / ⊙	⊕ ⊕ / ⊙
999 / 1,500	750 / 900	2,300 / 2,800	700 / 870
⁵ Photographic features only	⁷ Stereo using accessory microphone		
⁶ Measured values	⁸ Accessory flash (included, weighs 30 g)		



Ulrich Hilgefort, Angela Meyer

Light Field Photography with the Lytro

If focus or depth of field in a photo don't turn out the way you intended, you will probably try to improve your technique or repeat the shot. Scientist Ren Ng has taken a different approach, developing camera technology that enables you to decide where you want to position the plane of focus after an image is captured. His company's Lytro 'light field' camera is available now, so we decided to take one for a spin ...

The Lytro camera promises previously inconceivable creative possibilities and an end to blurred images to anyone who is prepared to invest at least US\$400 in this very new technology. Not only does the world's first consumer light field camera enable you to focus after shooting but – because it doesn't have to focus first – also claims to be faster than conventional cameras. The Lytro

has been available since March, and one of the models to hit the market found its way to our test lab.

Ren Ng, who worked on the prototype Lytro at the Computer Graphics Laboratory at Stanford University, published details of the new 'Digital Light Field Photography' technology in his doctoral thesis in 2006 (see [1] below). Ng says, "I love photography, but

I'm just not a great photographer. This thesis is grounded in my frustration at shooting so many out-of-focus photos." He has identified three basic challenges in focusing photographs:

Firstly, the subject has to be in proper focus before the shutter is released. Neither an autofocus system nor the photographer can solve this problem.

Secondly, depth of field depends on the size of the aperture you use – the larger the opening, the shallower the in-focus area behind and in front of the plane of focus will be. Additionally, closing the aperture down produces greater depth of field and automatically increases the exposure time required to capture the same image, but increases the risk of camera shake and blurred details. The settings selected by the photographer or the camera's systems always represent a compromise between these two fundamental factors.

Finally, all lenses produce optical errors due to refraction and reflection, whether the compound lens they are part of is correctly focused or not. The larger the aperture, the greater the differences in necessary refraction for inner and outer light rays and the degree of optical inaccuracies in the captured image. While it is no longer necessary to keep a portrait subject's head still using metal supports, there are still plenty of situations – indoors or at dusk for example – in which we have to use either a tripod or flash to capture enough light.

Until very recently, the desire to correct focus settings after image capture posed insurmountable technical problems. Conventional cameras register the amount and color of the light reflected by the subject and save the corresponding data in the form of a two-dimensional mosaic. The camera's image sensor adds all the photons that hit each pixel together to calculate a definitive value for the brightness of the light that reaches it. The only way a point on a subject can be reproduced in focus in a digital image is if the camera's lens focuses the light emanating from each point on the subject onto the sensor. Multiple pixels capture light from points on the subject that cannot be focused together with the light emanating from other points on the sensor plane, producing out-of-focus detail in the captured image.

Light Field Photography

Light field photography is based on the idea that if we know which point on the subject produces each point of light on the sensor,

Researchers at the Stanford Computer Graphics Laboratory used this multi-camera array to take the first experimental light field photos in the early 2000s

we can capture them all and 're-sort' them later. As well as registering the color and intensity of each point of light, a light field camera also registers the direction and distance it comes from. The term 'light field' was coined by the Russian scientist Alexander Gershun way back in 1936 and describes the distribution of light rays in space in mathematical terms. In order to capture light rays in a way that can be interpreted as a light field, the camera has to establish a relationship between the direction a ray comes from and the place where it hits the image sensor. The technology used in the Lytro camera combines contemporary digital photo technology with ideas for a 'plenoptic camera' first published by physicist and Nobel Prize winner Gabriel Lippmann in 1908.

A digital plenoptic camera has an array of microlenses positioned between the lens and the image sensor. Each microlens captures only some of the light emanating from each point on the subject, and the pixel on the sensor that the microlens steers the light toward depends on where the light source is positioned within the three-dimensional space being photographed. This means that for every light ray within the captured space, the camera stores a two-dimensional model of its color, intensity and the beginning and end of its path through that space (see the illustration on page 36). The Lytro software then uses this data to create images with varying planes of focus.

The technical demands when capturing so much light distribution detail are huge. The

sensor resolution and memory capacity requirements are far greater than for conventional digital image capture systems and you need a lot of computing power to turn all that data into usable images.

The basic principles used to transform plenoptic image data into a two-dimensional image have their origins in computer graphics. In 1996, Marc Levoy and Pat Hanrahan at Stanford University used the light field principle to develop algorithms capable of determining where and how light within space will be reflected while rendering a scene (see [2] below).

The resulting principle is called 'ray tracing' and can be used to separate the data relating to a single plane of focus from the mass of data captured by a light field camera. The resulting photo is the product of the average of all the light rays that make up the (subsequently) selected plane of focus. This way, you can change the plane of focus of the image after it has been captured.

The first attempts to capture light fields were made at Stanford in the 1990s using a veritable wall of cameras and mainframe computers to calculate each refocus. The first prototype of a handheld light field camera was exhibited in 2005. This was a conventional digital camera with an array of 296×296 microlenses that bundled the incoming light and redirected it toward a 4000×4000 -pixel image sensor (see [3] below).

The steps involved in processing the image data produced by this Contax prototype clearly show how light field techniques extend conventional digital image processing

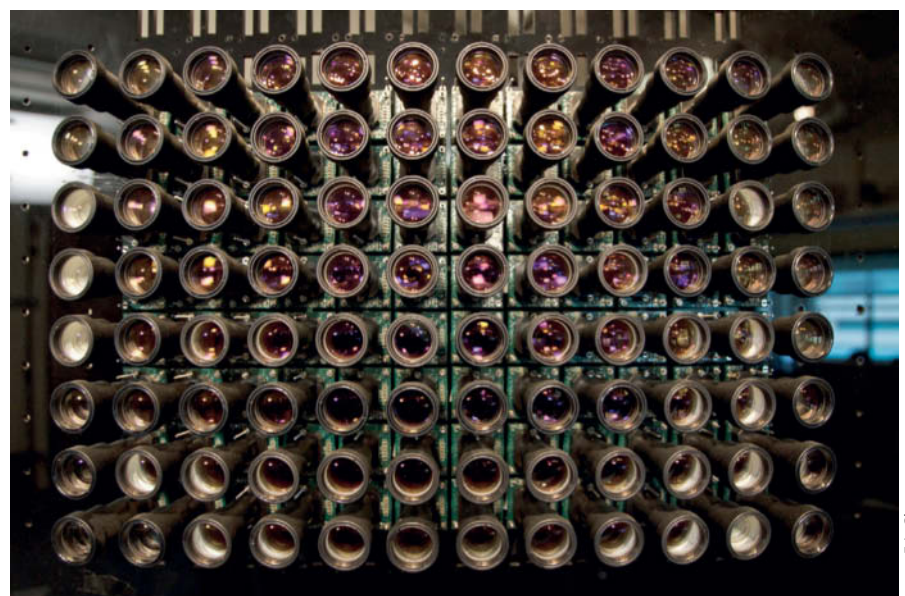
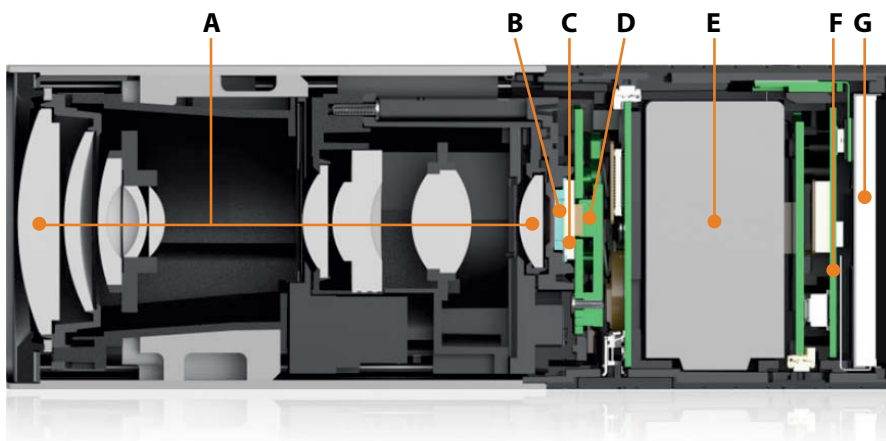


Image: Eric Cheng



The camera's tiny touchscreen display doubles as its control panel but can be difficult to view from an angle. Moving your fingertip over the grooves in the gray part of the camera body zooms the lens.



The main components of the Lytro in cross-section:
 A: 8x optical zoom lens, B: Microlenses, C: Converter chip, D: Processor board,
 E: Battery, F: Display board, G: Touchscreen

algorithms. The first step, called demosaicing, interpolates the RGB values for each pixel in the image based on the pattern of colors in the microlens array. The distance between the microlenses and the converter pixels located behind them is then compensated for by rotating the two-dimensional image by a maximum of 0.1 degrees. In the third step, the resulting pixels are again interpolated to produce a number of pixels per microlens that can be divided by a discrete number. Next, the two-dimensional data from the sensor is distributed to form a matrix of sub-images. The penultimate step involves refocusing – in other words, addition and shifting of the sub-images using ‘supersampling’ techniques and quadrilinear reconstruction filters. Finally, the finished image is separated from all the unwanted rays surrounding it using a digital vignetting process.

The Lytro

The Lytro is a fully functional consumer light field camera. It is small enough to be held in the palm of your hand, even though it has an 8x zoom lens and a CMOS analog-to-digital converter with an array of microlenses built in. The camera is supplied with a USB cable and a quick start guide, and software for importing and viewing images on Mac computers is stored in its built-in memory. A Windows version is available as well.

Even the appearance of the camera underscores its completely new approach to photography. The camera body is 4.41 inches (112 mm) long and 1.61 inches (41 mm) square in section. The rear end houses a 38.5 mm square touchscreen LCD display that also doubles as the camera’s control panel. The 8x zoom lens has an equivalent range of 43-350 mm and is zoomed by moving your finger over the sensor strips on top of the rear portion of the camera body. The currently selected zoom setting is indicated on the LCD screen. Pressing the shutter release button on the top of the camera captures the view shown on the screen as a light field, and the camera automatically displays versions with different planes of focus on the tiny display.

The touchscreen uses swipe gestures to access the menus and switch to playback mode or display the current battery charge level and the amount of free memory. You can also use it to switch between Everyday and Creative shooting modes. In Everyday mode, the refocus range (i.e., the distance between foreground and background objects that can be refocused) is set automatically, whereas in Creative mode, tapping an object within the frame sets that object as the middle of the refocus range. The Lytro does not have a

conventional focusing or any adjustable exposure parameters.

The camera is relatively easy to operate (see the explanatory video on this issue's free DVD), although the narrow angle of view of the LCD display does make using it quite tricky, and if your shooting position means that you have to view the screen from an angle, you will basically be shooting blind. You can view your captured images and change the focus setting in-camera, although the tiny size of the display makes the results pretty unspectacular.

Viewing light field images on a computer is an entirely different ball game. As soon as you connect the Lytro to a Mac using the USB cable provided, the camera automatically imports your images. Downloading our 165 test images took 13 minutes. Once your images have been transferred, all you have to do is select one from the overview in the supplied software and click on the image detail where you would like to place the center of focus. The software then automatically generates and displays the appropriate two-dimensional image. Changes in focus take place steplessly and independently of the optical characteristics of the lens itself. The resulting planes of focus and blur are similar to those produced by a standard lens at its widest aperture setting and have a convincing photographic look. The focus shift effect is really quite spectacular when viewed on a large monitor, although Lytro doesn't let on exactly how its software works.

Each captured image takes up about 20 megabytes of memory and has a quoted resolution of 11 megarays, which means that it contains data relating to the direction, intensity and color of 11 million separate light rays. These numbers indicate that the production Lytro contains technology that is a lot more sophisticated than that described by Ren Ng in his dissertation.

The company calls the images the device produces "living pictures", and the way you can adjust the point of focus within an image just by clicking on it is truly amazing. Light field images are great for use with interactive online or computer-based media, but their meager 1080 × 1080-pixel (1.2 MB) resolution isn't sufficient to produce usable prints.

You have to choose your subject carefully if you want to make the most of the light field effect, and most smartphones are more suited to general, everyday photography. The effect only really becomes visible if the subject has sufficient depth of detail to provide multiple effective points of focus. If you don't take such compositional factors into account while shooting, the Lytro cannot exploit its special capabilities to the full.

The top-of-the-range model from Raytrix delivers light field images with an effective resolution of more than seven megapixels



The Hardware

The Lytro's manufacturer keeps much of the device's technical data secret. What we do know is that the built-in zoom lens has a fixed aperture of f2 and that an array of microlenses – which scans and captures the direction the incoming light comes from – is positioned between the lens and the sensor chip. Lytro doesn't give away any information about the sensor resolution or the exposure parameters the camera uses, but we can safely assume that the sensor's resolution is at least 11 times that of the resolution of the resulting images. The metadata displayed in the viewer software includes shooting mode, aperture, focal length and the automatically selected exposure time and ISO values.

The Lytro also has a built-in Marvell Avastar 88W8787 WiFi and Bluetooth chip, although these capabilities are not activated in the current version of its firmware (see the FCC report at <http://goo.gl/Bo2nN>). Wireless technology would make all sorts of new applications of light field technology possible, such as a streamed image link to a mobile telephone. The image sensor is a 6.5 × 4.5 mm

model of unknown manufacture, and each microlens appears to steer incoming light towards 10 separate sensor pixels. The camera also contains a Zoran ZR364246BGXX processor, but Lytro doesn't provide any details about its intended use.

Not Yet Perfect

In spite of its fascinating built-in capabilities, the Lytro still has some obvious drawbacks. The Lytro image format is unique and proprietary, and doesn't give you any real control of the shooting parameters it uses. The range of available ISO values is quite narrow and the touchscreen monitor/control panel is too small with too narrow a usable angle of view. The usable resolution of the captured images isn't sufficient to provide adequate print quality over the entire range from macro to telephoto. Less important, but nevertheless limiting is the absence of a tripod thread, a self-timer and built-in flash.

The lack of a Windows version of the Lytro software is a serious shortcoming and, if you want to publish light field images on the Internet, you have to upload them to the Lytro

LYTRO LIGHT FIELD CAMERA DATA

Manufacturer	Lytro, USA / www.lytro.com
Equivalent focal length	43-350 mm ¹
Aperture / Zoom range / Min. macro distance	f/2 (fixed) / 8x (optical) / 45 mm
Exposure control / Zoom	- / manual via touch pad
Image sensor / Resolution	6.5 × 4.5 mm ² / 11 megarays
Image resolution	1080 × 1080 pixels
Modes	Everyday (adjustable exposure), Creative (adjustable focus)
Output format	Camera: Light Field Picture (.lfp), software image export: JPEG
Flash / Tripod thread	- / -
Power supply	3.7 V, 2100 mAh Li-Ion battery
Memory	Built-in 8/16 GB flash (350/750 images)
Display	LCD touchscreen, 38.55 mm (1.52") diagonal, 26 × 27 mm
Computer interface	Micro USB 2.0
Software	For image import, focus adjustment and JPEG export for Mac OS X (10.6.6 and later)
Dimensions (W × H × D) / Weight	41 × 41 × 112 mm / 214 g
Price	US\$399 (8 GB model), US\$499 (16 GB model) plus delivery
¹ measured optically	² according to the FCC
	- not included



You can alter the point of focus in 'normal' and macro light field images with a single mouse click. Generally speaking, the Lytro produces well-defined close-up images, but its telephoto images are not particularly sharp.

server because there is no separate plug-in available (yet) that can adjust focus in Lytro images.

Our lab tests confirmed that the Lytro's images are – to put it politely – not particularly high quality. We measured resolution of 215 vertical line pairs, which represents only 57 percent of the theoretical maximum. However, the camera's signal-to-noise ratio and visual noise value were comparable with those of some current compact cameras. Automatic white balance was extremely poor, and the Lytro produced very noisy images in artificial light. Images shot at telephoto focal lengths show a distinct loss of sharpness, probably due to the camera's limited overall image resolution. This is another aspect of the Lytro experience that is simply not as good as the results produced by conventional compact cameras.

Industrial Light Field Cameras

The purely consumer-oriented Lytro isn't the only commercial application of light field technology available. The Raytrix company in Germany (www.raytrix.de) has been marketing 3D light field camera systems for industrial measuring and photographic purposes since 2009.

Depending on which software you use to view it, light field data captured with a Raytrix camera can be displayed with all or just some of the captured planes in focus. This gives the user access to visual data relating to precisely definable levels within an object, which can be used for quality control during manufacturing processes or for complex face recognition applications, and can also be used to build 3D models of photographed objects.

The R5 is the simplest Raytrix camera. It has an effective resolution of 1.2 megapixels and captures data on more than 30 levels, while the top-of-the-range R291 has seven megapixels of resolution and is capable of capturing up to 200 levels of 3D data. The exact distances between these 'layers' is determined by the type of microlenses you choose when configuring the camera's hardware during manufacture.

Raytrix cameras are designed primarily for industrial use and are built to custom specifications that depend on the customer's individual requirements. You can choose from a range of lenses and software to match. The computer you use to analyze and display the resulting data needs to have a lot of graphic power (a fast NVIDIA card, for example) and CUDA support. Prices for such high-end technology start at around €8,500 (US\$10,500) for camera, software and

computer. The R29 starts at around €20,000 (US\$25,000) for the camera unit alone.

The Institute of Computer Graphics at the Johannes Kepler University in Linz (Austria) is currently using a Raytrix R11C to develop a light field panorama application. The system is still in the early stages of development, although the team has already produced light field panorama images with an effective resolution of 22 megapixels (17 885 × 1 275 pixels). More details and sample images are available at the Raytrix website. Raytrix cameras are also used to produce 3D data for use in the automotive industry.

Such highly specialized cameras are not at all suitable for taking spur-of-the-moment holiday snaps. Just as the first usable digital cameras were clumsy and far too expensive for everyday use, practical applications for light field photography are still very much in their infancy, and the companies and products introduced here are not the only ones that are busy harnessing this fascinating technology. Who knows – maybe in a few years' time, every smartphone will have a built-in light field camera ...

Conclusion

If measured against conventional yardsticks such as resolution or contrast ratios, the Lytro is sure to disappoint, but those criteria don't do justice to what is really fascinating about this technology. Its real strength lies in its sensational ability to change the point of focus in an image at will. This amazing functionality enables the photographer to focus attention on a particular detail and the viewer to 'customize' the current view of an image. The Lytro proves the viability of consumer applications for a technology that has, up to now, been the preserve of research labs and industrial specialists. Once the initial buzz has worn off, the current Lytro will probably not be seen as much more than an interesting toy. However, in the long term, its appearance might just prove to be a seminal moment in the history of digital photography. (anm)

References

- [1] Ren Ng: Digital Light Field Photography, Stanford University 2006, www.lytro.com/rengng-thesis.pdf
- [2] <http://graphics.stanford.edu/projects/lightfield/>
- [3] Ren Ng et al.: Light Field Photography with a Handheld Plenoptic Camera, <http://graphics.stanford.edu/papers/lfcamera/lfcamera-150dpi.pdf>



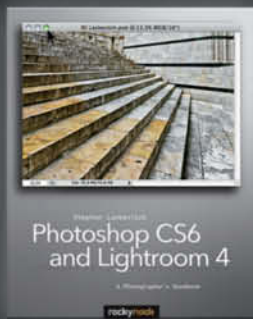


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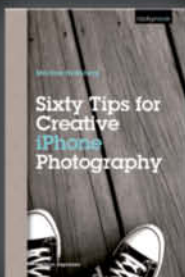
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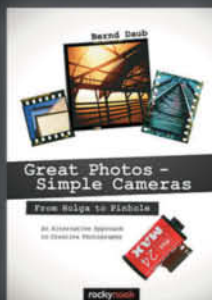
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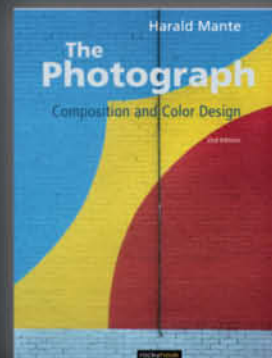


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Meike Fischer

Street Photography

Street photography illustrates public life in all its many facets. But don't be fooled: photographing strangers going about their business isn't as simple as it may seem, and it is all too easy to overstep the limits of everyday tolerance. We give you professional tips on how to go about unobtrusively capturing great spur-of-the-moment images.



In This Article

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Tips for Beginners/Workshops	Page 50

Finding and Choosing a Subject

Paris is considered to be the birthplace of street photography. The photos taken there by Eugène Atget and Brassai during the first half of the 20th century are just as relevant and moving today as they were when they were captured (see the box opposite). Nevertheless, you don't have to stalk the streets of major cities such as Paris, New York or London to find great photographic subjects.

Neighbors having a chat, business people hurrying by, kids playing, peaceful alleyways, and busy streets and squares can be found in small towns or even in the country. Large, small and often banal or absurd scenes take place everywhere, every day, although when you are taking your first street photography steps, it is of course easier to find subjects in the whirl of the city.

There are many different ways to approach street photography, and you can achieve great results whether you are loud and direct or quiet and subtle. There isn't even a generally agreed definition of what 'street photography' really means. While some photographers consider true 'street' shots to be of people taken from as close as possible, I consider virtually the opposite to be the case. Walker Evans' wonderful photos of people on the street and in the subway are, strictly speaking, portraits rather than street shots.

Signs of Everyday Life

'People' photos such as these are missing what I consider to be one of the central elements of traditional street photography, namely public signs of everyday life. Street photos do, of course, include people, but often only in a supporting role or as mere traces of their existence. The city, which couldn't exist without people, acts as a metaphor for its inhabitants – an idea developed, among others, by contemporary photographers such as Stephen Shore.

A 'special moment' framed in a well-composed photo is an image of 'true' street photography that is widely held and keenly discussed in many forums. However, in a photo that aims to document daily life, that 'special moment' can, by definition, only make up a small part of the whole. Daily life is, on the whole, unspectacular. The recently discovered street portraits taken by Vivian Maier in Chicago in the 1950s and 60s are great examples of impressive everyday photos, as are Fred Herzog's photos of the "unobtrusive reality" of city spaces.

The individualization of a human subject is not critical to the success of a photo of public

life, and people need neither to be recognizable nor be looking into the camera at the moment a photo is taken. Alongside Saul Leiter's photos, in which people are often shown out of focus, through misted-up glass or from behind, I find Trent Parke's wonderful sequence *Dream/Life & Beyond* particularly impressive. Parke often visualizes people as spectral-looking figures in high-contrast black and white images. Another example is Andreas Herzau, who uses out-of-focus people in the foreground, extreme crops of human subjects and silhouettes as stylistic elements in his documentary-style photos.

close as possible, without any warning, in order to achieve an 'authentic' look. The ball that started rolling with the success of Martin Parr's stark flash photos is obviously still going strong.

Driven by the desire to shoot authentic, moving images, many photographers end up shooting and publishing photos of vulnerable or disadvantaged people. I find this approach disrespectful and morally questionable, regardless of whether you adhere to the appropriate legal guidelines.

However, even if you are sure of your legal ground and you are shooting in ethically

"Photographs are often treated as important moments, but really they are just little fragments and souvenirs of an unfinished world."

Saul Leiter

In order to illustrate people in a temporal context, it is essential to include the immediate environment in a photo. Brassai and Marianne Breslauer both photographed street scenes as overviews in which people formed only a small part of the event being portrayed. Many photos by Andreas Feininger and Lee Friedlander, too, don't just include people, but also show them within their almost overpowering urban surroundings.

I am fascinated by such photos of urban scenes in which people play a subsidiary or even incidental role. Photos by Paul Graham and Abisag Tüllmann's shots of Frankfurt in the 1960s are impressive examples of this approach to the genre.

A Question of Respect

How you decide to portray people in your street photos is, of course, a matter of personal taste, but it is nevertheless important to stick to a few basic rules when taking photos of strangers.

One current trend among amateur photographers appears to be to 'hunt' subjects and to photograph them from as

unambiguous situations, you should still ask yourself how you would feel if you or your children were portrayed in the revealing way that a spontaneous photo often embodies. Along with the need to include the surroundings within the frame, these considerations often influence the way I approach my subjects and the distance I keep when shooting.

Developing Your Own Style

None of this should prevent you from getting out there and developing your own approach to street photography. It doesn't matter whether you want to shoot close-up portraits or keep your distance – the following pages include examples of many different types of street scenes and practical advice regarding what you can shoot freely and where you need to exercise caution. We have also included a section on equipment and we go into detail on what to do if you discover a great subject but don't dare to shoot. Our real-world tips and tricks are designed to help you find ways to get started and learn how to approach strangers with your camera.



This is a classic street photo. The rainy day mood has been captured perfectly, even though the people hurrying by are blurred or unrecognizable, like the main figure. The overview of the street gives the image depth and temporal context. A portrait could never reveal so much everyday detail.

Links

The following links contain work by some of the photographers mentioned in the text.

Andreas Herzau
www.andreasherzau.de

Trent Parke
www.magnumphotos.com/trentparke

Brassaï
www.atgetphotography.com/The-Photographers/BRASSAI.html

Stephen Shore
www.303gallery.com/artists/stephen_shore/

Paul Graham
www.paulgrahamarchive.com/

Andreas Feininger
www.geh.org/fm/feininger/htmlsrc/feininger_sld00001.html

Lee Friedlander
www.artnet.com/awc/lee-friedlander.html

Saul Leiter
www.lensculture.com/leiter.html

Fred Herzog
www.equinoxgallery.com/artists/portfolio/fred-herzog

Henri Cartier-Bresson
www.magnumphotos.com/henricartierbresson

Robert Frank
www.atgetphotography.com/The-Photographers/Robert-Frank.html

Joel Meyerowitz
www.joelmeyerowitz.com/photoarchive/index.asp

What is Allowed on a Street Shoot?

In principle, you are allowed to photograph whatever you want to in a public place, and this usually includes people. However, you have to be aware that you are not necessarily allowed to publish everything you capture. In these days of omnipresent photo blogs, online photo communities and endless stock photo agencies, it is important to know which basic rules you should follow when taking and publishing photographic images. Adhering to the law regarding personal rights doesn't indicate a lack of courage, but is rather a sign of respect that can also save you a lot of trouble and legal difficulties.

The photos on these pages, which are all of people in public places, are intended to illustrate what you can and cannot

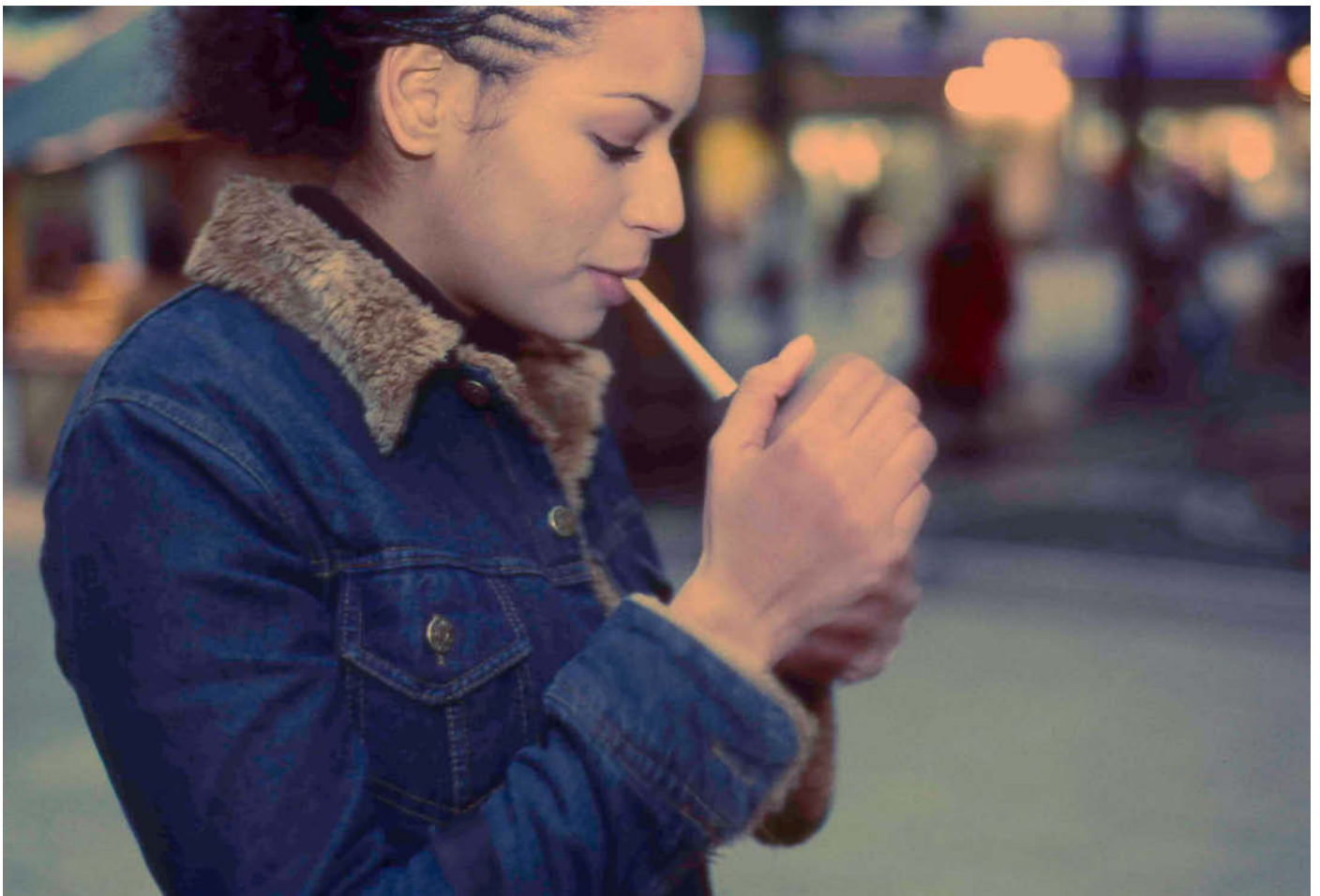
photograph, and indicate when you need to ask permission to publish.

If you photograph someone and plan to publish any or all of the results online or in print, you should always ask your subject for permission. However, if a person poses for the camera, this is considered to be equivalent to permission granted. You always need to obtain separate permission if it is not entirely clear to a subject that your images are intended for publication. Copyright law and laws relating to what constitutes art vary from country to country, so always check with a legal expert if you are not sure which regulations apply to your particular situation. Personal rights usually have priority over the laws governing general artistic freedom.

You are not allowed to publish photos of people that are taken without their knowledge, unless you subsequently obtain permission. It often helps to gain permission if you offer to send the subject a print of one of your photos. The widespread rumor that you are allowed to publish photos of groups of five or more people without asking permission is groundless.

People as 'Padding'

You generally require permission to publish photos of people, although there are some exceptions. Shots like the one of the scaffolding opposite in which people only appear incidentally and are not the actual



This is clearly a portrait, even if it was taken in an obviously public place. Such a photo always requires permission from the subject.

ISO 400 | 85mm focal length | f2.8 | 1/1000 s



Even though this child with her cotton candy looks cute and harmless, you are not allowed to shoot or publish images like this without gaining permission from the child's legal guardian first, even if the child is happy to smile for the camera and is located in a public place. This is obviously a portrait, and the only exception to the rules noted here is if the photo is of your own child.

ISO 400 | 85mm focal length | f2.8 | 1/1000s

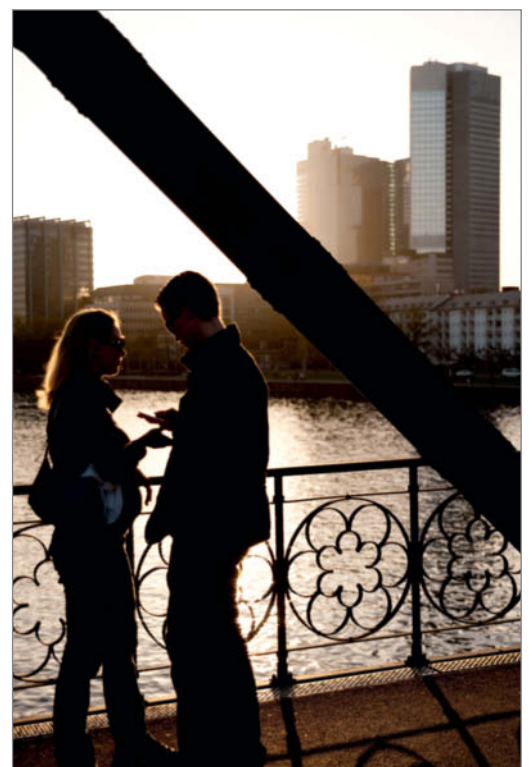
The anonymous nature of people who appear as silhouettes means that you don't have to ask their permission to publish

ISO 125 | 50mm focal length | f2.8 | 1/2000s



You don't usually need permission to publish photos like this in which people appear only incidentally

ISO 800 | 85mm focal length | f6.3 | 1/80s



subject of the image are usually publishable without gaining permission. In other words, if the person or people in a photo can be retouched or replaced without changing the character of the shot, you are usually on safe ground. If a person is portrayed out of focus, extremely small, as a silhouette or in any other way that makes them unrecognizable, you are usually allowed to publish without special permission.

Public Events

If you are photographing parades, markets or other public events, you are generally allowed to publish photos of individuals if they are portrayed within the context of the event itself and do not constitute the subject of the photo.

People who take part in such events are considered to be aware of the fact that they might get photographed, and cannot insist on the right to give permission to have their likeness published.

Portraits that do not obviously relate to a larger-scale event cannot be shot or published without first gaining the subject's permission, even if the person involved is located in a public place. The legal stipulations vary from country to country and from situation to situation, so always get permission first, even if you are not sure whether you need to. Remember, if a person willingly poses for the camera, this can be legally construed as an agreement to be photographed and a grant of permission to the photographer.

At public parades like Christopher Street Day, you don't have to get permission to publish photos of obviously willing subjects such as the one shown here

ISO 400 | 50mm focal length |
f11 | 1/125s | analog



Photos like this in which the person concerned cannot be recognized can be published without getting special permission. If the man in this scene had turned to face the camera, I would have required permission to publish, even though the urban scene in the background takes up most of the frame.

ISO 800 | 35mm focal length | f8 | 1/1000s



Preparing for a Shoot

A city shoot can easily see you spending several hours on your feet, so it is important to use equipment that isn't too heavy.

You need to know your camera's switches and functions well so that you can react quickly to any situation that crosses your path. If you have to spend too much time making the right setting, your subject will be long gone!

Types of Camera

Due to their light weight and quiet operation, Leicas have always been lauded as 'the' street photographer's camera. Leica lenses, too, are of excellent quality and are very compact. Henri Cartier-Bresson and Robert Frank are just two of the famous names who used Leica gear to capture their best shots. High prices and sometimes complex handling are the downside of the Leica experience and make these cameras less suitable for beginners.

Cheaper compact cameras are small and easy to carry, but often suffer from a degree of shutter lag that makes them unsuitable for spontaneous shooting. Compacts also have much smaller image sensors, which gives them greater depth of field, even when you are shooting at wider apertures. If you like using wide-aperture effects, remember that the sensors in Micro Four Thirds (MFT)

mirrorless system cameras such as the Panasonic LUMIX and Olympus PEN models are significantly smaller than those found in most DSLRs. The Sony NEX range and the Fujifilm X100 have APS-C sensors that lie between the MFT and full-frame sizes. If you use a DSLR, always carry a spare battery and make sure that everything is set up so that only minimal adjustments will be required while shooting. The smaller the camera you use, the less conspicuous your activity will be.

Choosing a Lens

Fixed focal length lenses with large maximum apertures are perfect for most street situations. Wide apertures make it possible to shoot using short exposure times, even if there is little ambient light available – for instance, at dusk or in bad weather. If you want to use motion blur creatively, you can always stop down the aperture to increase your exposure time. Using a fixed focal length lens is a great way to train your eye and practice framing. If you only have a zoom lens, simply set it to a preset focal length and leave it there while you shoot. 50mm lenses are well-loved all-rounders that double as great short telephotos when used with non-full-frame cameras. Medium wide-angles with equivalent focal lengths between 28 and 35mm are perfect for

capturing the surroundings of a subject as context

Less is More

You won't need a tripod or an accessory flash for daytime shoots. The less gear you have to carry, the more likely you are to take your camera with you on an outing and the easier you will find it to work. For 'pure' street photography, doing without a tripod altogether gives you maximum freedom of movement. If you still find yourself needing to use longer exposure times, you can always open up your aperture and/or increase your ISO value. In emergencies, a little camera shake doesn't necessarily detract from the overall effectiveness of an image.

Right-angle Viewfinders

A right-angle viewfinder is a really useful accessory if your camera doesn't have a tiltable monitor, and enables you to frame low or ground level shots without having to lie down. It is also helps to make your use of the camera less conspicuous. Even in urban situations, I often recommend that my students place their cameras on the ground for certain types of shots, making an angle finder much more than just a landscape photographer's accessory.

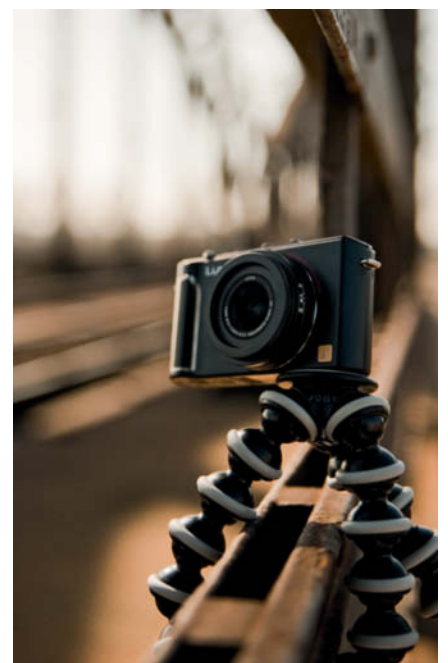


Full-frame Leica cameras are compact and extremely quiet due to the lack of a reflex mirror in the rangefinder design

ISO 200 | 50mm focal length | f3.2 | 1/60 s

If you have a relatively light camera, a Gorillapod is a great accessory for taking night shots or shooting from unusual angles

ISO 200 | 56mm focal length | f2.8 | 1/3200 s





Unless you are just out for a stroll, you will need tough clothing and a waterproof groundsheet of some sort if you want to get the most out of a trip

ISO 400 | 50mm focal length | f8 | 1/40 s

Camera Bags

If you want to shoot incognito, a bag that doesn't necessarily look like a photo bag (such as those made by Kalahari) is a great place to start. Handbag-style bags made by dothebag and Artisan & Artist are also great alternatives to traditional styles.

The simplest and best solution is to do without a bag altogether and to carry your camera 'as is'. Padded straps – for instance, from OP/TECH – relieve the stresses and strains of carrying a camera for hours at a time. SunSniper straps attach to your camera's tripod thread and enable you to hang your camera from your hip with the lens pointing down. This a great solution and means that your camera is always close to hand when an opportunity arises.

Clothing

Always wear robust, weatherproof clothing that can stand a bit of dirt. If you are worried about your clothes, you won't be able to

concentrate on the situation at hand. I don't really care what I am wearing if a photo opportunity arises, but I still find it easier to kneel in the dirt if I am wearing cargo pants. Cargo pants are also great for carrying accessories or a spare lens and make it easier to do without a bag. A lightweight foldable rain jacket and comfortable long-distance shoes are a must. You have to be able to walk for miles and turn tail quickly if necessary.

Camera Presets

I am often asked if there are any camera presets that I make when I am on a street shoot, and the answer here is a definite maybe. You always have to allow for the light in your current situation, although there are a couple of things you can look out for when getting ready to shoot:

Focusing: Autofocus often fails in hectic urban situations due to the enormous range of contrast and fast-moving action. With a little practice, manual focusing can be just as fast as autofocus. If you preset focus to a specific distance and look for subjects at a similar distance, you will only have to adjust focus a little (if at all) before you shoot.

Shooting in manual mode: Make some test shots at your chosen location and select the combination of aperture and exposure time that gives you the best results. As long as the ambient light doesn't change significantly, you can then use these settings to create a consistent-looking sequence of images, but remember to reset your parameters if the light changes. You can, of course, also use aperture or shutter-priority mode to preselect your preferred exposure values.

ISO values: Select an ISO value that prevents camera shake. Increase your ISO setting at dusk or in bad weather.

Tips and Workshops

The tips and workshop ideas presented on the following pages will help you to get the most from your street photography exploits. They explain how to overcome your own uncertainty when photographing strangers and give you hints on how to spot great photographic opportunities when they arise. Use the tips listed below while trying out the ideas described in the workshop sections, or simply to help you develop your own ideas.

If you are serious about street photography, you need to give yourself plenty of time to concentrate on taking photos. This way, you will achieve much better results than if you just take the odd snap or two while you are out and about. The more you practice, the easier it will become to find and capture great street photos.

Which of these tips you find most useful is a matter of personal taste. I have used all the following ideas with my students, and everyone ends up developing their own personal favorite tricks and techniques anyway. I prefer to use medium focal length lenses (50-90mm) and work at a slight distance. This way, I don't bother my human subjects and can include the immediate surroundings in my compositions.

Always at the Ready

If you stroll down the street with your camera constantly in its shooting position, no-one will

know when you actually release the shutter. This helps to dissipate the feeling that everyone around is a potential 'target' for a photographer they don't know personally, and is less obtrusive than if you suddenly raise your camera in front of someone. Always being at the ready also gives you a better chance of capturing exactly the right moment.

'Submarine' Tactics

If you plan to photograph a particular person or have already done so, but you don't trust yourself to make eye contact, you can stay on their trail simply by pretending to be completely disinterested. Some photographers consider this type of approach to be sneaky and inauthentic, but it is nevertheless a good way to practice. You are definitely not allowed to publish 'secret' images captured this way.

Using Wide-Angle Lenses

Wide-angle lenses capture a relatively broad section of what is going on in front of you, which can be useful if you want to capture people at the edge of the frame without them feeling as if they are being photographed. However, this approach makes it more difficult to create satisfying compositions. People at the edge of a wide-angle frame tend to look slightly 'lost' and distances

appear greater than they are in reality, making background objects appear further away than they really are. Wide-angle photos often contain too many details, giving an image a cluttered look with no obvious main subject. This is a useful technique if you like wide-angle effects, but it won't help you get up close and personal if true portraits are what you are after.

Events

You are less likely to attract attention and will be able to move around more freely at events where others are taking photos too. Street parties, parades, markets, fairgrounds and pleasure boats are ideal locations for going unnoticed while you shoot.

Narrow Streets

If you like to photograph passers-by, position yourself in places where they have less room to get out of your way, such as on footbridges or at subway exits in the rush hour. If you use this technique, don't forget to concentrate on background detail too.

'Hideaways'

Parked cars or trees and plants in pedestrian zones make great impromptu screens to hide behind while you shoot.



Wide-angle lenses can be used to casually position a subject at the edge of the frame

ISO 800 | 24mm focal length | f10 | 1/250 s

The constant noise and action at an amusement park will help you to fade into the background and snap away undisturbed

ISO 400 | 50mm focal length | f6.3 | 1/60 s



BREAK DANCE

BREAK DANCER

BREAK DANCER

BREAK DANCER



Use a Friend as Your Foreground

If you ask a friend to accompany you, they can pose in the foreground to distract your real subject's attention, and can even remain as an additional out-of-focus detail in the finished image.

Shooting from the Hip

Shooting without looking at the monitor or through the viewfinder requires a lot of practice. This technique allows you to shoot

largely unnoticed, but means you have no control over your composition. You will often have to crop images shot this way to get rid of unwanted details. Walker Evans' famous subway portraits are nearly all cropped.

In a Café

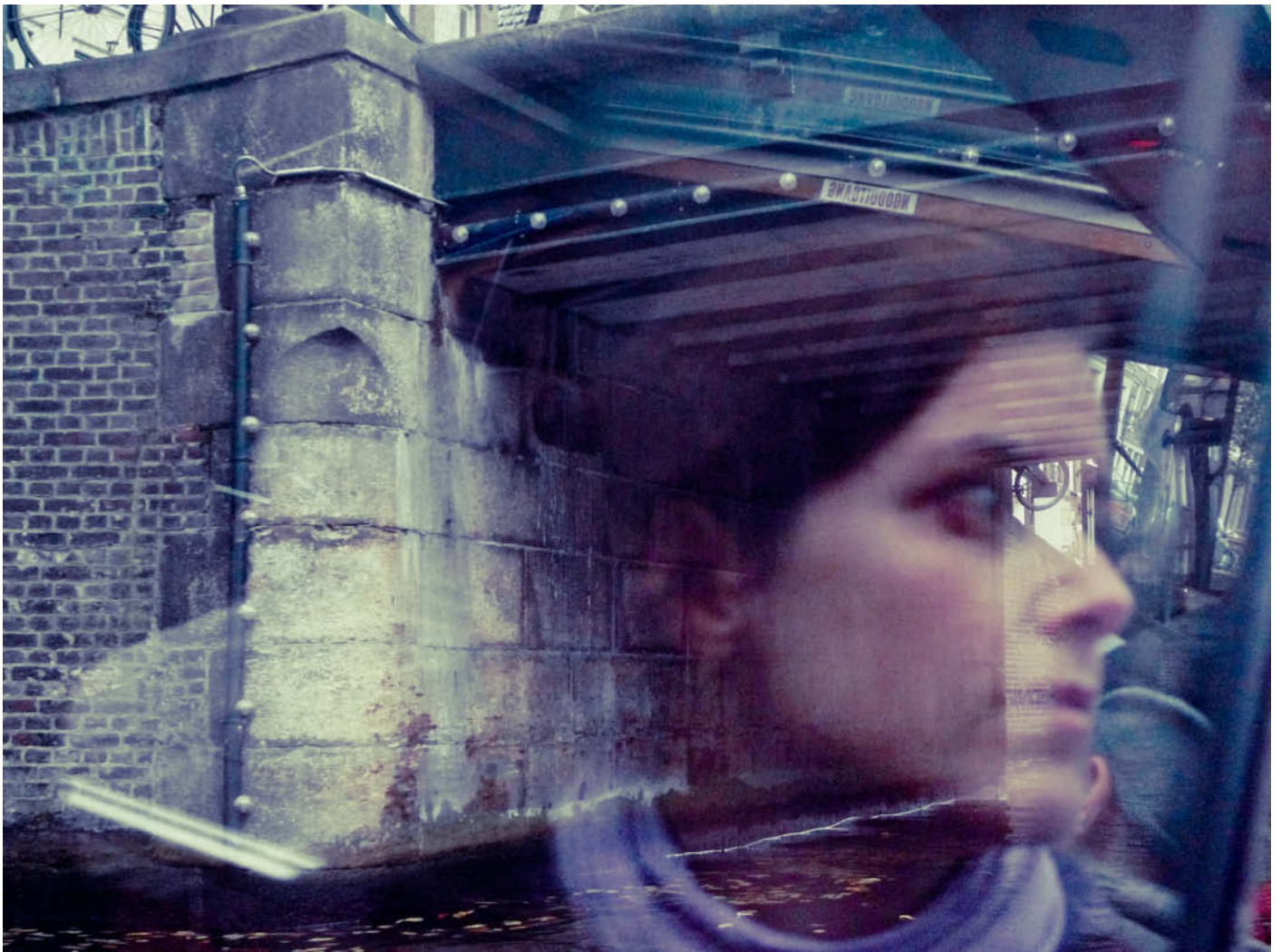
Cafés – especially at busy corners – are great places to sit and watch the world go by and allow you to shoot from a sitting position. Make sure you sit at a table that gives you an interesting background.

Shop Windows

Using a shop window as a mirror provides an extra level on which you can capture images unnoticed. You can also use the reflections that occur in puddles to capture unusual compositions (see page 55). Using reflections as a compositional tool is a great way to produce mysterious and poetic images.

Right-angle Viewfinders

Tilttable monitors and right-angle viewfinders are useful accessories if you want to shoot



Using reflections is a great way to shoot unnoticed or anonymize your subject

ISO 400 | 60mm focal length | f2.8 | 1/160 s



In situations like this, it is impossible to remain unnoticed and you will always end up talking to the subject. Allowing your subjects to see the photos you have taken is often the best way to gain their confidence and get permission to publish.

ISO 320 | 70mm focal length | f8 | 1/100s | -1.3 EV



photos of people in an inconspicuous way while retaining control of your composition. These devices make it simple to use the camera in an unobtrusive lowered (or raised) position.

The Right Time of Day

The early morning hours when a city is waking up is a great time to capture all sorts of action. Markets are the scene of a lot of activity, with stallholders going about their business and shoppers meeting and chatting between purchases. Sundays and public holidays are best for capturing more relaxed scenes of people who are, for once, not in a hurry.

Keep Coming Back

If you have the chance to visit a location more than once, each time you go back you will find it easier to take great photos. Once the locals

are used to seeing you and your camera, you will simply blend in and will be able to snap away unhindered. If people ask you what you are doing, always be polite and give honest answers. Speaking to shop and kiosk owners or residents of the area you are interested in often helps to break the ice and makes it easier to get interesting and unusual photos.

An Open Approach

Sometimes going out in the open is the best way to get the results you are looking for. If you see a potential subject approaching you can always frame them in the viewfinder and try to get in a shot or two in before they get too close. Some people are sure to simply move out of your way, but you might get lucky and get a well-framed shot. A direct approach often results in a chat and an opportunity to take more photos.

Get Closer Slowly

Street photography beginners are often told that shooting shoes or other incidental details is a good way to practice in public. Personally, I don't recommend this approach, unless you really want to concentrate on photographing shoes (a subject that does have its own charm, it has to be said). It is unlikely that looking at the ground will give you the confidence to suddenly start taking photos of strangers. My students often tell me that gradually getting closer using increasingly short lenses is a much better way to get results with an intimate feel.

Photographing People From Behind

Time required:

3x three hours

Equipment:

Camera with fixed focal length lens (approx). 50mm

If you think that photographing people from behind has nothing to do with street photography, think again! There are many wonderful examples by Saul Leiter, Fred Herzog, Joel Meyerowitz and others that prove the effectiveness of this particular approach. We see many of the people we encounter on the street from behind.

Shooting this way makes you the follower; the path your subject takes and their point of view become your own. You can photograph over people's shoulders to capture their view of the world. It is often the unseen details that

give such photos charm and leaves space for the viewer to imagine how the subject might look. Is this person happy or sad? Are they smiling? Do they have dark or bright eyes? Are they younger or older than we perhaps imagine?

The details you omit often create additional tension in an image. The blur effects that Saul Leiter used in many of his photos provide the poetic aspect that makes the difference between a simple documentary approach and true street photography. Straight street portraits are too obvious for my taste; I prefer to veil my intentions and infer or obscure details to attract and involve the viewer's interest. Leave strangers looking 'strange' – a full-frontal portrait with the subject looking directly into the lens doesn't necessarily reveal more about their character than a more cryptic shot.

Following someone at a distance keeps you anonymous and can help to give you the confidence you need to press the shutter button. You can make it your job to follow as many people as possible during a session or follow just one subject and track their movements step for step.

Decide in advance how you want your photos to look. If you want to freeze your subject's movements, select a short exposure time. Because you will be the one moving about, I recommend 1/250 or 1/500s, depending on the brightness of the ambient light. Always make some test shots at your chosen location before starting a shoot. If you want to use motion blur to capture or symbolize movement, or as a purely artistic effect, exposure times between 1/15 and 1/30s are best.

This task is successfully completed once you have 10 shots that form a coherent sequence in the bag.



I photographed this man for my own 'People From Behind' series. I specifically asked him to turn away before I released the shutter.

ISO 500 | 50mm focal length | f4.5 | 1/640s | -0.7EV

Opposite:
Taken on a rainy day in Frankfurt, the dual reflections of the man's back and the buildings combine to form a fascinating composition. The puddle infers bad weather, giving the image an extra level of meaning.
In case you hadn't already guessed, I love shooting in the rain and snow!

ISO 250 | 50mm focal length | f2.8 | 1/800s | -1EV



The City as a Stage

Time required:

3x three hours

Equipment:

Camera with fixed focal length lens
(approx. 50mm)

Many photographers only realize when they view their photos on the computer at home that they have forgotten to include the background in their compositions, usually because they were concentrating too hard on the main subject. A poor background can often spoil an entire image, which is a shame if you have spent the whole day capturing images.

Consider the city as your stage. A great way to practice is to concentrate exclusively on the background rather than the main subject in your image.

Check out the area you want to photograph for suitable backgrounds and use the lens you want to use for your session while doing so, always looking for where there are plenty of passers-by. An old, forgotten corner on the wrong side of the tracks may be picturesque, but is no use if no-one happens by.

Once you have selected your background, all you have to do is wait for someone to appear. There are many great sequences of photos that use a single, static

urban background as a stage for a number of different subjects. As long as you keep an eye on your chosen background, you can, of course, approach your subjects directly or follow them while moving around. This helps to give your sequence variety and gives you the chance to respond to changes in the scene unfolding in front of you. Remaining in a single position is a good way to develop an eye for the background and, with a little practice, you will instinctively include the background in your overall composition.

Once again, the task is completed once you have shot a meaningful sequence of 10 photos.



Having found my 'stage' and set up my camera, I approached the woman in the photo and asked her to simply carry on on her way without looking at the camera. She was very friendly and happy to do as I requested. If possible, take several versions of a shot like this to ensure that you capture your subject in just the right position.

ISO 200 | 60mm focal length | f14 | 1/200s

Telephoto Effects

Time required:

3x four hours

Equipment:

200mm telephoto lens

Street photography beginners are often quite cautious and don't dare to photograph even the shoes of a stranger. If this applies to you, I recommend that you use a telephoto lens for your first attempts. Long lenses can be used to produce great street shots, as proved by much of Andreas Feininger's best work. Telephoto lenses not only bring the subject closer but also compress the space within an image, which visually reduces the distances between objects. This effect can be used to create striking and often quite abstract-looking compositions.

Once you have had some practice using a telephoto lens to shoot strongly cropped images, you will realize that it is much more than just an emergency solution; you can use it to isolate your subject and block out distracting detail in the surroundings. However, you have to remember that the relatively large reproduction ratios produced by a telephoto lens cause significant background blur, even at medium apertures (f5.6 or f8). If you want to avoid producing too much blur, you will have to stop down and increase your ISO value accordingly to prevent camera shake creeping into your results.

For this exercise, look for an interesting location that provides plenty of everyday action, but is not as hectic as a funfair or a parade. Saturdays are perfect, as more people have time to go into town without having to

hurry. Street cafés, bus stops and park benches are great places to start a shoot like this.

Make some test shots to check your exposure values and then begin to view the activity around you through your camera's viewfinder. Try to guess which situations will bring people together. It is often more productive to concentrate on a single situation and wait for it to develop than it is to constantly pan around looking for isolated

moments to capture. If you plan to publish your images later on, make sure that you select an angle of view that prevents your subjects from being recognizable in the finished photos. Shooting at telephoto distances makes it much more difficult to make contact with your subject and get permission to publish once you have finished shooting.

The aim of this exercise is to capture a sequence of 12 effective telephoto images.



Telephoto shots have their own special look. Converting this image to black and white and adding a digital grain effect makes this couple look as if they inhabit the good old analog era.

ISO 250 | 220mm focal length | f5 | 1/40s | -2/3 EV

Portraits of Strangers

Time required:

4x two hours

Equipment:

Fixed focal length lens (50 or 85mm)

Ask people you think look interesting if you can take a portrait. Even if this approach seems a little forced, asking for permission can break

the ice and get the ball rolling. It is easier than you might think to go up to people on the street, and openness often creates a relaxed atmosphere right off the bat. What have you got to lose? And next time, you might even be confident enough to simply snap away.

If you intend to shoot at a single location for a longer period of time, it nearly always helps to make contact with residents, shop owners and stallholders to explain what you are doing and

ask for permission to take occasional photos. A chat in advance of a shoot helps people to relax and gives you the chance to capture spontaneous scenes once your subjects have forgotten you are there. I once shot a long-term project on the subject of home slaughtering in the village where I grew up. The local farmers were skeptical at first, but soon got used to having me and my camera around. Before long, they were happy to have me take photos and



I took this shot while sheltering from heavy rain on a trip around the city of Frankfurt. This man wanted to shelter too, but posed spontaneously for a portrait while doing so. I used the telephoto lens that happened to be mounted on my camera.

My subject told me that he was on his way back to Africa after a lengthy stay in Europe. I sent him a copy of the photo via e-mail.

ISO 400 | 250mm focal length | f5.6 | 1/160s



I spent quite a lot of time at the meat market in Athens and asked in advance for permission to photograph the people at several of the stalls. I specifically asked my subjects not to look at the camera and, as soon as they were used to my presence, they went about their daily business without giving me a second thought.

ISO 400 | 50mm focal length | f2.8 | 1/125 s | analog

were delighted when I presented them with a selection of the resulting images. In the end, my project and I were very well received.

If you can, always show your subjects your photos, or arrange a way to send them some later. If you agree to send photos by mail or e-mail, always make good on your promise. Don't be put off by people who don't wish to be photographed – it is their right, and you should always consider how you would feel if someone asks you to model spontaneously. Always respect a "No", but don't stop shooting

because of it. If you are simply having a bad day, try again another time. Less experienced photographers tend to take more care composing photos if they use a fixed focal length lens, so avoid using a zoom lens when you are starting out. Don't use a wide-angle lens to shoot portraits, as you will most likely end up with too much irrelevant detail in the frame. Focus manually on your subject's eyes in portraits.

Plan to spend two hours per day on three separate days for the first phase of the

exercise, which is complete once you have 15 to 20 strong portraits in the bag.

For the second phase, spend two hours taking portraits, but this time give your subjects directions on how you want them to behave while you shoot – for example, ask them to turn slightly away from the camera or look at an object outside the frame.

This second exercise is finished as soon as you have five successful portraits to show for your efforts. (anm) **ct**



The shape of the leaf spring is reminiscent of a pair of wings and provides a poetic reference to the name of the guitar

ISO 200 | 1/200 s | f6.3 | 60 mm

Cyrill Harnischmacher

Photographing a Guitar

on location

My client wanted a moody, 'blues'-style photo of a semi-acoustic guitar. "No problem", I thought, once I had found the right location – but the shoot turned out to be trickier than I had imagined, with unexpected reflections, curved surfaces, dust and various lighting anomalies all presenting their own special challenges. The following pages tell the story of how we finally achieved the look and feel we wanted.

Guitarist Jan Henning commissioned me to shoot a series of photos with a 'blues' theme for his CD *Ojo de Gato* and for a coffee-table book about his collection of guitars. The idea was to create images that immediately evoke musical associations for the viewer. Railroads are a recurring theme in blues music, symbolizing loneliness, the sheer size of the United States and the long journeys we sometimes have to undertake to reach our goals.

The Location

We used a disused railroad yard full of old wagons awaiting restoration. From the

moment we found this place, it was obvious that we had stumbled on an endless source of wonderful moods, textures, colors and shapes: weeds, overgrown tracks, weathered wood and virtually limitless expanses of metal covered in peeling paint and rust. After a few phone calls, we were able to contact the site's owner, who quickly gave us permission to stage a photo session. Even if a location appears abandoned, I have often found that it helps to make contact with people in the know before beginning a shoot. I usually find that people respond positively and are interested in my plans. In this case, my inquiries also provided us with the key to an

old locomotive shed, where a vintage steam train was being renovated.

Lighting

Technically speaking, a cloudy day with homogenous, diffuse light would have been better for balancing the contrast between the heavy shadows beneath the wagons and the brightly-lit gravel between the tracks. In the end, we were so fascinated by the effects produced by the sun peeking out from between the wagons that we chose a sunny day after all.

There was no power supply in the vicinity, and we had to stay mobile, so we used a Nikon



Dust settling on the subject can be a serious problem when you are shooting on location



Some parts of the guitar were heavily shaded and had to be artificially brightened

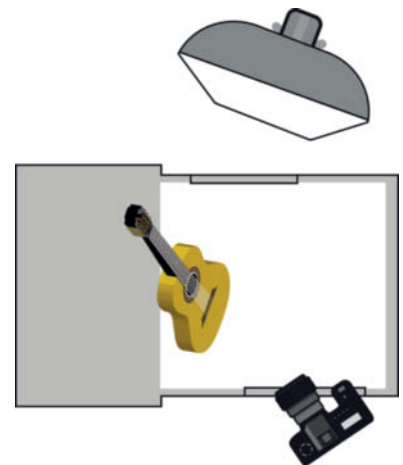


SB-26 accessory flash with a guide number of 36 (at 35mm) as our main light. This flash has manual power settings that range all the way from 1/1 to 1/64 and enabled us to significantly brighten the shadows and work with the minimal available light inside the wagons and the engine shed. We attached a 50×70cm softbox to the flash using a Flash2Softbox adapter, which gave us soft light that was perfect for producing fill effects without generating hard shadows.

We also jury-rigged a grip to the flash to enable us to steer it precisely by hand. We didn't really need a light stand; our assistant simply pointed the flash in the right direction when required while we adjusted its output either by varying the distance to the subject or by adjusting power output on the flash itself. We used a radio transmitter to fire the flash, as the partially bright ambient light made it impossible to use an infrared controller.

There was no room for our flash and softbox in the cramped driver's cab, so we had to set it up outside

ISO 400 | 1/125 s | f8 | 28 mm



The Shoot

Most of the images we captured were shot using shutter-priority exposure mode and -2EV exposure compensation to accommodate the additional brightness provided by the flash. In order to undercut the camera's native flash sync speed and give us the necessary flexibility to shoot handheld, we used an exposure time of 1/125s. This produced mostly balanced exposures, although some shots required the use of manual exposure mode to get things just right. In these cases, we altered the exposure time to adjust the balance between daylight and flash and took some test shots to check our settings. If we ended up using an exposure times of less than our 'standard'



In order to accentuate the texture of the background and produce edge highlights on the strings and the head, we also used the softbox as a lateral light for detail shots

ISO 200 | 1/80 s |
f5.6 | 24 mm

1/125 s, we used a tripod to avoid producing camera shake.

The mixed light sources and the large variations in the scenery made it difficult to find a white balance setting that worked for every shot, so we began each new sequence by making a test shot with a gray card. We performed any necessary fine-tuning later during RAW conversion. In particular, the dark brown walls inside the wagons gave the interior shots an obvious color cast. However, the mood we wanted to create didn't really demand 100-percent authentic colors, and some of the images actually benefit from the slight color casts produced by mixing daylight and flash. The setups we used for some of the shots are shown in the illustration on pages 60 and 62.

Special Challenges

Dust and fingerprints on the subject can be problematic on location shoots, and were a recurring problem during these sessions. Rust, coal dust and the decades of dirt that had collected in the wagons presented a real challenge, and we had to clean everything at least once each time we changed location. We had glass cleaner, Q-tips and cotton gloves with us, and we frequently used a blower brush to remove the fresh dust that fell from

the ceiling every time we moved things around.

The reflections on the highly polished surface of the guitar presented another challenge on this particular shoot. We differentiated between 'natural' and unwanted reflections and used deliberate highlights created using our softbox to accentuate the shape and the classy nature of the subject. A surface only appears shiny

when a light source is reflected in it, and we welcomed the reflections caused by parts of the scenery – such as those in the wagon wheels – as an additional artistic element in the resulting images.

It took a lot of hard work to get everything set up so that the reflections we wanted were exactly where we wanted them, while keeping the unwanted ones at bay. You have to be patient in situations like this and, as well



We increased the camera ISO setting to 400 to compensate for the low levels of available light. Our flash/softbox setup then provided the main light.

ISO 400 | 1/125 s |
f4.9 | 28 mm



Direct lighting caused unwanted reflections on the instrument's shiny surface and, in this photo, the shadow behind the guitar also spoiled the overall effect. The background and the metal objects scattered on the floor of the wagon all look too plain and two-dimensional in this shot.



A soft lateral light gives the entire scene a much more three-dimensional look and eliminates the unwanted shadow. Although this image was shot using just flash, it creates the impression of a low sun shining through an opening in the side of the railroad wagon.

ISO 200 | 1/125 s | f10 | 24 mm

as making sure the light is reflected in the way you want, you have to make sure that neither you nor your equipment produces reflections in the finished image. Always wear inconspicuous clothing (black is great) and, if necessary, you can always 'zoom' yourself out of the frame by using a longer lens.

Safety Considerations

You also have to take great care of your 'model' on a shoot like this. Guitars are sensitive instruments, and the mid-80s 'Bluesbird' model shown here is now a valuable collector's item. We attached small pieces of foam rubber to the guitar with double-sided sticky tape to protect it from scratches and scuffs. It wasn't always possible

to keep these out of the shot, so we had to remove some of them digitally later on.

Both the lighting and the nature of the environment made this quite a difficult location to shoot in, but a considered approach and a modest amount of equipment enabled us to produce a thoroughly atmospheric sequence of images. (jr) **ct**

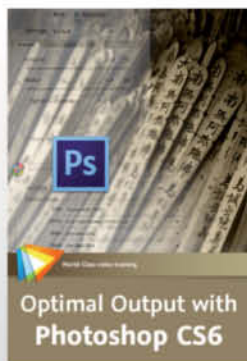
The book *Ojo de Gato* shows the cream of Jan Henning's huge collection of guitars in a number of spectacular settings, captured using a variety of photographic techniques



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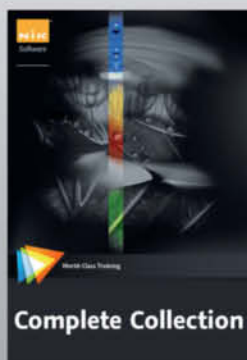
Steve Caplin
1 hr 45 min, \$29.99



Uli Staiger
55 min, \$16.99



Tim Grey
1 hr 55 min, \$34.99



Richard West
4 hrs 50 min, \$54.99



Joseph Linaschke
2 hrs 10 min, \$34.99



Tim Grey
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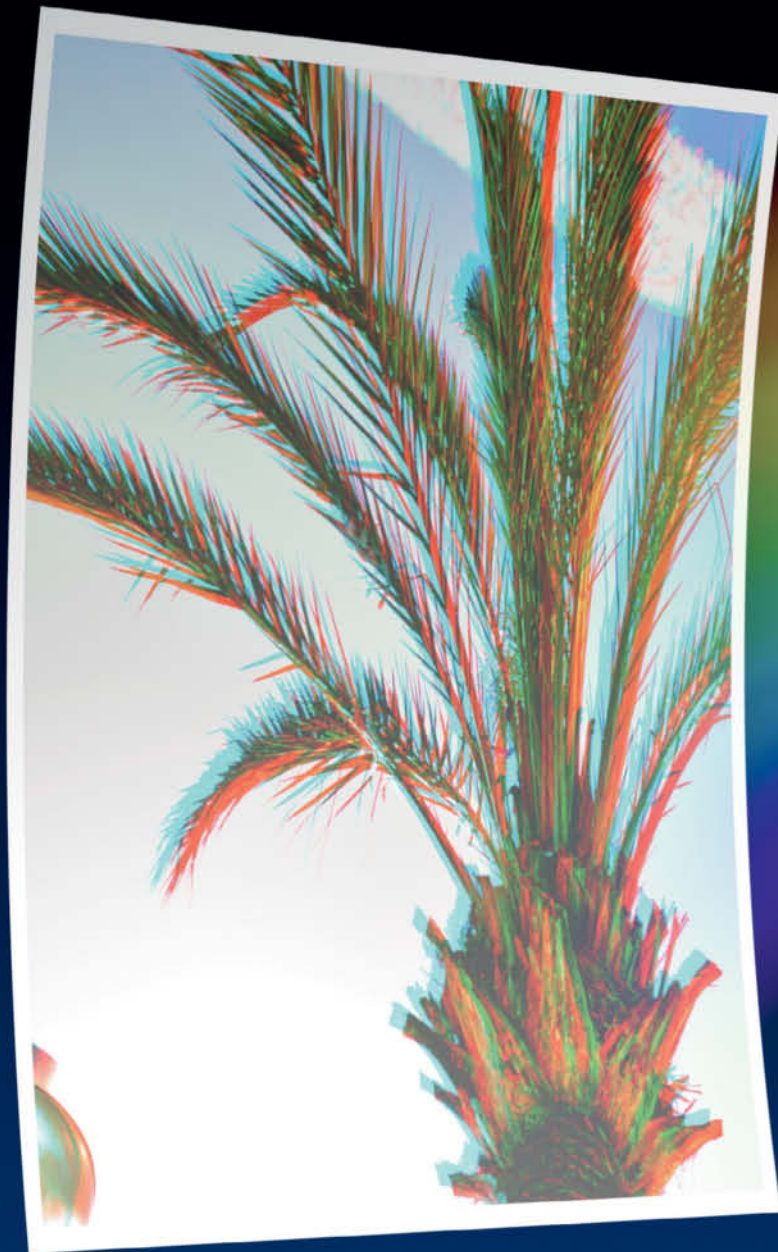
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Sascha Steinhoff

Chromatic Aberrations

Chromatic aberrations and other lens errors were just as prevalent in analog times as they are today, but it is the development of digital image processing technology that has given us the tools we need to correct them effectively. This article takes a look at some of the specialized programs on offer and explains how you can use them to get rid of those irritating RAW and JPEG color smears.



Chromatic aberration is a widespread phenomenon that occurs in both contemporary and legacy lenses. The term is used to describe a number of different types of focusing errors.

Spectral Colors

Whether you use high-end or cheap equipment, most lenses display one sort of chromatic aberration or another. Regardless of exactly how they are formed, chromatic aberrations are always caused by light of different wavelengths being refracted to differing degrees. The individual elements in a lens not only direct the incident light but also split it into its component colors the same way that a prism does.

This article introduces various types of chromatic aberrations and explains how to distinguish them from other types of optical errors such as sensor blooming or flare. We also test a range of dedicated software tools designed to correct lens errors.

Axial and Transverse Aberrations

Generally, we distinguish between longitudinal (axial) and transverse (lateral) aberrations as seen in relation to the optical axis of the lens. Both types can cause false colors and halo effects, but have fundamentally different characteristics.

Fringing

Lateral color errors often occur at the edges of images because the images of red, green and blue spectra are reproduced at slightly different sizes. This causes color fringing, which is especially obvious at high-contrast edges. The further a point is from the center of the image, the more prone it will be to this type of error, whereas fringing doesn't occur at all in the center of the frame. Stopping the aperture down neither reduces nor increases the likelihood of this type of error occurring.

All non-radial high-contrast edges are likely to suffer from fringing. Sure-fire sources of this type of artifact are subjects at the edge of the frame that contain thin black lines against bright backgrounds, such as the leafless branches of a tree in the snow or a chain link fence shot against a bright sky.

The color of a fringing artifact depends on whether it occurs at a dark-to-light or a light-to-dark transition, seen relative to the center of the frame.

Lateral aberrations are relatively simple to correct, provided a couple of basic preconditions are met. You need to know in detail about the specific optical characteristics

of your particular lens and you should perform the adjustments on a RAW image file. These preconditions usually produce great results with automatic computer-based or in-camera correction tools. Lateral errors don't produce 'hard' double images the way axial errors often do, but it is still virtually impossible to completely erase edge softness and loss of contrast after shooting. It is nevertheless relatively easy to filter out obvious color fringes.

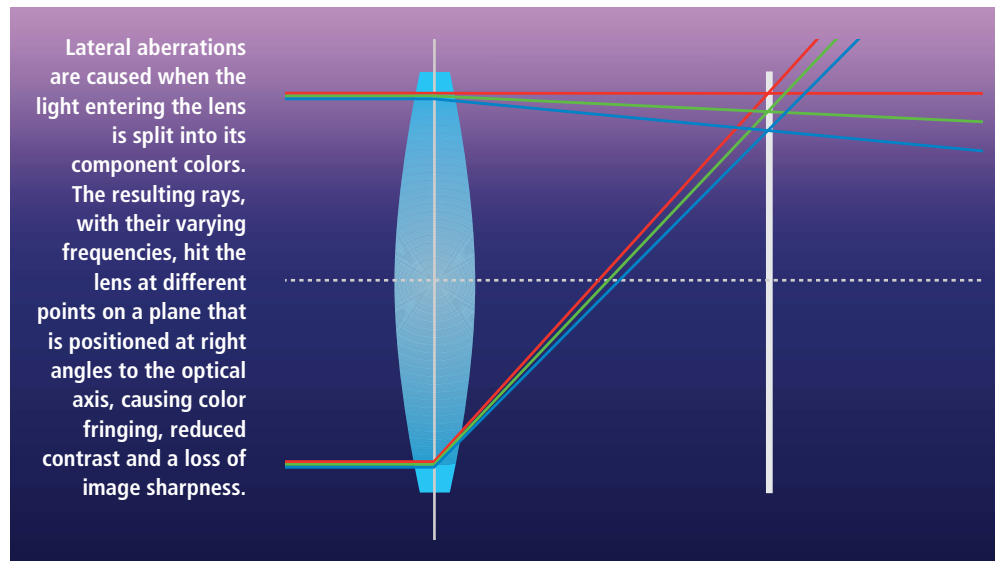
Double Images and False Colors

Axial aberrations are anomalies caused by the different component colors focusing at different points along the optical axis. This results in multiple, single-color images instead of a single, sharp, multi-color image. Like the sub-images produced by lateral aberrations, those produced by axial aberrations tend to appear at high-contrast edges. However, they neither vary in size nor depend on the direction of the incident light.

Axial aberrations cause fringing and image softness across the entire frame and are particularly obvious at wider apertures (i.e., in images with shallow depth of field). The critical factor here is the focus setting rather than the position of an object within the frame. Lateral errors increase toward the edges of the frame.

Depending on the type of subject, it is possible to reduce the incidence of axial aberrations by stopping down the lens. Smaller apertures increase depth of field and reduce the probability of a single color channel appearing unsharp in the final image.

The obvious reduction in sharpness caused by axial aberrations manifests itself in the form of double images at high-contrast



edges. Axial aberrations can also produce whole areas of false colors that often tend toward magenta and are particularly obvious in brighter image areas. This leads to color casts in image areas that lie outside the area of sharp focus.

The spectral color of such areas changes according to whether the affected image detail lies in front of or behind the focal point. Axial aberrations seldom occur at the focal point itself because its depth of field is usually sufficient to cover all three color channels.

Due to their predominant magenta color, axial aberration artifacts are often known as 'purple fringing'. However, this is not a particularly precise term, as other types of artifacts – such as image noise, blooming and stray ultraviolet or infrared light – can cause similar looking effects. Even lateral

aberrations can be confused with axial ones under certain circumstances.

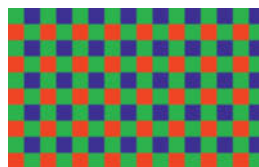
Computer-based correction of axial aberrations is only possible to a limited degree, as no tool exists that can effectively adjust a single unsharp color channel. Fringing and color casts can be removed in a general sense, but this type of correction always results in an additional reduction in image sharpness that tests the limits of even the smartest algorithms.

Other Types of Image Error

In addition to the types of chromatic aberrations we have mentioned, there are various other phenomena that can lead to fringing and color errors, including stray UV and infrared light. Compact cameras especially have a high degree of automatic error

In-camera Error Correction

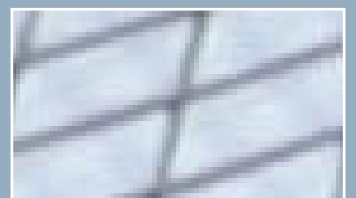
Most of today's image sensors are arranged according to the Bayer Pattern, which alternates rows of green/blue/green and red/green/red photoreceptors. In order to be displayed on a monitor or saved as an image file, the data captured by the photoreceptors has to be converted to an RGB format made up of pixels. Each pixel contains red, green and blue sub-pixels. This conversion process is known as interpolation and is performed using a demosaicing algorithm.



Algorithms designed for correcting chromatic aberrations are much more effective when applied to RAW image data than they are when used on pre-processed JPEG image files. If you want or have to shoot in JPEG format, you should use a camera

that has built-in color correction functionality. All Nikon DSLRS since the D300 automatically correct lateral color aberrations at the edges of the frame. This feature cannot be configured separately in the camera's firmware, but can be adjusted manually using Nikon's *Capture NX* software package.

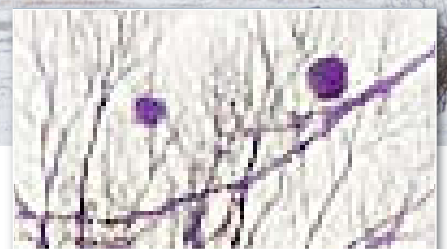
Camera hardware, too, can influence the creation of chromatic aberrations. Microlenses positioned in front of the image sensor ensure that the light entering the lens is distributed evenly across the sensor, but also have a reputation for fostering chromatic aberrations. Even if they have identically sized sensors and are fitted with the same lens, different camera models often produce fringing artifacts with quite different characteristics.



Lateral aberrations: the lower detail image is taken from the center of the main image and does not display any chromatic aberrations. Green and pink fringes occur more frequently within the wire mesh toward the edges of the frame. This type of error is easy to correct digitally.



Image: Thomas Saur



Typical axial aberrations: only the branches in the foreground show a magenta cast and ghost-like 'doubles'. The trees in the distant background are not affected.

correction built into their firmware that often causes interpolation errors. Image noise can also cause color errors, and brightly lit objects can produce fringing due to oversaturation.

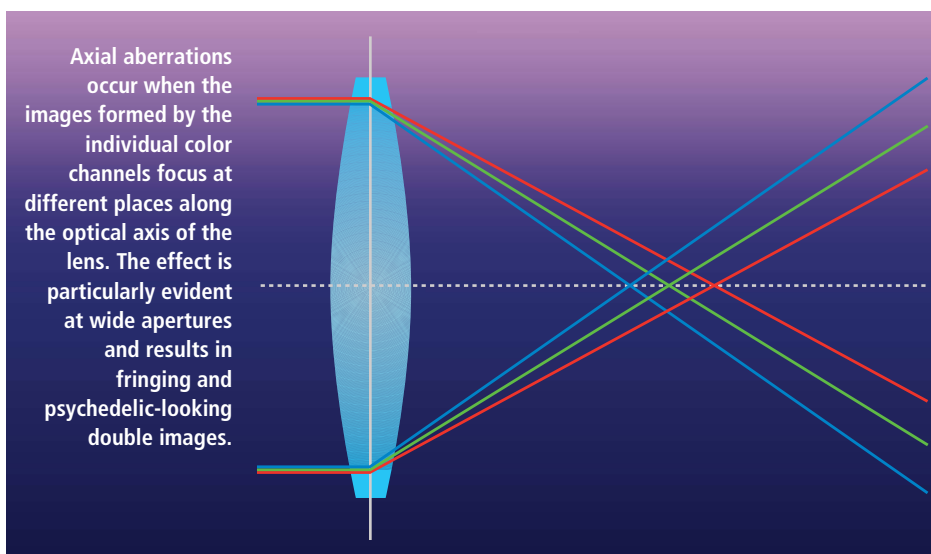
The image sensor itself can also be the source of fringing effects, due to smearing or blooming. Blooming often occurs in older cameras that are equipped with CCD sensors, especially if used to shoot a bright subject (such as the sun) using a wide aperture. Newer cameras with CMOS sensors are less sensitive to this type of error.

Color errors and ghosting can also occur if you photograph a brightly lit subject using a poor-quality lens. It is often quite tricky to differentiate between the exact causes of these types of effects.

Software Filters are a Proven Solution

Chromatic aberrations are some of the more irritating image errors that can occur, and are obvious even to the untrained eye. They occur regularly in various forms, even if you have invested a lot in high-end equipment.

Software filters are a proven way to take the edge off lateral aberrations, whereas axial aberrations are more difficult to correct digitally. As for all other types of lens errors, chromatic aberrations cannot be completely eliminated, even using the most sophisticated tools, so it is essential to use the best lenses you can and appropriate shooting techniques to keep them to a minimum.



Optimum Aperture

An accepted way to prevent axial aberrations from occurring is to use the optimum aperture. This is the smallest aperture at which your lens produces its best sharpness. The optimum aperture depends on a series of variables and can be quite complicated to determine. Generally speaking, it will be somewhere between f8 and f11 for a conventional DSLR, although the precise value will vary from lens to lens. Other systems, such as Micro Four Thirds, have greater overall depth of field than DX or full-frame cameras and are thus less prone to chromatic aberrations. The only reliable way to determine the optimum aperture for your particular setup is to subject it to a controlled lens test.

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Chromatic Aberrations in Camera Lenses

Every lens-based optical system has to deal with chromatic aberrations in one form or another. It is impossible to eliminate them completely, but specially constructed lenses can help to lessen their effects at source. The following sections explain what to look out for when purchasing cameras, lenses and optical accessories.

Chromatic aberrations in photographic systems are caused by the refraction of light within the elements of the camera's lens. Various types of specialized elements provide effective ways to combat their effects.

The 'Right' Glass

Optical glass is available in a wide range of qualities. Nikon uses its patented ED (Extra-low Dispersion) and Super ED glass, while Canon uses its own fluorite, UD (Ultra-low Dispersion) and Super UD glass.

There is not enough natural fluorite in the world to cater for all lens manufacturers' needs, so Canon began producing artificial

crystal fluorite in the 1960s. Third-party lens manufacturers all produce various types of lenses with low-dispersion elements, such as Tamron's LD (Low Dispersion), XLD (Extra Low Dispersion) and AD (Anomalous Dispersion), Sigma's FLD (F Low Dispersion), ELD (Extra Low Dispersion) and SLD (Special Low Dispersion), as well as Tokina's SD (Super Low Dispersion) and HLD (High Refraction, Low Dispersion) models, to name just a few.

Low-refraction glass is most often used in telephoto lenses due to the particular sensitivity of long focal lengths to chromatic aberrations. However, some wide-angle lenses are also built using this type of element.

Photographic lenses are never made completely out of elements with low

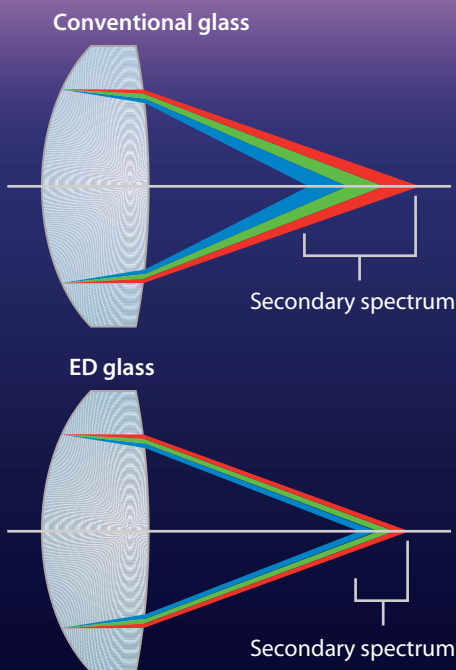
refractive indexes, but instead use just one or two within a system of conventional glass elements. This helps to keep manufacturing processes simple and the cost of production down to an acceptable level.

As well as increasing costs, ED glass is also said to scratch more easily than conventional optical glass, although this is not generally a problem because ED glass is not usually used for front or rear lens elements. Fluorite is said to be more sensitive to impact than normal glass and its refractive index actually fluctuates with changes in temperature.

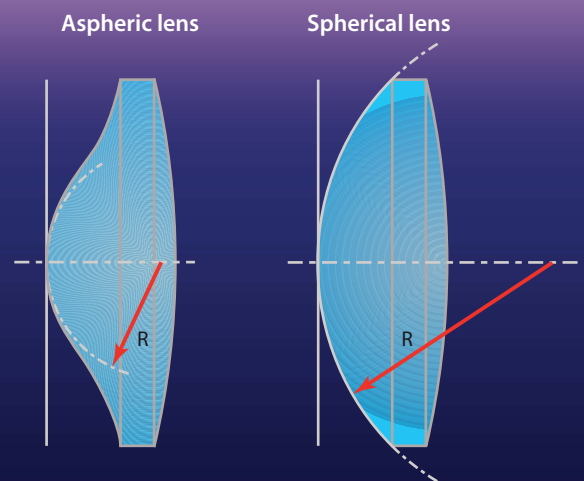
Low refractive index elements are nowadays a standard component in most high-end photographic lenses throughout the range of available focal lengths.

Spherical vs. Aspheric

To keep costs down, most optical systems use spherical lenses. With their spherical surfaces, these are cheap to produce but are inherently prone to significant chromatic aberration.



The low refractive index of ED glass reduces the degree of dispersion of incident light, thus reducing (but not completely eliminating) the resulting aberrations



The surface of a spherical lens is shaped like part of the surface of a sphere. Aspheric lenses have a more complex shape that is more difficult to manufacture.

Aspheric lenses have better reproduction characteristics. Because they have asymmetrically curved surfaces, they used to be extremely expensive to produce and were only built into extreme high-end lenses when the technology was introduced in the 1970s. New production techniques have reduced the cost of aspheric elements to a point at which some manufacturers even build them into mid-range and budget lenses, such as the current US\$100 Nikon 18-55mm basic zoom. The other 10 elements in this particular lens are spherical.

Most lenses are built using a combination of spherical and aspheric elements. The more aspheric elements a lens contains, the lighter and more compact the overall design can be. Aspheric elements can also help to reduce distortion and increase the optical performance of wide-aperture lenses.

Aspheric elements are divided into different grades according to their shape. The ones used in cheaper lenses (like the Nikon mentioned above) are usually hybrid models constructed from spherical glass lenses glued to additional plastic elements that give them their aspheric shape. The intended aspherical effect is somewhat reduced by the fact that plastic disperses light more than glass. Further up the price scale are pressed glass aspheric lenses, and most expensive of all are ground glass

aspheric elements, which also have the best reproduction characteristics.

Whether high-end or budget, most lens elements are spherical, and individual aspheric elements are added to enhance optical performance.

Diffractive Elements

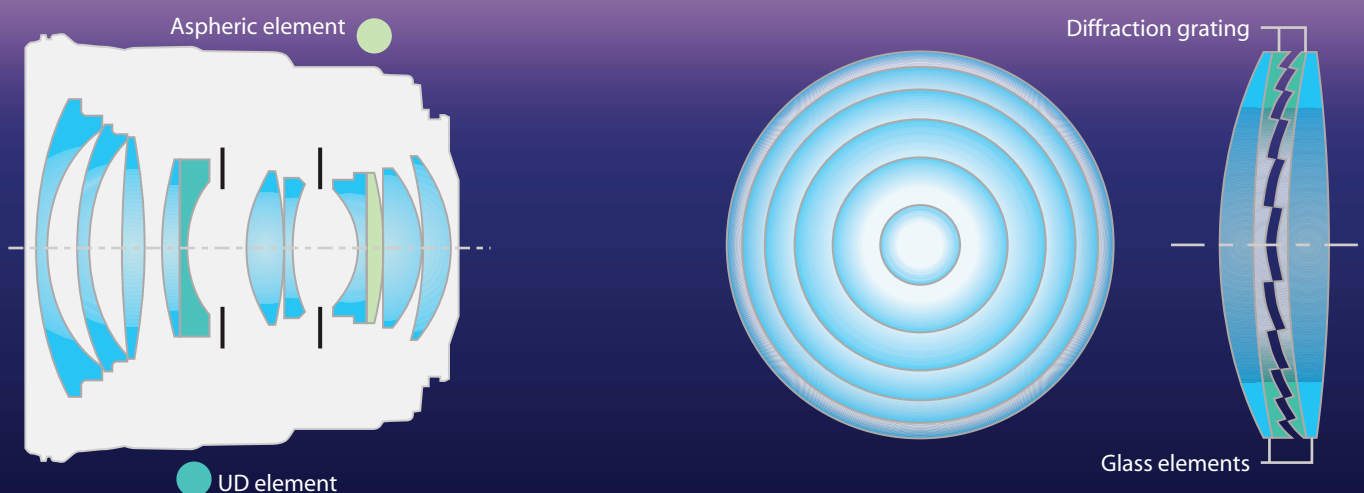
Canon introduced the then revolutionary EF 400mm f/4 DO IS USM lens at Photokina 2000. The new Diffractive Optical (DO) elements in the lens made it extremely compact and reduced chromatic aberration significantly. The technology hasn't been developed much further, and the lens since added to the range is the EF 70-300mm f/4.5-5.6 DO IS USM. This amazing lens weighs just 720 grams (1.58 lb) and is only 10 cm (3.9 inches) long. A direct comparison with the identically priced EF 70-300mm f/4-5.6L IS USM (1,050 grams, 14.3 cm) demonstrates the real advantage of DO elements, in that they are significantly smaller and lighter than their conventional glass counterparts.

DO elements are built using a unique two-piece construction that consists of two diffraction gratings mounted between two glass elements. DO elements designed for photographic purposes have to include at least two diffraction gratings in order to cover the entire spectrum of visible light.

Diffractive gratings are difficult to manufacture due to the variable distances between the openings in the grating and their extreme thinness of just a few micrometers. You can see the pattern of the grating if you hold the front element of a DO lens up to the light. A DO element on its own has similar dispersion characteristics to those of a normal glass element and produces its own chromatic aberrations. The all-important difference is that a DO element disperses the component colors of the spectrum in the opposite sequence to that of a normal lens element. Combining a conventional element and a DO element thus cancels out color deviations and eliminates chromatic aberrations.

The disadvantages of DO elements include their tendency to produce bokeh that mirrors the structure of the grating rather than the unobtrusive circles produced by conventional lenses. These DO circles of confusion tend to look like a sliced onion and are similar to the ring-shaped ones produced by mirror telephoto lenses.

The precise shape of bokeh depends not only on the lens but also on the nature of the subject, and whether you find it attractive when it does occur is a matter of personal taste. With just two lenses being introduced in 11 years, DO lens technology remains a niche product and has yet to break into the mass market.



This Canon EF 24mm f/1.4 lens has one aspheric and one UD element. Aspheric elements are used to improve the quality of high-end lenses and to make value lenses less expensive.

DO elements use custom diffractive gratings positioned between two lens elements to alter the path of the light rays entering the lens. This structure is visible to the naked eye if you look at a DO element head-on (shown on the left).

Achromatic, Apochromatic and Super Achromatic Lenses

Photographic lenses are classified according to the type and quality of the color correction features they possess. Achromatic color correction techniques focus just two colors (usually red and blue) in the same plane and have been used since the 19th century. The first photographic lenses were achromatically corrected.

The color errors that achromatic lenses nevertheless produce, known as 'secondary spectrum', are very difficult to eliminate completely. However, the effects of secondary spectrum on image quality are generally negligible if you use a good quality achromatic lens.

Optical engineers are constantly searching for new ways to reduce or eliminate secondary spectrum and thus improve the quality of photographic images.

Apochromatic lenses can correct three colors. While achromatic lenses require two elements made of different materials, an apochromatic lens requires at least three different types of element. Apochromatic correction is designed to reduce or, ideally, eliminate secondary spectrum by focusing all red, green and blue rays to the same point on the focal plane. The only way to do this using currently available materials is if you are

prepared to accept other types of aberrations as part of the deal. Most lenses therefore represent a compromise between faithful color reproduction and a number of other optical characteristics and anomalies.

Lens manufacturers build lenses to a standard that they themselves are happy to call apochromatic. However, it is probably safe to say that Sigma's definition of 'apochromatic' for a US\$300 lens will differ from the Leitz definition of the term in a lens that costs 20 times as much.

The term 'apochromatic' is neither standardized nor patented, so you can only really find out what various manufacturers mean by it by conducting a thorough lens test. The incidence of chromatic aberrations varies enormously throughout the zoom range, particularly in budget telephoto zooms that nevertheless carry the 'APO' label. Today's market offers APO models in the entire range from budget to high-end, while some manufacturers whose lenses actually earn the description don't use it at all.

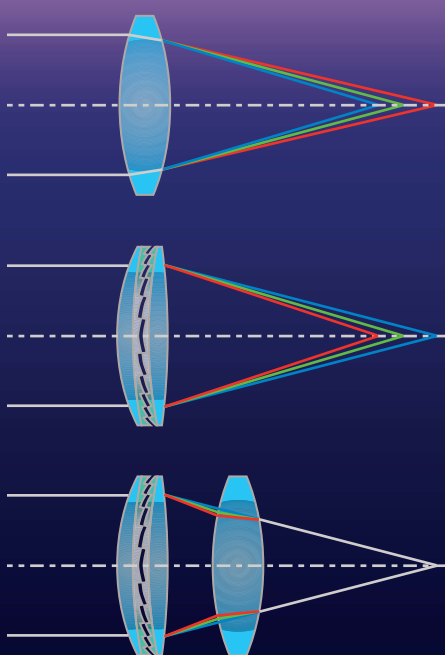
At the very top end of the quality (and price) scale are 'super achromatic' lenses that are capable of correcting four different colors. The Carl Zeiss Tele-Superachromat T* 5.6/350 (for Hasselblad cameras) is one example of an extreme high-end lens with unbeatable color correction.

Even if it is not as commonly used as 'apochromatic', the term 'super achromatic' is not precisely defined and is still used according to the needs of marketing people rather than photographers. The first super achromatic lenses were made by Zeiss in the 1960s and the 'Superachromat' label has remained a Zeiss trademark ever since. Zeiss' direct competitor Leitz describes its equivalent lenses as having APO characteristics, although the products themselves are directly comparable. Once again, even though the description is based on definable technical attributes, the presence or lack thereof doesn't accurately describe the quality or performance of a lens.

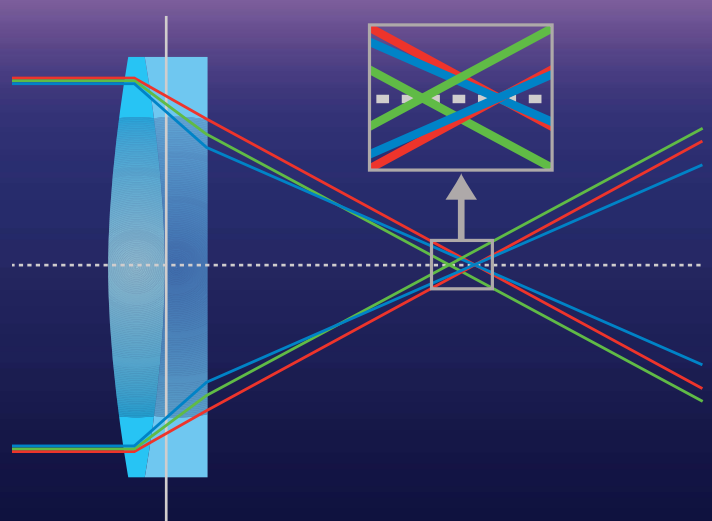
Close-up Lenses and Teleconverters

If you interfere with a lens manufacturer's carefully designed system of elements and gears, you run the risk of producing not only optical anomalies but also additional chromatic aberrations.

Using a teleconverter is a simple way to increase the focal length of a lens, but is almost guaranteed to increase chromatic aberrations too. Teleconverters are normally constructed with quite a lot of internal space and some manufacturers use this to add additional corrective elements.



The conventional element (top) and the DO element (center) refract incoming light in opposite directions. Used together, the two elements cancel out each other's aberrations.



Achromatic correction – a standard feature in most photographic lenses these days – corrects two colors but leaves the third uncorrected

In contrast, most close-up lenses made for attachment to the filter thread on a lens have single-element designs and cannot be corrected using additional elements.

Some high-end close-up lenses (or 'achromats', as they are sometimes called) are constructed using twin-element achromatic designs and are appropriately corrected. Some achromats are designed for use with a specific lens and offer appropriately high image quality with relatively few chromatic aberrations. Twin-element achromats are, however, larger, heavier and more expensive than their single-element counterparts. As far as we are aware, there are no three-element apochromatic close-up lenses.

Many of the telephoto and wide-angle accessory lenses available for compact cameras represent a serious change in the design of the camera's optical system and often produce obvious chromatic aberrations as a result. High-end accessory teleconverters like the Nikon TC-E3ED use low-dispersion glass and are a lot more expensive than the competition as a result.

Introduced in 2004, the Nikon TC-E3PF telephoto converter is based on a Phase Fresnel lens that works much like the Canon DO lenses described above. In spite of its small size and light weight, this innovative technology didn't gain a foothold in the market and, along with the other planned PF lenses, has now been discontinued.

Mirror Telephoto Lenses

Chromatic aberrations are caused by the refraction of light in optical lenses, so the fewer lenses an optical system contains, the less likely it is to produce irritating fringing effects. Mirror telephoto (or 'catadioptric') lenses contain very few elements and those they do contain don't refract the light entering the lens to a great degree. As a result, these lenses have a reputation for producing little or no chromatic aberration. On the negative side, mirror lenses produce donut-shaped bokeh, which is generally considered unattractive.

There are still a number of third-party manufacturers – mainly in Asia and eastern Europe – producing this type of lens. These include Vivitar, Rokinon, Bower, Phoenix, Opteka, Walimex, Danubia, Maksutov and Samyang. Most of the lenses we have seen look extraordinarily similar to the models offered by Maksutov and Samyang, and we are fairly sure that many are simply rebranded lenses made by one or other of the two.

Mirror telephotos are cheap, lightweight and compact. The disadvantages of this

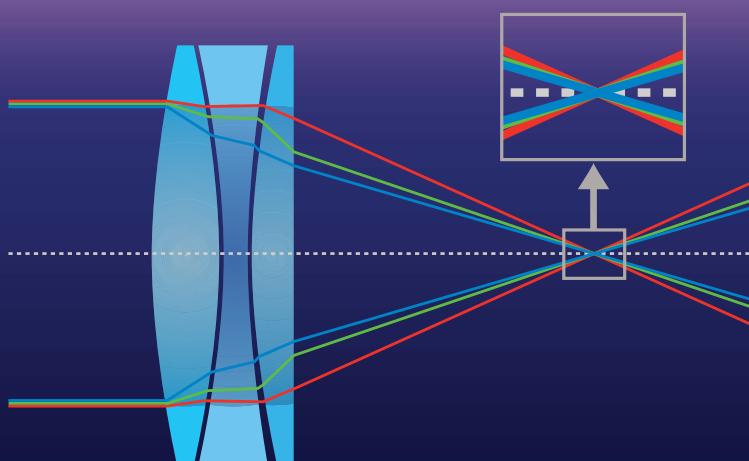
type of design are their relatively small, non-adjustable apertures and their vulnerability to capturing stray light.

In general, conventional lenses with glass elements produce better-quality images, relegating mirror lenses to the level of a hobbyist's tool in most everyday photographic situations.



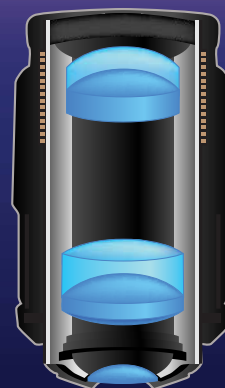
Mirror telephoto lenses are light and compact in comparison to the conventional competition. The Rubinar 500mm f/5.6 lens shown here weighs just 1.6 kg (3.5 lb) and is 23.5 cm (9¼ inches) long.

Image: Wikipedia/Armin Kuebelbeck

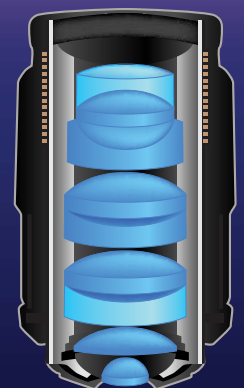


Apochromatic correction is, theoretically, capable of completely eliminating secondary spectrum and requires the use of at least three elements made of three different optical materials

Achromatic lens



Apochromatic lens



The structure of an apochromatic lens is more complex and therefore more expensive than that of an achromatic lens

Computer-based Chromatic Aberration Filters

We checked out a range of image viewers and RAW converters, from **ACDSee to Lightroom and RawTherapee**, to see just how useful their built-in filters are for combatting chromatic aberrations.

For our lateral aberration test, we used a black, red and white checkerboard target that made it relatively easy to observe the increase in fringing toward the edge of the frame. For the axial aberration test, we used a photo of a grid pattern taken at an angle that caused strong color casts in front of and behind the plane of focus.

Chromatic aberrations in images of homogeneous patterns look very different from the ones that occur in everyday subjects, so we tested each program (in RAW and JPEG formats) on four selected test photos too.

While comparing our results, we noticed that the colors in our RAW samples varied quite strongly, so we ended up comparing the effect of the filters themselves rather than overall image quality. In other words, we observed how the program behaved with the filter switched on and off. For the JPEG test, we converted all of our RAW source images using *RawTherapee*.

Overall, our test revealed that lateral aberrations can be effectively removed using automatic tools and an appropriate lens profile. Axial aberrations are much more difficult to correct. Many programs don't have built-in tools for combating this type of error and we didn't find any really effective automatic filters. We simply couldn't eliminate our focus-dependent color casts. Some of the better test programs managed to suppress isolated color patches and purple fringing to a tolerable degree.

Filters that are capable of removing blue/yellow fringes from out-of-focus areas in an irregularly shaped subject are few and far between. This is an important feature for photographers who use long telephoto lenses at wide apertures – a setup that is prone to producing artifacts, even if the lens carries a Leica or Zeiss label.

ACDSee Pro 4

Since the release of version 4, the *ACDSee Pro* Detail menu contains the Chromatic Aberration Correction tool, which has sliders for correcting red/cyan and blue/yellow errors. The Detail menu also contains the Defringe tool.

The chromatic aberration tool worked well on the lateral errors in our RAW files, and produced visible improvements. But take care: if you remove fringes at the top edge of the frame, you need to make sure that they have been effectively removed from the bottom edge as well. This aspect of the *ACDSee* tool's functionality is slightly temperamental due to its lack of lens profile support.

There is no before/after view, but the original image can be displayed quickly and easily using a single mouse click. Nikon's *Capture NX 2*, for example, is much more sluggish in this respect.

We were unable to produce any improvement in our axial aberration test image and the program had trouble with the high-contrast edges in our portrait shot too. Our attempts to remove blue fringing produced new halo-like double images, which wasn't the effect we were looking for!

On the other hand, the program scored well on the purple fringing in our dolphin image. The Defringe tool effectively suppressed the obvious pink fireworks in the

Free Test Images

Our test images and their source files are included on this issue's free DVD. You can use them to perform the same tests as we did on your computer at home and decide for yourself which are the best tools for your situation.



water, although the tool's limits are still obvious in the 100% view. The tool requires you to juggle three separate sliders, and there is no single setting that can effectively remove irregular fringing in a single subject.

Basically, the tool works very well if the fringes you want to remove are all the same color and you are not too critical of the results. The Defringe tool reliably removed the color cast in our tree image, although – as with *Capture NX 2* – the color of the sky suffered a little as a result. Our JPEG tests caused no surprises, and the results were very similar to those produced by our RAW run.

To conclude, the *ACDSee* tool is great for removing lateral aberrations, but the lack of a batch processing tool makes it less practical for use with multiple images. The Defringe tool is fine for removing single-color fringing of consistent strength. *ACDSee* does not currently offer any usable options for removing variable axial aberrations.

Apple Aperture

Apple's own RAW converter started with a bang but hasn't managed to keep up with the competition since. It still doesn't provide lens profile support and it supports only a limited number of camera models. On the positive side *Aperture's* Chromatic Aberration tool includes features that are superior to those offered by much of the competition.

The bad news is that you can only apply corrections manually using the Red/Cyan and Blue/Yellow sliders, and the only way to compare before/after versions of an image is to use a working copy of your image as a

OUR TEST PROGRAMS

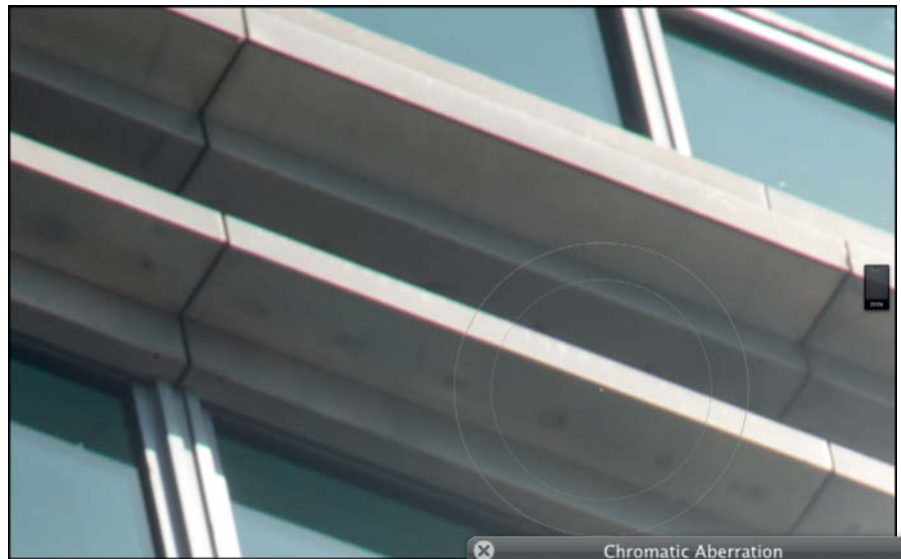
Manufacturer	Program	URL	Version tested	Win	Mac	Linux	Price (US\$)
ACD Systems	ACDSee Pro 4	de.acdsee.com	4.0	yes	yes	no	74.99
Adobe	Lightroom 3	www.adobe.com	3.5	yes	yes	no	299.99
Apple	Aperture	www.apple.com	3.2.1	no	yes	no	159.95
DxO	DxO Optics Pro	www.dxo.com	6.6.0.173	yes	yes	no	169.00
Nikon	Capture NX2	www.nikon.com	2.2.8	yes	yes	no	179.95
Phase One	Capture One	www.phaseone.com	6.3.2	yes	yes	no	59.99-179.99
RawTherapee Team	RawTherapee	www.rawtherapee.com	4.0.4.2	yes	yes	yes	free

workaround. You can, however, use the **M** key to toggle between views. The potentially cool loupe view took too long to refresh on our 2011 2.3Ghz i5 Mac Mini, and it's quicker to use a 100% (or larger) preview. The tool removed the lateral aberration from our RAW test image in fine style.

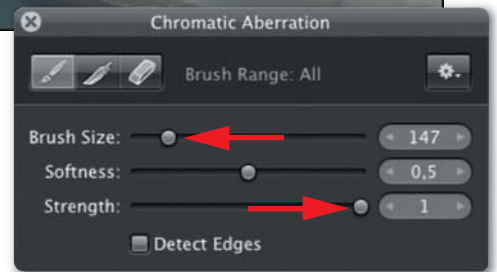
Apple's brush HUD is a great bonus and can be used to apply, strengthen or weaken the effect selectively. This is a great aid when you are using generic filters that you only want to apply to part of an image. In such cases you can also modify a filter's effect once you have applied it.

We weren't able to improve our axial aberration using the Apple tool, and it doesn't have a dedicated defringing option. Our JPEG test turned out very similar to our RAW run-through.

The brush functionality is great for performing selective adjustments, but is far less practical than tools like Nikon's *Capture NX 2* that support profile-based corrections. Many automatic correction tools nowadays produce results that are just as good as manual corrections and are also a lot quicker to use. *Aperture* does not have a dedicated filter for correcting axial aberrations.



Aperture's Chromatic Aberration tool can be applied and removed selectively using a brush



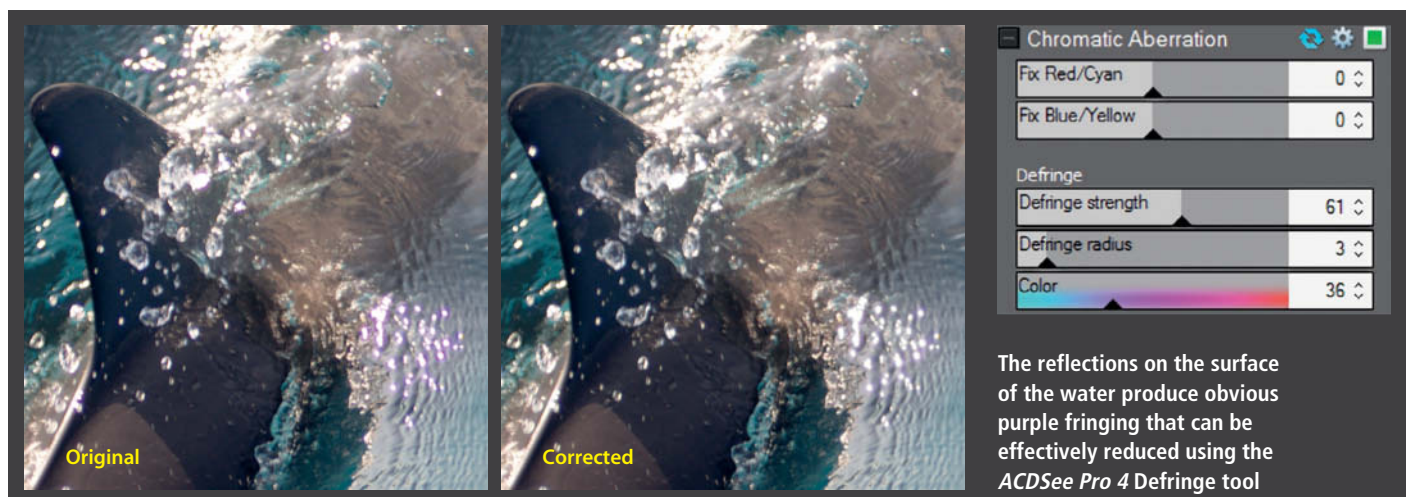
Capture One

Capture One has included lens correction filters for a while now, but the lens profiles supplied are few in number and are aimed squarely at medium-format photographers. It does enable you to define and save your own presets for individual lenses, but this is a laborious process, especially when dealing with zoom lenses. This is because a preset's aperture, focal length and ISO value (amongst other settings) all have to match those of the photo you want to adjust.

There is also a separate Chromatic Aberration tool, which we tested using the program's preset generic lens profile. All you have to do is select the Analyze option in the tool's drop-down menu and wait for a few moments while the program calculates the appropriate adjustments. The process works very well for lateral aberrations, but there are no user-configurable options. The Viewer's Zoom function enabled us to detect slight fringing in our target and skyscraper sample

images that we were unable to see in the standard view. Generally, you can ignore such slight errors.

The filter is obviously designed to correct only lateral aberrations, and using it on our images with axial aberrations produced additional flaws. The model in our test portrait acquired a red fringe on her hand, so we can't recommend using it as a general chromatic aberration correction tool. On the plus side, the axial errors in our images were less severe due



The reflections on the surface of the water produce obvious purple fringing that can be effectively reduced using the *ACDSsee Pro 4* Defringe tool



The *Capture One* Zoom tool makes it easy to detect chromatic aberration, even in the standard Viewer window

to *Capture One's* advanced conversion functionality, which reduced the required degree of correction in the first place. Overall, the filter didn't produce any visible improvements. The only really positive result we achieved was using the *Purple Fringing* option on our dolphin image, where it noticeably reduced the extraneous colors in the reflections.

An attempt to correct a JPEG image resulted in a disappointing 'Unsupported file' warning and grayed out automatic Chromatic Aberration and Purple Fringing options. Lens error correction for JPEG images is simply not supported.

Overall, *Capture One* made a mixed impression. The automatic correction tool was easy to use, but produced only average quality results and lacks even the simplest user-adjustable options. The lack of JPEG support isn't a problem for most pro and semi-pro photographers, but makes the program useless for hobby photographers and those wanting to process JPEG sequences shot using a DSLR.

DxO Optics Pro

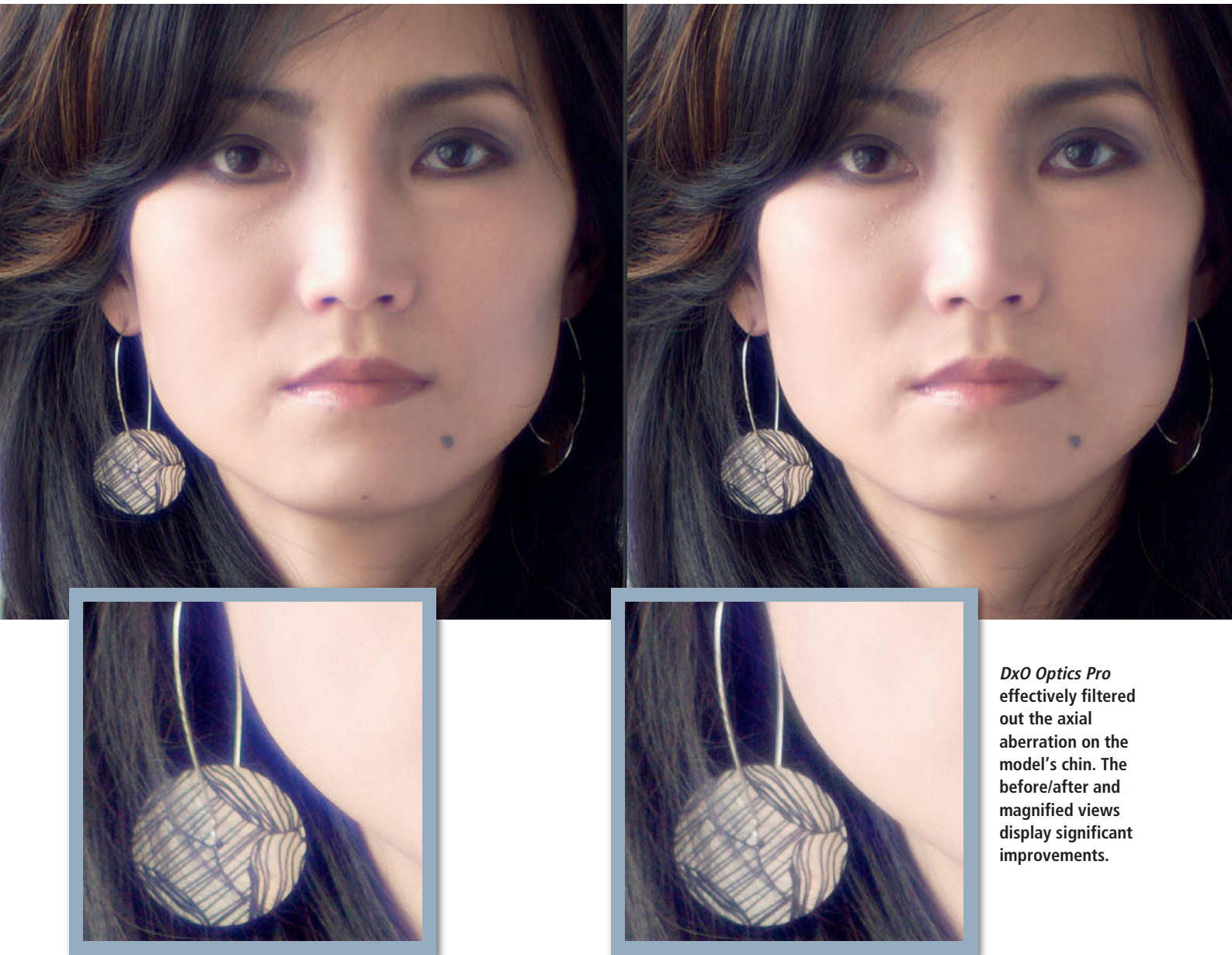
Automatic correction tools are DxO's trump card and, together with the countless dedicated camera and lens modules the manufacturer offers, make performing lens corrections a snap for the owners of most currently available camera/lens combinations. Things are not quite so simple for users of exotic gear or unusual camera/lens combinations. In principle, *Optics Pro* was not really designed with manual profile adjustments in mind and users are dependent on the company providing a profile for each specific setup. There are currently about 5,000 modules available, but many more are necessary to completely cover all currently available cameras and lenses. There was no module available for three of our six test images.

Optics Pro removed lateral aberrations automatically and effectively from our RAW images. There is no way to perform corrections on images shot using a camera and lens that are not covered by an appropriate module. This lack of manual

adjustment options is a serious weakness. In our case, there was no profile available for our older 80-200mm f/2.8 Nikkor or our rare Leica Noctilux 50mm f/1.0. On the other hand, our combination of a Zeiss 28mm f/2.0 and a Canon EOS 5DII is supported.

We were able to correct the axial aberration in our tree image and the 'before' and 'after' views helped us to judge the results. The program runs smoothly, although scrolling through a 100% preview of a corrected image was sometimes a little sluggish. *Optics Pro* is, however, faster than *Capture NX 2* in every respect.

Optics Pro was no different from the other programs in our test and wasn't able to correct color casts with varying colors in our axial aberration test image, although it produced good results when correcting the axial aberration in our test portrait. It wasn't really clear to us why we had to select the *Purple fringing* option to correct blue fringes, but it worked nonetheless. The same setting also effectively corrected the reflections in our dolphin image.



DxO Optics Pro effectively filtered out the axial aberration on the model's chin. The before/after and magnified views display significant improvements.

The program was not nearly as good at correcting lateral aberrations in JPEG images. DxO says that this is because our sample images were not OoC (Out of Camera) JPEGs produced directly by the camera and claims better results for OoC files. Our correction attempts left obvious artifacts in our target and skyscraper images, and the lack of manual adjustment options makes DxO unsuitable for everyday JPEG corrections.

Good automatic lateral corrections in RAW but poor JPEG results and the absence of profiles and manual settings make *Optics Pro* a mixed bag. Axial corrections were consistently good for RAW and JPEG images. The program is a recommend for RAW

photographers who use popular equipment covered by the its proprietary profile modules.

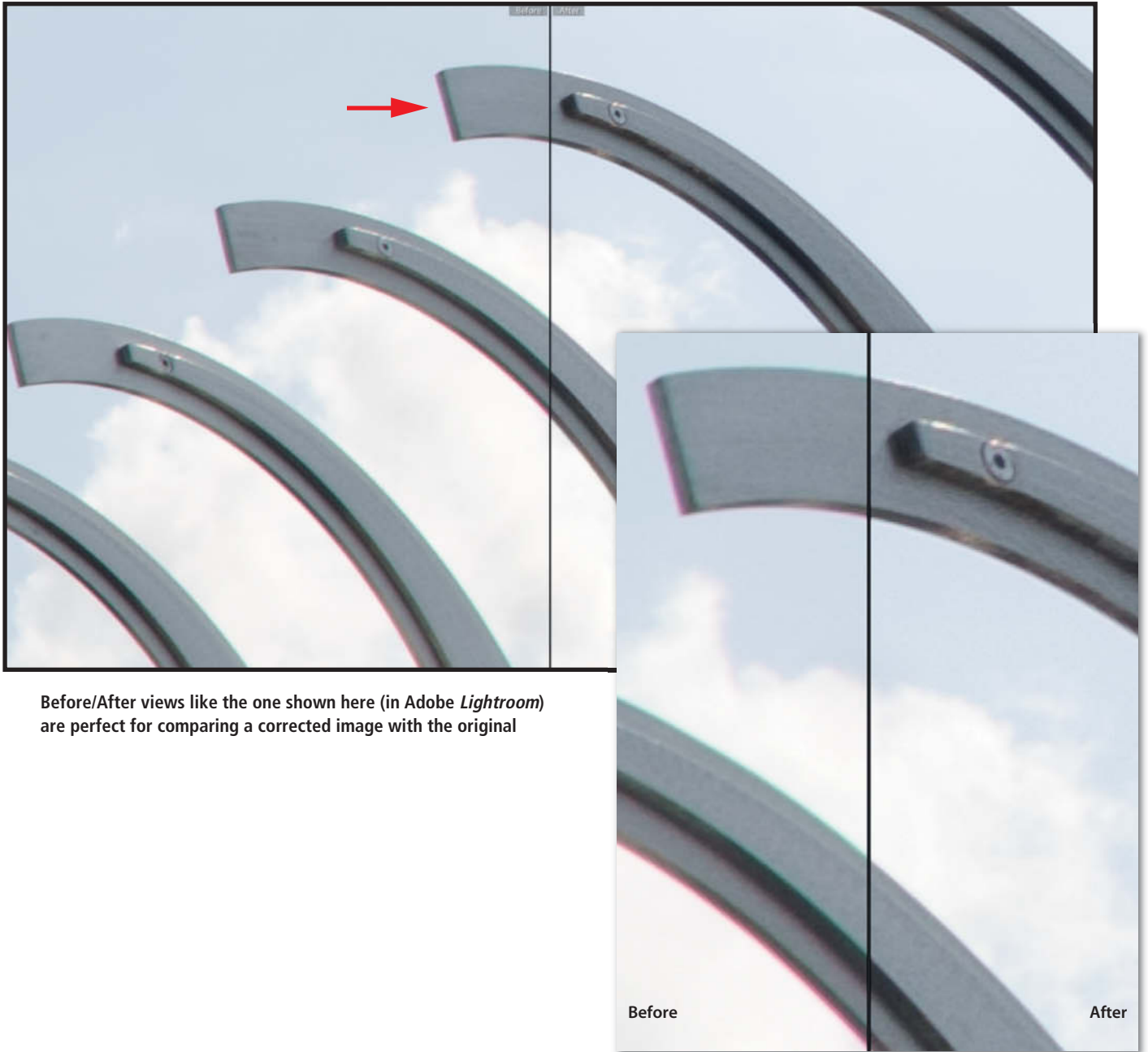
Adobe Lightroom

Lightroom uses the same profile-based ACR (*Adobe Camera Raw*) RAW conversion module as *Photoshop*. Our test delivered great results for lateral aberrations in both *Lightroom* and ACR, and the filter's handling was exactly the same in both programs. Unfortunately, both were unable to produce usable results for our axial aberrations, and failed to remove the blue fringe in the portrait, the purple fringe in the tree image and our dolphin's colored reflections.

Lightroom's automatic filter produced markedly better results when correcting RAW images automatically using lens profiles, although a little manual tweaking improved things quite a bit for our lateral aberration test. The small number of Canon and Nikon lens profiles available in JPEG mode makes manual correction unavoidable for many images. If you have the choice, always shoot RAW images – the range of lens profiles for making corrections later on is much broader.

In contrast to ACR, *Lightroom* allows you to select a lens profile without first having to select a camera model.

All in all, *Lightroom* is a great program, but still has a lot of room for improvement when



Before/After views like the one shown here (in Adobe *Lightroom*) are perfect for comparing a corrected image with the original

it comes to correcting chromatic aberrations. Filtering lateral errors in RAW mode is easy and effective, but the program does not provide an effective solution for fringes and flare caused by axial lens errors.

Nikon Capture NX 2

Just like its browser/editor cousin *ViewNX 2*, Nikon's RAW converter offers broad-based options for correcting chromatic aberrations. For images shot using current Nikon DSLRs, the Auto Lateral Color Aberration tool is automatically activated in the Camera & Lens

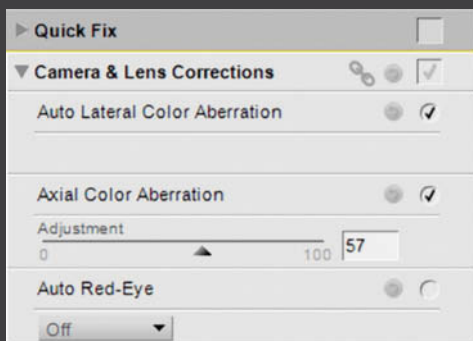
Corrections section of the program's Develop panel. You cannot adjust this setting in the camera, but you can undo it by unchecking the option in the software interface. There are no other adjustment options for the automatic version, but a separate, manual Lateral Color Aberration tool is available in the Adjust panel. This contains separate sliders for correcting red-cyan and blue-yellow artifacts, and an additional slider for adjusting the opacity of the effect.

The axial correction tool is not activated by default but has a single slider for adjusting the strength of the effect it produces.

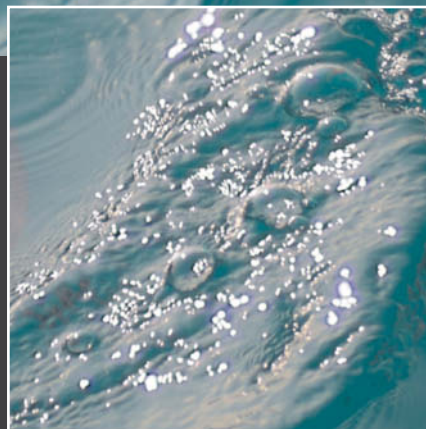
Capture NX 2 produced good results for our lateral error target and skyscraper images in RAW mode. The Nikon automatic correction function works well and it is only evident that even Nikon lenses produce color errors when you switch it off.

Capture NX 2 wasn't able to do much with the variable color casts in front of and behind the focal plane in our axial target image. It was able to reduce the obvious fringing in the dolphin image, but some errors nevertheless remained visible after correction.

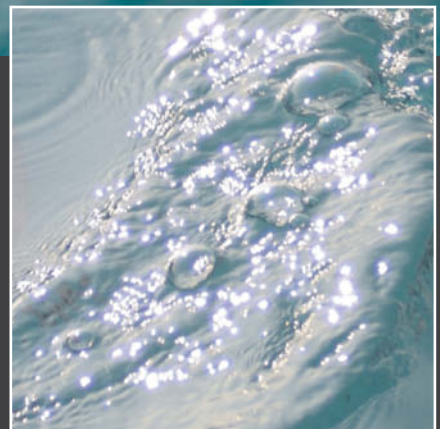
The lack of a before/after view is a hindrance if you want to compare corrected



Nikon's *Capture NX 2* is the only program we found that has dedicated lateral and axial aberration correction tools



Capture NX 2 removed purple fringing more efficiently in our JPEG test image than it did in our RAW sample



The quality of the RAW correction was clearly not as good

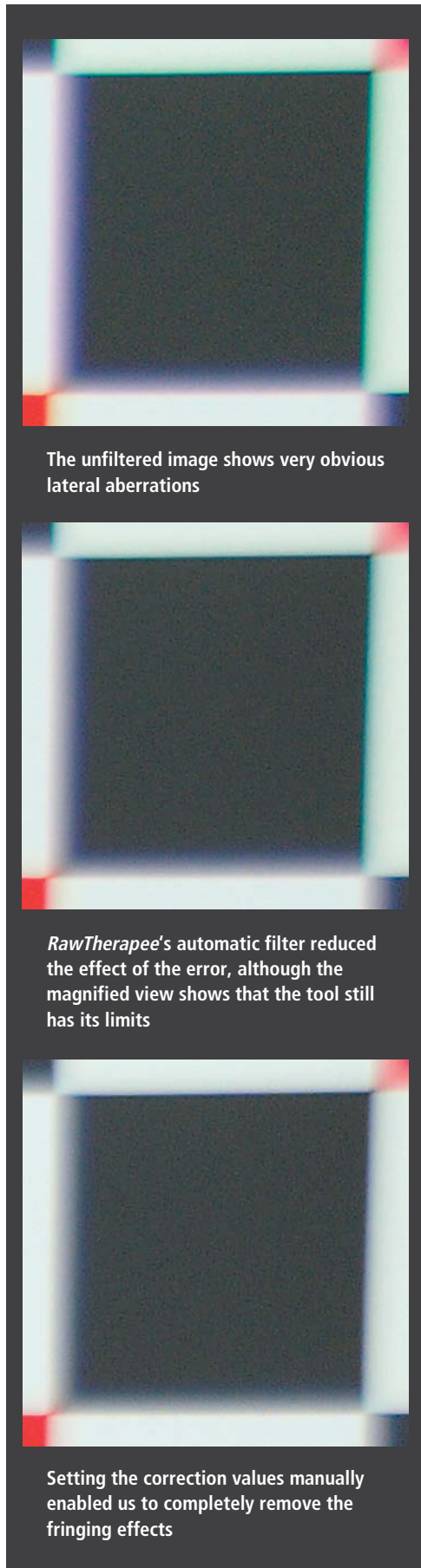
and uncorrected image versions during complex corrections, and the built-in *Compare with Original* option is not at all easy to use. We were unable to try out RAW correction on our other test images because they weren't captured in Nikon's proprietary NEF format.

The program filtered lateral errors fairly effectively in JPEG mode. It produced minimal improvements in our axial target, but did manage to reduce the color cast caused by our

original RAW conversion using *RawTherapee*. *Capture* wasn't able to fully correct the varying color casts in JPEG mode, but did improve things somewhat. It adjusted the purple cast in the branches of our tree to much more natural tones, but tended to adjust the overall colors in an image while correcting axial errors. While it produced a visible improvement in our colorful portrait image, it did produce some slight edge artifacts in the process.

Purple fringing correction worked much better for our JPEG test image than it did for RAW, and reduced the strong colored artifacts so much that they became virtually invisible.

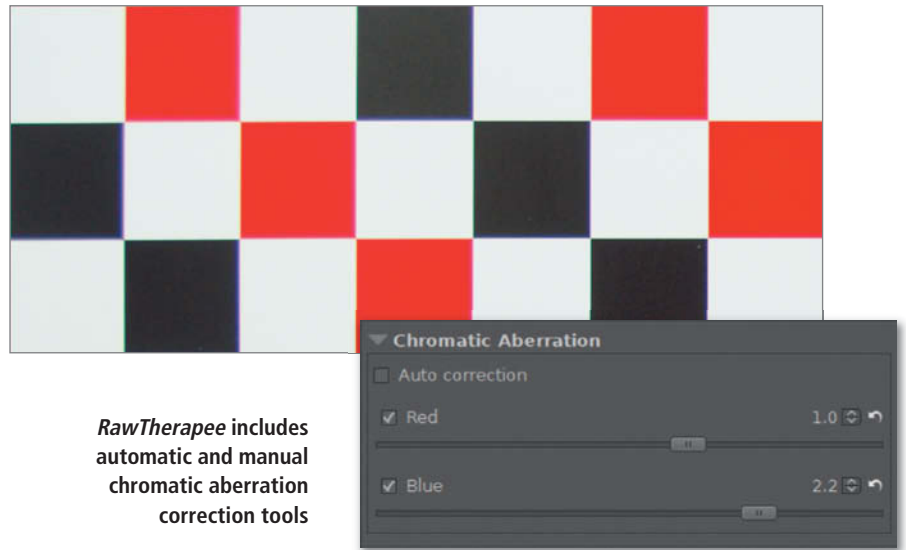
Capture NX 2 offers solid, easy-to-use color error correction tools, but is restricted to correcting only Nikon RAW images. It can be used to correct JPEGs from any camera. The software's known weaknesses regarding stability, sluggishness and rather odd user



The unfiltered image shows very obvious lateral aberrations

RawTherapee's automatic filter reduced the effect of the error, although the magnified view shows that the tool still has its limits

Setting the correction values manually enabled us to completely remove the fringing effects



RawTherapee includes automatic and manual chromatic aberration correction tools

interface haven't noticeably improved in the current release.

RawTherapee

This freeware RAW converter has, over the years, developed into a comprehensive RAW conversion and editing package with a feature list that is just as long as that of the commercial competition (see our article on *RawTherapee* in Issue 7 of *c't Digital Photography*). The program includes a number of tools for correcting chromatic aberrations – the Detail tab includes the Defringe filter, the Lens/Geometry tab includes the C/A Correction tool and the RAW tab has its own Chromatic Aberrations tool that offers manual and automatic error correction.

RawTherapee was able to open all of our test images, and the automatic correction tool produced great results (although still not quite up to Nikon standards) for our lateral aberration test. Manual corrections are quite laborious because the preview image refreshes very slowly after each slider adjustment. As recommended by the software's authors, we used a dual-core 64-bit system with plenty of RAM for our test, but we still spent quite a lot of time waiting.

There is no before/after view, which makes comparing images difficult, and 'features' like the heavily pixelated view when shifting a detail in the preview window often reminded us of the program's open source heritage. This isn't particularly nice to look at but does make recognizing erroneously colored pixels quite simple.

In general, the program's automatic correction tool produced passable results with little effort for everyday subjects like our skyscraper. It is safe to say that the differences in quality produced by all of the programs we tested are not particularly significant at normal viewing distances. Where *RawTherapee* couldn't really compete was correcting axial errors, and we weren't able to produce any visible improvements using any of the built-in tools.

Neither the automatic nor the manual Chromatic Aberration tool worked at all for JPEG images, although the Defringe and C/A Correction tools both produced usable results after a bit of manual tweaking (automatic correction only works for RAW images). Care is required when correcting chromatic aberrations in *RawTherapee*. We often found that by the time we had perfected a correction in one part of an image, new artifacts had appeared elsewhere. Just as in RAW mode, we weren't able to produce any convincing JPEG results for our axial errors, and we searched in vain for settings that genuinely improved our target and sample images.

RawTherapee is fine for correcting lateral errors in JPEG and RAW images, although its handling in RAW mode is much more user-friendly. If you don't want to correct any significant axial errors and you don't mind a bit of a fight with a somewhat clunky interface, *RawTherapee* offers a no-frills RAW converter that is easy to use, and its freeware status makes it a real alternative to the commercial competition, especially for occasional users. (keh) **ct**

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Sascha Steinhoff

Digital Image Protection with **Invisible Watermarks**

In the digital world, and especially on the Internet, where a mass of audio and visual data is just a click away, people have very different views as to what the terms 'yours' and 'mine' really mean. Visible watermarks are simple to create and offer a fair degree of protection, while invisible watermarks offer the advantage of retaining visual integrity while confirming irrefutably who an image belongs to. We decided to test the robustness of some of today's invisible watermarking tools, and quickly came to the conclusion that many of them simply aren't up to scratch.

Watermarks are old hat in the analog world. They are used on banknotes and stamps to help prevent illegal copying, and on writing paper as a manufacturer's label and a sign of quality. Watermarks have long been a familiar part of our everyday digital lives, and visible watermarks are a tried and trusted tool at image portals such as Fotolia. Invisible watermarks offer various advantages over visible ones, but require dedicated software if you want to use and analyze them properly. Digital watermarks are generally simpler to remove or manipulate than their analog counterparts, and most home computers have a range of tools installed that can be used for just that purpose. The intended use for a photo will determine which type of watermarking technique is most appropriate.

Why Use Watermarks?

Digital image protection is a form of medicine that unfortunately cannot be used without producing side effects. Visible watermarks mar the look of an image, while invisible watermarks can, under certain circumstances, reduce image quality. Embedding any kind of watermark involves effort that will, ideally, save time and money in the long run, but whether you use a watermark at all will

depend on how you wish to use your images. If, for example, you sell your images as postcards via a website that includes thumbnails of your products, the tiny size of the published images makes them useless to potential pirates. And, should your thumbnails turn up elsewhere, they are unlikely to cause any real commercial damage to your sales of printed postcards.

The situation is quite different if you create images specifically for commercial use on the Internet. In this case, every image sold is the perfect raw material for an illegal copy, and every pirated copy reduces your potential income from legitimate channels. Once you have decided to use watermarks, you need to decide whether to take the visible or invisible route. Each approach has its own particular advantages and disadvantages, and there is no ideal solution.

Visible Watermarks 'Brand' Your Images

Creating a visible watermark is, technically speaking, a trivial task, and every halfway decent image processing program includes the necessary tools. These use various techniques, but all produce a watermark that behaves like a kind of stamp on the 'surface'

of the image. This approach usually spoils the appearance of the image, although a watermark that is too subtle – such as a string of letters at the edge of the image – can simply be cropped away; watermarks have to cover a large part of an image to be effective. Nevertheless, it is still possible to remove most visible watermarks if you are prepared to put in some effort retouching. The techniques used to remove watermarks are similar to those used in digital image restoration, but are usually too time-consuming to make it image piracy worthwhile. To put it simply: if stealing involves more work than taking the legal route, no-one will bother trying.

Online stock photo agencies like Fotolia use semi-transparent visible watermarks that make the images less attractive to would-be thieves. These aren't necessarily a problem in purely documentary images, but make a big difference if they are plastered across the middle of a romantic sunset under palm trees.

Visible watermarks are the simplest way to effectively protect online images against theft and make it impossible for third parties to use stolen images without revealing their source. They are internationally recognized, and every user can see who an image belongs to without having to make any additional technical effort.

The screenshot shows the Fotolia website interface. At the top, there's a header with the Fotolia logo, contact information (+61 280-114-769), and statistics (17,908,646 high quality images). Navigation links for 'Buy Images!', 'Images', 'Vectors', 'Videos', and 'Logos' are present. A search bar is located below the navigation. The main content area displays a product page for a palm tree image by Dmitry Ersler. The image has a visible watermark. To the right of the image is a table of available sizes and prices, along with an 'Add to cart' button and social media sharing options.

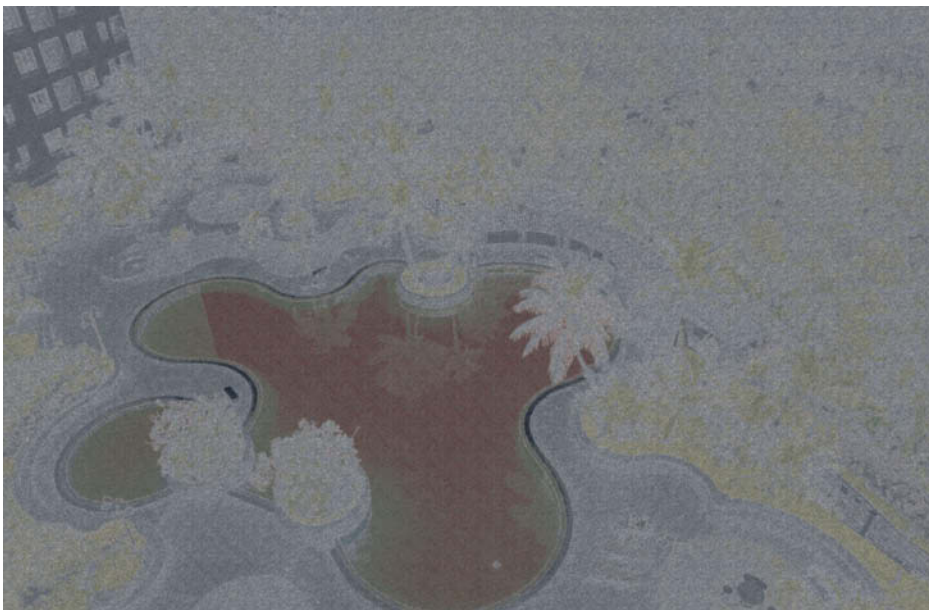
Size	Pixel	Inches	Price	Credit Download
Standard XS	424 x 283 (0.1 MP)		2 credits (from \$1.50)	
Standard S	848 x 566 (0.5 MP)		6 credits (from \$4.50)	
Standard M	1688 x 1126 (1.9 MP)		12 credits (from \$9.00)	
Standard L	2356 x 1571 (3.7 MP)		16 credits (from \$12.00)	
Standard XL	3500 x 2334 (8.2 MP)		20 credits (from \$15.00)	
Extended X	3500 x 2334 (8.2 MP)		100 credits (from \$75.00)	

Additional information on the page includes: '125 views', '24 downloads', 'Download comp image', and a link to 'Learn more about sizes and licenses'. A promotional banner at the bottom offers a subscription plan for \$0.16 per image.

Online stock agencies such as Fotolia protect their low-resolution thumbnails and high-resolution images with obvious visible watermarks. Purchased images don't have watermarks.



Digimarc watermarks are not immediately visible ...



... and you can only see which pixels have been altered if you massively increase the contrast of the difference image created by subtracting the original image from the watermarked version

No-one wants to purchase images that contain visible watermarks. When you purchase an image from a stock agency like Fotolia, the image you receive will not have a watermark and is simple to copy and use illegally. This is the point at which invisible watermarks come into play.

Hidden Labels

Wikipedia defines digital watermarks as invisible markings made in carrier media such as digital images. The visible watermarks

described above are created digitally, but can be read using analog techniques. In other words, a digital image that contains a visible watermark can be analyzed without the use of digital technology, and does not conform to the generally accepted definition of a digital watermark. In everyday situations, visible watermarks are often incorrectly described as digital watermarks.

It goes without saying that an invisible watermark in a digital image shouldn't be immediately obvious to the viewer. As a rule, the creation and reading of a digital

watermark requires the use of dedicated software. Digital watermarks are generally classified as either 'fragile' or 'robust', but both types use steganographic methods to bind the watermark with the medium it is designed to protect. Copyright and camera metadata for example, are fragile and simple to remove, while invisible watermarks are robust and much more difficult to manipulate.

Fragile Watermarks – a Seal for Your Image File

Fragile watermarks are useful if you want to prevent unwanted changes to an image file. Even the slightest manipulation of a file destroys the watermark, making the manipulation traceable. Fragile digital watermarks are thus equivalent to a seal in the analog world. A seal on an envelope doesn't prevent the postal service from opening it, but does prove to the recipient that the letter has been tampered with. Fragile watermarks are therefore a great device for checking and documenting data integrity, but do not offer direct data protection.

Robust Watermarks – Hidden Proof of Ownership

The only thing that robust and fragile watermarks have in common is that they are invisible. Unlike fragile watermarks, robust watermarks are designed to resist the application of even the most abrasive image manipulation techniques. Ideally, they will survive format conversions and the application of common image processing steps, and even deliberate attacks. The basic aim is to embed the watermark in such a way that removing it will destroy the data that it is part of. If successful, the protection process makes a stolen image useless to a thief.

Uses for Invisible Watermarks

The wide range of potential uses for invisible watermarks goes way beyond simple detection of digital image theft, even as far as tracing the paths taken by illegally copied images. For example, if you attach images with invisible watermarks to a press release, you can quite easily perform a media response analysis using crawler software.

Watermarks embedded in product photos can also be used to analyze sales and competition on the Web, and can help to identify gray market importers who use a manufacturer's own images for advertising purposes. Most manufacturers also prohibit the use of official images for second-hand sales – on eBay, for example – and watermarks can help to stem this kind of usage.

Steganography vs. Digital Watermarks

Digital watermarks are similar to steganographic techniques in that they embed additional information in digital image files. In fact, some of the techniques used to create digital watermarks directly involve steganography. Steganography hides invisible information in a carrier medium in such a way that it can only be read by the intended recipient. This can, for example, be a text string hidden in an

image. The image remains the same visually while the additional information remains hidden. The main aim of the steganographic process is to hide information, whereas invisibility is only the first degree of protection offered by digital watermarks. Robust watermarks are designed to be embedded in the carrier medium in such a way that the carrier itself will be destroyed if someone

attempts to remove the watermark without appropriate authorization. In this case, it is the irreversible embedding rather than the hiding of the information that defines the process. Watermarks are designed to aid the discovery and recovery of stolen images, and the addition of hidden copyright information is more or less a side effect of the main process.

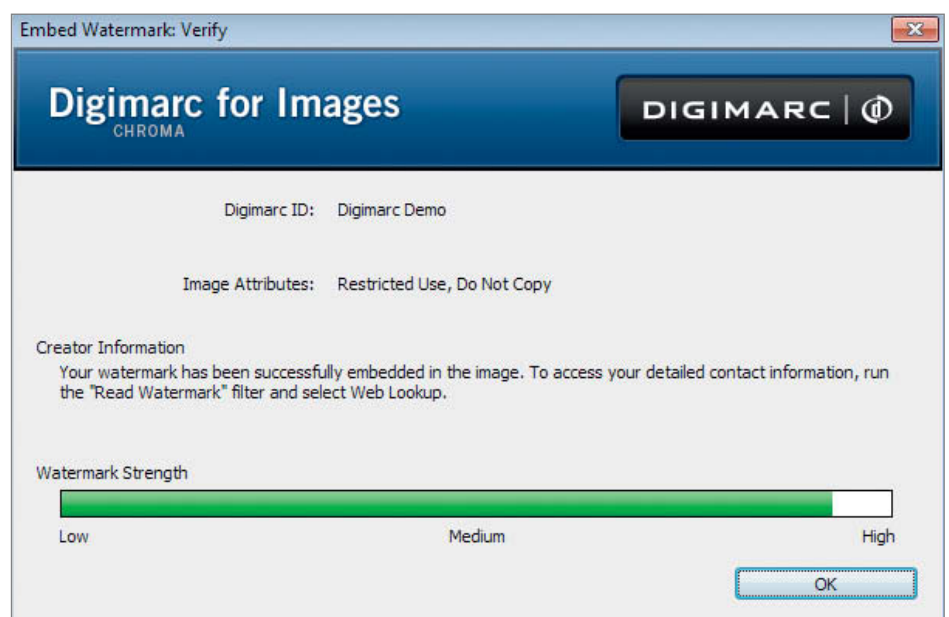
Product photos in online shops can be protected using invisible watermarks, although visible watermarks are still more common for this type of application as they are easier to apply. Online shops don't usually rely on the aesthetics of a product photo to make a sale anyway.

Analog Reproduction

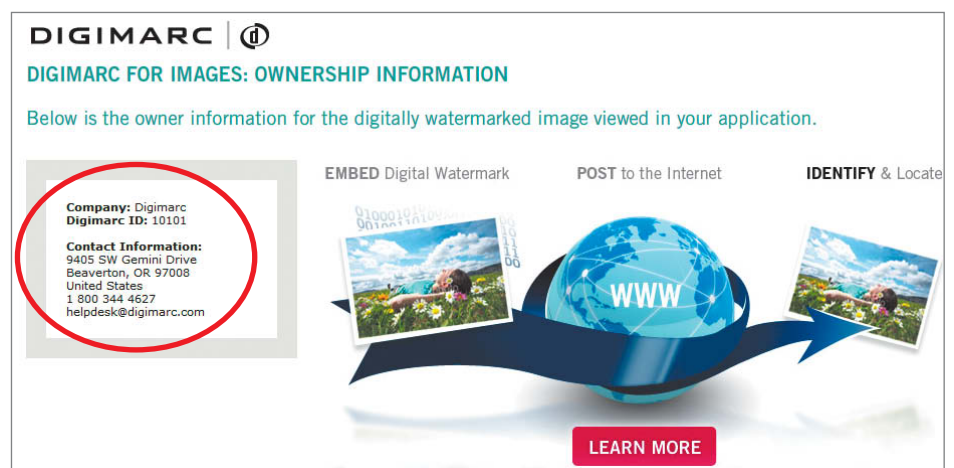
Watermarks also have their uses when it comes to preventing analog (i.e., print) reproduction of high-resolution digital images downloaded from the Internet. In the past, people tended to use only low-resolution images in online situations, but the trend is moving quickly toward higher online resolutions. The thumbnails that used to be popular look unimpressive, even on today's handheld devices. You need images with at least three megapixels of resolution if you want them to look good on the 2048 × 1536-pixel screen built into the current model iPad. Commercial websites are sure to follow this trend, thus increasing the risk of analog reproduction of digital image data.

Conclusion

Digital watermarks are the only way to reliably embed copyright information in an image without altering it visually, and they also make it possible to locate stolen photos. Previous attempts at creating robust watermarks proved too easy to crack, and the last test performed by our German sister magazine in 2009 showed that all it took to deactivate most watermarks was to rotate an image by one degree. The tests documented on the following pages take a close look at the latest watermarking developments. The Chroma digital watermarking technology introduced by Digimarc in 2010 claims to be more robust and less conspicuous than any of its predecessors' methods. Read on and find out for yourself what's good and what's not.



Digimarc watermarks can be read using a *Photoshop* plug-in or dedicated Windows client software



The Digimarc online watermark monitoring service is only available to users who take out a paid subscription

Interview: How Do Digital Watermarks Work?

There are various ways to embed digital watermarks in image files. In this interview, Martin Steinebach from the Fraunhofer Institute for Secure Information Technology explains the pros and cons of the most common watermarking methods and suggests some other ways to protect digital image content.

What other methods compete with digital watermarks for the protection of media data?

Martin Steinebach: There are various alternatives to digital watermarks. If you want to prevent data from being copied, then proprietary file formats or a Digital Rights Management (DRM) system are great techniques to use – in other words, you either keep your data format secret or you encrypt it. If you want to find stolen data, robust hash techniques – also known as fingerprinting – are an excellent alternative. In this case, a heavily simplified description of the media (similar to a checksum) is used as a reference. This description data can then be used to compare found data with the original.

What are the advantages and disadvantages of digital watermarks compared with other techniques?

MS: Watermarks are not designed to prevent copying, but rather to help you find and retrieve data that has been stolen. They are often used as a deterrent when it comes to enforcing copyright law. If you want to prevent your data from being copied in the first place, you will have to use DRM or some other copy protection system. The main advantage of watermarks is that they are fully transparent for the end user, and they do not alter the data format or its quality. Unlike robust hashing, watermarks can mark files individually – in other words, you can produce multiple versions of a single image. Robust hashing can distinguish between different image files, but not between individual copies of a single image. However, it is often more robust than watermarking and is capable of surviving stronger compression and scaling processes.

Can you briefly describe the technical aspects of how a digital watermark works?

MS: There are virtually limitless ways to embed a digital watermark. A common method involves what is called patchworking in a frequency domain. Here, a Fourier transform is used to transform an image from its original pixel-based space into a 'frequency domain' in which the image exists in the form of a set of frequencies that relate to the individual color channels. A secret key is then used to create frequency pairs and alter the strength of the frequencies so that they form a specific mathematical relationship to one another, whereby the relationship represents a single bit of the resulting watermark. A 'zero' or a 'one' bit is then embedded in the image, depending on which of the two frequencies is stronger. Once all these bits have been embedded, the watermarked image is transformed back to its original pixel space.

How does this work in practical terms for a potential customer?

MS: We usually license our methodology to the owners of online shops who store their digital wares in a secure server environment where watermarks are embedded. Only the shop owner has access to the secret key that is used to protect them. The watermarked file a customer receives is indistinguishable from an unmarked one. The shop owner's terms of business advise the customer of the fact that the image can be traced. If a shop owner finds an illegal copy of an image, the watermark can be read and the original customer can be traced.

How can everyday users find out if an image contains a Fraunhofer watermark?

MS: In short, they can't! Identifying one of our watermarks requires knowledge of the process and access to the customer's individual key, which should, of course, remain secret. This is one of the major advantages of watermarks over cryptography – a potential attacker can never be sure whether a watermark has been successfully deleted because there is no sure way of checking. If you have cracked cryptographically protected data, you know you have succeeded because you can see or use the data in its original form. If we license our methodology to a service provider who then uses it to provide customers with a watermarking service, the provider will have to provide a way of reading watermarked data. We always license embedding and reading technology together, although it has to be said that we only sell licenses to companies, not to individuals.

Where do you think the development of digital watermarks is headed?

MS: Watermarking methods are constantly under development, and we are still a long way from discovering the perfect technique. There are still many ideas from the world of graphics processing that we can build into our processes to make them more robust. One major challenge is speeding up our processes to keep pace with the increasing size of the images in everyday use. Our aim is to adapt methods already used in the movie and music industries for use with digital images. One of our long-term projects is data integrity protection. We are currently using our CASED security cluster to investigate ways of using watermarks as a kind of secure coating for digital images that makes changes to their content visible. We have already come up with some great leads, but so far, none of the resulting methods are secure enough for use in real-world applications.

Martin Steinebach has a PhD in informatics and is head of the Department of Media Security and Data Forensics at the Fraunhofer Institute for Secure Information Technology (SIT). Much of his work involves developing digital watermarks for audio, video, image and document data. The Fraunhofer Institute licenses its processes to industrial and media customers, as well as to the public sector.

Using Crawler Software to Find Stolen Images

Invisible watermarks make it possible to use crawler software to find stolen images in the wilds of the Internet, although there are various technical challenges that you need to overcome before you can start to retrieve lost data. Even the best spider bots are choosy about what they can find, and they often take their time too.

Alongside effective watermarking, finding marked images is another very interesting aspect of the data security process. The best watermark in the world is no use at all if it simply disappears in the mass of data stored on the Internet. All the major watermark services run their own crawler services for finding and retrieving watermarked images from the endless depths of the Web.

Capacity Is Key

Server capacity and available bandwidth are critical to the success of a crawler service. Nowadays, any small company has access to entire server farms via Amazon Cloud Drive or similar services, so you need to treat the statistics quoted by a potential crawler service provider with care. As an end user, it is virtually impossible to find out exactly what resources a provider has at its disposal. According to company data, market leader Digimarc crawls the Web monthly and claims that it usually takes between one and six

months to locate a stolen image, although precise estimates are simply not possible. Like search engine optimization, Web crawling is subject to a number of factors that influence a provider's ability to find exactly what it is looking for.

An image has to be recognizable to a crawler if it is to be found at all. If stolen images are presented as part of a Flash gallery, most crawlers will have trouble finding them.

Even if an image is stored in a format that the crawler can read, there is still no guarantee that it can be found. The chances of finding a stolen image are best if it is part of a well-frequented and technically well-built website. Less popular sites that are not so search engine-friendly make it much more difficult to produce positive results. If the particular page on which an image is posted is not linked internally or externally, a crawler will quickly reach the limits of its capabilities. Crawlers depend on Web content that has been appropriately optimized for search engines.

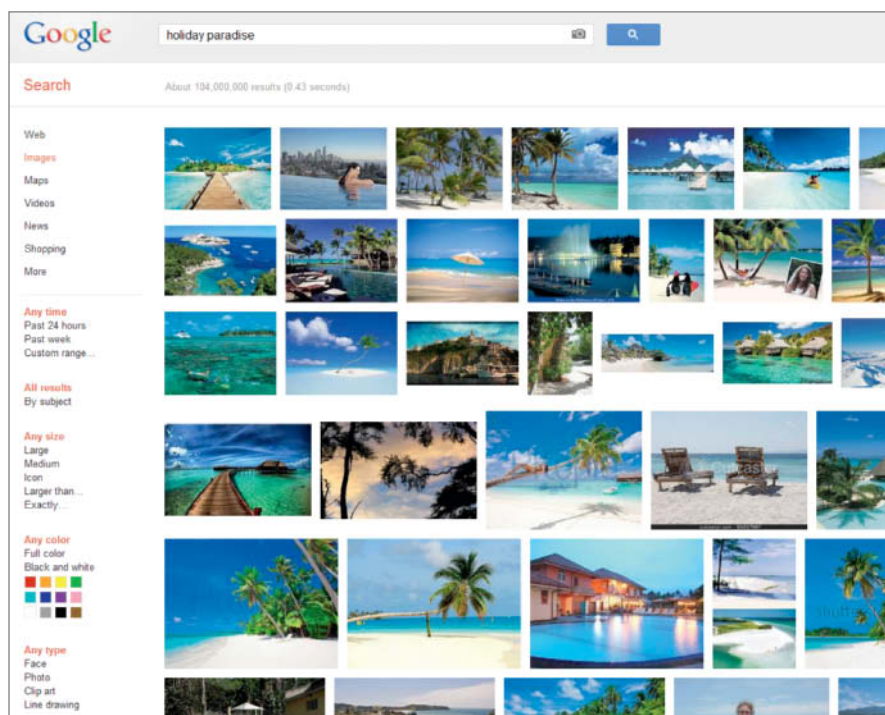
Social Networks and Crawlers Don't Get On Well

The situation is also quite tricky at photo portals like Google's Picasa and on social networks like Facebook. These types of website deliver dynamic content stored in CMS (Content Management System) databases. This is common practice at larger websites and their operators always try to create search-friendly pages at all levels of the database structure. Ideally, a site will use CMS to simulate a static structure that a crawler can easily interpret. Search engine optimization plays only a minor role at sites such as Facebook where most of the content is only visible to members, making it extremely difficult for a crawler to find all the relevant related content. Additionally, a spider will not usually have appropriate access rights, and will not be able to search relevant pages even if it can find them.

Generally, crawler software can only find publicly available material or material for which it has appropriate access rights, making password-protected or pay-to-view sites off limits. Adult entertainment sites are nowadays almost exclusively pay-to-view, and major publishers are placing more and more of their content behind commercial barriers of one sort or another. If a thief steals images protected using just a watermark and posts them on a pay-to-view web page, crawler software will be powerless and the watermark becomes useless.

Not Perfect, but still Useful

A manual search using visual source material at TinEye or Google is painstaking, whereas crawler services are capable of monitoring large collections of images automatically. Crawler technology is imperfect, and it is fairly simple for a webmaster to undermine the rudimentary protection it provides. Nevertheless, crawler services are a useful tool for content owners and make it relatively easy to document image theft. If a thief goes public with a stolen image, the chances are pretty high that a crawler will find it sooner or later.



The ADP Tools crawler searches the Web for images in a similar way to the familiar Google Image Search

Tools for Creating and Managing Invisible Watermarks

A few years ago there was a wide range of digital watermarking tools available. Time and technological advances have taken their toll, and some of the high-flyers from yesteryear have now disappeared from the market. There are currently just two services offering functionality that is robust enough for use in today's online world.

Digital watermarks were a hot topic at the turn of the 21st century, but have since disappeared somewhat from the public eye. This test only looks at tools that have been updated within the last two years. All other legacy tools are listed in the table on page 95. The following sections concentrate on tools that offer digital photographers genuine help when protecting their intellectual property. Only Digimarc and SignMyImage really fulfill our test criteria, and both offer their own crawler service.

The online Photoprotect service was an attempt to offer a cloud-based photo tagging service based on checksum methodology. The service hasn't been updated since it was acquired by the DAPD news agency, which now uses it as an internal tool as well as selling its services to other agencies. The Photoprotect crawler searches for metadata and can thus only find images that include appropriate keywords. Because the service is not currently supported, we left it out of our test.

SignMyImage

SignMyImage (SMI) is available as a standalone program, as a *Photoshop* plug-in or as a command-line utility. The manufacturer's own crawler service is called Image Spider and has to be activated by purchasing an annual subscription in addition to the program itself. There is also a free trial version of the program available that allows you to test its functionality but with the restriction that it produces visible watermarks in the resulting images. Manufacturer ADP tools (www.adptools.com) also offers an end-to-end photo sales and protection suite called Vericuff.

We conducted our test using the 4.0 standalone version of the software but, because this version appeared somewhat unfinished, we also tested the older, more stable 3.52 version. The results in the table on page 92 relate exclusively to the 4.0 version. Compatibility-wise, the newer version no longer supports 16-bit RGB TIFF and 8-bit grayscale images, whereas the older version does. The user interface has also lost some ground in the new version, and many

functions that were easily accessible in the previous version are now hidden away in the tool's menus. Both versions are quite slow and took as long as 45 seconds to embed a signature in a high-resolution sample image using our test system (3.3GHz Intel Core i3 2120 with an SSD and 16GB of RAM) with all cores active. Digimarc took about 15 seconds to perform the same task, which is better, but still not particularly fast.

Rather than spreading watermarks around the entire image area, SMI embeds them in selected areas and tells the user where these are once it has completed the process. These areas are recognizable by their slightly convex appearance in the difference image in *Photoshop*, and can cause a visible reduction in image quality in monotone areas. SMI only

partially protects images against serious cropping, and if you crop outside the marked areas, the watermark will be destroyed. SMI signatures don't survive conversion to grayscale and are also susceptible to damage by a variety of image processing tools, including standard processes such as noise filtering and distortion correction. Reducing image size to 25 percent or less also deactivates the signature, as does rotating an image through just 0.3 degrees using *Photoshop*.

At the end of the day, SMI offers great value for money but still embodies all the familiar pros and cons of checksum signatures. The software, bundled with a year's subscription to the crawler service, costs just US\$32 and, unlike Digimarc, you

Our Test Methods

Digital watermarks are hidden amongst the pixels that make up an image and are stored in the form of artificial luminance or color noise that slightly alters the original image data. A high-quality watermark is not visible to the naked eye but is robust enough to survive deliberate attacks. Altering image data is, in itself, a trivial task that can be performed using a wide range of free and commercial image editing programs. The problem with removing watermarks using basic editing techniques such as noise filtering, scaling or distortion is that this also destroys much of the image data, thus rendering the resulting file useless. We tested the tools detailed here by embedding watermarks at their default strength. Stronger watermarks are more robust but have more obvious effects on the images they are designed to protect.

We used everyday editing techniques to subject our test images to real-world tests but without doing them too much damage. For example, we converted RGB images to grayscale or a lower bit depth.

Watermarks based on changes in luminance data generally survive these tests quite well, whereas the nature of the process makes those based on additional color noise data much more susceptible to damage and/or deactivation.

A watermark that is worth its salt should survive all common image editing steps, including distortion correction, noise filtering, unsharp masking and rotation. When we tested digital watermark software three years ago, many of our test candidates were particularly weak when it came to applying rotations, so we were interested to see if the manufacturers had done anything to improve the situation since then. Image size reductions are also quite common – for example, when you scale a high-resolution image for online publication as a thumbnail. We used *Photoshop* for most of our tests but, due to Adobe's strong cooperation with Digimarc, we also performed some additional spot checks using *GIMP* and Nikon's *Capture NX 2*.



Instead of using the entire frame, SignMyImage embeds its watermarks in selected image areas

don't need to use *Photoshop* as your host application. The downside of the low price and product simplicity is slightly clunky handling, slow processing and watermarks that don't win any prizes for robustness.

Digimarc for Images

Digimarc is a heavyweight in the industry, offering content protection for various types of digital media. Digimarc for Images creates digital watermarks for image files and requires either *Photoshop* or *Photoshop Elements* as its

host application. Digimarc is only available as a plug-in, although there is free reader software available for the Windows platform, which adds appropriate functionality to Windows Explorer and *Internet Explorer*. Equivalent software is not yet available for Mac. The freeware is fine for trying out the Digimarc functionality, but you can only actually apply unique working watermarks if you take out a paid subscription to the service. These start at US\$50 per year, and the crawler service costs the same again. The price brackets vary according to the number

of images you want to track, so if you have a large collection of online photos, it can get quite expensive to keep an eye on them all.

In the past, Digimarc used the same basic luminance-based technology to watermark RGB and grayscale images, although this method can produce unwanted image artifacts. In 2010, the company introduced its new 'Chroma' technology, which uses changes in color data to watermark images. These changes are much more subtle and less likely to create unwanted artifacts. Chroma is

Watermarks and Image Quality – Sample Images on DVD

Today's watermarks are often extremely robust and cause irreparable damage to the carrier image if you attempt to remove them. This is certainly true of the products offered by market leader Digimarc and, at normal magnifications, any reduction in image quality for everyday subjects is pretty well negligible.

Additional noise is, of course, not especially desirable in a digital image but, among all the other imperfections that plague our photos (such as chromatic aberrations or sensor noise), a watermark can usually be well hidden without producing critical changes to the look of an image. It is more difficult to hide

watermarks in digitally created graphics, which tend to have a super-clean look in the first place. The high-resolution sample images included on this issue's free DVD include watermarks created by both of our test programs so you can see for yourself whether you think they make a difference.

Quick Tip: How to Make Digital Watermarks Visible

A well-made digital watermark will be invisible to the naked eye. However, it is relatively simple to use *Photoshop* to make the differences caused by the watermark visible. Note that without access to the original, unmarked image or reader software from the watermark manufacturer, it will be impossible to detect a high-quality invisible watermark.

To make a watermark visible using *Photoshop*:

1. Open the source image and the watermarked image in a tiled view.
2. Copy the source image using the Image > Duplicate command and save the new 'difference' image using an appropriate name.
3. Copy the watermarked image to the clipboard using Select > All followed by the Edit > Copy command.
4. Create a new layer in the difference image using Layer > New Layer.
5. Insert the contents of the clipboard into the new layer using Edit > Paste.
6. Select Difference in the blend mode drop-down in the Layers panel. If the image contains a high-quality watermark it should appear completely black - i.e., the changes the watermark has made to the original image data are invisible.
7. Merge the two layers using the Layer > Merge Visible command.
8. Open the Image > Adjustments > Levels dialog, and shift the white slider under the figure 255 to the left until it meets the black tone curve. The watermark will become visible once you have performed this radical adjustment.

Performing these steps should make the differences between the source and watermarked image data clearly visible in the new 'difference' image. This test helps you to judge how a watermark affects your image data, and to determine which parts of the image might suffer from unwanted artifacts as a result.

also more robust than the older technology (now called 'Classic'), but doesn't function with grayscale images, so Digimarc now offers both. By default, the software watermarks RGB images using the Chroma process, while grayscale images still require the older software.

The only way to switch between Chroma and Classic modes is using the Ctrl+Alt+E shortcut, which isn't immediately obvious. During the embedding process, the software displays the watermark that is being applied, but you still have to guess whether you are looking at a Classic or a Chroma watermark when it comes to reading one that has already been applied. We tested both types and found them to be equally robust. Most of our attempts to remove the watermarks from our high-resolution sample image were ineffective, regardless of whether we tried rotating, scaling or any one of a number of potential hacks. Chroma is more resistant to heavy image size reduction than Classic, but a watermark created using the Chroma process can still be completely removed by simply converting the image that contains it to grayscale.

All in all, we were pleasantly surprised by the robustness and overall performance of the Digimarc system. The inability of the Chroma process to deal with grayscale images raises the question, "Is it a bug or a feature?", and you will have to decide for yourself whether this is a serious loophole, especially in view of the fact that Classic mode is still resistant to black-and-white conversion. Price-wise, Digimarc is aimed directly at the commercial end of the market, which makes its lack of 16-bit support all the more surprising.

DIGITAL WATERMARK TOOL TEST			
Program	Digimarc Chroma 4	Digimarc Classic 4	SignMyImage 4.0
Manufacturer	Digimarc		Advanced Photo Tools
URL	www.digimarc.com		www.adptools.com
Minimum price (incl. 1 year crawler subscription)	US\$98		US\$32
Test: Embedding Watermarks			
JPEG	yes	yes	yes
PNG	yes	yes	yes
GIF	no	no	no
TIFF 8-bit color	yes	yes	yes
TIFF 16-bit color	no	no	no
TIFF 32-bit color	no	no	no
TIFF 8-bit B&W	no	yes	no
TIFF 16-bit B&W	no	no	yes
TIFF 32-bit B&W	no	no	no
Test: Bit Depth Conversions			
8-bit RGB to 256 colors	yes	yes	no
8-bit RGB to grayscale	no	yes	no
8-bit RGB to 1-bit B&W	no	yes	no
Test: Image Editing			
Distortion correction	yes	yes	no
Luminance noise filtering	yes	yes	no
Color noise filtering	yes	yes	no
Unsharp mask	yes	yes	yes
Cropping from 4928 × 3264 to 512 × 512 pixels	yes	yes	no
Cropping from 4928 × 3264 to 256 × 256 pixels	yes	yes	no
Cropping from 4928 × 3264 to 128 × 128 pixels	yes	yes	no
Test: Scaling			
Reduce to 91.5 %	yes	yes	yes
Reduce to 50 %	yes	yes	yes
Reduce to 25 %	yes	no	no
Reduce to 11.75 %	yes	no	no
Reduce to 10 %	no	no	no
Test: Rotate			
0.3 degrees	yes	yes	no
1 degree	yes	yes	no
3 degrees	yes	yes	no
3 degrees	yes	yes	no

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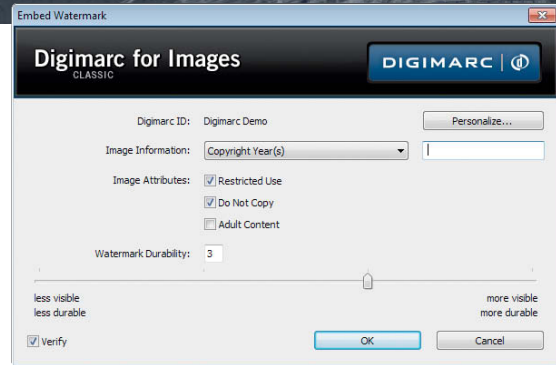
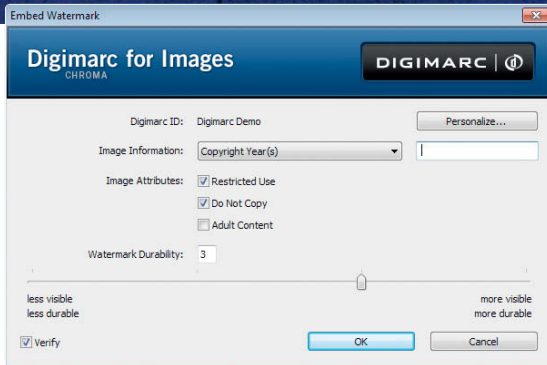


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The difference between the *Chroma* and *Classic* versions of the Digimarc software becomes obvious when you view the difference image. The *Classic* version makes much more obvious adjustments to the original image data than the *Chroma* version.

Conclusion: The Future Is Cloudy

Most sub-branches of the software industry tend to be dominated by oligopolies, and the digital watermark market is no exception. Our last major watermark test three years ago included no fewer than five products, but only Digimarc and SignMyImage have managed to survive until today. This is probably due to mediocre robustness on the part of many systems combined with a general lack of demand from individual consumers. Security remains a product that is a lot more difficult to sell than a new, full-frame DSLR with an ultra-high-resolution sensor.

The Web-based search functionality offered by both contenders has reduced the amount of effort photographers have to make to find stolen images, but annual tracking fees charged by the manufacturers make them less attractive to some users.

The future of watermarking most probably lies in the cloud. Using *Photoshop* to embed an individual Digimarc transaction ID in a

series of images is still a painstaking process. In contrast, an online service like Vericuff can automatically apply a pre-defined SignMyImage watermark to any image at the moment it is sold.

And while the subject of oligopolies is still fresh in our minds, perhaps Google will one day see the light and extend Picasa to include

online shop and watermarking functionality. Such a move would surely bring the rather specialized subject of watermarking to the attention of a broader public. Regardless of whether money is to be made, most photographers are sure to want to know where their images can be found on the wonderful World Wide Web. (tho)

LEGACY SOFTWARE (old or not updated)

Program	URL	Minimum Price	Comments
SITMark Image/ImageMark	www.sit.fraunhofer.de	n/a	No consumer products available
SureSign, Hide & Seek, Mandelsteg, PGE106, StegDos, S-tools, S-tools2	www.highwatersignum.com	free	Not updated, Demo software free, Company licenses fee-paying
WNSTORM	www.uni-hamburg.de	free	Development stopped, no longer available
Eikonamark	www.alphatectd.com	n/a	Website offline
Icemark	www.phibit.com	approx. US\$47	Last update 2009
SysCoP	www.mediasec.com	n/a	Website offline
JK_PGS	www.epfl.ch	free	Development stopped, no longer available
Steganos Security Suite	www.demcom.com	n/a	No longer available
PixelTag	www.media.mit.edu	free	Development stopped, no longer available
Stirmark	www.petitcolas.net	free	Tool for testing the robustness of watermarks, only available as source code
SureSign	www.signumtech.com	approx. US\$4,500	Development stopped
Photopatrol	www.photopatrol.de	free	Cloud-based watermark service, Website no longer current

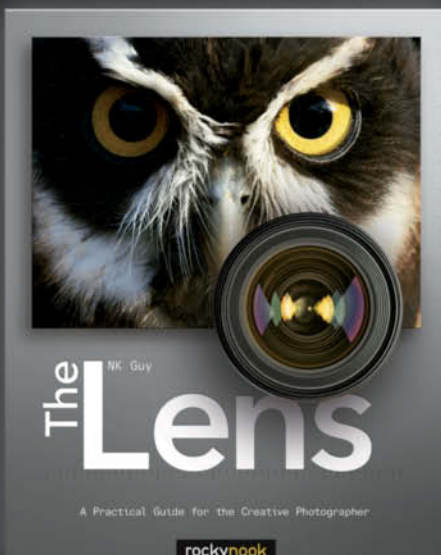
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NK Guy

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Which lens should I buy for my camera?

It's such a simple question, but choosing the right lens or lenses is actually one of the most important photographic decisions you can make. Nothing affects the quality of a photo more than the lens. It's no longer just about the megapixels—it's the glass that makes all the difference!

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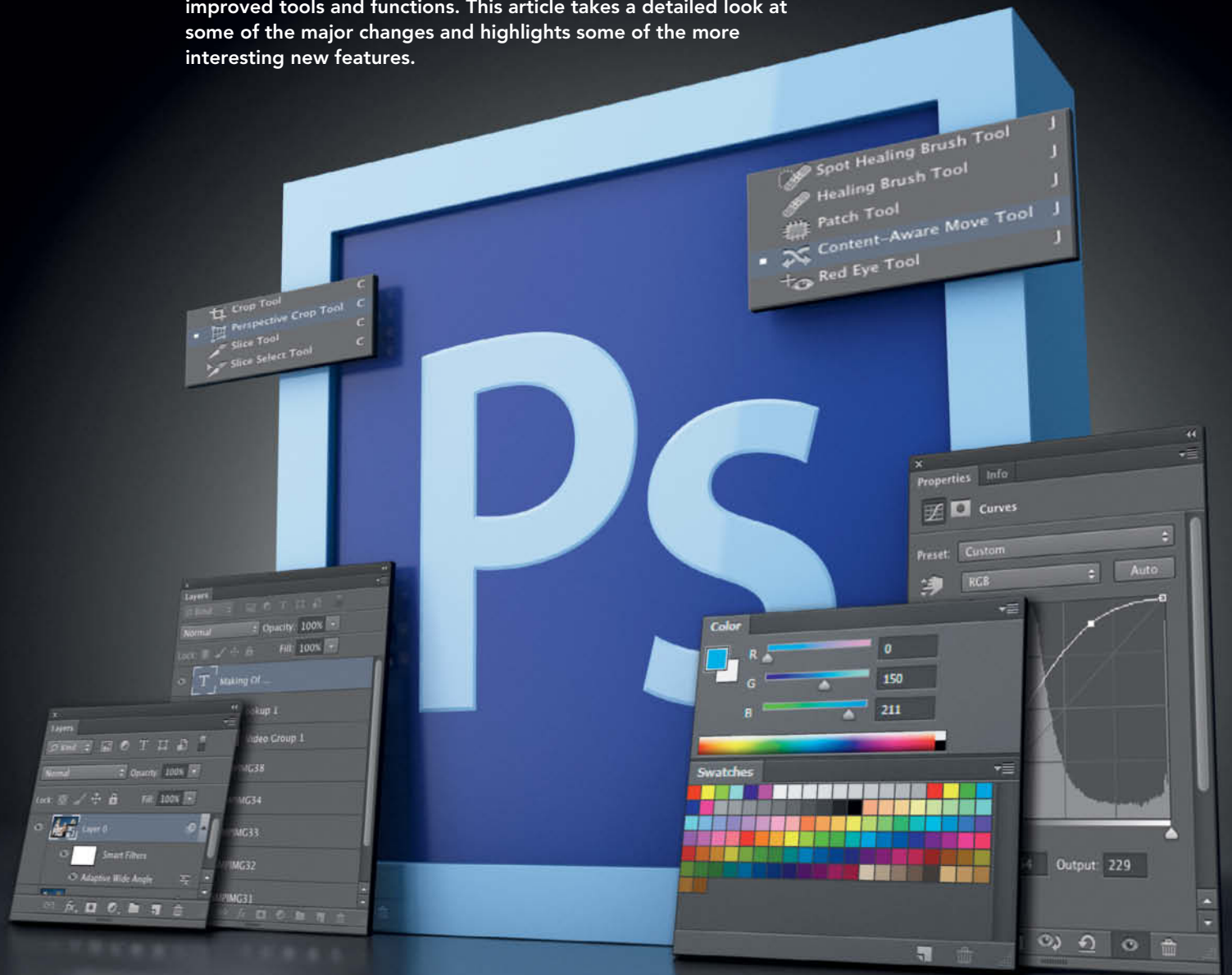
In this book, author N.K. Guy gives you all the information you need to make smart buying decisions. Optical technology is demystified, arcane terminology is decoded, and practical tips are provided.

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Maike Jarsetz

What's New in Photoshop CS6

With the release of its latest Creative Suite, Adobe gave Photoshop, its 23-year-old flagship application, a facelift and a raft of new and improved tools and functions. This article takes a detailed look at some of the major changes and highlights some of the more interesting new features.



The updated features in *Photoshop CS6* are divided more or less equally between image editing, text and graphics functions for designers, and new 'Extended' 3D functionality. This article presents the ones that are directly aimed at photographers and image editors in easily digestible, themed sections.

'Just Do It' Features

Adobe's developers have been adding new JDI ('Just Do It') features to the last couple of releases. These improvements to the user interface or individual tools aren't necessarily game-changing new features, but were either simply long overdue or have been made on the strength of user requests.

Photoshop CS6 includes a number of new JDIs and some overall performance improvements that we will go into later.

The first and most obvious new JDI asks if you would like to migrate the presets from earlier *Photoshop* versions when you start the program for the first time. These include all the presets that you have stored in the Preset Manager, such as custom brush tips or colors, thus enabling you to carry on working in *CS6* just as you did with *CS5*.

Many established tools have been enhanced, and tool size can now be set universally at up to 5,000 pixels. The brush preview displays the currently selected opacity setting and Transform values are shown in real time at the tool's tip.

Other enhancements include functionality that enables you to use the Patch, Eyedropper and Quick Selection tools on multiple layers. The Patch tool has also been given Content-Aware functionality. A new *Bicubic Automatic* interpolation method has been added, which automatically selects the

optimum method for the task at hand, depending on whether you are enlarging or reducing the size of an image. Actions are no longer limited to recording just menu commands and are, at long last, capable of recording individual tool movements alongside other parameters.

The Contact Sheet functionality that was scrapped with *CS4* due to the lack of 64-bit support has been reinstated in the latest release. This feature was sorely missed by many users in spite of the alternative PDF contact sheet function provided by *Bridge*. Now it's back in its all-new 64-bit guise and with a whole bunch of new options, including separate image and text layers and the ability to sort image folders by pages.

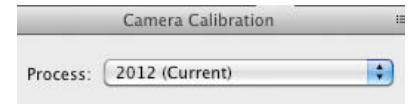
The new file-saving options are not immediately obvious. 32-bit images can now be background saved as TIFFs, which keeps the workflow running smoothly when you are working with large image files. There is also an *Auto Save* option, which saves all the necessary recovery information at a preset, user-defined interval.

Mercury Graphics Engine

The new Mercury Graphics Engine works away in the background and directly accesses graphics memory during complex processing steps. This type of graphics support accelerates preview image display and transformation actions, especially when you are dealing with very large files. Older tools, such as *Liquify*, also benefit from this architecture, and there is no visible delay during image refresh or when applying an effect. The *Liquify* tool now has an increased size range that extends all the way up to 15,000 pixels.

Our CS6 Top Six

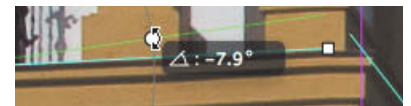
- ▶ Camera Raw 7 with **Process Version 2012**, which develops critical shadows and highlights more evenly and allows local color temperature adjustments.



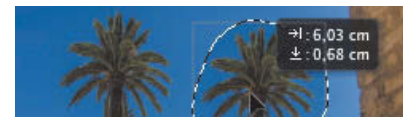
- ▶ The **Blur Gallery** with its new Field Blur, Iris Blur and Tilt-Shift effects.



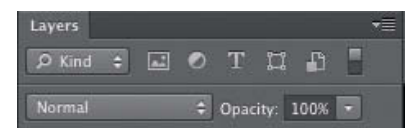
- ▶ The astonishing **Adaptive Wide Angle** filter, which can custom straighten and align distorted lines independently of lens profiles.



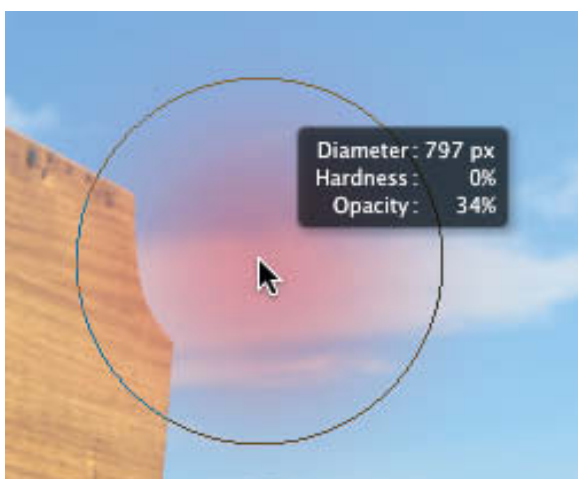
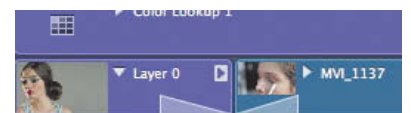
- ▶ The **Content-Aware Patch tool**, which now works on multiple layers and functions in tandem with the Content-Aware Move tool.



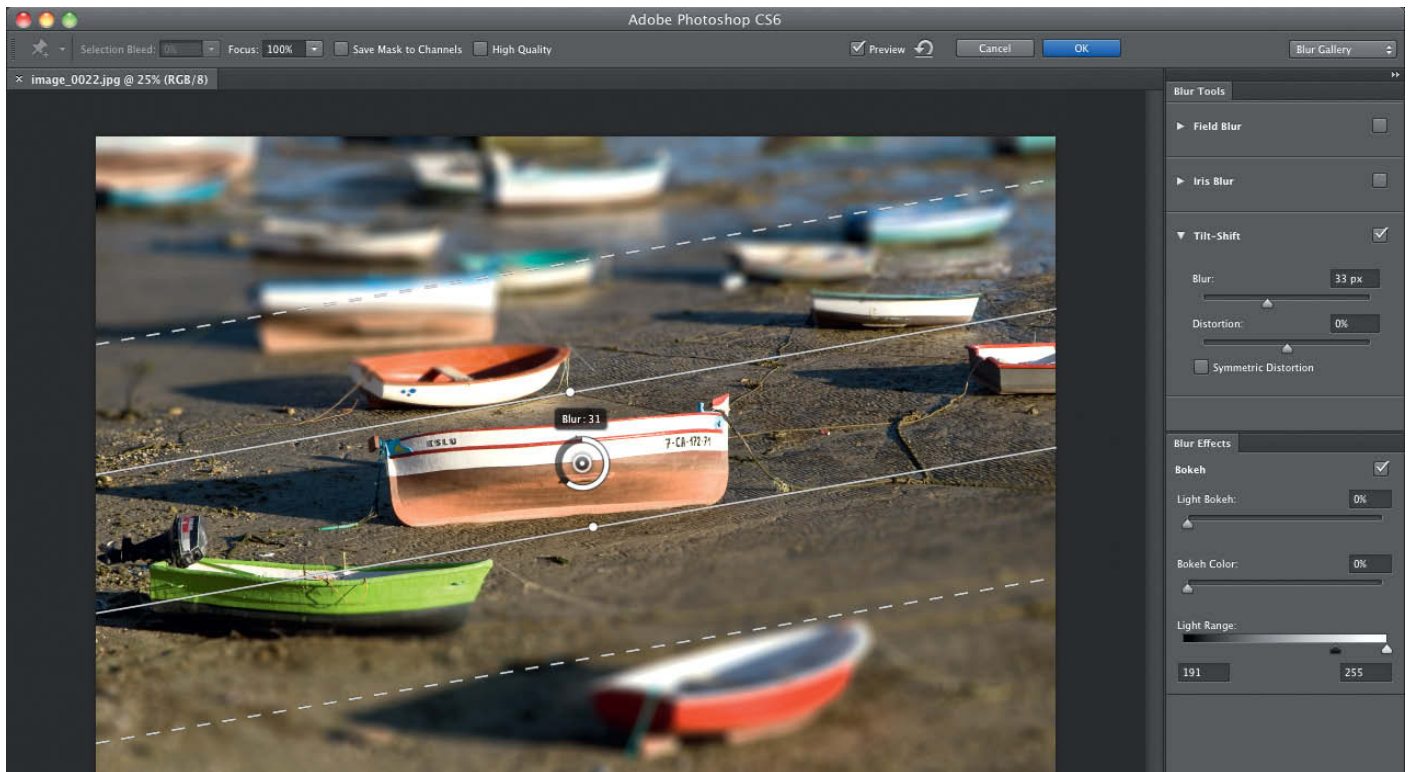
- ▶ **Layer filtering**, which helps you to quickly find key layers in complex documents using a range of parameters.



- ▶ The **Video Timeline Panel**, which has been redesigned to enable video novices to get to grips with editing, transitions, key frames, audio tracks, adjustment layers and animated text effects.



The CS6 on-image 'rich cursor' display includes the current opacity setting and real-time transform values, if applicable



The Blur Gallery offers not only a completely new filter interface, but also includes three new filters that allow you to intuitively adjust various aspects of a photo's depth of field

In our opinion, these tool enhancements are much more significant than 1,800 revised icons or the much-vaunted new dark interface (which can, by the way, be switched back to

its familiar gray theme with just a couple of mouse clicks).

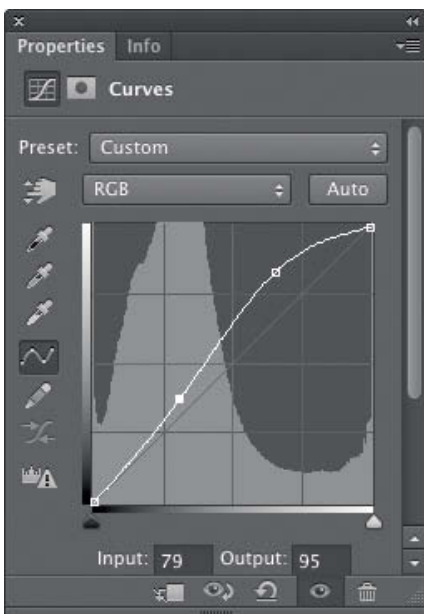
However, some of the new interface enhancements are really quite useful. For example, the Application Bar has been scrapped to increase the space available for image processing (although I miss it myself because I often use it when teaching). Another plus point is the new filter gallery interface, which displays complex blur and lighting effects and their controls at full size in the tool window.

Blur Gallery

The Blur Gallery is one of our favorite innovations, and offers not only a completely overhauled Field Blur filter, but also the new

Iris Blur and Tilt-Shift filters and stackable blur effects.

The Blur Gallery window no longer looks like a filter interface at all, and you can adjust your image directly from within the tool using on-image controls. All three filters use the same controls. Field blur uses user-selected pins, the sharpness of which can be adjusted directly using the tool's slider. You can then adjust the sharpness gradient using the adjustment 'ring' positioned around each pin. In Iris Blur mode, the slider adjusts the degree of blur in its own immediate environment and the shape of the iris you use determines where exactly the blur zone is located. You can alter the shape of the iris ellipse as well as scaling and rotating it using the built-in handles. Separate feather handles determine



Two new functions in one:
Mask adjustments and adjustment layer properties can now be altered in the Properties panel. Auto Correct adjustments can now be edited.

where the blur and protected zones begin and end. The Ellipse and Feather handles move in sync by default but can be adjusted separately using the Alt key.

The Tilt-Shift filter simulates the Scheimpflug effects produced by mechanical tilt/shift lenses, producing a precisely defined sharpness gradient that you can adjust by altering the positions of the tool's built-in delimiting lines. You can, in fact, select a number of points of sharpness for the Iris Blur and Tilt-Shift filters, although the more points you set, the less realistic the results will look.

All three filters can be combined and can also be enhanced with an additional bokeh effect. Unlike most other *Photoshop* filters, the Blur Gallery effects cannot be used as smart filters and consequently cannot be adjusted later. You can, however, save any sharpness gradients you set as alpha channels that can then be loaded as selections and used as the basis for subsequent adjustments in the blurred areas of your image

Image Processing

The most obvious change to the program's image processing functionality is, once again, a change in the panel system. The CS4 and CS5 versions used the Adjustments panel to select and make adjustments, whereas CS6 has a new, dedicated panel called Properties for doing the same thing. This panel displays not only the adjustment layer controls, but

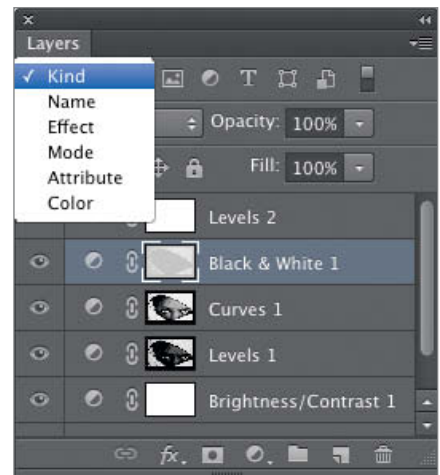
also the 3D controls included with the Extended version of the program. The panel is freely scalable and thus adaptable to all different types of adjustments. All in all, the user interface has once again become a little more flexible. The separate Masks panel (which many users have possibly never found) is now part of the Properties panel.

The Layers panel has changed visually too, and now includes an inconspicuous but powerful filtering tool for locating specific layers within complex documents. You can use the tool to find empty layers or ones that include specific adjustments, blending modes, text or labels.

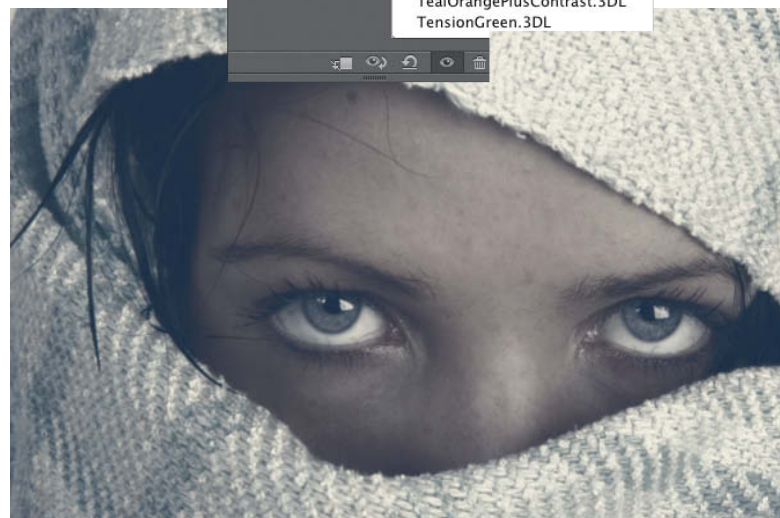
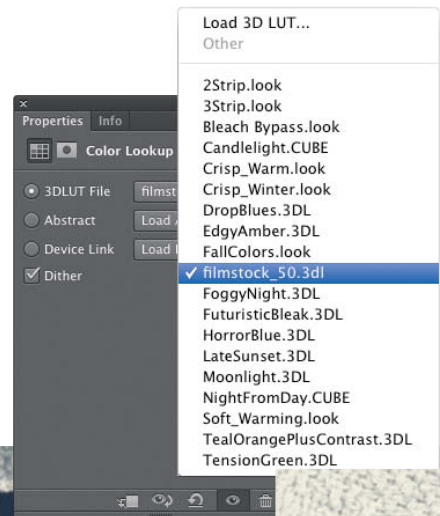
The ill-reputed Auto Correct tools – long considered a 'no go area' for serious imaging enthusiasts – are now editable, making them a useful starting point for your own, more complex image adjustments. Auto functionality is built into the Levels, Curves and Brightness/Contrast tools, and there is now an *Enhance Brightness and Contrast* option included in the Auto Color Correction Options dialog.

Another novelty that is sure to appeal to filter and plug-in lovers is the Color Lookup adjustment (see the image at the bottom of this page). This influences image color and contrast by providing color lookup tables (LUTs) that replace the original tonal values.

Many video aficionados already use 3D LUTs to apply preset lighting moods (such as the 'HorrorBlue' or LateSunset' provided here) to an entire movie. The options on offer also



The layer filtering tool makes it quick and easy to search complex documents for empty layers or ones that contain specific effects, modes, attributes, colors or labels



The Color Lookup adjustment enables you to make quick global adjustments to the mood of an image using a range of standard looks and movie-style effects

Image: Paul Piebinga (iStockphoto)



The Adaptive Wide Angle filter is a clumsy name for a fantastic feature. The tool uses simple line-based tools to straighten a broad range of distorted horizontal and vertical lines and perspectives. These adjustments can also be used as smart filters.

include various other abstract LUTs and device-link effects. Additional tables can be loaded for each group of settings.

Video Functionality

In the CS6 release, video editing functionality has made the leap from the Extended version to the Standard version of the program – a move that is sure to be welcomed by the growing number of DSLR video makers out there.

The video processing features are now grouped together in the new Timeline panel, which is intuitive to use and is sure to help video novices get to grips with the medium. Video clip, still image and audio import functions, as well as trimming, editing, transition and export tools can all be controlled from the timeline, and each video

project automatically generates a video group in the Layers panel that can be enhanced with text and adjustment layers. This makes it child's play to add text and other effects to a clip.

Adaptive Wide Angle Adjustments

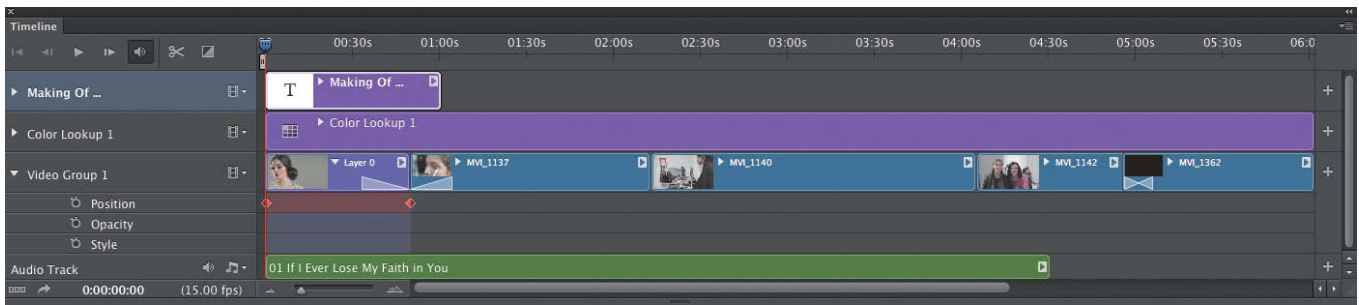
This new filter offers a complete set of corrections for all types of lens-based distortion. Unlike the current Lens Corrections filter, the new filter does much more than just correct edge distortion or converging lines. It doesn't work globally, but instead uses tools that straighten individual lines within an image using reference lines defined by the user and lens information gleaned from a file's Exif metadata. The tool then performs a transformation that applies your adjustments

to the image. Pressing the Shift key enables you to drag any constraints you have set to the edge of the frame. This tool offers extremely flexible distortion corrections that can also be applied as smart filters.

Other Tool Enhancements

Various established tools have been refreshed in CS6. New options make the Crop tool more similar to the one found in *Lightroom*, and include a number of new grid overlay options, automatic centering, a built-in straightening tool and – importantly – the option to either keep or delete excess pixels that lie outside the crop area.

The aspect ratio has been decoupled from the resolution setting and you now have to use the options in the Crop Image Size & Resolution dialog to change the size of



The new, intuitive Timeline panel gives newcomers to video processing all the tools they need to start trimming and editing movies

an image. There is also a new, separate Perspective Crop tool.

Another tool that has undergone a major change is the Patch tool, which now works – like most other retouching tools – on multiple layers. It has also been given the content-aware option already built into the Scaling, Fill and Healing Brush tools. The new Content-Aware Move tool is really exciting, and is able not only to invisibly remove but also to insert selections into completely different image areas!

Camera Raw 7

Last, but not least on the list of new photo and imaging features is the latest version of Adobe’s in-house RAW converter. This is actually no surprise, as the new version has already been ‘pre-released’ in *Lightroom 4* (see [1] below). The most important changes are:

Process Version 2012, which provides much more subtle tonal corrections, especially in highlight and shadow areas. Newly organized Exposure, Recovery, Fill Light and Blacks sliders replace the previous

correction controls (including the Brightness slider). The main emphasis of the Exposure slider is now on midtones. Previously converted images can be switched to the new process version or processed using the older tools.

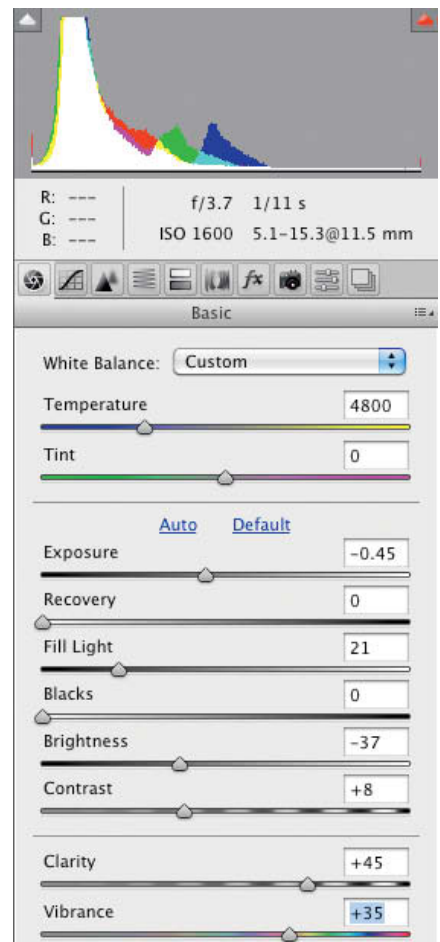
Local adjustments have at last been extended to include color temperature, and this new adjustment is available alongside local denoising functionality in the Adjustment Brush and Graduated Filter tools.

Even the *Camera Raw* Tone Curve tool has been enhanced and enables you to make adjustments to individual channels the same way as in *Photoshop* – a welcome addition for the many imaging professionals who prefer to make tonal adjustments this way.

Once again, Adobe has managed to come up with a worthwhile collection of useful tool refreshes, clever workflow enhancements and fascinating new features. (pen)

See also:

[1] Maïke Jarsetz, *Lightroom 4*, c’t *Digital Photography 8* (2012) p. 118ff.



The new process version built into Camera Raw 7 offers not only improved Blacks and Fill Light functionality, but also local color temperature and denoising adjustments



The new Content-Aware Move tool can be used to automatically and invisibly move sections of an image on multiple layers





Dmitri Popov

RAW Development with **GIMP Plug-ins**

Although GIMP is a powerful image editing and retouching application that can work wonders in the hands of a skillful user, the program's default functionality can be extended even further using plug-ins and scripts. In fact, you can turn GIMP into a complete digital darkroom using the UFRaw plug-in and dedicated scripts designed for developing digital negatives and post-processing photos.

While there are several solid open source RAW processing applications available (such as *Photivo* and *RawTherapee*), enabling RAW support in *GIMP* significantly simplifies the digital photographic workflow. Which plug-ins and scripts you choose will depend on your specific needs, but there are several modules that are essential for any user who wants to use *GIMP* as an all-round photographic tool. These include *UFRaw* plug-in (<http://ufraw.sourceforge.net/>), which is included on this issue's free DVD.

Although *UFRaw* acts as a helper module in *GIMP*, it is also a powerful RAW processing tool. *UFRaw* relies on the excellent *dcrw* RAW decoding library (<http://www.cybercom.net/~dcoffin/dcrw/>) and can handle a wide range of RAW formats (see the list of supported cameras at <http://ufraw.sourceforge.net/Cameras.html>). Thanks to the *LittleCMS* software (<http://www.littlecms.com/>), *UFRaw* supports ICC color profiles, providing you with full color management support. Nikon users will also appreciate the fact that *UFRaw* can read Nikon camera tone curves. In short, if you shoot in RAW, installing the plug-in should be high on your list of priorities. During the installation process, you will be prompted to associate RAW files with *UFRaw*, and you should do this if you want to use

the *UFRaw/GIMP* combo as your primary RAW processing tool.

If you are a *GIMP* beginner, we recommend that you read our *GIMP* Master Class in Issue 2 of *c't Digital Photography* (page 56ff). This issue is unfortunately out of print but is available digitally at www.ct-digiphoto.com. *GIMP*'s main image processing tools are easy to find, but work in a way that might not be intuitive to users of other imaging software, so this introduction will help to get you started.

Working with UFRaw

The *UFRaw* interface is split into two panes. The preview pane to the right displays a preview of the currently open RAW file, and all adjustments you make to the file appear here in real time. The left pane contains the RAW histogram with conversion curves and the live histogram, as well as a tool palette that contains several tabs of its own. The exposure compensation slider below the RAW histogram allows you to manually adjust exposure settings. Alternatively, you can use the 'Auto adjust exposure' button to let *UFRaw* make its own settings. The *White Balance* tab contains all essential tools for tweaking white balance settings. Like other RAW processing tools, *UFRaw* offers several

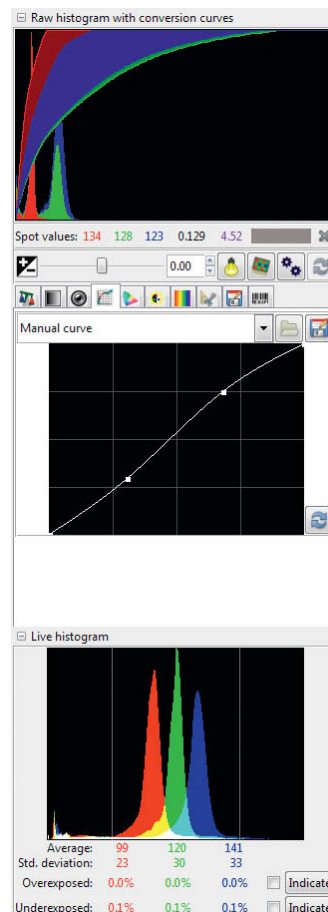
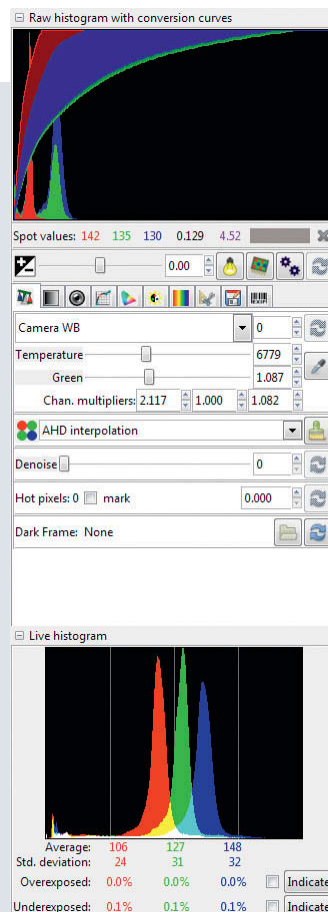
ways to adjust white balance – you can choose one of the many presets from the *White Balance* drop-down list, or use the *Temperature* and *Green* sliders and the color picker tool to tweak white balance manually. The *Bayer pattern interpolation* drop-down list gives you a choice of demosaicing algorithms. By default, *UFRaw* uses the AHD interpolation algorithm, but you can experiment with the other included options to see if you prefer the results. Once the interpolation algorithm has been applied, you can use the 'Color smoothing' button to reduce color artifacts such as pixel noise and other blemishes. The *Denoise* slider offers a quick and simple way to reduce digital noise in RAW files, while the 'Hot pixels' feature can help you to counteract the effects of hot pixels in your image.

In the *Base Curve* tab, you can tweak brightness and contrast settings by adjusting the base curve, which imitates Nikon's native tone curve. You can adjust the settings manually or import an existing .ntc-format base curve. If you don't have any curves of your own, you can download and try out curves from the Fotogenetic website at <http://fotogenetic.dearingfilm.com/downloads.html>, and you can save manually adjusted curves in the plug-in's own .curve format for use with other RAW files.

UFRaw supports color management, and the Colors page on the project's website



1. *UFRaw* enables you to process virtually all known RAW formats and includes all the basic tools you need for developing digital negatives



2. *UFRaw*'s base curve functionality emulates the Nikon tone curve feature. It directly supports .ntc tone curves and enables you to import existing curves and apply them to RAW files.

3. The Color Management tab enables you to import existing camera profiles as well as specifying custom ICC output and display profiles



Raw histogram with conversion curves

Spot values: 134 128 123 0.129 4.52

Gamma: 0.45

Linearity: 0.000

sRGB

Output intent: Perceptual

Output bit depth: 8

System default

Display intent: Perceptual

Live histogram

Average:	99	120	141
Std. deviation:	23	30	33
Overexposed:	0.0%	0.0%	0.0%
Underexposed:	0.1%	0.1%	0.1%

4. The Corrections section offers tools for adjusting saturation, brightness and black levels. You can tweak brightness manually or load an existing curve file.



Raw histogram with conversion curves

Spot values: 146 133 125 0.129 4.52

Saturation: 1.97

Manual curve

Black point: 0.023

Live histogram

Average:	80	128	166
Std. deviation:	24	34	42
Overexposed:	0.0%	0.0%	0.0%
Underexposed:	1.6%	1.5%	0.8%

Raw histogram with conversion curves

Spot values: 0 0 0 0.001 -2.07

Lightness Adjustments

1.00

0.56

Live histogram

Average:	76	125	162
Std. deviation:	23	29	40
Overexposed:	0.0%	0.0%	0.0%
Underexposed:	1.6%	1.5%	0.8%

5. The Lightness Adjustments tab enables you to specify up to three colors and adjust their lightness individually



Raw histogram with conversion curves

Spot values: 0 0 0 0.001 -2.07

Path: gimpscriptsplugins

Filename: 20120223-163251-9046.ppm PPM

JPEG compression level: 85

JPEG progressive encoding:

TIFF lossless Compress:

Embed EXIF data in output:

Create ID file: No

Save image defaults: Always

Remember output path:

Overwrite existing files without asking:

Live histogram

Average:	76	125	162
Std. deviation:	23	29	40
Overexposed:	0.0%	0.0%	0.0%
Underexposed:	1.6%	1.5%	0.8%

6. You can open processed RAW files directly in GIMP or export them to one of the plug-in's supported formats



(<http://ufraw.sourceforge.net/Colors.html>) provides a brief description of the plug-in's color profiling functionality as well as providing a handful of pre-defined camera profiles for you to try out. All color management features are included in their own tab, where you can load camera profiles and select ICC output and display profiles. By default, *UFRaw* provides only an sRGB ICC profile, but you can use other ICC profiles, too, such as the AdobeRGB color profile available at ufraw.sourceforge.net/Colors/AdobeRGB1998.icc. The *Color management* tab also allows you to adjust midtone brightness and contrast using the *Gamma* and *Linearity* sliders.

To adjust contrast and saturation, switch to the *Corrections* tab. You can adjust saturation using the appropriate slider and tweak the curve to adjust the brightness of the image. As with base curves, you can load and apply existing curve files and save modified curves for later use. The 'Auto adjust black point' button can be used to fix images that look washed out, while the 'Auto adjust curve' button can be used to boost contrast by flattening the histogram.

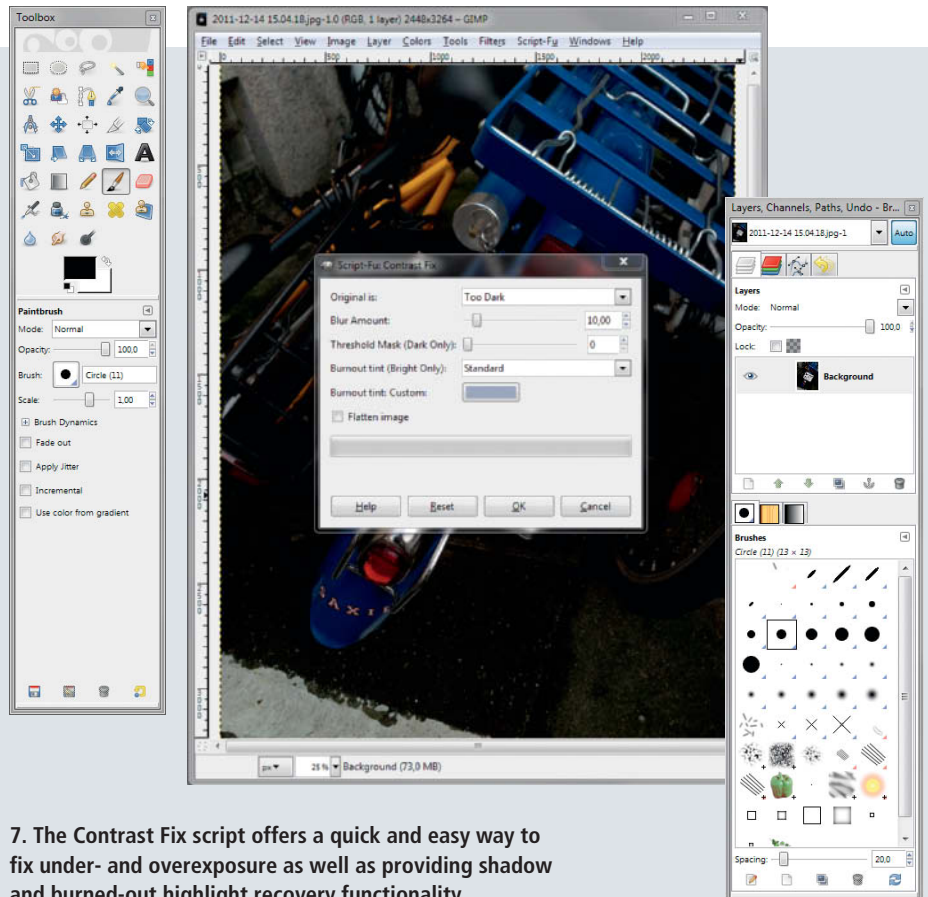
The *Lightness Adjustments* tab includes a tool for increasing or reducing the hue (i.e., lightness) of up to three specified colors within an image. All you have to do is select a color using the color picker and use the slider to adjust its lightness. Repeat these steps for your other two colors if necessary.

Although you can open processed RAW files directly in *GIMP* for further retouching and editing, you can also use the options in the *Save* tab to export your file to one of the supported formats, which include PPM, PNG, TIFF and JPEG. You can also specify the compression level for JPEG files, enable EXIF metadata and specify a range of other options.

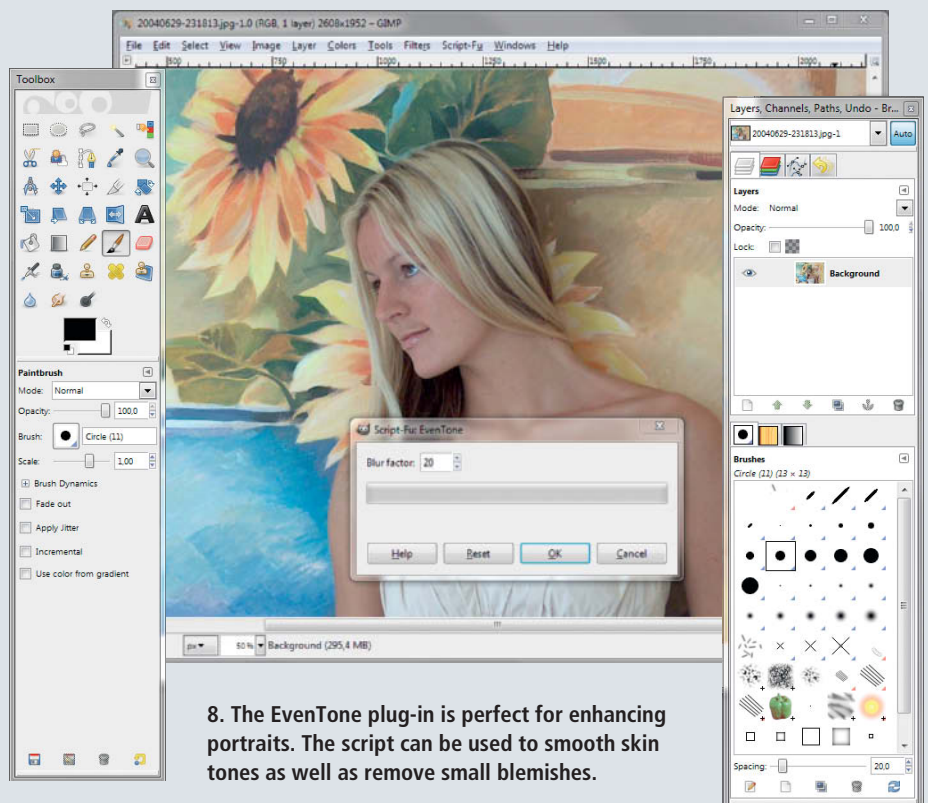
The features mentioned here are just a few to get you started, and *UFRaw* offers a wide range of other useful features such as lens correction tools, crop and rotation, black and white conversion capabilities and much more besides. Take a look at the user guide at ufraw.sourceforge.net/Guide.html to learn how to get the most out of this powerful RAW processing plug-in.

Using GIMP Scripts to Tweak Photos and Apply Image Effects

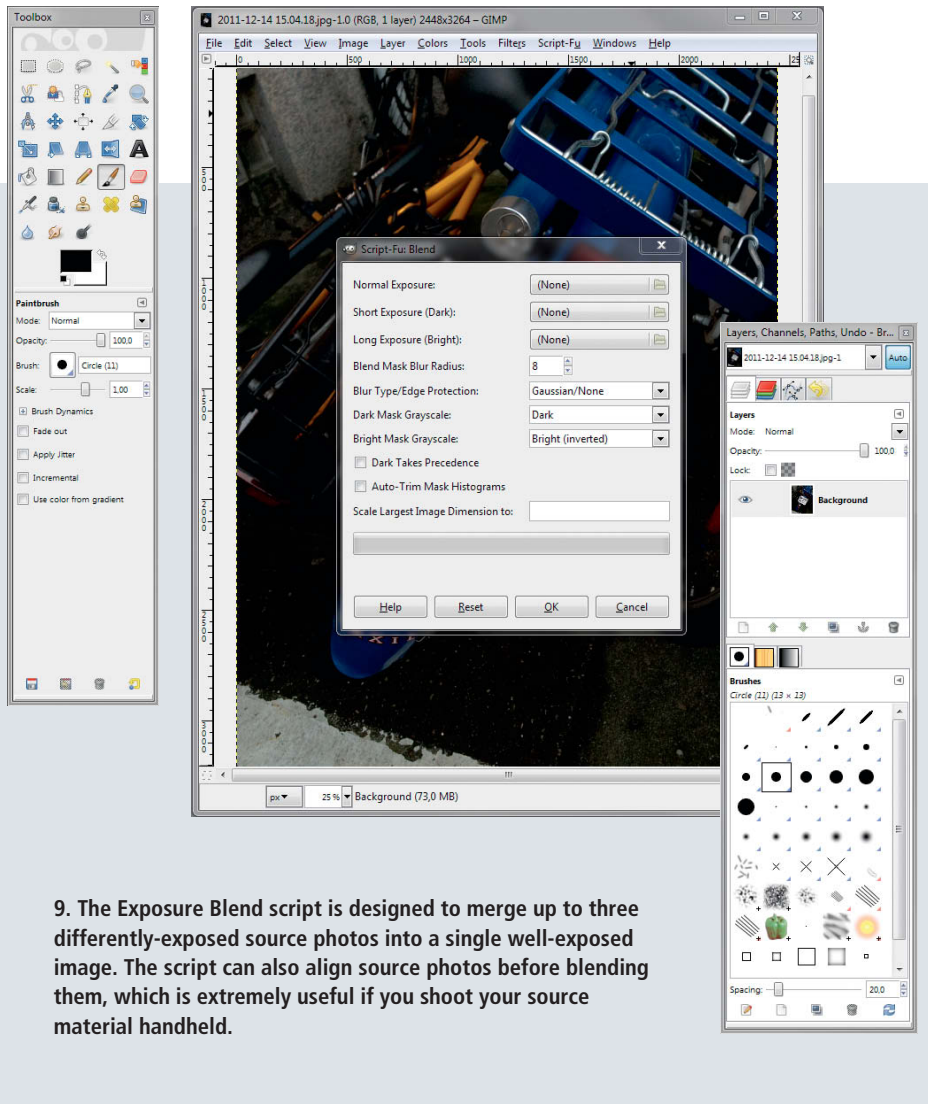
Virtually every *GIMP* action can be automated using Python scripts, and the official *GIMP* plug-in repository (<http://registry.gimp.org/>) contains hundreds of ready-made scripts that you can use to enhance and tweak your photos with a minimum of effort. To install a script,



7. The Contrast Fix script offers a quick and easy way to fix under- and overexposure as well as providing shadow and burned-out highlight recovery functionality



8. The EvenTone plug-in is perfect for enhancing portraits. The script can be used to smooth skin tones as well as remove small blemishes.



9. The Exposure Blend script is designed to merge up to three differently-exposed source photos into a single well-exposed image. The script can also align source photos before blending them, which is extremely useful if you shoot your source material handheld.

grab the desired .scm file from the repository and move the downloaded file to the ...\.gimp-2.x\scripts folder. Note that the .gimp-2.x folder is hidden by default, so you have to configure the Windows file browser to show hidden files in order to perform these steps. The steps required to install scripts in the Mac port of *GIMP* are quite complex, so we will stick to describing just the Windows version for now.

Most scripts add a dedicated command or menu to the *GIMP* interface, although the exact location depends on the script's individual settings. For example, the Orton Effect script adds a dedicated command to the Script-Fu > Enhance menu, while the Vintage Look script is accessible via the Filters > Artistic menu. You can often find clues as to where a script puts its commands in the description, so make sure you read it before installation.

The plug-in registry offers scripts that cover a wide range of tasks, from removing purple fringing to hiding text messages in

images (a technique known as stenography). There are also a number of scripts available that can help you to fix common problems and create some interesting effects.

Contrast Fix

The Contrast Fix script (<http://registry.gimp.org/node/182>) enables you to selectively fix under- or overexposed images and recover shadows in targeted images areas. To fix an entire photo, choose Script-Fu > Darla > Contrast Fix and select either the *Too Dark* drop-down option for underexposed photos or the *Bright/Burned Out* option for overexposed images. To fix selected image areas you have to specify a threshold value. To determine the required value, navigate to Tools > Color Tools > Threshold before you run the script, and use the sliders to isolate the parts of the photo you wish to fix. Note the resulting threshold value and close the Apply Threshold dialog window. You can now run then the Contrast Fix script and enter the value you noted into the

Threshold Mask field. The script also allows you to specify a tint color to apply to the white areas when fixing overexposure, which is great for fixing burned-out skies. Simply select the *Color tone (sky)* item in the Burnout Tint drop-down list and click OK. The script will then add a dash of color to your washed-out sky.

EvenTone

The EvenTone script (<http://registry.gimp.org/node/13362>) can be used to enhance portraits by smoothing skin tones and removing blemishes. Once installed, the script is located under Filters > Light and Shadow > EvenTone. The script's dialog window has just one adjustable parameter called *Blur factor*, and the default value usually produces pretty good results. The script doesn't automatically merge the layers of the finished image, so you can make further adjustments by tweaking individual layers. For example, to add extra sharpness, the script's author recommends that you switch the High Pass Sharpen layer to Grain Merge mode. If you want to fix skin blemishes, simply switch the High Pass Sharpen layer off.

Exposure Blend

Combining multiple shots with different exposure settings is a popular technique for producing a well-exposed photo, and the Exposure Blend script (tir.astro.utoledo.edu/jdsmith/code/exposure_blend.php) enables you to perform this clever trick directly via the *GIMP* interface. The script is simple to use, but nevertheless offers a number of high-end features, including various smoothing options, optional histogram trimming for better contrast and Differencing alignment mode, which simplifies manual image alignment. The latter is particularly useful if you shoot your source photos without the use of a tripod. To launch the script, select Filters > Exposure Blend > Blend. This opens the Blend dialog, where you can select your three (normal, dark and light) source photos and specify your blend parameters. The default values usually produce satisfactory results, but if you want to get the most out of the script, be sure to read the detailed explanation of the its functionality at the project's website.

Photo Effects

The plug-in registry also contains a variety of scripts for applying artistic effects to images, including Photo Effects (<http://registry.gimp.org/node/25636>) and assorted scripts by elsamuko (<http://sites.google.com/site/>

elsamuko/gimp). The original version of the Photo Effects script is written in French, but you can download an English version from <https://s3-eu-west-1.amazonaws.com/dmpop/photoeffects-en.scm>. The script offers several popular effects, including Vintage, Orton, Fake HDR, Infrared and Tilt/Shift, and some of these allow you to choose between different 'methods' which produce varying results. Although there are no explanations of the methods or processes used by the scripts, all you have to do is try them out to see the effects they produce. The script dialog is located under Filters > Photo Effects. Simply select the effect you want from the Effect drop-down list and specify any optional parameters that you wish to apply. For example, if you choose the Vintage effect, you can enable the *Vignetting* option and choose one of the methods on offer. If you want the script to flatten the final image (i.e., merge all layers into one), tick the Flatten Image check box before clicking the 'OK' button to apply the effect.

The El Samuko Collection

The El Samuko collection offer no less than 29 effects for you to try, including advanced scripts (such as Lomo) that offer a wide range of adjustment parameters. These scripts are not grouped in a single *GIMP* menu, so you sometimes have to search around a little to find the one you want. The Lomo script, for example, is tucked away in the Filters > Light and Shadow menu, while the Photochrom script is located in the Filters > Artistic menu. However, each script in the elsamuko collection has its own page on the project website where you can find details of its functionality and its location within the program interface. The website also provides sample photos to give you an impression of each script's effect.

Conclusion

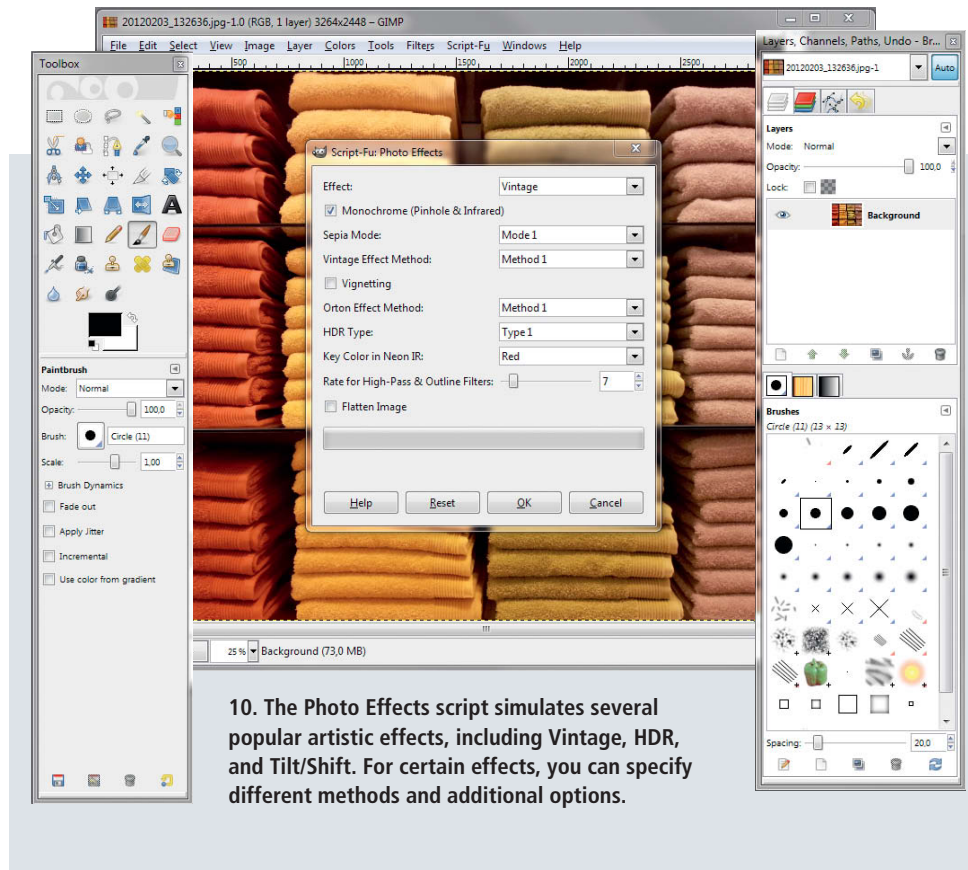
The ability to extend *GIMP*'s default functionality means that you can build an entire photographic workflow around the basic image editing and retouching application. Enthusiast photographers will really appreciate the *UFRaw* plug-in, which turns *GIMP* into a complete RAW processing tool. The hundreds of other scripts available offer countless ways to tweak and enhance your photos with very little effort. (jr)

Literature

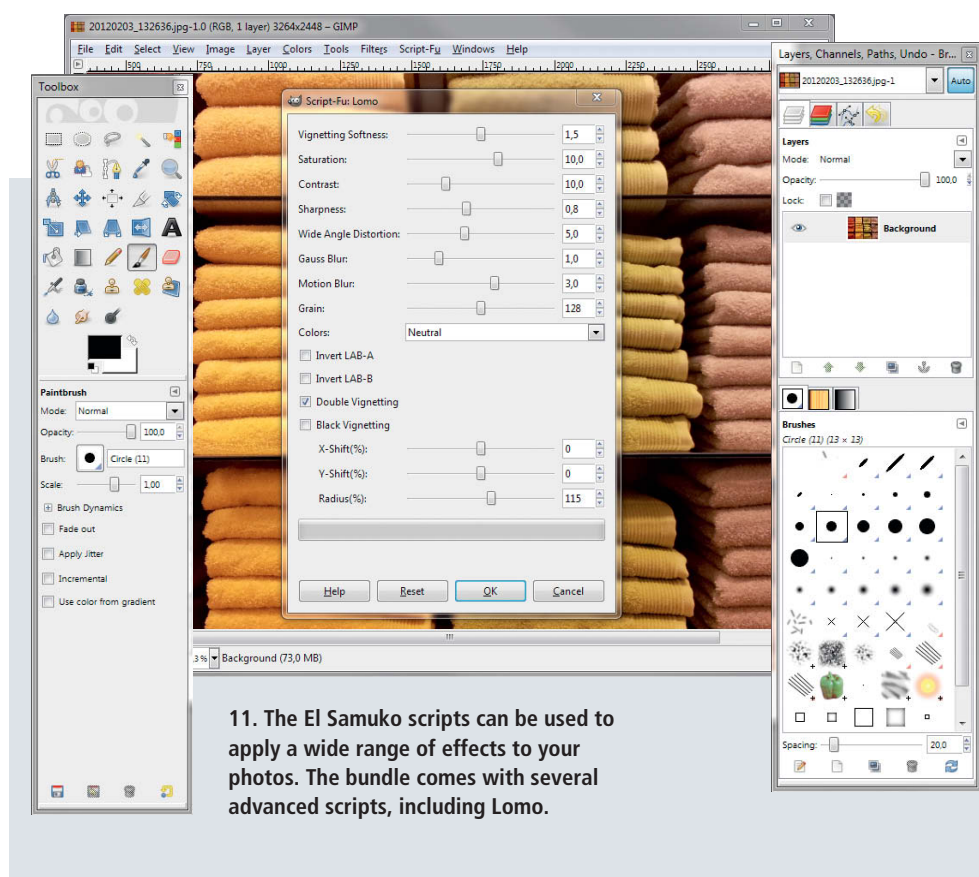
[1] *GIMP Master Class, c't Digital Photography 2 (2011)*, p. 56



c't Digital Photography 9 (2012)

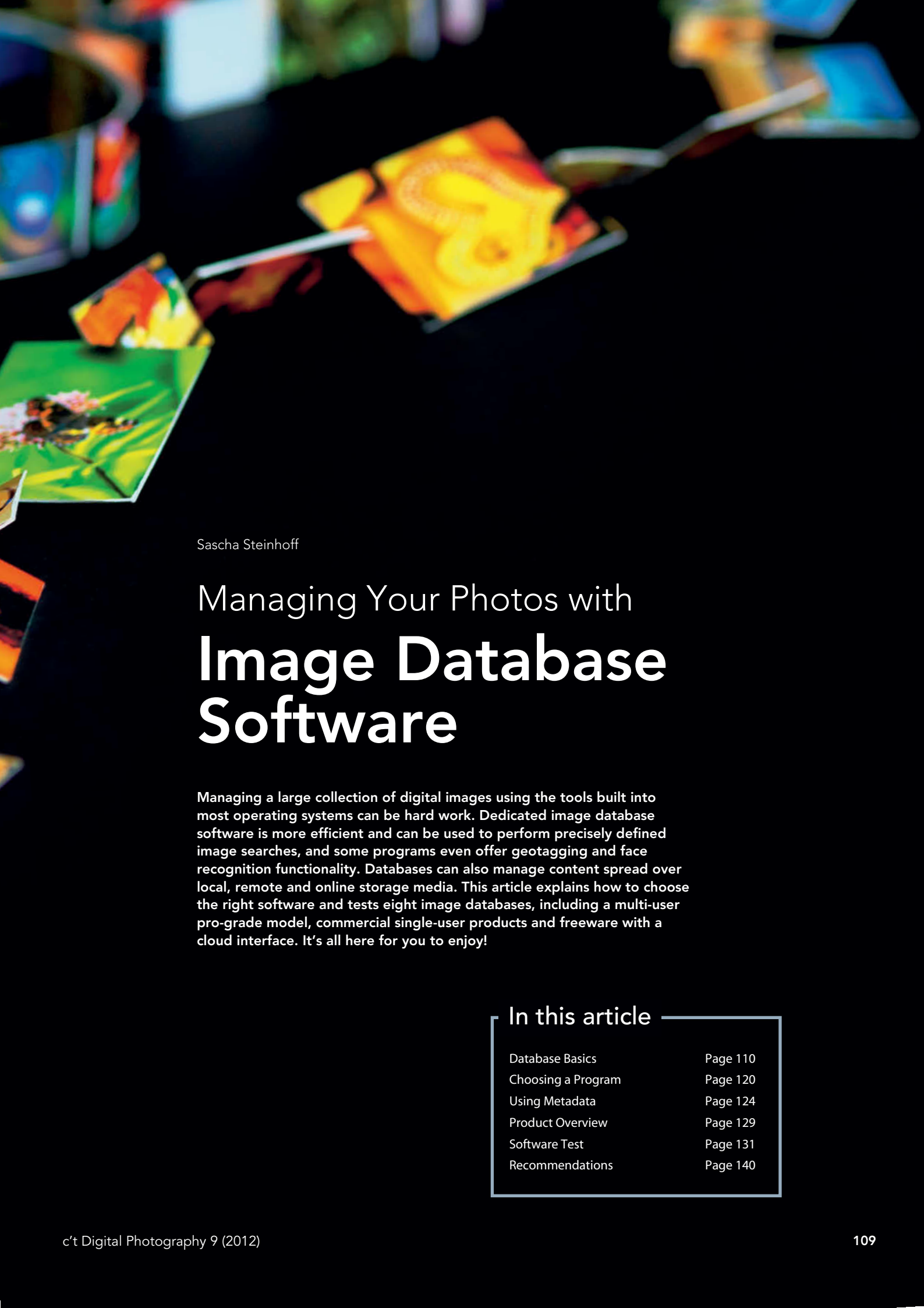


10. The Photo Effects script simulates several popular artistic effects, including Vintage, HDR, and Tilt/Shift. For certain effects, you can specify different methods and additional options.



11. The El Samuko scripts can be used to apply a wide range of effects to your photos. The bundle comes with several advanced scripts, including Lomo.





Sascha Steinhoff

Managing Your Photos with Image Database Software

Managing a large collection of digital images using the tools built into most operating systems can be hard work. Dedicated image database software is more efficient and can be used to perform precisely defined image searches, and some programs even offer geotagging and face recognition functionality. Databases can also manage content spread over local, remote and online storage media. This article explains how to choose the right software and tests eight image databases, including a multi-user pro-grade model, commercial single-user products and freeware with a cloud interface. It's all here for you to enjoy!

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Database Basics

Every operating system has to be capable of managing files. If you can't remember where you saved a file, you can find it using your system's indexing service, which is basically a kind of built-in database. The Library function introduced with Windows 7 makes it possible to create virtual collections of files, regardless of where they are physically stored. In view of this kind of functionality, you may be wondering if there is really a need for separate database software to manage your image files.

The answer lies in the sheer size and complexity of many people's photo collections, which demand smart, high-end search and administration functionality to make them manageable. Dedicated software is also required for managing ratings and geodata. Using image database software is more complex than merely relying on your system's built-in tools when you first start, but makes life simpler in the longer term. And, if you want to make your data available to multiple users, there is no alternative to using a database anyway.

What Do You Want From Your Software?

The days of image database software that is limited to managing, archiving and viewing files are well and truly over. Nowadays, many

image processing tools are integrated into database programs and, conversely, many image processing packages also include caching, cataloging and search functionality. Even simple image viewers support thumbnail caching, and RAW converters such as Adobe *Lightroom* or Apple *Aperture* have their own built-in cataloging tools.

Today's photographers have a wide range of options to choose from when it comes to getting a grip on their photo collections. The first question to ask when selecting your software is, "What do I want to do with it?"

Single-user Solutions

Most image databases are desktop tools, designed for installation on a single user's computer and based on simple back ends such as SQLite, that don't have built-in user rights functionality. There are also a number of tools available that use proprietary database formats. Whichever tool you choose, most single-user database packages do a good job of hiding the complexities of their inner workings from the user, which makes them extremely user-friendly.

It is not usually possible to make the images stored in a single-user database available to other users, although some do allow you to store catalog data on a network. However, it can still be quite tricky to manage

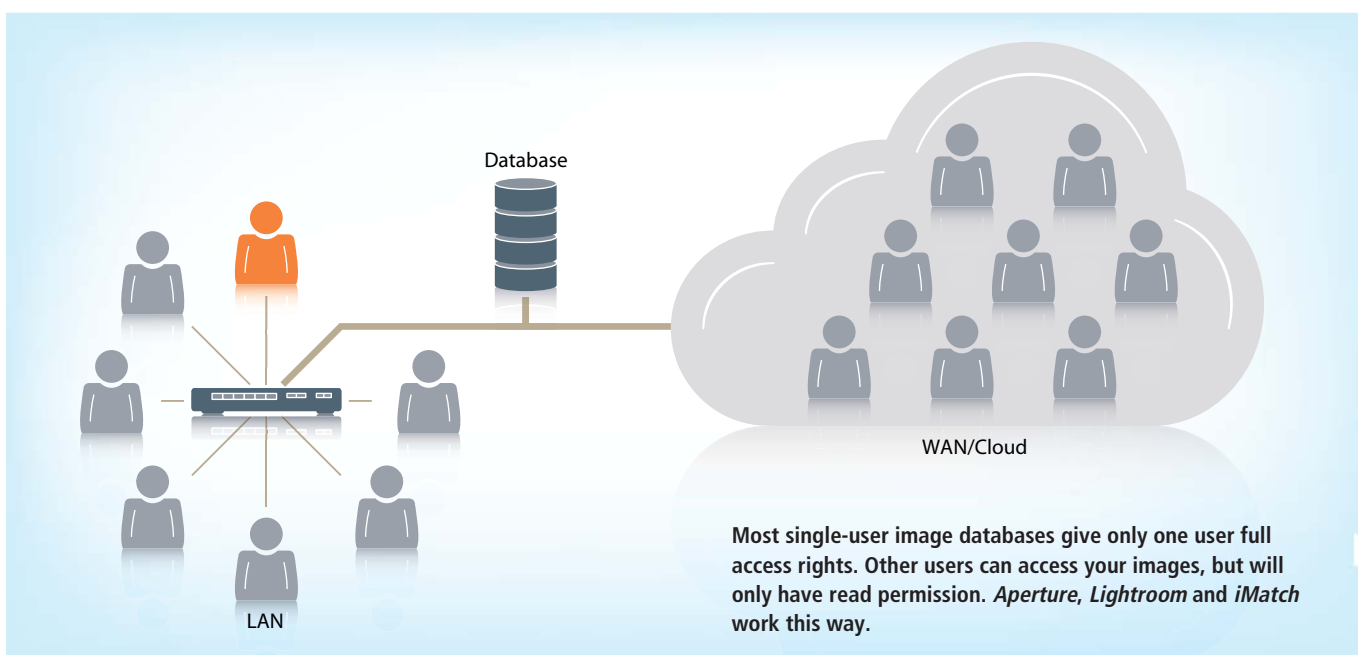
each user's read/write permissions. Programs such as *Aperture*, *iMatch* and *Lightroom* belong in this category and allow a parent to give family members access rights on the home network. However, if you want to give the rest of the world access to your images, this will usually have to be done via a conventional cloud interface.

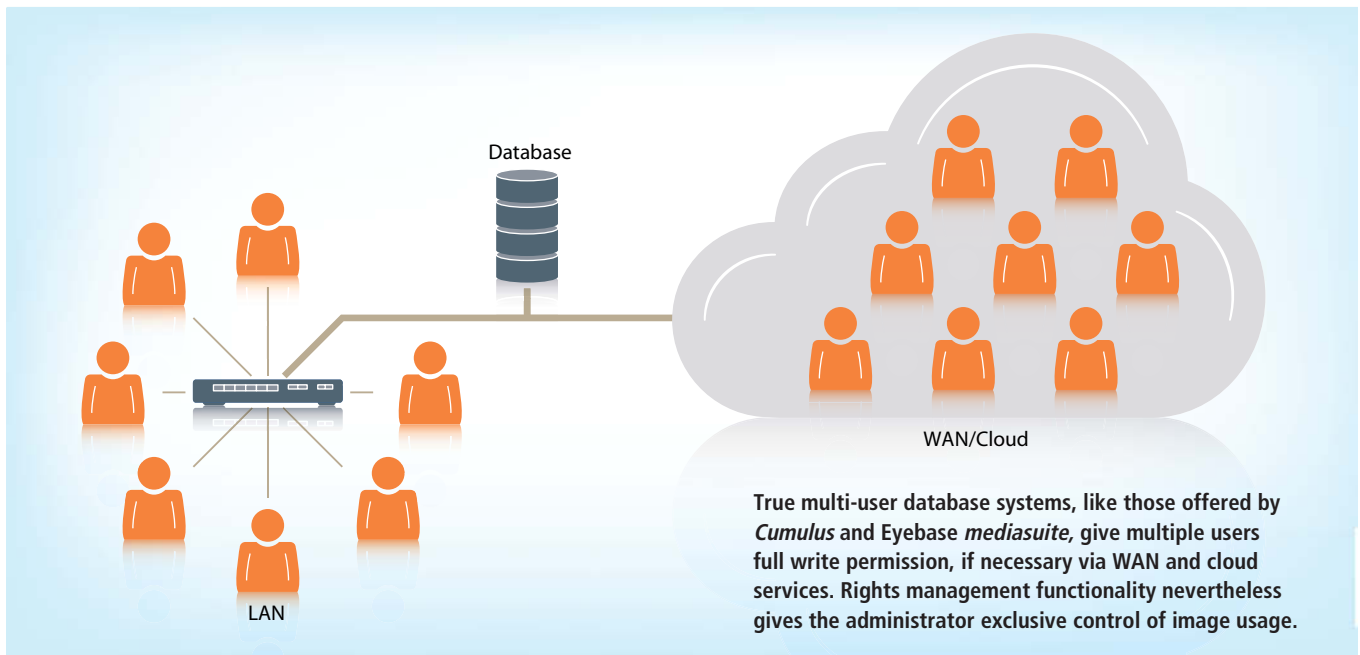
These applications provide sufficient basic output and Internet download functionality for many users, and their real strength lies in simple access to the host computer's file system, which makes it much easier to use other tools to process images.

Multi-user Solutions

If you want to give multiple users full access to your images or manage your digital assets via the Internet, you will need to use a server-based solution. Canto's *Cumulus* and the cloud-based eyebase *mediasuite* system are popular multi-user solutions that don't necessarily require the use of a server operating system, although they are better suited to use in large-scale computing environments.

While single-user solutions are often based on proprietary catalog formats, server-based products tend to use more popular formats such as InnoDB, MySQL, SQL





and Oracle, so while they have a wide range of functions, they are more complex to administer and use. Image database manufacturers try to give users access to as many tools as possible via the GUI, but you will still find basic knowledge of how a database works very useful when it comes to administering a multi-user system – especially if you want to get the most out of its search functionality. The strengths of this type of system lie in asset management rather than image processing. Some include rudimentary image editing tools, but they cannot hold their own when compared with the wide-ranging editing functionality built into most locally installed RAW converters.

Most manufacturers of multi-user image database software also offer stripped down ‘starter’ versions of their software. The combination of the big name and reduced price might seem tempting, but these versions rarely offer real multi-user functionality and are usually just as complex to use as their networked counterparts.

Starter versions can be useful for learning the software prior to scaling up to a full version. This approach allows your database to grow organically and saves you the bother of performing a complex (and often error-prone) migration later on. Starter versions are also worth considering if you sell your images and want to make it easy for your customers to search your resources online, or if you want to prepare online collections to show to potential clients. The SaaS (‘Software as a Service’) approach used by *eyebase*, in

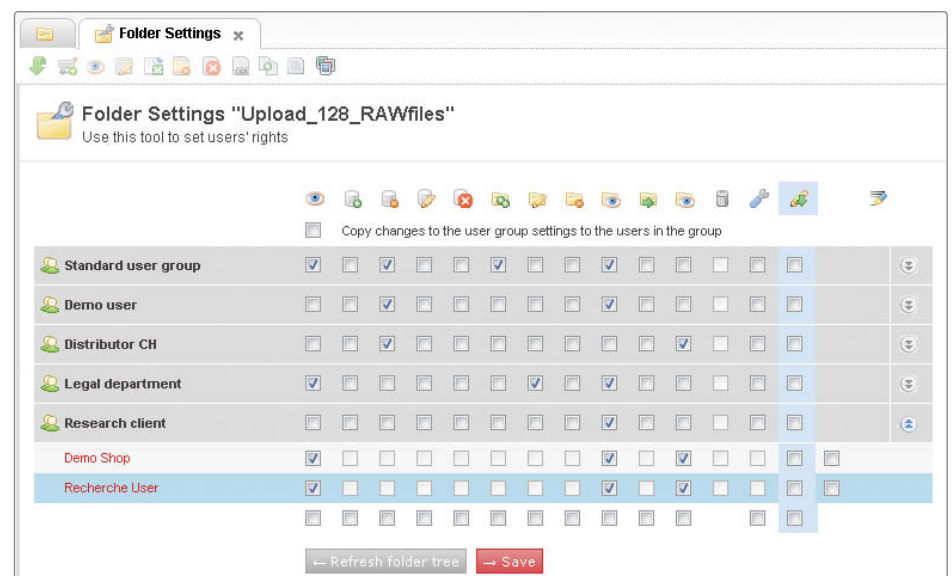
which the software manufacturer also hosts your image database, is an interesting option for single users and small offices.

Our Test Candidates

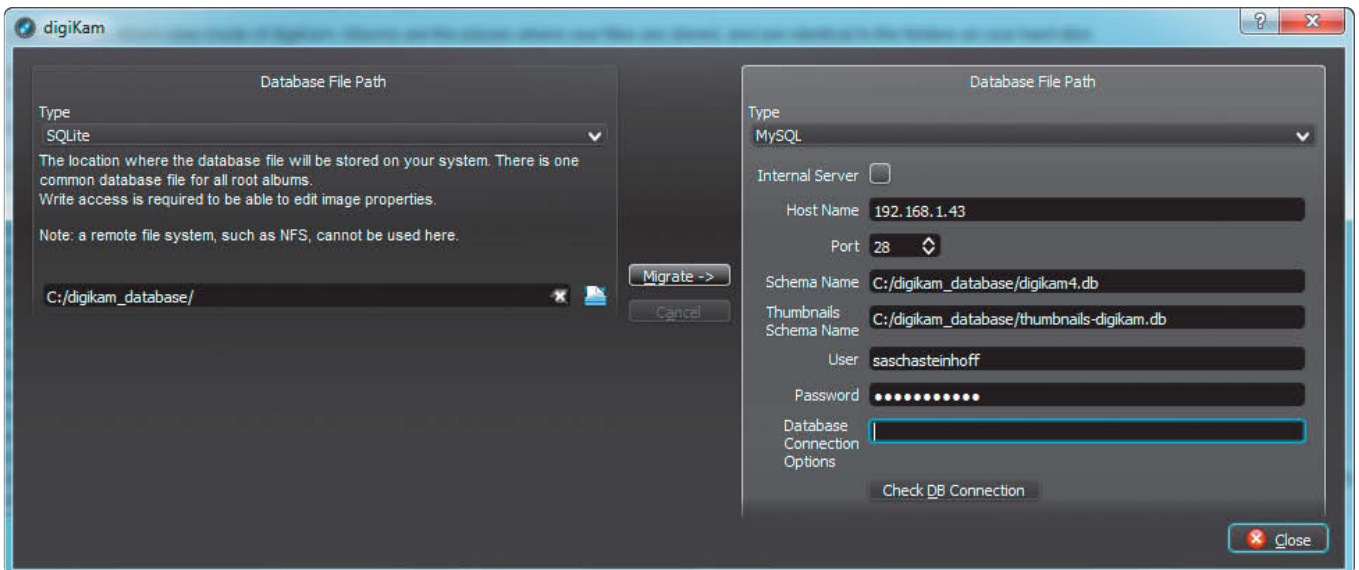
There is a vast selection of image database software on the market (see the table on page 123), and our test includes a cross-section of all the available categories, from freeware to costly pro-grade software.

The low-budget end of the scale includes single-user programs like Google’s *Picasa* and the open source *digiKam* (see our review in Issue 6 of *c’t Digital Photography* for more details). *digiKam*’s experimental multi-user functionality is not yet reliable enough for real-world use.

Aperture, *Lightroom* and *Media Pro* are commercial products aimed at single users. While *Aperture* and *Lightroom* have built-in RAW processing functionality, Phase One’s



Only true multi-user programs like *eyebase mediasuite* offer a precisely configurable system of access rights



Multi-user support requires an appropriate database back end. *digiKam's* experimental multi-user functionality allows you to migrate your data from a single-user (SQLite) to a multi-user (MySQL) environment.

Media Pro is compatible but not directly integrated with the *Capture One RAW* editor offered by the same manufacturer. We didn't test any software that doesn't offer RAW

support, as it is of no interest to a majority of today's photographers.

Unlike the other single-user solutions we have already mentioned, *iMatch* doesn't include any genuinely useful editing functionality and represents its own category of single-user, pure database tools.

Canto Cumulus is a pro-grade, multi-user solution with network support. We tested the single-user starter version to see how pro software performs in a simpler environment.

Our final test product is *eyebase mediasuite*, which is a purely cloud-based solution with browser-based user access. This approach saves a lot of maintenance work compared with most other self-hosted, Web-based solutions. *eyebase* charges its users a monthly fee.

Our Test Procedures

Our aim was to test the performance limits of the selected products in each of the following categories:

Image Import: We started by filling each database, retaining the original folder structure where possible. We used one set of 28 images in common formats such as BMP, GIF, JPEG, EPS, PSD and TIFF, as well as more

Imbas supports a wide range of databases, from free single-user packages right up to pro-grade enterprise solutions

exotic formats such as Targa and Pixar. We created our test images using *Photoshop*, using a total of 10 different TIFF variants with differing bit depths and compression methods. These are included on this issue's free DVD to enable you to conduct the same tests on other, similar products.

Our other set of test images comprised 128 RAW files in various formats. These included everything from early Kodak DCS files to photos taken using contemporary Nikon, Canon, Pentax, Olympus and Sony cameras. To keep things interesting, we also included less common, proprietary Leica and Hasselblad formats.

We tested each program's ability to import all the formats and to display thumbnails and full-screen previews of each. A program can only usefully manage a file if these conditions are met.

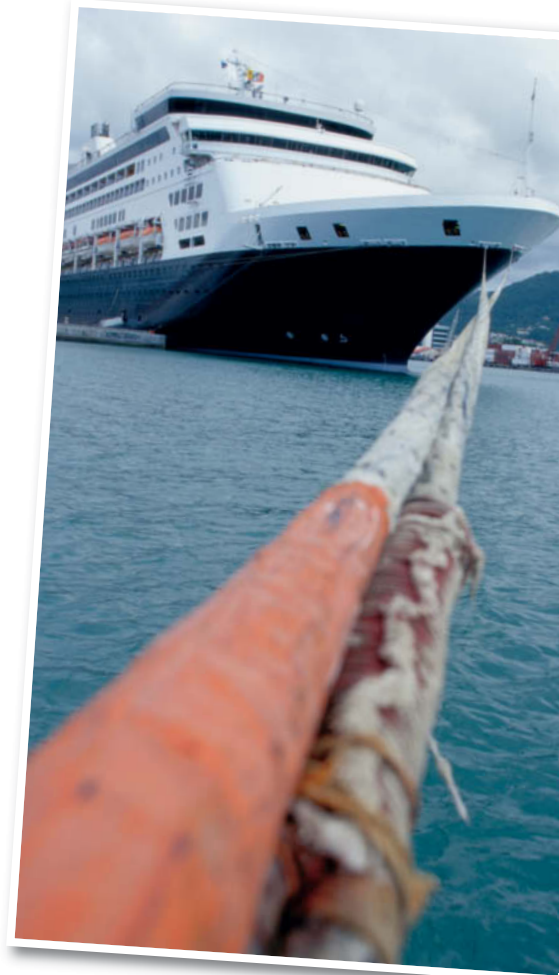
Asset Management via a built-in File System: Although all of our setups allowed us to access our test images directly via the host file system, we don't recommend that you use this approach, as it can lead to synchronization errors in the database. A quality image database should be capable of performing all standard file operations, such as copying, deleting, moving files and creating new folders.

Geotagging: Just displaying existing geotags is no longer enough by today's standards, and built-in map functionality is required for user-friendly editing and display. We put the geodata functionality through its paces for all the test programs that offer it.



Export to <u>V</u> Kontakte...	
Export to <u>R</u> ajce.net...	Alt+Shift+J
<u>I</u> ntant Messaging contact...	
Export to Flickr...	Alt+Shift+R
Export to <u>2</u> 3...	Alt+Shift+2
Export to <u>Z</u> oomr...	Alt+Shift+Z
Export to <u>H</u> TML...	Alt+Shift+H
Export to <u>P</u> iwigo...	
Export to <u>I</u> mgur...	Alt+Shift+I
Export to <u>D</u> ebian Screenshots...	Alt+Shift+D
Export to <u>Y</u> andex.Fotki...	Alt+Shift+Y
Export to <u>S</u> hwup...	Alt+Shift+W
<u>E</u> mail Images...	
Export to <u>P</u>icasaWeb...	Alt+Shift+P
Export to <u>W</u> ikiMedia Commons...	
Export to <u>F</u> acebook...	Alt+Shift+F
Export to <u>I</u> mageshack...	Alt+Shift+M
Export to <u>F</u> lash...	Alt+Shift+L
Export to <u>S</u> mugMug...	Alt+Shift+S
Export to <u>G</u> allery...	Alt+Shift+G
Export to <u>i</u> Pod...	Alt+Shift+I
Export to <u>K</u> ML...	
Export to remote <u>c</u> omputer...	Alt+Shift+K

Open source *digiKam* includes a wide range of presets for exporting data to cloud services, although you have to re-grant user rights after you have exported your data. None of our test candidates supports automatic comparison and transfer of user rights via the interface between a LAN and the cloud.



Face Recognition: Face recognition functionality can be used to keyword large numbers of images semi-automatically. All the user has to do is allocate appropriate names and intervene if the software makes a mistake while scanning for faces. Our test folder contained 350 images and was designed to test the user-friendliness of each program. We also wanted to see whether the personal data thus gathered could be written to standard metadata fields. The recognition rates we recorded were variable, but were not directly comparable due to the ability of some programs' ability to 'learn' from user input.

Search Functionality: Powerful search functionality is one of the major differences between 'real' image database software and the indexing services built into most operating systems. We tested search capability and user-friendliness.

Metadata: Keywording is one of the core functions of image database software. We checked the effectiveness of each solution and the types of data fields it supported. Again, it is difficult to compare these products directly. The lack of generally accepted standards for the type, size and labels of metadata fields means that they vary widely from program to program.

Performance and Stability: We recorded perceived performance and stability and noted crashes and slow performance in our test results (see page 131ff). Our relatively small (5GB) test database shouldn't have overtaxed any of these products, but our tests proved otherwise.

General: A test like this cannot, of course, provide a comprehensive view of each product. We deliberately restricted our view to the everyday usefulness of each program's database functionality, and did not include the image processing performance in our assessments.



File Import and Management

The decision to implement image database software has significant consequences. Once you have settled for a particular product, switching to another almost always involves a lot of effort and the risk of losing valuable image data. System architectures often contain idiosyncrasies that can make life very difficult should you decide to migrate your data. Different manufacturers use very different approaches to file import and management, so it is essential to find out how a particular product works before you commit your digital photo collection to storage using a particular brand of software.

Image Viewer vs. Database

Until quite recently, you needed a whole arsenal of tools to manage and optimize your digital images, including a viewer, a RAW converter, an image editor and probably also a database. Nowadays, strict differentiation between the individual components of such a system is largely passé. Most image viewers now have built-in thumbnail caching functionality, even if it is not as powerful as that included with most dedicated image database products.

In the endless bid to win new customers, software manufacturers continue to include an increasing number of features in their products, which makes them more powerful, but also more complex. Incorrect matching of thumbnails to images is a problem that is unknown in the world of image viewers – a

thumbnail is rendered from the current state of the image file, and nothing can really go wrong. Although serious problems are rare, database thumbnail caches are nevertheless more susceptible to false mapping errors.

In spite of their similar feature sets, image viewers often do better than unwieldy database programs at pre-sorting large collections of images. It is often using programs like Nikon's *ViewNX 2* or the popular *Photo Mechanic* to sort and pre-select your images before importing them. An image viewer is simply more agile if you need to do a lot of copying, moving and deleting before you start work in earnest. Once you are sure that there are not going to be too many significant changes to the content of your collection, it is time to import your image data or synchronize it with your database.

File Import

One thing an image database doesn't do is import the actual files to data fields, as this would make it unfeasibly large. It is possible to use BLOB (Binary Large Object) technology to save image files directly to a database, but managing and searching the huge amounts of data that this creates is slow and clumsy. Most database software imports links to the files it manages using one of two basic approaches:

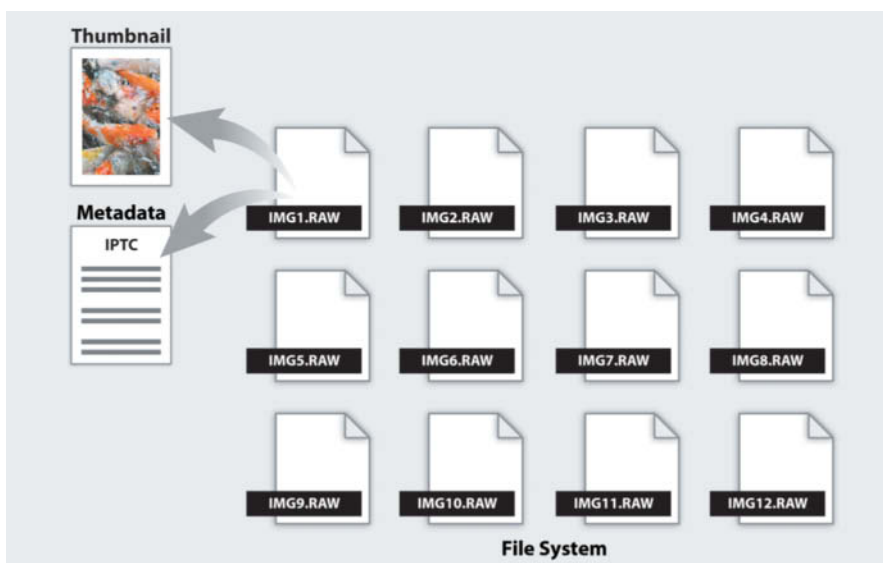
Import links, copy images to onboard file system: This approach involves copying all the image files to a new folder and

renaming them. The database program is then the only software that can access the new folder. This approach is used by *pixafe*, which is based on the IBM DB2 architecture. Renaming files and removing unwanted file extensions ensures that the database itself is the only program that can read (and alter) the results. Among our test candidates, *Cumulus* and *Aperture* use this approach, although both also enable the user to use links to existing folder structures if desired.

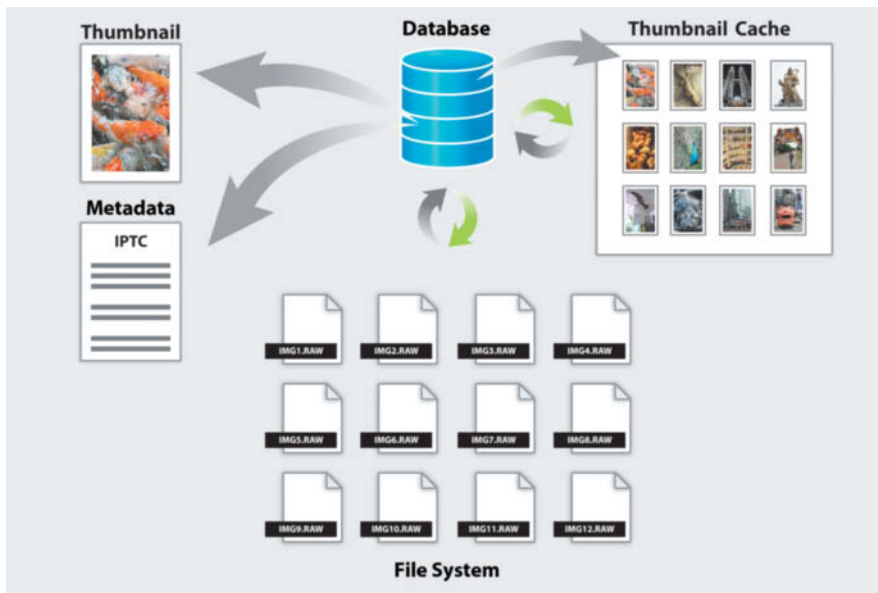
This type of system is great for preserving data integrity but also has disadvantages. Data import usually destroys the original folder structure, so you have to decide which is the lesser of two evils: either keeping a parallel set of image files in your conventional file system (which means you need twice as much disk space and have to keep both collections up to date), or crossing your fingers and deleting your source folder once you have committed your precious images to the potential vagaries of a particular manufacturer's software.

If you take the latter route, you can only do what the software manufacturer wants with your data, and it is no longer possible to take a quick look at the source file system to check whether everything is shipshape. If you are a home user, we only recommend this approach if you are prepared to keep a separate copy of your files for safety's sake. This is also a practical approach if you only want to import some of your images for the duration of a particular project or to organize them for sale. In such cases, the amount of administrative work you have to do will remain manageable.

Committing to a database also makes it much more difficult to switch to a different system later on, as you can never be sure that a proprietary database will be capable of exporting clearly structured data that is readable to other software. The success of such an export maneuver depends on the degree to which a database writes its own management data to the metadata of the



An image browser without caching functionality has to re-read the image data and recreate the thumbnail every time it is accessed. This makes previews slower, but guarantees that they show the current version of the image.



Database software saves metadata and thumbnails (or links to thumbnails) in the database itself, providing fast searches and previews. The Achilles' heel of most database systems is the synchronization between the database and the computer's file system – the contents of the hard disk aren't always identical to the contents of the database.

your existing local image folders instead of creating new, database-internal folders.

Thumbnail Caching

A thumbnail cache that enables you to create fast previews of the entire contents of your image collection used to be the killer argument for using dedicated image database software. Nowadays, virtually all image viewers have built-in thumbnail caching functionality, although this also causes data loss if a thumbnail isn't mapped to the correct image file. This type of bug has been documented for *iPhoto*, *Aperture* and *ViewNX*, and even *Lightroom* has had its fair share of mismatch run-ins.

In all these cases, thumbnails were incorrectly matched to image files, causing files to be wrongly moved, sorted or deleted. Altering image data directly in your computer's file system instead of via the database interface can cause similar

individual image files. Some products produce clean data, while others don't work as smoothly (see the section on metadata on page 118). If you're not sure, we recommend that you always save your images using a chronological folder system – this will usually preserve your image data in a form that you can successfully export. *Aperture*, for example, gives you a choice between copying your images to the Library or creating links to their current location.

Import links, use the existing folder structure in the onboard file system: Many image database programs (including *iMatch* and *Picasa*) don't allow you to copy images, and simply use the existing folder structure instead. This makes things a lot easier, especially for less experienced users, and means that you can search your images using a familiar system while enjoying the benefits of the additional search features offered by the software.

While this approach prevents the creation of large amounts of redundant data, it also tempts the user to use other tools and utilities to open and alter files, which quickly leads to inconsistencies in the database.

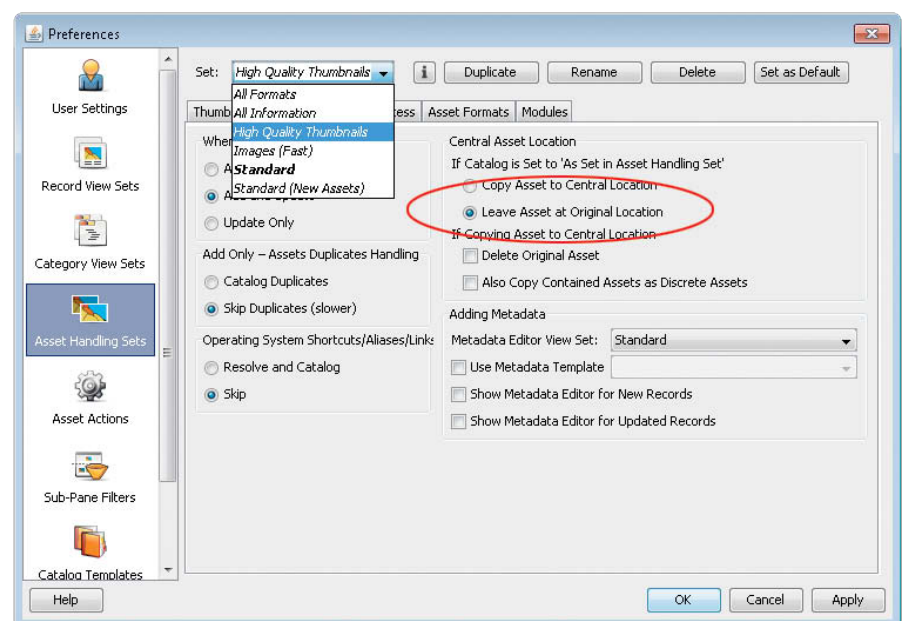
For this reason, *iMatch* constantly monitors the designated image folders and warns the user to resynchronize the file system with the database if it finds any unregistered changes. If the database uses internal metadata that is not saved to the file itself or a sidecar, errors can occur here too (see page 118 for more details).

Generally, you should always manage your images via the database interface, although there is no reason why you shouldn't give

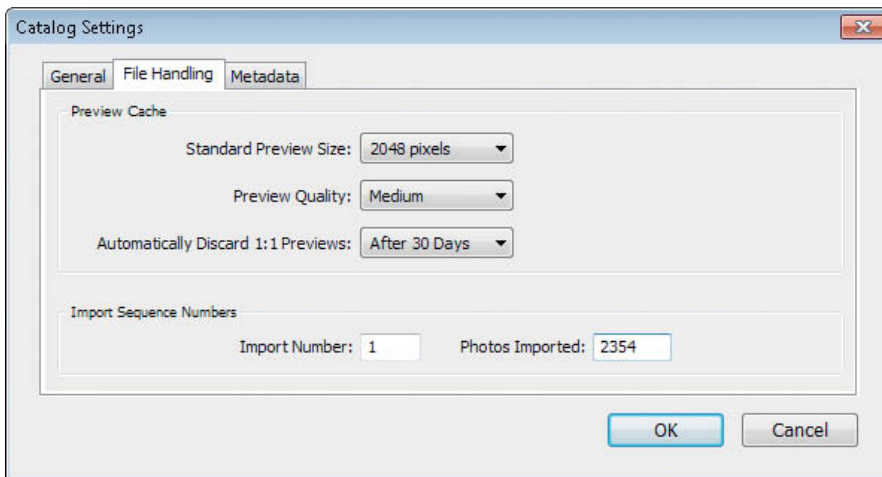
yourself read-only access to your images via other applications.

Some products give you a choice. *Cumulus*, for example, lets you keep your images in their original location or import them to its own central image folder.

Using your existing folder structure makes it easier to keep backup copies of your data and to migrate to a different system later if necessary. With the exception of *eyebase mediasuite* (which is cloud-based), all of our test programs give you the option to link to



Cumulus gives you the choice of either importing your images to a single, central folder or leaving them in their source folders. We recommend the latter approach to home users.



The term 'thumbnail' is a bit of an understatement for a file with a side length of up to 2048 pixels. *Lightroom* saves its preview images separately to prevent the database from getting too big. This approach means that you can use large preview images without affecting the program's overall performance.

problems. The best way to prevent these kinds of inconsistencies is to open the image file itself for processing rather than relying on a link to a thumbnail. This is time-consuming, but makes it impossible to open or alter the wrong image.

Recently, there has been a noticeable trend toward using larger thumbnails. In these times of virtually limitless disk space and large monitors, there is no real reason to stick with tiny

preview images. The thumbnail size you use can usually be selected in the program preferences, but remember: the higher the resolution and the quality level you select, the more disk space you will have to provide for the thumbnail cache.

Thumbnails are either imported directly to the database (*Cumulus*) or saved to a separate folder (*Lightroom*). The first method is fast, but usually means that the size of the thumbnails you can select is restricted to prevent the database from becoming too large. Saving thumbnails separately prevents larger preview images from slowing down the program's other operations.

RAW Compatibility

All operating systems and image databases support common image formats such as TIFF and JPEG, but confusion still reigns regarding the multitude of proprietary RAW formats used by camera manufacturers. In its standard configuration, Windows cannot display or open a number of file types. The free Microsoft Camera Codec Pack helps to a degree, but still doesn't include many common device-specific formats. Popular camera manufacturers such as Canon, Nikon, Pentax and Panasonic offer their own codec packs for download.

Apple's OS X is much better equipped, and RAW support is an integral part of the operating system.

Regular updates ensure that support includes all current formats.

In contrast to operating system manufacturers, image database software manufacturers have a vested interest in providing regular updates to keep pace with the flood of new and updated RAW formats that are constantly hitting the market.

Lightroom supports more camera models than *Aperture*, while smaller manufacturers like *eyebase* provide support for individual RAW formats on request – something that most major software providers wouldn't dream of doing. All software manufacturers publish lists of the makes and models of camera they support, so it is always advisable to check whether your particular camera is supported before making a purchase.

And while we're on the subject, browser-based format support isn't necessarily the same as local support, even if we are talking about the same manufacturer. The local version of Google's *Picasa* can display and process many RAW formats, whereas they can only be downloaded (without previews) if you are using the Google Cloud. Additionally, RAW files cannot be uploaded to *Picasa* Web Albums, but can be stored as Google documents. However, *eyebase mediasuite* is capable of displaying thumbnails of RAW images in its browser-based interface.

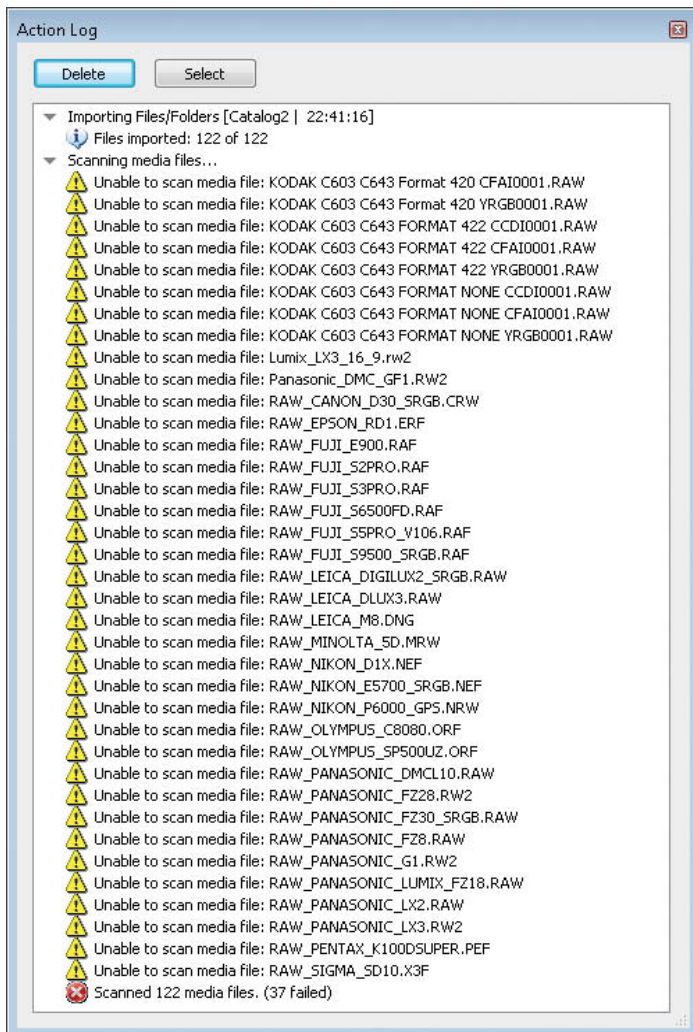
In spite of all these anomalies and idiosyncrasies, a regularly updated database is always preferable to built-in operating system tools if you want to be sure of maintaining optimum file format compatibility.

Database Image Management

If you need to organize collections of photos or find images based on specific keywords, an image database is always the tool of choice. Unlike most simple file systems, database software enables you to add a single image to various different collections without producing redundant data. Again, this approach is all well and good up to the point when you attempt to transfer an existing database to a different software platform – internally created collections don't usually survive migrations.

If you want to stay manufacturer independent, it is preferable to sort your images according to metadata-based criteria, as these can be read by most programs, independently of their database architecture. If you want to market your images through stock agencies, you will have to spend a fair amount of time organizing your metadata anyway (see the following section). Even





RAW format recognition is still a fairly haphazard feature in most image databases. As one of only a few programs, *Media Pro* warns the user of any unrecognized formats. In spite of these shortcomings, a dedicated database is still a better choice than the file management tools built into most operating systems.

editorial team and on to the layout department and the printer. This is the level at which pro-grade image database tools begin to leave their home-use counterparts behind.

Our Conclusions So Far

A well-maintained image database that you set up to suit your own needs will speed up your digital photo workflow and help you to find just the right photo for the job at hand. But remember: a database requires a lot more user input and maintenance than a simple image browser. At the end of the day, the solution you choose will depend on the size of your archives and how you plan to use your images. Once you are familiar with typical stumbling blocks like RAW compatibility, file import limitations, metadata details and thumbnail caching, you will be able to find just the right software and avoid making common mistakes once you have set it up.

Windows includes basic IPTC metadata editing functionality, but quality image database software should also include batch processing functionality that enables you to rename large numbers of images in one go using custom data fields.

The next way to extra long-term work is to keep a hierarchically ordered collection of keywords, sometimes known as a 'thesaurus'. For example, the hierarchy 'Camera/Nikon/D7000' automatically applies any higher-ranking keywords along with the lowest-level keyword – in other words, if you add the keyword 'D7000' to an image, it will automatically be tagged with the terms 'Camera' and 'Nikon' as well. Some databases have a built-in thesaurus, while others require you to build your own from the ground up.

Building your own thesaurus is often the best approach, as it allows you to define and order your own keywords. The complexity of your thesaurus will depend on the number

and complexity of the subjects your photos cover. If you aim to sell your images internationally, a multilingual thesaurus like the ones built into *Cumulus* and *eyebase mediasuite* are a real bonus.

File Export and Publishing Functionality

Databases really come into their own when you begin to use them not just for managing but also for distributing and publishing your work. The functions you can apply during image export vary enormously, ranging from simple scaling all the way up to RAW processing. For home users, the export features and image processing tools built into single-user solutions like *Lightroom* and *Aperture* are usually sufficient for most needs.

On the other hand, commercial users require dedicated, often complex workflows in order to keep images flowing as efficiently as possible from the photographer to the



All about Metadata

Always use metadata in preference to proprietary solutions when keywording your images – this approach is more flexible and helps to keep your options open should you decide to switch to a different system later on. In spite of the obvious advantages, metadata still has its drawbacks, not least the various standards in current use and the different ways these are implemented from product to product.

There is no simple solution, so the following sections detail the advantages and disadvantages of the various available formats. Combined with your own preferences and the metadata that has already been applied to your images, these should help you to develop your own successful keywording strategy.

Exif – More Than Just Camera Data

Most digital photographers will have heard of the Exif (Exchangeable image file format)

metadata standard used by virtually all digital cameras to save shooting information along with visual image data. Exif data includes information relating to the camera manufacturer, image orientation (i.e., portrait or landscape), shooting date, aperture and exposure time. These are standard tags that are (supposedly!) the same in all digital image files and can be interpreted by all types of image management software.

Maker Notes: In addition to standard tags, image metadata also contains maker notes, which are additional data fields defined and filled according to the camera manufacturer's own specifications. This is where data such as the camera model and lens information is stored. Maker notes vary in their form and content between manufacturers and camera models. Making all currently used maker notes readable would involve an enormous effort on the part of software manufacturers and doesn't make commercial sense. Most photographers consider maker notes to be a useful source of additional information, but



Modern cameras like the Nikon D7000 can be programmed to add optional copyright information to image Exif data

Just about every image browser can read Exif metadata. The data shown here was extracted using the donationware *FastStone Viewer*.



Don't Forget to Check IPTC/XMP Compatibility

There is a list of supported software at http://www.iptc.org/site/Photo_Metadata/Software_list that includes manufacturer's own data on how various programs handle IPTC metadata.

A closer look at the list reveals just how neglected the implementation of current metadata standards is. Much of the

data is either old or no longer relevant because manufacturers have introduced new program versions without bothering to update the relevant IPTC information.

Instead of studying an out-of-date list, reverse engineering is a much more reliable way to find out which metadata standards and which data fields have been implemented in a specific program.

one that can't necessarily be displayed, interpreted or searched by photo management software.

Editing Exif Data: Exif is not just readable but also editable. Generally, Exif data fields whose content can be altered by image editing processes – such as color space, image orientation and size – are automatically updated when changes are applied, whereas data specific to the shot itself (such as the lens or the exposure time) remains unaltered. If you want to freely edit all Exif data fields, you will have to use tools like *EXIFeditor*, *ExiferB* and *ExifTool* (all included on this issue's free DVD). This type of tool is extremely useful if, for example, you set your camera's date incorrectly and have to change your

image metadata accordingly. Non-standard alphanumeric characters are not generally supported by Exif and IPTC metadata fields (see the box on page 121). The latest Exif release from January 2012 defines how all Exif fields can be saved in XMP format.

IPTC – Custom Metadata

The IPTC-NAA metadata standard, commonly known as IPTC, was formulated in the 1970s in cooperation with the International Press Telecommunications Council. This standard allows users to enter their own data in the available fields, providing a flexible custom keywording tool. The IPTC standard defines both the list of fields (which is the same as

those found in the Exif standard) and their formats, which are different from those defined by the Exif model. Virtually all relevant (standardized) metadata that is relevant to photography is written to an image's header. Writing metadata directly to the image data is also possible for RAW files, but is not generally recommended because the lack of generally accepted standards creates incompatibility issues.

Always use the manufacturer's own metadata editor if possible (in Nikon's case, *Capture NX 2*) or use a dedicated metadata format such as XMP that is capable of creating separate sidecar files.

Even though the IPTC standard enjoys worldwide acceptance, there is a strong case



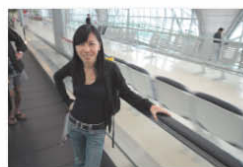
.picasa.ini



Taiwan-DSC1742.NEF



Taiwan-DSC1742.xmp



Taiwan-DSC1771.NEF



Taiwan-DSC1771.xmp



Taiwan-DSC1847.NEF



Taiwan-DSC1847.xmp



Taiwan-DSC1911.NEF



Taiwan-DSC1911.xmp



Taiwan-DSC1912.NEF



Taiwan-DSC1912.xmp



Taiwan-DSC1913.NEF

Sidecar files with formats such as XMP and *picasa.ini* help to overcome the limitations of existing metadata standards and RAW compatibility issues. Metadata saved in a separate file protects the original image data, but you have to take care not to break the connection between an image and its sidecar file – for example, by manually renaming one or the other.



Rating flags or stars and color codes are a great aid to sorting images but, because every program has its own system, they are not of much practical use as permanent archiving tools

the program's image processing tools. You can also edit XMP data to include extra information (such as geodata) that can be added later.

There are disadvantages to using XMP sidecar files, especially if either the image or metadata file gets unintentionally renamed or moved within the host file system. It is always safer to manage your images via the program's interface.

Sidecar files also have their advantages. First and foremost, they enable you to work around the limitations of the countless proprietary RAW file formats available today. For example, if you want to add GPS data to a Nikon NEF file, you can't even use Nikon's own *Capture NX2*, whereas an XMP sidecar file and *GeoSetter* do the job admirably. And remember: if you use sidecar files, you can only ever access your photos in read mode, which is the best possible way to prevent damage to the original image data.

Adobe is the driving force behind the XMP format, and provides a free SDK along with the original format specifications for anyone who wants to develop their own 'smart assets'. XMP has been around since 2001, and has been the suggested successor for the established IPTC standard since 2004. However, in spite of Adobe's enormous market presence and an explicit recommendation from the IPTC itself, the changeover still hasn't fully taken place.

We are convinced that XMP has a bright future as a universal container format for many types of metadata, particularly as it has

(supported by the IPTC committee itself) for replacing it with XMP. However, such a change would only affect the format and not the definition of the IPTC data fields.

The original 1990 IPTC-IIM (Information Interchange Model) standard, which has been updated several times since it was introduced, has now been replaced with the newer IPTC-NAA (Newspaper Association of America) standard, which is divided into 'Core' and 'Extension' data field sets. The Core fields cover most currently relevant data, while the Extension set covers more comprehensive information to describe content, aid administration and define licensing and copyright terms. If you want to ensure backward compatibility for your images, you should definitely stick to using the Core data set. Not all applications are capable of displaying Extension data fields.

XMP – Snapping at IPTC's Heels Since 2004

Like IPTC, the XMP (Extensible Metadata Platform) format is eminently suitable for defining keywords for image files. XMP is generally considered to be more up-to-date than IPTC (see below). Although the data fields themselves are largely the same, the format in which the data is saved is very different.

XMP data can be written directly to an image file – as is the case with DNG, TIFF, PSD and JPEG files in *Lightroom* – whereas the lack of standardized RAW image formats makes it prudent to save RAW metadata to a separate (.xmp) sidecar file with the same name as the image file.

Lightroom uses sidecar files to store not only basic IPTC and Exif image data, but also the details of any adjustments you make using

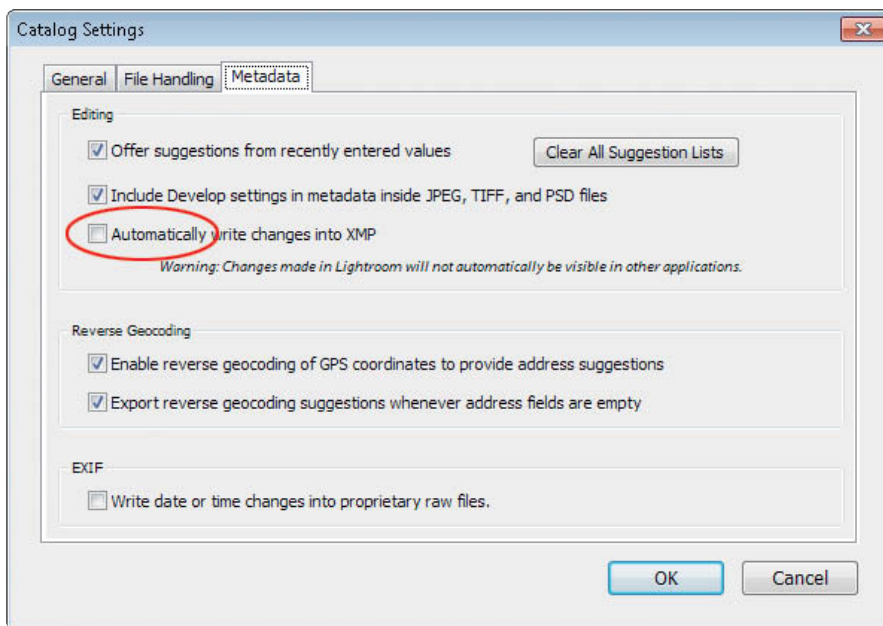
Sorting Images using Stars and Color Codes

Rating systems that use stars or color codes are very helpful when it comes to pre-sorting collections of digital images. The IPTC metadata standard has no provision for these types of data fields, whereas XMP includes the 'xmp:Rating' field that specifies star-based ratings.

However, software manufacturers still tend to prefer to do things their own way. *Picasa* gives us the options of a single star and no colors at all, while *Capture NX2* offers up to five stars and nine colors, Windows Explorer has up to five stars but no colors, and

Lightroom compounds the confusion with its five stars and five different color codes. This means that each system is only of use within its host program, but lacks the necessary interoperability for use with other software.

Even apparently identical functions are often good for a surprise. For example, if you add star ratings to a single NEF file using *View NX2* and *Lightroom*, the metadata produced by each program cannot be interpreted by the other – Nikon saves stars directly to the image data, while *Lightroom* saves them in an XMP sidecar file.



Lightroom's default setting only writes metadata directly to image files if you save them manually. This setting can be changed in the program's Preferences dialog.

Switching Databases

Database software saves metadata not only to image and sidecar files, but also to the database itself, often using proprietary formats and non-standard locations. Such practice makes it difficult to stick to globally accepted metadata standards. For example, *Picasa* saves name tags created using its face recognition functionality in its own *picasa.ini* file and not to the predefined IPTC name field.

If you should decide to switch databases, information like this will be lost. Your new program will need to have extremely powerful export functionality if you want to rescue and re-use all the metadata created using your previous database program.

Before you spend a lot of time and effort writing and saving metadata, always check which parts of the data you create can be easily exported should you decide to switch programs later. In multi-user scenarios, individual image metadata, once imported, is updated (if at all) via the database interface.

In such cases, the image files themselves can only be altered at the export stage, and many administrators use the opportunity to update image metadata. This approach is fine in an enterprise environment, but is less suitable for single-user scenarios. For home users, we recommend writing important metadata directly to your files or to an XMP sidecar.

If you follow our recommendations meticulously, face recognition will be reduced to a virtually useless 'fun' function. The standards that do exist have only been half-heartedly implemented. For example,

already been ISO certified (ISO 16684-1:2012). However, we also predict that the sometimes confusing mass of currently available formats will keep us busy for a while to come.

What about Duplicate Metadata?

It is always advisable to avoid redundancy in an image database. However, because the Exif and IPTC/XMP standards come from different sources, some data fields – such as copyright information – are duplicated.

We recommend that you use camera settings that include Exif data for all the data fields you want to cover. It is nevertheless a good idea to save separate information (in the above example, copyright data) to the appropriate IPTC data field as well. Unlike Exif metadata, IPTC data is still the standard

that many agencies and photographers expect their customers and business partners to use.

Metadata and Face Recognition

Standardized formats for storage of people's names and the positions of faces within an image have only recently been addressed. The IPTC standard has always contained a field for names, but includes no practical way to save positional information. The XMP standard was adapted to include positional information in 2010, but the necessary support is still lacking in most metadata editing software. However, if you open a JPEG image using a full-featured text editor such as *Notepad++*, any name tags and localization data that your database software has written to an image can be found using a text search.

IPTC Metadata and Special Characters

IPTC data fields are precisely defined, but not every software manufacturer adheres to the prescribed definitions. Discrepancies often affect the descriptions and character sets that can be used. IPTC gives manufacturers a free hand, so it is important that the intended character set is itself defined in the appropriate field.

These definitions are all too often ignored by software applications, which means that the operating system's default character set is used, leading to rows of question marks where the

image metadata includes special characters that the operating system doesn't recognize.

Because it is based on XML, which is Unicode-based, XMP prevents such anomalies. If you want to be doubly sure that your keywords will be correctly recognized, you can always use good old ASCII. This approach is time-consuming and means you can't use special characters, but you can be sure that the characters you use will be reproduced correctly.

No Metadata, No Rights ...

Small companies and individuals often get by without keywording their images, simply because it's easier not to. However, even if you really dislike doing more work on an image than is absolutely necessary, you should always include at least copyright information with your images – otherwise you run the risk of losing the rights to your own work.

In the USA and the UK, images that are published without copyright information are considered to be 'orphaned works'.

This concept may seem a little rough-and-ready, but is a reaction to the untold numbers of archives that are brimming with insufficiently labeled photos. It is often impossible to find the creators of older images, so it became necessary to come up with workable rules for public images that have no obvious owner.

If you want to retain the rights to your own work, you must tag your images appropriately. Here too, you need to

watchout for potential errors and idiosyncracies. Up to and including the CS3 version, the *Photoshop Save for Web* command automatically deleted all metadata. Various CMS systems and cloud applications are also known metadata killers. For example, *WordPress* deletes all metadata if you simply crop an image or reduce its size.

By the way, unauthorized deletion of image metadata is illegal in the USA and most of Europe.

Picasa uses its proprietary *picasa.ini* file by default, and – even if you change the program's settings to use XMP – its lack of sidecar functionality means that it can only use the format with JPEG image files.

the program's default view. You can change this by activating the *Unsaved Metadata* option in the Library View Options dialog. *Lightroom* then marks the files for which metadata still has to be synchronized with an arrow icon in the top right-hand corner.

Again, the exact setup options you select will depend on your own particular requirements. We recommend that you back up the *Lightroom* Catalog regularly and avoid using other applications to access your images.

Lightroom Case Study

Even if your database software is capable of reliably writing metadata to your images or to sidecar files, you still need to keep an eye on when and how it replicates metadata. For example, *Lightroom's* Catalog settings include the non-default *Automatically write changes into XMP* option. If you don't activate this option manually, any changes you make to your image metadata will be saved in the *Lightroom* Catalog but not in the images themselves.

However, because *Lightroom* saves both IPTC metadata and editing steps to XMP, it is not generally advisable to automatically save all changes to a sidecar file, as they are duplicated in the database itself, which slows the program down appreciably, especially if you are working on large numbers of images.

Lightroom is a good example of the advantages that can be gained when software manufacturers concentrate on using pure database functionality rather than the image files themselves when managing data. For this reason, you need to make doubly sure that you back up your database regularly. If you use the metadata stored with your images with other applications too, it is essential to write any changes in metadata to your image or sidecar files immediately.

While we are on the subject of *Lightroom* peculiarities, note that differences between camera and image metadata are not visible in

Strategic Metadata Development

There are many metadata standards currently in use, and a number of accreditation committees involved in their development. The global software industry has recognized the issues, and Microsoft and Adobe have created the Metadata Working Group in order to coordinate progress in this complex area. The group's website includes a

PDF that describes the 13 (!) current standards that are in use (see http://www.metadataworkinggroup.org/pdf/mwg_guidance.pdf). In contrast, the Embedded Metadata Manifesto (<http://embeddedmetadata.org>) is attempting to persuade the world to save metadata directly to image files and not in the form of separate sidecars.



The Metadata Working Group website includes detailed information on the current state of the often confusing world of metadata standards

Image Database Software Test Results

You can find comprehensive reports on the eight image database products we tested on the following pages. The table below lists a

number of other, similar products in both the single-user and multi-user categories. A table of test results is printed on page 133.



IMAGE DATABASE SOFTWARE FOR NETWORK AND MULTI-USER ENVIRONMENTS

Program	Manufacturer	URL	Price (approx. US\$)	Comments
4All-Portal MAM 2.0	Cross Media	www.4all-portal.net	On request	Manages all types of digital assets, plug-in available for integration into Adobe Create Suite
Akibase	Akitogo	www.akitogo.com	3750 (setup) from 300 (monthly)	Browser-based solution for the image agency market; uses MS SQL server and Adobe ColdFusion application server; comprehensive choice of marketing options
celum IMAGINE	celum	www.celum.com	On request	Enterprise media platform with interfaces to Sharepoint and other systems; can be integrated into MS Office and Adobe Creative Suite
dhs Image Database	dhs Dietermann & Heuser Solution	www.dhssolution.com	On request	Modular DAM with many built-in processing and image analysis features, e.g., microscopy and metallurgical analysis
Elvis	dutchsoftware.com	www.elvisdam.com	On request	Powerful DAM software with intuitive interface; also available as SaaS
Fotostation Pro	Fotoware	www.fotoware.com	600	Expensive pro-grade tool, widely used by agencies; with useful remote access functionality
MAM Suite	Contentserv	www.contentserv.com	On request	Media database with Web interface for corporate environments; modular construction
Media Asset Management	BrandMaker, Inc.	www.brandmaker.com	On request	Media management is just one of many available modules; product aimed at large corporations and industrial customers
Media Management	Open Text Digital Media Group	www.opentext.com	On request	Enterprise media management system, also available as SaaS; formerly known as Artesia
meebox	meebox GmbH	www.meebox.de	From 7 per month	Browser-based database with image management features; only available as SaaS
Phraseanet	Alchemy	www.alchemy.fr	Free	Complete open source web-based DAM system based on MySQL, PHP and XML; consulting is fee-based
Portfolio	Extensis	www.extensis.com	From 99.95	Multi-user-capable DAM for corporate use; full version is good value for this type of software at US\$199.95
ResourceSpace	Montala Limited	www.resourcespace.org	Free	Web-based open source database with download tool for original files; multi-language, based on PHP/MySQL; also available as SaaS
Web Native Suite	Xinet	www.xinet.com	65,000	Extremely powerful DAM system for automating commercial workflows; suite license price includes 4 full clients and unlimited Web users

DAM = Digital Asset Management
SaaS = Software as a Service

IMAGE DATABASE SOFTWARE FOR SINGLE-USER ENVIRONMENTS¹

Program	Manufacturer	URL	Price (approx. US\$)	Comments
ACDSee Pro	ACD Systems	www.acdsee.com	129.99	Database with built-in RAW editor, similar concept to Lightroom; Mac and Windows versions very different
F-Spot	Novell	f-spot.org	Free	Photo management application for the GNOME desktop, development stop since 2010
Gerbing Fotoalbum	gerbingsoft	www.gerbingsoft.de	From 12.50	Minimalist image database for large archives, runs on Access or SQL; author says that he deliberately doesn't support thumbnails and other "frills"
iPhoto	Apple	www.apple.com	14.99	Pre-installed on most Macs with the iLife suite; has a reputation for crashing when used with large numbers of images; built-in face recognition
JPhotoTagger 0.17.0	Elmar Baumann	jphototagger.org	Free	Free photo manager with a wide range of search options and complete XMP support; includes plug-in for upload to Flickr
Photo Manager Deluxe	Magix	www.magix.com	59.99	Photo manager with built-in RAW editor and face recognition functionality; non-destructive editing, supports 270 different camera models
MediaShow	Cyberlink	www.cyberlink.com	49.95	Low-end photo/video database with face recognition functionality; Facebook upload
Photoshop Elements	Adobe	www.adobe.com	99.99	Elements has a powerful built-in database; no geotagging tools, but with face recognition and various automated image effects
PicaJet	Pacific Business Centre	www.picajet.com	59.95	Single-user image database; freeware version has too little functionality to be useful
Qpict	Rune Linsman Development	www.qpict.net	From 35	Cheap image database for Mac OS
Shoebox	KavaSoft	www.kavasoft.com	30	Alternative to iPhoto for Mac OS; with import function for iPhoto and password-protected private folders that don't appear in the recent catalogs menu
Shotwell	yorba	yorba.org	Free	Photo manager for GNOME with RAW support; has now replaced f-spot as standard in Ubuntu
StudioFlow	TTL Software	ttlsoftware.com	749.95	All-in-one tool for portrait and wedding photographers; hasn't been updated for some time
StudioLine Photo Classic	H&M Software	www.studioline.net	From 59	Offers various Web publishing options; DigitalXpress interface great for exchanging data between photographer and clients; no payment functionality, no additional user accounts
Windows Live Photo Gallery	Microsoft	www.windowslive.com	Free	More of an Explorer extension than a full-blooded image database; similar to but less popular than Google's Picasa; RAW format recognition still poor, even with additional codec pack installed

¹ Nearly all products allow read-only access to folders that are given appropriate permissions. This is, however, not 'real' multi-user capability, i.e., with full write access rights.

Apple Aperture 3

Aperture is a comprehensive all-in-one digital photo workflow tool that offers various RAW editing tools and integrates seamlessly with Apple's Media Library functionality. The library is capable of managing all your media assets, whether you copy them to the Library folder or simply use links to associate them with the program. 'Real' import makes it easier to back up your data, but impossible to open and process your files using other applications.

Our import test revealed a common weakness in many image database programs. *Aperture* only displays the 119 of our 128 sample RAW files that it recognizes as image files. Of these, the program imported only 110 and produced error messages for the others. At the end of the day, *Aperture* was only able to correctly display, render and produce a full-frame preview for 87 of our images. *Lightroom's* RAW recognition results were much better, although *Aperture* proved more capable of recognizing more common image file formats.

Aperture is not designed for managing images stored in your computer's native file system, but does offer a number of options for managing logical drives and assets. Apple's use of the outdated IPTC-IIM metadata standard brought it a lot of criticism, so version 3 finally supports XMP sidecar files as well as IPTC Core data fields. The IPTC Extension data set is not supported.

Geodata display and tagging is reliable; Apple uses its own servers to find place names and Google Maps for its map material. The face recognition functionality works quite well, but is not as simple to use as the equivalent tool in *Picasa*. Face recognition slows down most computers, and Apple's tool is no exception. The equivalent *Lightroom* function was a lot smoother and faster when run on our 2.3 GHz Core i5 SSD-based Mac Mini with 8 GB of RAM.

The rather complex handling makes it more difficult to tag large numbers of files, but *Aperture's* interoperability results were better

than those produced by *Picasa*. Name tags are exportable and can thus be used with applications that run independently of the Apple Library.

The search tools built into the interface are, in fact, simple filters, and the search mask reached using the Edit > Search command is actually much more powerful. You can save the results of complex searches to the Library in the form of Smart Albums. All in all, the interface is a bit clunky and appears to have been cobbled together.

In spite of its shortcomings, *Aperture 3* offers the best value for money of all our test candidates. The package includes a full-featured RAW editor and a database with face recognition and geotagging functionality for just US\$79.99. On the negative side, Apple no longer offers a 30-day trial version, so you have to commit to spending money if you want to give *Aperture* a whirl.



Aperture's face recognition interface is attractive enough, but the simpler interface provided by Google's *Picasa* is easier to use

Canto Cumulus

Cumulus is designed for use in large multi-user environments. We used a single-user license with multi-user functionality for our test. Obviously, the starter version doesn't support Web publishing via Cumulus Sites or the Web-based administrator tools offered by its multi-user cousin. Although we only tested it with image files, *Cumulus* is designed to function as a full-blooded DAM (Digital Asset Management) system that can be used to manage video, sound and layout files too.

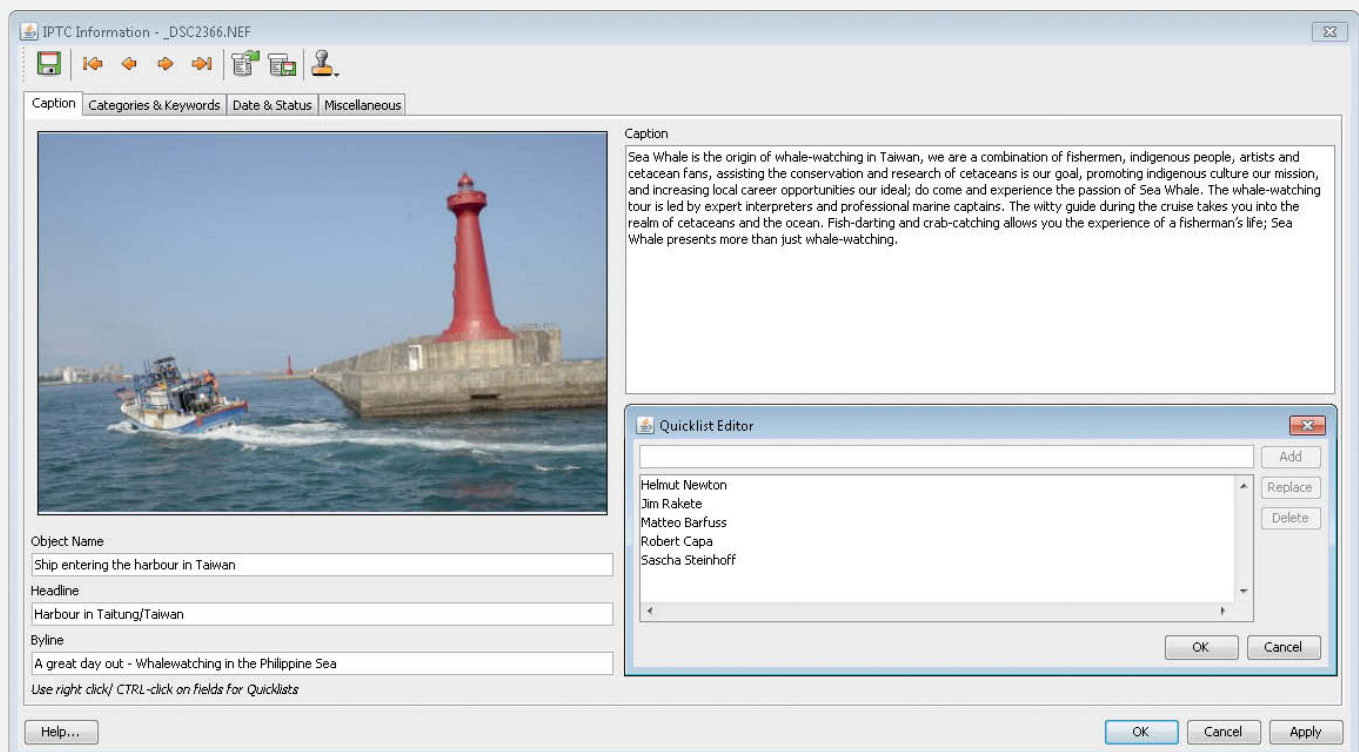
During import, *Cumulus* gives you the choice of importing your assets to its own file system or leaving them in their current location. The import process offers an impressive set of options, including import for unrecognized files. This enabled the program to import our complete set of sample images, something most of the other test programs couldn't do. Overall, the file recognition is a two-edged sword – *Cumulus* recognized more standard image formats than all our other test candidates, but was unable to recognize a

lot of our RAW files (especially those shot using older camera models). The manufacturer is promising to add manual catalog configuration functionality to address this deficiency.

Cumulus is not really designed for managing data on a file system level, but is well equipped for handling logical assets in the form of Catalogs, Categories and Collections. It also supports XMP and IPTC Core metadata. The built-in metadata editor is extremely powerful, although not all the changes you make in the GUI are saved to the image files. For example, to preserve data integrity, the program doesn't support direct backups for Exif metadata. On the other hand, the editor allows you to define your own custom metadata fields to adapt the program to your own specific requirements. There is no face recognition or geotagging/map functionality, but the Find window can be used to perform extremely detailed searches, provided you

have some previous knowledge of how databases work. *Cumulus* can save assets to FTP servers and catalog them, and the built-in multi-language thesaurus is a fine tool for professional imaging workflow situations.

Cumulus' real advantage lies in its scalability, as it expands in accordance with the user's needs. There is no real reason for photographers to use *Cumulus* as a single-user solution, and the single-user license only really makes sense as a trial version for companies that plan to implement some kind of multi-user solution later. Both *Lightroom* and *Aperture* are better desktop solutions, but *Cumulus* comes into its own as soon as you want to integrate multiple users into your environment or give customers Web-based access to your digital assets. The combined local and/or client-based interface offers more flexible access options than the browser-based eyebase *mediasuite* solution.



The *Cumulus* metadata editor is highly customizable. You can create a list of keywords for each data field, like the IPTC Author field shown here.

digikam

digikam is a richly featured open source image database application developed for Linux and now ported to the Mac and Windows environments (see Issue 6 of *c't Digital Photography* for a full review). Our test revealed stability problems on Ubuntu and 64-bit Windows 7 systems, with fairly frequent crashes and freezes, especially when writing metadata to image files.

digikam copies imported images to a folder that you specify during installation, while its default settings copy metadata to the database only. This means you simply have to remember to update your image files on a regular basis.

The program, with its promising RAW converter, is similar to *Lightroom* in many ways and recognized just as many RAW files and just as few standard formats as the Adobe product.

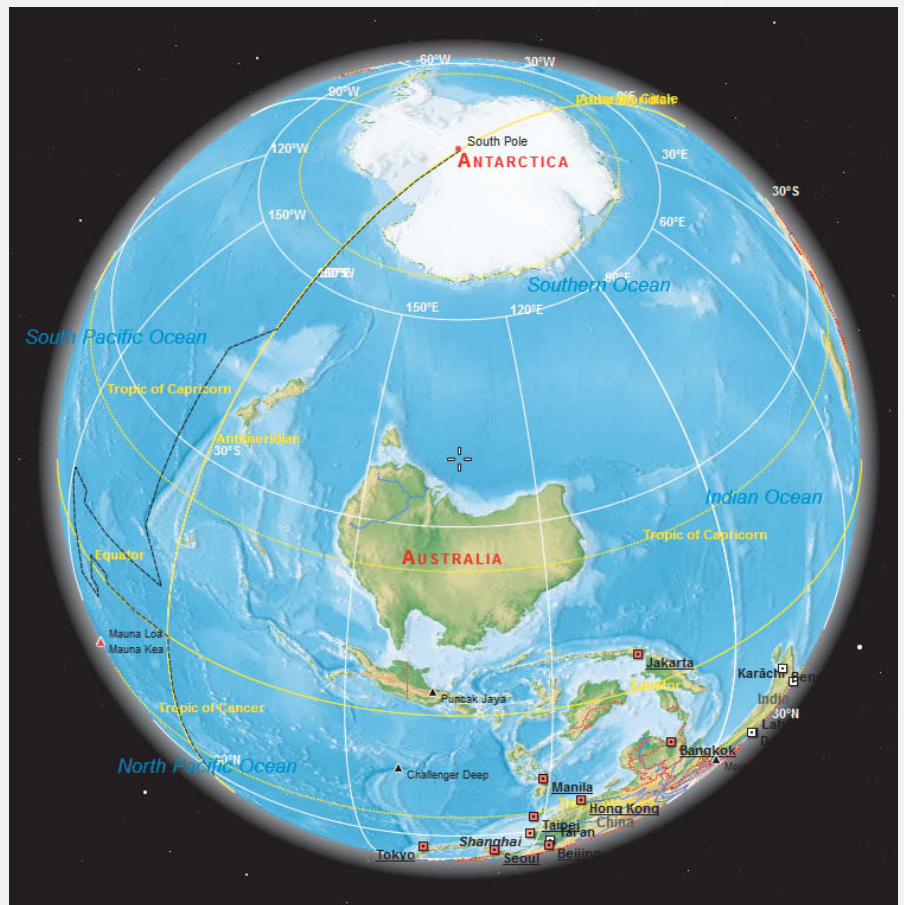
Files can be managed using the program's own file system, but using logical links is much more flexible. Views can be filtered using keywords and the package offers XMP and IPTC Core metadata support.

The built-in face recognition functionality often recognizes miscellaneous objects as faces. At the start of our test run, *digikam* kept matching names to the wrong faces, although it did 'learn' every time we confirmed a hit. It doesn't support the IPTC Extension field for people's names, but does allow you to build up and manage effective hierarchies of keywords.

The built-in geotagging module supports a whole slew of map tools, and includes a really useful area search function that allows you to filter your photos according to place names. Overall, the basic and advanced search functionalities are just as good as those offered by the commercial competition. Once you are used to the slightly clunky handling, batch application of geotags works smoothly too.

Overall user-friendliness is of an acceptable standard for an open source application, although switching from *digikam* to one of its commercial counterparts feels like the move from your first car to a brand new BMW – simply worlds apart. Under the hood, the open source offering has a number of goodies (such as an Exif editor) that Adobe and the like don't include in the price.

digikam uses SQLite as its default back end, and is designed as a single-user solution. Version 1.3 introduced the option of using



digikam offers a freely rotatable and scalable virtual globe, as well as conventional two-dimensional maps

MySQL, accompanied (in theory at least) by multi-user support. However, we have heard reports that configuration and use of this new functionality is anything but trivial and appears to be still at the development stage.

All in all, *digikam* is an interesting alternative to its commercial cousins, with a feature set to match any offered by the competition. Nevertheless, it still has a lot of catching up to do before it can compete in terms of handling and general user-friendliness.



eyebase mediasuite

This is the only purely cloud-based image database in our test and has a browser-only interface. *eyebase* offers *mediasuite* as a Web service that can be purchased for a monthly fee and provides its own hosting service. You have the option of running the server on your own network instead, although this only really makes sense in large-scale environments. The 'Smart Start' starter pack costs approximately US\$1,000 to set up and US\$140 per month to run, and includes 4 GB of online disk space.

There are various upload mechanisms, including Java, e-mail, Dropbox and direct upload from *Lightroom*, and we used FTP to upload several gigabytes of test files. Massed FTP uploads are not usually an issue, even using variable bandwidth, and can be paused and restarted if necessary. However, *eyebase* apparently does not support this basic functionality; it reloads files that are not completely transferred but doesn't delete incomplete transfers. We ended up with a number of duplicate files during our test, although we were using an international upload link to transfer files as large as

170 MB. We assume that transferring smaller files via local connections should be less of a problem.

eyebase displays thumbnail previews of RAW images in its Web-based front end, which gives it a head start over most other cloud services. However, it is impossible to tell whether the service renders its own thumbnails or simply uses the one stored with the RAW file, so we haven't included any RAW preview results in our table of results. RAW file recognition rates weren't nearly as good as most of the locally installed software we tested, but the program coped admirably with the standard formats we fed it.

The *mediasuite* front end has a Windows look and feel and even less experienced users will find it easy to use, in spite of the many options on offer. The folder structure is self-explanatory and, unlike Windows, allows you to allocate individual files to multiple folders. You can also build virtual collections of files and folders.

Superusers can write to all existing IPTC and Exif metadata fields and define additional

fields as necessary. Keywording is quick and easy thanks to built-in multi-language thesauri. The advanced search tool is highly customizable, but doesn't include face recognition or geotagging functionality. One of *mediasuite's* obvious strengths is the wide range of publishing options it offers, although the viewer functionality is not as good as those offered by other Web album services. With its built-in research and online payment tools, the *eyebase* offering is an obvious choice for anyone looking for an online image marketing platform.

mediasuite is not a real alternative to a locally installed database, if only because cloud solutions are inherently much slower than locally based systems. However, its asset distribution capabilities make it a great add-on for linking *Lightroom* (using a dedicated plug-in) to an intranet or the Internet. Unlike other multi-user solutions, the *eyebase* approach doesn't require a dedicated server, and the 'Software as a Service' approach to licensing makes it a good choice for small companies.

The *mediasuite* Web GUI offers a wide range of highly configurable features, like the search mask shown here. The software is not a realistic alternative to a local image database but is a useful add-on if you want to distribute your assets via the Internet.

Phoools iMatch 3

iMatch is developed and supported in Germany, but is available exclusively in English for US\$65. Essentially a conventional single-user image database solution, it can also give networked users read-only access to your assets. It also provides a basic built-in image editor and a range of image export options.

Our file import test produced average RAW recognition results but better than average results for standard photo formats. The software had trouble rendering thumbnails for many of our sample RAW files, although it was still able to open some of the files themselves. We had no issues importing common RAW formats.

iMatch has comprehensive file management functionality that includes efficient batch renaming, and also offers a range of virtual management functions (such as categories) for organizing large collections of images. We really liked the binary search tool, which enables you to find

duplicate images even if they have different names. The search tools can also be used to find different image versions that are visually identical.

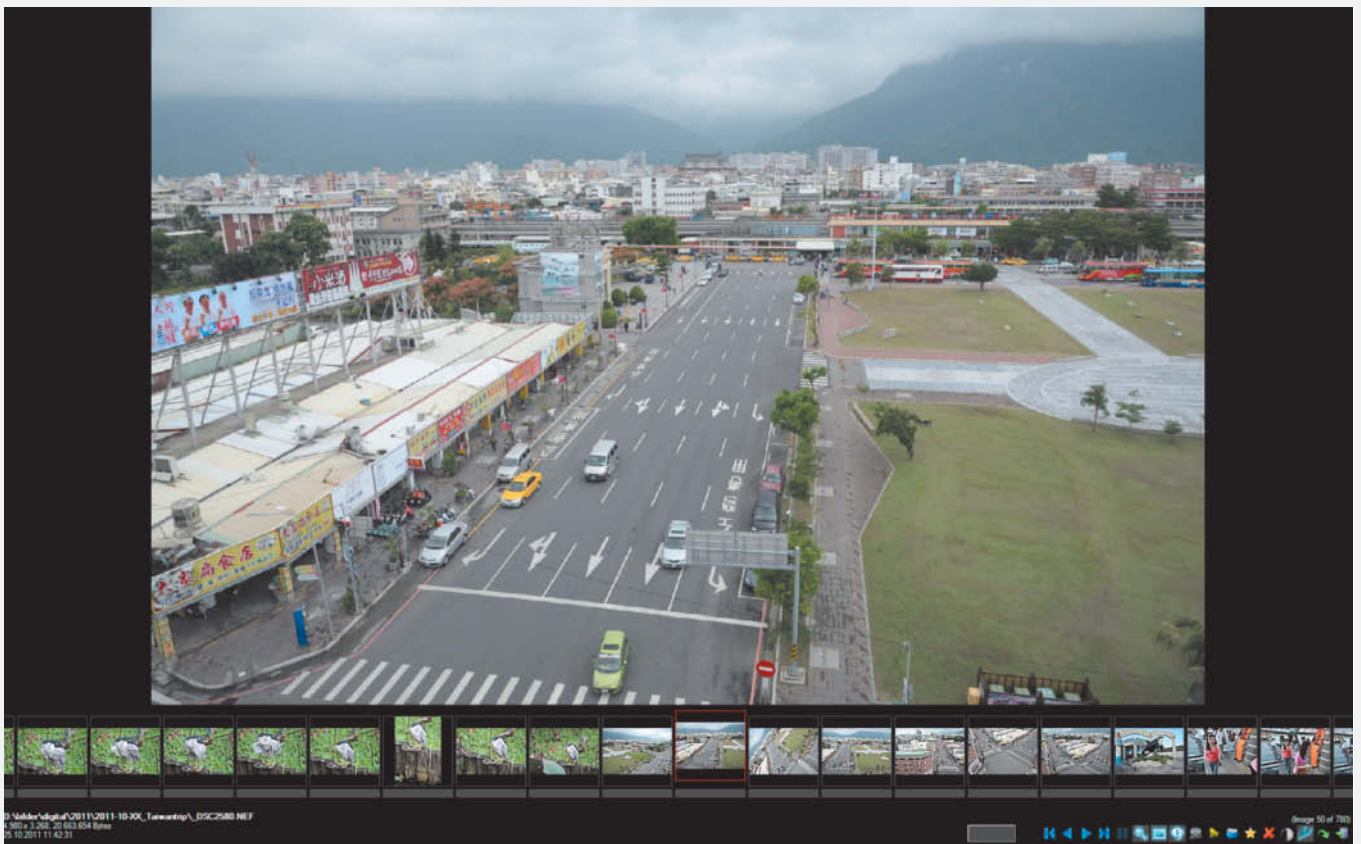
All in all, *iMatch* has better search functionality than *Lightroom*, offering searches that cover predefined periods of time (from ... to) or places that are a certain distance from a named location. Users who are familiar with the way databases work can also define their own comprehensive search criteria.

Keywording is also one of the program's strengths, and you can adapt the system to your own requirements using a range of thesauri. However, *Lightroom*, with its versatile view and sorting options, is better at finding images within collections that haven't been effectively keyworded.

GPS support is rudimentary, with neither built-in maps nor a proper interface to an external service. There is no face recognition functionality.

iMatch is only available as a 32-bit application, but worked very smoothly during most of our test, producing fast full-screen previews. It only slowed down when importing our test folder of exotic file formats. Like *Lightroom*, *iMatch* doesn't automatically write changes to XMP metadata straight to the image file, and saves them initially to the database only. You have to make sure that any changes have been replicated to your image or sidecar files, especially if you access your images using other applications too.

iMatch is a useful asset management tool, but its relatively poor user interface and missing getoagging and cloud interface make it less interesting than some of its contemporaries. The manufacturer is currently working on a non-public beta version 5 to replace the current 3.6 version, and the fact that it there will be no version 4 leads us to think that the new release will contain a lot of improvements.



The *iMatch* viewer functionality is better than that offered by many of its rivals, making the program a great choice for creating image presentations

Adobe Photoshop Lightroom 4

Photoshop Lightroom is Adobe's all-in-one solution that offers non-destructive JPEG and RAW image processing and an effective SQLite database in the background.

Adobe gives its users the choice of using conventional static folder views or its own more flexible logical views. After import, *Lightroom* only displays (and issues error warnings) for files that it recognizes as images. During our test, it failed to recognize BMP, GIF and PNG files.

RAW support is generally very good, but still doesn't cover legacy formats such as Kodak DC120 from 1997. *Lightroom* effectively manages physical folders as well as its own virtual collections, which don't alter the underlying folder structure. Like other image database applications, *Lightroom* does its best to avoid data redundancy, and only allows you to create virtual image copies.

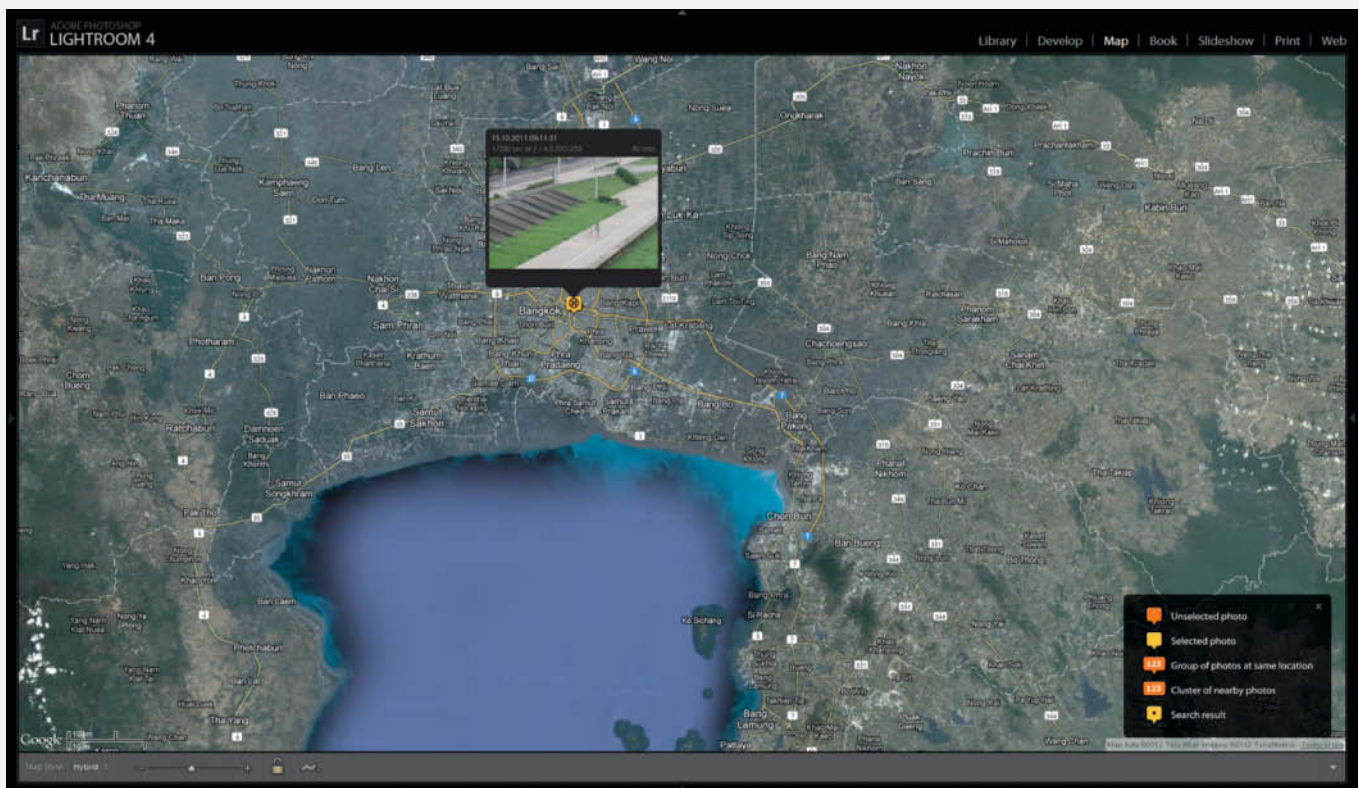
The program is extremely agile and stays up to speed by writing adjustments to the catalog instead of embedding them in the image file. This default behavior reduces the number of write cycles, but necessitates regular catalog backups. You can use the Ctrl+S keyboard shortcut or the Save Metadata to File command (in the context menu) to write metadata to selected image or sidebar files. Instead of a conventional search mask, the program offers a powerful, intuitive Library Search feature, that helps even beginners to navigate quickly and easily through large collections of images.

The program includes support for IPTC Core and Extension metadata and you can use metadata presets to simplify batch keywording processes. You can also set up your own hierarchical thesaurus. We were slightly surprised to find that the latest

Lightroom release still doesn't include face recognition functionality – a feature that is obviously still reserved for *Photoshop Elements*.

However, version 4 scores highly with its new, improved geotagging tools. Whereas version 3 could only display geotags as text, version 4 has built-in Google Maps functionality and a broad range of geotagging features and options. Better late than never!

Comprehensive search functionality, a smooth, integrated workflow, simple handling and a balanced feature set make *Lightroom* perfect for single-user home installation. Multiple users are not supported in any form. *Lightroom 4* is more powerful and cheaper than its predecessor, tipping the scales at a highly reasonable price of US\$149.



Lightroom 4 introduces comprehensive geotagging functionality, but still doesn't include face recognition – a feature that has been included in *Photoshop Elements* for some time

Phase One Media Pro

Media Pro has a checkered history. Microsoft acquired the original *iView Media Pro* in 2006 and marketed it under the *Expression Media* brand before selling it on to Phase One in 2010. The new owner has integrated the *Capture One* RAW engine into *Media Pro*, but not its editing functionality. *Media Pro* is capable of working in tandem with *Capture One* or other external image editors, but is not a genuine all-in-one solution.

Media Pro imports images by creating links to the original file locations. The process is fast and recognizes a good range of standard image format, but produced poor RAW recognition results. This is because its default settings rely on the RAW converter built into the operating system. Things look better if

you use Phase One's own Decoder, but even this is not up to the standards offered by *Lightroom*, *Picasa* and *digiKam*.

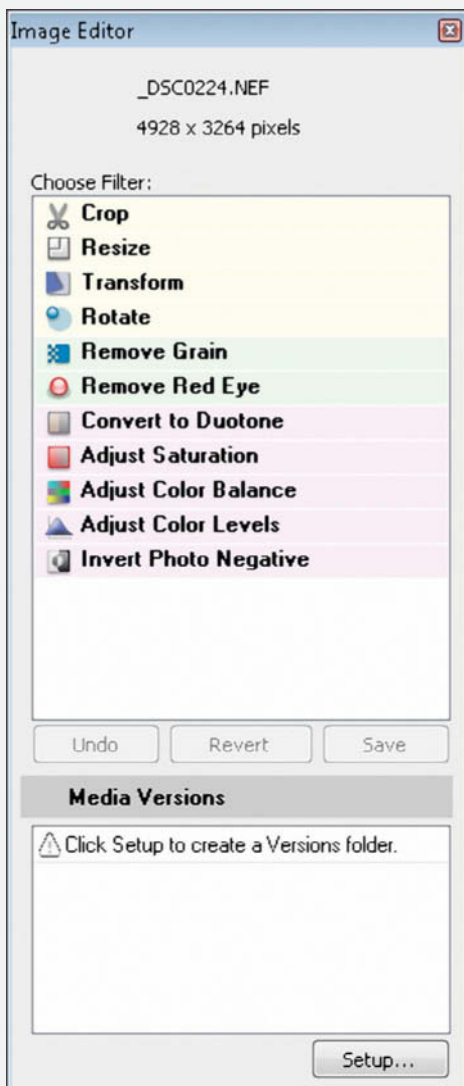
File management has some issues. For example, if you create a new folder in the catalog, it will be created in the physical file system too. However, deleting a folder only deletes the catalog entry and the folder itself remains intact within the computer's file system.

On a logical level, you can organize your images according to keywords and catalogs. Keywords can be organized hierarchically in custom thesauri and catalogs can contain any number of virtual folders.

Phase One's geotagging functionality is disappointing. The old Microsoft version of

the program had a direct interface with Virtual Earth, but this has now been replaced by a simple text display of GPS coordinates that can't even be edited if they come from an XMP sidecar file. There is no face recognition, but *Media Pro* supports the IPTC Core and Extension metadata sets. There is no interface for image export to the cloud and the static HTML pages on offer are old hat.

US\$169.99 for an image database application with no added editing functionality is simply too expensive, especially in view of the *Media Pro*'s limited feature set and clunky handling. For the same money, *Lightroom* gives you a well-developed all-in-one workflow tool with a full-fledged database and a built-in RAW editor.



***Media Pro* is not an integrated workflow solution and uses the *Capture One* RAW editor as an external tool**



Google Picasa 3

Picasa 3 – not to be confused with the Picasa Web Albums service – is available for Windows and Mac. The Linux version is no longer being developed. Right from the start, Google remains true to its reputation as data collector extraordinaire, and the default import settings index all your personal folders and sometimes even your entire hard disk! However, once the program is running, you can use the folder manager to decide which data you want to have scanned. The program itself determines the time interval between scans, so you may have to be patient if you have made significant changes to your photo collection since the last scan. The program uses the local file system and provides only rudimentary asset management functionality, making it necessary to use the operating system to perform many routine file management tasks.

Right from the start, *Picasa* recognized and supported 122 of our 129 sample RAW

formats. The only files that caused problems were NEF and older Canon TIF-RAW files. Files and folders of files that it doesn't recognize are simply not displayed. Albums work like virtual collections and, thanks to full integration with Google+ and Picasa Web Albums, uploading your images to the cloud is a snap.

Picasa provides only titles and tags for the user to apply. Its lack of support for complete IPTC metadata field sets means that its search functionality is meager, although it does allow you to search using name tags and folder names.

On the plus side, the display and application of geodata tags is very well implemented, but you have to take care when geotagging RAW files, as the metadata this creates is stored in Google's proprietary *picasa.ini* file instead of in a standardized XMP sidecar. We also found that the program was unable to interpret *GeoSetter* tags that we added to sample NEF files.

Face recognition is one of *Picasa's* real strengths, and it searches large numbers of images quickly and accurately. Hit rates are high and increase with added user input.

Name tags function just like geotags and are only saved directly to an XMP sidecar (for JPEG images) if you adjust the program's preferences accordingly. Name tags for RAW images are saved to the *picasa.ini* file. These limitations make *Picasa* less than perfect for sharing data between applications. Even within the Google ecosystem, the use of name tags is subject to various legal restrictions. Currently, you can only export tagged images to Google+, and then only if the person portrayed gives their explicit permission. Name tags are not supported in Picasa Web Albums.

All in all, *Picasa 3* is easy and fun to use, its face recognition features are by far the best in our test and it integrates well into the Google cloud. However, its meager metadata functionality lets it down and ensures that it remains an isolated single-user solution.



Picasa uses simple mouseover techniques to check if it recognizes the faces in a photo

Conclusions

Although our test candidates represent a wide range of different applications – from single-user to multi-user, server-based solutions – there are certain recognizable trends throughout the entire spectrum. The products with built-in RAW converters offered the best overall performance and ease of use, and are hard to beat when it comes to setting up an end-to-end digital photo workflow. Of these, the fully integrated products – i.e., *Aperture* and *Lightroom* – are a better option than *Media Pro* and *digikam*, which still have a way to go before they can be classed as true all-in-one tools.

The downside of this type of application is the lack of any networking functionality or the ability to give multiple users access to the assets managed by the database. However, it is often possible to give remote users read-only access using administrator permissions. Some software manufacturers don't offer much information on how to do this, but many useful tutorials can be found on the Web.

Single-user image database solutions (like *iMatch*) that have no built-in editing features are of little use to today's photographers. Using an external image editor often hampers the overall workflow,

and the search functionality built into the likes of *Lightroom* is more than sufficient for most users' daily needs. The days of single-user, pure database products appear to be well and truly numbered.

Teamwork is key in commercial environments, and multi-user functionality often entails a reduction in user-friendliness. Sorting and processing a few gigabytes of material can be trickier within this kind of setup, whereas these types of applications come into their own when managing and distributing marketable material. If you have the financial resources, embedding open database architecture in company workflows is a relatively simple matter, although if you need to combine multiple users with your own fully functional Web interface, you will need to acquire a dedicated server and an appropriately sized license pack. If such startup investments are prohibitive, it is definitely worth taking a look at cloud-based solutions like *eyebase mediasuite*. Performance is generally a little slower than conventional server-based solutions, but if your users are accessing your assets via the Internet anyway, the difference will be negligible.



For small to medium-sized enterprises, we recommend a two-pronged approach, using a local solution such as *Lightroom* to prepare and process your material and a multi-user, network-enabled system like *Cumulus* or *mediasuite* for marketing and distribution purposes. This might appear complicated at first, but the costs and effort involved will quickly pay off in a professional, multi-user environment.

Conversely, using a pro-grade database application in a single-user environment is like going to the corner store in a Porsche. (jr)

What Our Tests Involved

RAW format compatibility

Importing 128 different RAW formats (1.66 GB). The database should be able to display correctly rendered thumbnails and full-screen previews. Simply displaying thumbnails embedded in the image metadata is not sufficient.

Photo format compatibility

Importing 28 files with various formats created using *Photoshop* (1.17 GB, included on this issue's free DVD). Most of these are standard photo formats that can be processed by a range of applications. We expect the test software to be capable of displaying correctly rendered thumbnails and full-screen previews.

File import (copy)

Copying the imported files to a folder managed by the database. Usually performed via virtual links – embedding via BLOB or similar procedures not expected.

File import (linked)

Generating links to the existing files without copying them to a new location.

Cloud export

Exporting database assets via a built-in interface to a cloud-based Web album service (Picasa, Flickr etc.).

Geotags

Display and editing of geotags using a built-in or associated map service. Display of numerical GPS coordinates alone is not sufficient.

Face recognition

Automatic tagging via face recognition.

LAN server

Database can be used in full server mode (i.e., full read/write access for all users) on a LAN. Client access essential, browser access not sufficient.

WAN server

Database can be set up as a server by the main user. Subsidiary users can access assets via client application or browser.

Cloud server

Manufacturer hosts WAN server for the customer, who doesn't have to provide own infrastructure as a result. Simple export to cloud-based albums is not sufficient – full access for admin, users and customers (if required) should be possible.

IMAGE DATABASE SOFTWARE TEST RESULTS								
Program	Aperture 3.2.3	Cumulus 8.5.2 (Single User)	digiKam 2.5.0	mediasuite 4.1	iMatch 3.6	Photoshop Lightroom 4.0	Media Pro 1.2	Picasa 3.9
Manufacturer	Apple	Canto	Open Source	Eyebase	Photoools	Adobe	Phase One	Google
URL	www.apple.com	www.canto.com	www.digikam.org	www.eyebase.com	www.photoools.com	www.adobe.com	www.phaseone.com	picasa.google.com
Operating System	Mac OS	Windows, Mac OS	Windows, Mac OS, Linux	Browser-based	Windows	Windows, Mac OS	Windows, Mac OS	Windows, Mac OS
Format Compatibility								
Raw Formats	67.9 %	52.3 %	90.6 %	not applicable	67.9 %	91.4 %	62.5 %	95.3 %
Foto Formats	64.2 %	75.0 %	39.3 %	64.3 %	71.4 %	32.1 %	31.1 %	42.8 %
XMP Sidecar Options								
Read	yes	yes	yes	yes	yes	yes	yes	no
Write	yes	no	yes	yes	yes	yes	yes	no
File Import								
Copy	yes	yes	yes	yes	no	no	no	no
Link	yes	yes	yes	no	yes	yes	yes	yes
Other								
Cloud Export	yes	no	yes	yes	no	yes	no	yes
Geotags	yes	no	yes	no	no	no	no	yes
Face Recognition	yes	no	yes	no	no	no	no	yes
Multi-user Support								
LAN Server	no	yes	yes	no	no	no	no	no
Web Server	no	yes	no	yes	no	no	no	no
Cloud Server	no	yes	no	yes	no	no	no	no
Price (approx. US\$)	79.99	450	free	1,000 (setup fee), 140 (monthly fee)	65	149	169.99	free

c't





Sascha Steinhoff

Scanography

How to Create Macro Images
Without Using a Camera

Scanography is the art of creating macro images using a standard desktop scanner instead of a camera. The resulting 'scanographs' not only have a special aesthetic quality all of their own, but are also extremely large, and can be as much as several hundred megapixels in size.

Scanners make great macro imaging tools. They are easy to use and comparatively inexpensive, and the images they create have extremely high resolution. Placing a flower in a flatbed scanner is a lot simpler than setting up and adjusting a macro-capable camera to capture an image. Not only that, but sharpness and resolution don't fall off toward the edges of the frame the way they usually do when using a lens to capture a subject.

A simple US\$300 scanner is perfectly adequate for making your first 'shots', but don't go too cheap. It is worth acquiring a scanner with the greatest possible resolution for your money when you are setting out in scanography. There are three major factors to consider when choosing a scanner:

The resolution figures quoted by manufacturers are seldom realistic and the true effective resolution is much lower than the technical specifications would lead you to believe. Even the highest-quality flatbed scanners only achieve a fraction of the claimed resolution, and anything above 2000 spi (samples per inch) is rare.

A scanner delivers its best resolution in transmitted-light (i.e., film) mode. Reflected-light mode (the mode most commonly used for scanography purposes) generally produces images with lower resolution. For example, Canon quotes maximum film scan resolution of 9600 spi for its CanoScan 9000F model, but just 4800 spi for reflective document scans.

Finally, the supplied software has to support maximum resolution in reflective scan



Image: Werner Abel

This tiny flower, just 4mm in diameter, is transformed into a screen-filling masterpiece when captured by a scanner

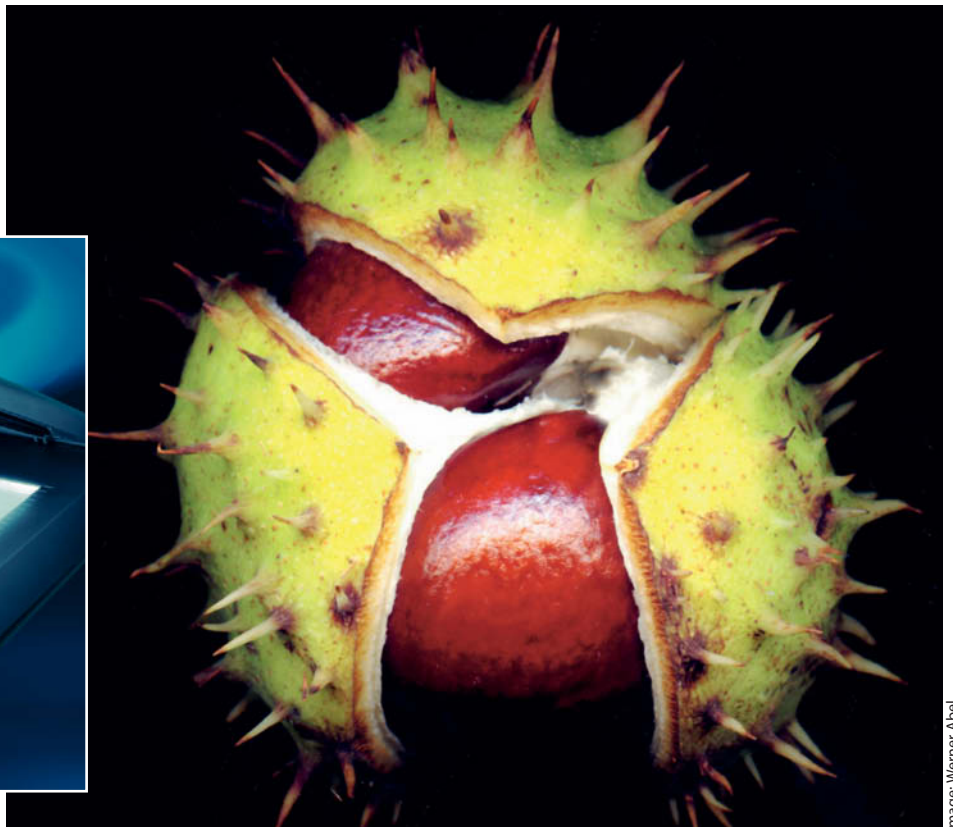


Image: Werner Abel

A flatbed scanner is a great tool for making high-resolution images of non-moving subjects



mode. If this is not the case for your particular model (and it usually isn't), you can use commercial third-party scan software such as *VueScan* or *SilverFast*, both of which support high-resolution scanning for a wide range of scanner models.

Massive Resolution

An issue that can become a problem is the large size of the image files that using this technique creates, making it less tempting to use maximum resolution every time. For example, an A4-sized image scanned at 4800spi and saved as a 16-bit TIFF produces a 12.5-gigabyte file! Such dimensions can cause hardware problems, and regularly crashed Canon's own software while making test scans at 1200spi on our 64-bit Windows 7 system with its 16GB of memory. We used a CanoScan 8800F, which is officially designed to scan reflective documents at 1200, 2400 or 4800spi.

VueScan didn't crash while performing the same test, but saved 1200-spi files for all three nominal resolutions. The program's

developers later told us that this is because the program automatically reduces file size to a maximum of two gigabytes to conform to the maximum allowed by the TIFF specification. *SilverFast* effectively captured 1200-spi and 2400-spi scans, but also crashed when we attempted to scan at 4800spi.

Once you have found a combination of hard- and software that works for you, the rewards of all your efforts will be enormous image files that beat anything that you can capture in a single image using a conventional digital camera. Our 2400spi file captured using *SilverFast* was 3.2 gigabytes and 556 megapixels in size, providing extremely high resolution and very good image quality. We were able to process the image without restrictions using 64-bit *Photoshop*.

Working with Scanners

Scanographs don't use the scanner's lid in the normal way. This is because many subjects are simply too thick to fit under the lid, and also because the deep black backgrounds that make scanographs so effective can only be

produced if the light from the scan unit 'disappears' into the distance. You will have to work in a darkened room to achieve this effect, although complete darkness is not a prerequisite. Simply make sure that no direct light or reflections reach the scanner's platen during the scan.

It would help scanographers a great deal with their compositions if scanners were to include focusing functionality to pick out specific subject details. However, most flatbed scanners function on a fixed-focus basis and only very expensive models, such as the Epson Expression 10000XL have built-in autofocus functionality.

Scanographic Art

The unique look and feel of these images has already gained a firm following, and websites such as www.scannography.org go a long way toward showing what is possible using easily available scanning gear and healthy creative instincts. Scanography is already an established alternative image creation method on the international art scene. (jr/keh)



Image: Werner Abel

The depth of field produced by most scanners is surprisingly large for devices that are primarily designed to capture two-dimensional documents and images captured on film. This image of a dog rose shows very fine detail and well saturated colors.



Image: Werner Abel

The green gladioli give this image an almost mystical feel. The high image quality is due mainly to the low overall subject contrast. All types of sensors – whether in scanners or digital cameras – quickly reach the limits of their image capture powers when confronted with excessive contrast.

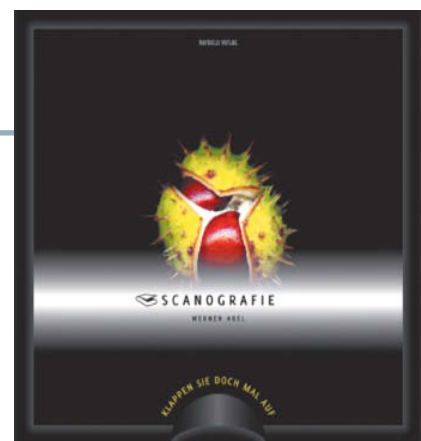
Recommended Reading

Author Werner Abel used a scanner to get right up close to his natural subjects in this extraordinary book. His scanographs display a depth of detail and richness of color that often go unnoticed in small subjects. As a gesture of respect to his tool of choice, the author designed the book's cover to open upward like the lid of a scanner. The images reproduced in this article

all come from the book, which is only available in German, but which communicates its subject using very few words and spectacular visuals.

Scanografie

By Werner Abel, published by nardelli.
208 pages, €49.90. ISBN: 978-3-9814616-0-2



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Coming up in Issue 10

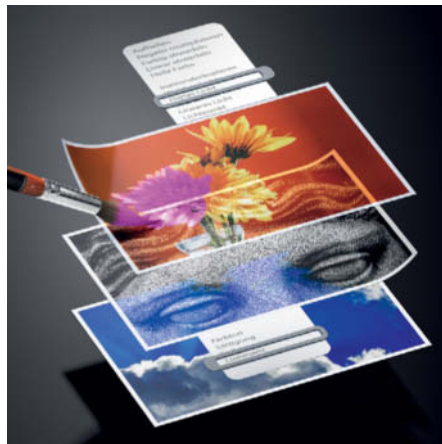


Shake-free Photos

■ Even if you don't have a tripod to hand, with a little practice you can still shoot shake-free photos in low light. This expert tutorial shows you how to use your body and advanced breathing techniques to keep your camera perfectly still, whether you are standing or sitting. We also take a look at commercial and home-made stabilizing systems.

Sophisticated Image Processing Using Layers

■ Blending modes and layer techniques are relatively simple to apply and provide a wealth of additional options for high-end image processing, making your photo processing workflow simultaneously more powerful and more creative. This comprehensive workshop starts with simple techniques for beginners and works all the way up to advanced methods for experienced users.



The End of Medium Format?

■ The Nikon D800E represents a true revolution in high-end full-frame camera construction. We ask if the camera's new 36-megapixel sensor can compete with medium-format giants like the significantly more expensive Hasselblad H4D-40. Using a variety of lighting situations and lab tests, we compare the strengths and weaknesses of the two systems, and we can tell you this much already – the Nikon cuts a very good figure.

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