

**Free DVD
inside**

Experimental Photography • Lens Tests • GPS Tools

ct *Digital Photography*

The in-depth quarterly for the photo enthusiast

Ralph Clevenger Workshop

Paths to Creativity

New Inspiration for Your Images

Similarity Search Low-light Shooting

Gear Tests
Olympus OM-D E-M1
High-end Micro 4/3 Lenses
Canon EOS 70D vs. Nikon D7100

Experimental Photography

Getting it Right by Doing it Wrong



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Spring Issue

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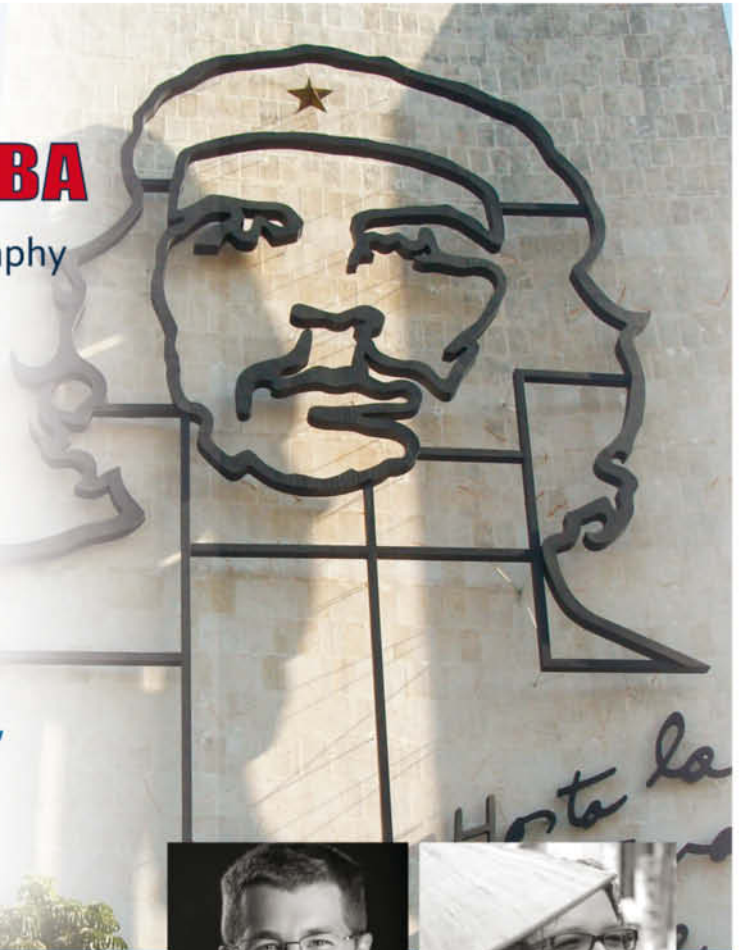
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Mike Hagen



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Starting on page 20, our article *Getting it Right by Doing it Wrong* aims to get your creative juices flowing by ignoring convention and deliberately 'shooting wrong'. Admittedly, it is not a good idea to completely ignore important factors like focus, correct exposure or noise control but, if you learn to consciously bend the rules, you can give your creative repertoire a real boost. Our workshop explains how to use camera movements and multiple exposures to give your images a new slant, and also details some of the limitless possibilities of playing with exposure shifts, perspective and motion blur.

The results are anything but random, and each broken rule produces a planned effect, so solid technical skills and a good photographic eye are essential if you want to retain control while you push the envelope. Our author, Cyrill Harnischmacher, is convinced that the techniques he introduces will help you take a step closer to developing your own unique photographic style.

An equally fascinating but completely different approach to developing your skills is provided by nature photographer Ralph Clevenger in his article *Paths to Creativity* (page 120). National Geographic photographer Jim Richardson once remarked, "If you want to be a better photographer, stand in front of more interesting stuff", and Ralph Clevenger takes this advice to heart, using his own top-notch images to explain how he finds and captures his subjects. His work is based on the unshakable precept: "Everything can be more interesting if you learn to shed your preconceptions and see things in more interesting ways."

Have fun experimenting and see you next time ...

Juergen Rink

Juergen Rink



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Portfolio

Juergen Scriba is a physicist who uses his own special take on the world to produce surprising and thought-provoking images.

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Experimental Photography

Breaking the rules is often the best way to create new and exciting images. Designer Cyrill Harnischmacher introduces some of his favorite ways to 'shoot wrong'.

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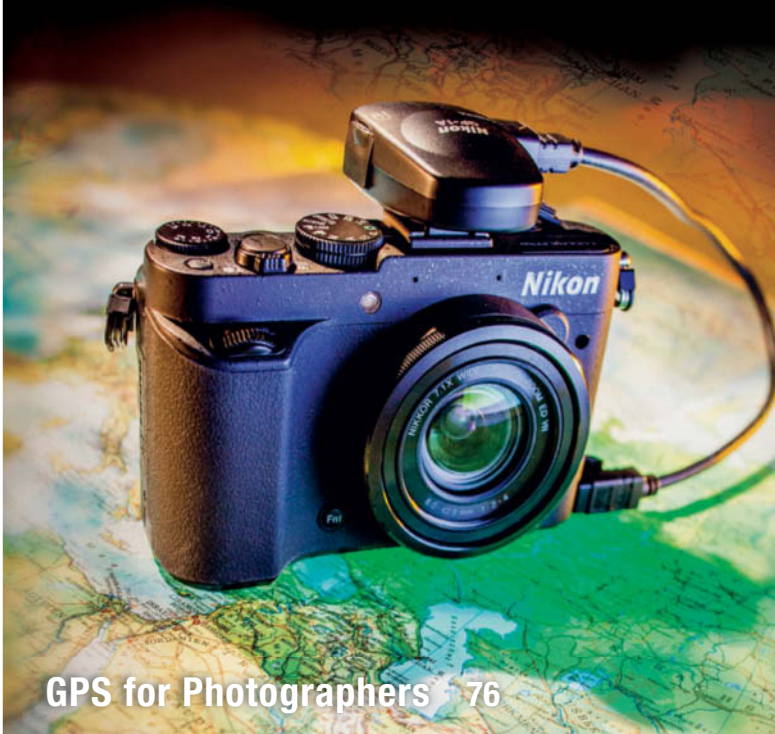
Many cameras have built-in GPS and Wi-Fi functionality, making them perfect for recording geodata that you can then use to document your trips via online map services.

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Desert Beauty Shoot

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Low-light Photography

The twilight hours and the dark of the night are perfect times to shoot astounding photos. Our workshop guides you through the techniques you need to make the most of low-light situations.

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Paths to Creativity

Renowned photographer Ralph Clevenger uses nature photography as the basis for an in-depth look at how to expand your creative horizons and take your photography to the next level.

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DVD Download

If your copy of the magazine contains no DVD, navigate to www.ct-digiphoto.com/dvd152014 to download the DVD content for free.

Free DVD

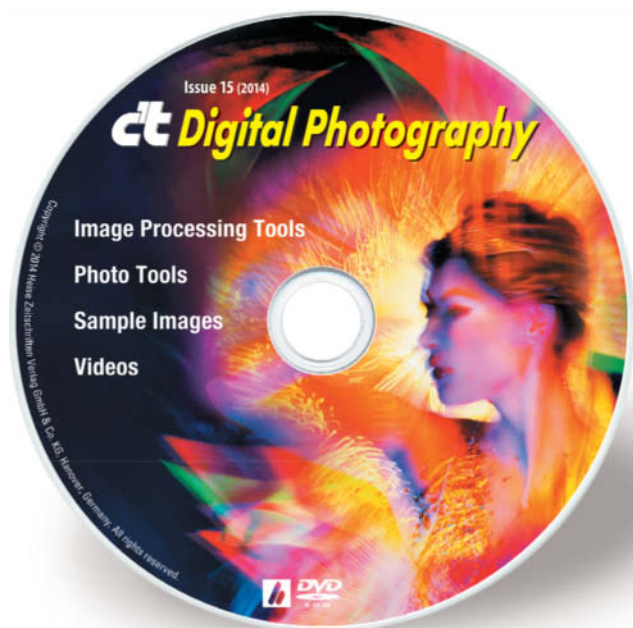
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Special version software: Studio Line Photo Classic

An exclusive **ct** version of a great all-in-one asset management and editing suite.

Videos

- Digital Night Photography
- Steve Sasson: The Inventor of the Digital Camera
- Animal Photography with Ruth Marcus
- Sandro Santioli: Colors of the World



Reader Forum



Oil-painting Wizard

The water-soluble oil is done. Of course, the model is far more beautiful than I can do justice to, but here it is, with a tonne of artistic license (clearly). The colors are a radical departure, due to my obsession with orange, blue, and gold. As it turns out, I had a heck of a time photographing the oil painting due to spectral highlighting. I had to get assistance from someone more handy with cameras to get this far! In fact, modern cameras actually seem to make these sorts of photos more challenging for me. It's really very hard to find the proper settings among the many, many menus. While working the knobs and dials, part of my brain is generally going "This camera would be handy if it came with an oil-painting wizard". A professional photographer would have done much better than I can! All told, though, thank you for the inspiration, and to Thomas Saur and the model for the idea and execution! Thank you! I continue to check your magazine for photo-refs!

Tracy Paddock

Clever Downsizing

Thanks for an interesting magazine. Whilst I was waiting for treatment for my right shoulder I revisited the article titled *Something for Everyone* in the Fall 2013 Issue. I found it very useful in the pressing context because my shoulder means I need lighter gear than my usual Nikon D700, 28-300 lens, other lenses and associated equipment. I was turning to the Micro 4/3 system when I read an article in the RPS Journal. I also noticed that the Leica V-Lux 4 appeared to replicate the features of the Panasonic Lumix FZ200. One of the features of the Lumix that appeals to me for bird photography is the ability to increase the optical zoom digitally to approximately 1000mm. Can this be done with the Leica? In looking at what is available I am concerned that the lens magnification factor (vis-a-vis 35mm full-frame) does not parallel the magnification factor. For instance, the lens factor for an APS-C sensor is 1.5 (1.6 for Canon) but the magnification factor is of the order of



2.2. It is of course greater for Micro 4/3 and more so for Lumix and the Leica. The sensor size for both is 1/2.3". Can you please tell me what this is in millimeters?

Stanley Robinson

Leica's V-Lux 4 is based on the Panasonic Lumix FZ200 but costs more than twice as much, although the Leica does include a free copy of Lightroom. A 1/2.3" sensor measures 6mm x 4.5mm and has a crop factor of about 5.6. Its total surface area is about 28mm².



Photoshop Alternatives

I have spent tens if not hundreds of hours studying alternatives to Bridge and Photoshop and they all have one or more issues that preclude them from being real contenders. While GIMP is a great program it lacks a proper thumbnail browser (an easy implementation) and an integrated RAW Converter. As far as I can tell, UFRW will not work in Windows. In any event, it's really a standalone program. While not free, *Zoner Photo Studio Pro* is a serious contender for Windows users.

Ronald Hobbs

Composing with Color

Thank you for the excellent article, *Composing with Color*, in *c't Digital Photography 14*, p. 116. I hope to see more composition articles in the future. Perhaps an article on photography composition books? I went to amazon.com and searched for "photo composition books" and received pages of results. Which ones would you recommend?

Richard

Thanks for your positive feedback! Our sister publisher Rocky Nook offers a great book on photo composition: "Learning to Photograph, Volume 2: Visual Concepts and Composition" by Cora and Georg Banek.



Tell us what you think:

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

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DVD Highlights & Contents

This issue's free DVD provides a rich selection of image editing tools, including an exclusive special version of the StudioLine Photo Classic image management and editing application. Free HDR creation, RAW conversion and image viewing tools round out the package.



Digital Night Photography

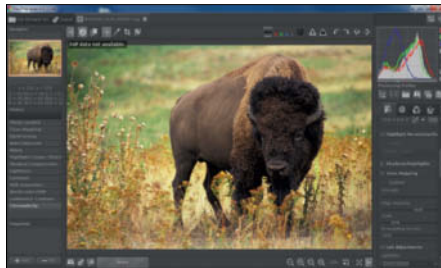
Video tutorial: Photography is all about light, but at night there is virtually no light to capture. This video provides some solutions.

Night photography plays an important role in Leo Seidel's portfolio, although the night itself is not his favorite time to shoot. Even low-light photographers require some incident light to create images, and Seidel most likes to shoot during the twilight hours.

The time between sunset and complete darkness provides a rich variety of fading shades that can be turned into great night shots if you know how to go about capturing them. At this time of the day, the contrast between light and shade is subtle and perfectly suits the recording capabilities of digital camera sensors. Seidel's advice is not to trust the camera's automatic ISO and exposure settings but instead to go against the grain and use low ISO settings in low-light situations.

This video provides a brief explanation of the basic techniques Seidel used to shoot some of his best night shots and documents a nighttime visit to the Tegel airport in Berlin. Even though this location provides virtually no visible light, the camera sensor still managed to capture some fine images of the vintage aircraft on show. To pep up his images, Seidel uses a handheld spotlight to add subtle accents that enhance the unique atmosphere of his photos.

The result of using modified camera settings together with light painting techniques results in outstanding nighttime photographs. (sts)



Raw Conversion with RawTherapee

Free software: Database-based RAW editors are not everyone's cup of tea, and *RawTherapee* offers a pure file-based alternative.

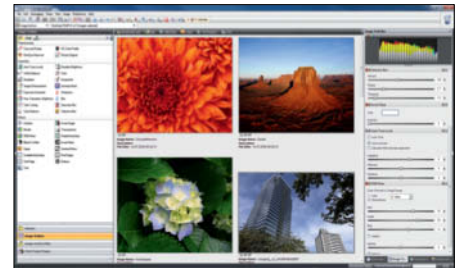
RawTherapee is a fully-featured but lightweight RAW editor without any built-in database functionality of its own.

Compared with heavyweight programs like the commercial *Lightroom* or the open-source *digiKam* packages, it inevitably lacks some asset management features. However, this can be an overhead, as less features mean less administration, and switching between editing applications is certainly easier if you don't have to synchronize databases.

RawTherapee is a great choice for photographers who prefer the lightweight approach to using bloated all-in-one applications. The program supports all major desktop operating systems and always offers recent builds that mirror OS updates.

Like most RAW developers, *RawTherapee* offers non-destructive image editing and uses the open-source *DCRaw* tool for image encoding but uses proprietary algorithms to perform all image development steps. For experienced users, the program offers a wide range of options for tweaking the RAW development process, including the unique ability to set black and white points on a RAW level.

The package is a popular addition to many advanced users' RAW processing toolset but still provides a streamlined interface that is simple for beginners to master. (sts)



StudioLine Photo Classic 3 SE

Special version software: Our exclusive version of *StudioLine Photo Classic SE* gives you Image editing, archiving and geotagging functionality for free.

If you like to use a single tool for your entire photo workflow, *StudioLine Photo Classic* is definitely worth a look.

The program has an integrated database that makes managing and searching your images quick and easy, and offers a range of filters and image editing tools for fine-tuning your photos. The program's main workspace is based on a thumbnail view and there is a separate viewer utility for zooming and comparing 'before' and 'after' views, making it perfect for use in dual-monitor environments. On the output side, *StudioLine* offers various printing options.

To use our exclusive *c't* version of the software, you have to register your copy online to receive your personal activation code. The *c't* edition includes many of the features found in the commercial version, including backup to external media, various filtering options and geotagging.

c't Digital Photography readers who wish to unlock the program's full potential can upgrade to *StudioLine Photo Classic 3 Plus* for the special price of just US\$19. The regular online price is US\$59. In addition to the features mentioned above, the full version also offers web galleries, timeline functionality, and custom printing and layout options. The *c't* activation key and upgrade discount option are available until August 15, 2014. (sts)

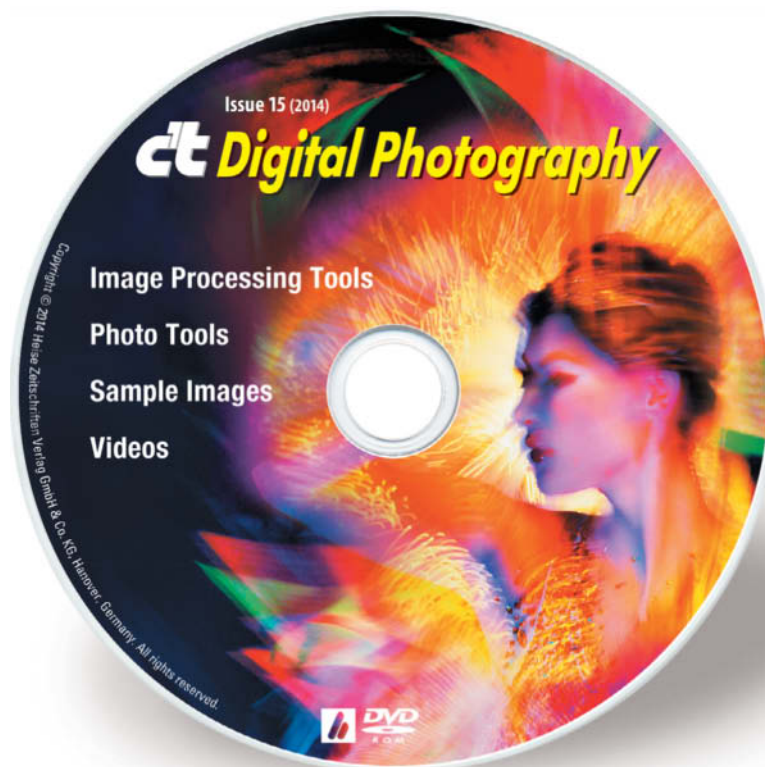


Image Processing Tools

Windows

Fotomatic 1.4
 GIMP 2.8.10
 GIMP Portable 2.8.10
 GREYCs Magic Image Converter (GMIC) 1.5.8.2
 Image Analyzer 1.36.1
 Inkscape 0.48.4
 Inkscape Portable 0.48.4
 Luminance HDR 2.4.0
 Photivo 2013-12-09
 PhotoFiltre 6.5.3
 PhotoFiltre Portable 6.5.3
 PSPI 1.0.7
 RawTherapee 3.0.1.0
 StudioLine Photo Classic SE 3.70.61.0
 (c't Edition)
 UFRaw 0.19.2
 Wavelet decompose
 Wavelet Denoise

Mac OS

GIMP 2.8.10
 GREYCs Magic Image Converter (GMIC) 1.5.8.2
 Inkscape 0.48.4
 Luminance HDR 2.4.0
 Photivo 2013-01-11
 Raw Photo Processor 4.7.2
 RawTherapee 3.0.0

Linux

GREYCs Magic Image Converter (GMIC) 1.5.8.2
 Luminance HDR 2.4.0
 PSPI 1.0.7
 RawTherapee 2.4.1

Photo Tools

Windows

Enblend/Enfuse 4.1.2
 EnfuseGUI 2.1.3
 ExifTool 9.49
 FastStone Image Viewer 4.9
 FastStone Image Viewer Portable 4.9
 GTKRawGallery 0.9.9
 GTKRawGallery Portable 0.9.9

jAlbum 11.6.4
 XnView 2.13
 XnView Portable 2.13

Mac OS

EnfuseGUI 2.1.3
 ExifTool 9.49
 jAlbum 11.6.4
 MacPorts 2.2.1

Linux

ExifTool 9.49
 jAlbum 11.6.4

Sample Images

Camera Test Sample Images
 Lens Test Sample Images

Videos

Animal Photography
 Colors of the World
 Digital Night Photography
 The Inventor of the Digital Camera

Get in the Picture



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

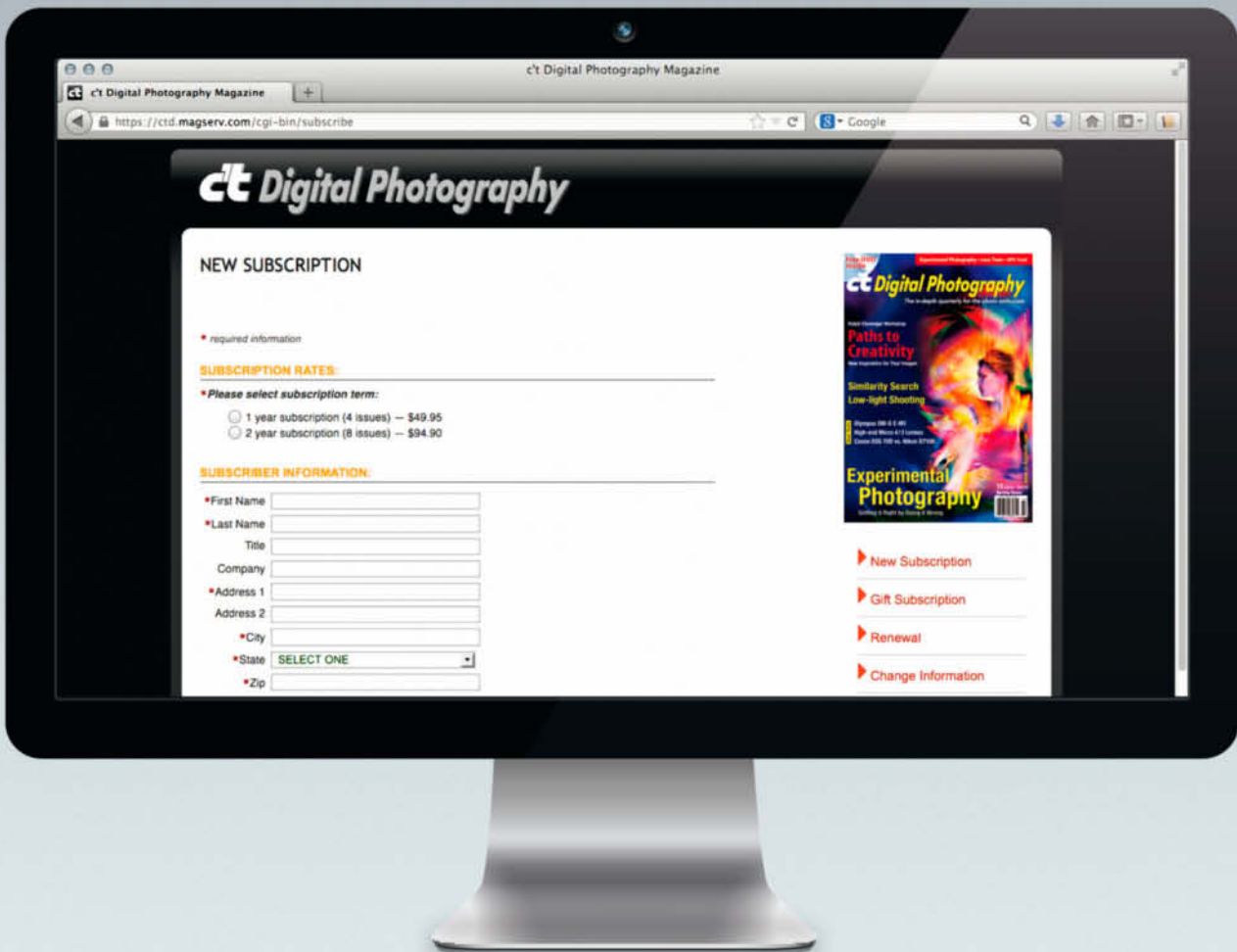
Keep on top of the latest trends and get your own regular dose of inside knowledge from our specialist authors. Every issue includes tips and tricks from experienced pro photographers as well as independent hardware and software tests.

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

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Portfolio

Juergen Scriba

With an unusual background as a physicist, journalist and artist, Juergen Scriba seemed destined to produce unusual photos. Pushing the boundaries of digital technology, he goes his own way when it comes to selling his work, too, as he is no great fan of the traditional gallery scene.

Former physicists crop up in some surprising places – Angela Merkel became the Chancellor of Germany, for instance. But there are probably very few who have dedicated themselves to photographic art. Perhaps it is not surprising to discover that Jürgen Scriba came to it via a career in journalism that included taking the readers of news magazines deeper into the subjects of science and technology. The surname Scriba is not a pseudonym and means ‘writer’ – destiny or happenstance?

Scriba has been working exclusively as an artist since 2006. He describes himself as a ‘media artist’, which describes his work better than the conventional label ‘artistic photographer’. For his *DLDscape* project, Scriba had people attending an event walk through a corridor where a three-meter-high sign saying ‘Look – You are in the Picture’ made them fully aware they were being photographed. The end product is a gigapixel image composed of 1152 individual source images that shows the myriad of different ways people reacted to the presence of the camera – from completely informal and at ease to striking a deliberate pose. *DLDscape* reveals an individual aesthetic that stretches all the way from the ‘type case’ feel of the whole image to the single images in which the subjects appear to be caught in someone’s crosshairs. Scriba’s website provides a link to the original gigapixel image that can be viewed using Zoomify (http://jscriba.com/dldscape/dld_zoom.html).

Scriba is highly dedicated to digital technology, not only in the *DLDscape* project. For him, the digital images he makes are merely the raw material he uses to create his works. *situ art* is another series that comprises images of individuals: in a paternoster elevator, strolling along an embankment, riding escalators or, seen from above,

hurrying through an airport. These digital riddles are Scriba’s way of documenting how people randomly come together in public spaces without actually communicating.

His photos do not claim to portray reality, nor even an illusion of reality. Deliberate errors of perspective make it clear that something is awry. *Airport*, for example, shows a tile pattern from above, but the people are standing at an angle. The strange perspective is even more striking in *Summer City*, in which the people and cars are photographed side on, but the ground is shown from above. That the alternating gray-green rectangles and gray asphalt create a filmstrip effect is no accident. Scriba is exploring the way time elapses and, just like in a filmstrip, some people appear several times.

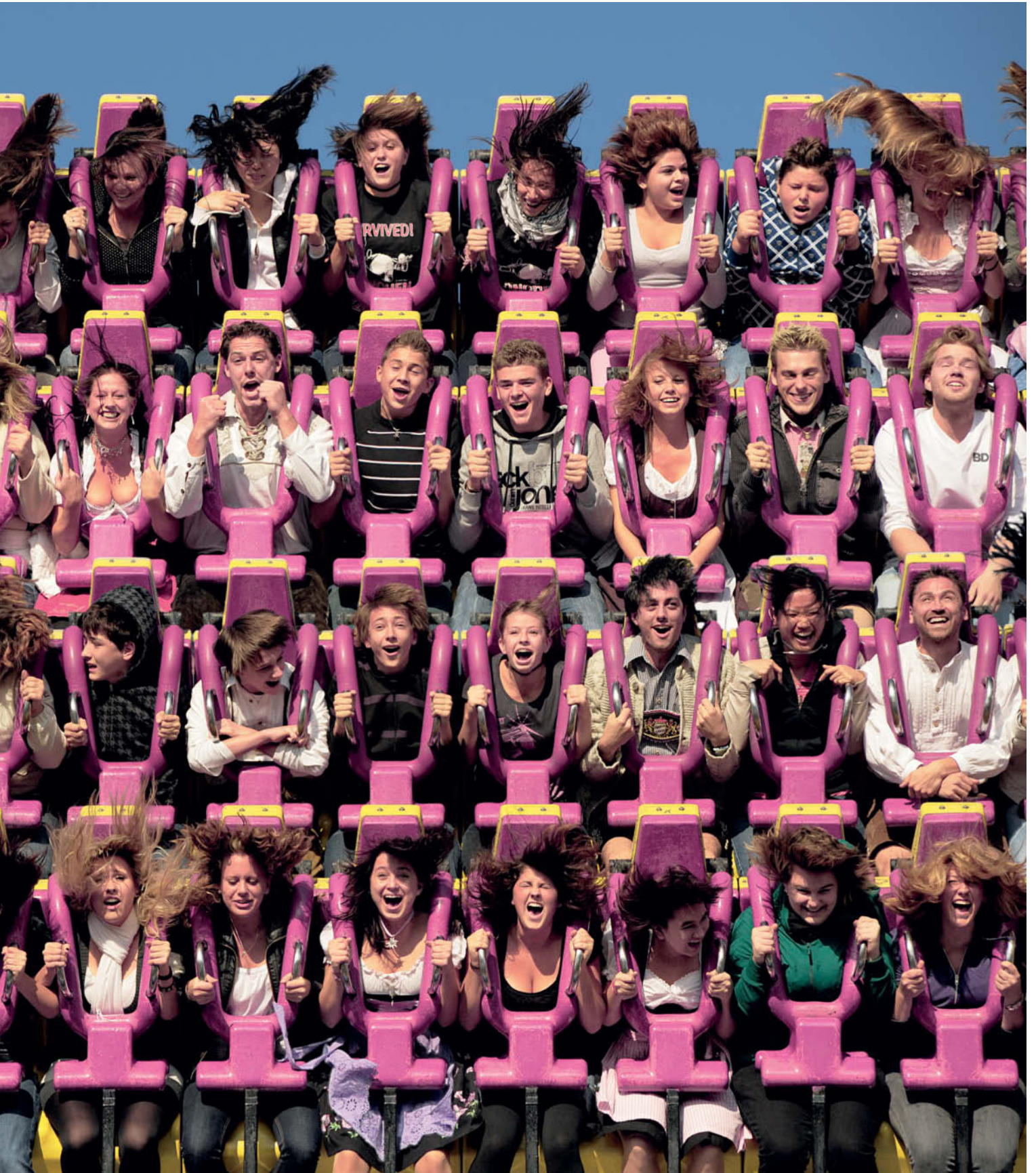
Scriba conceived his latest series, *elements*, to research the elements fire, water, air and earth through photography. It is an unusual tack for a scientist to take, but the result is most intriguing. In the ‘fire’ photos, the flames appear frozen, as if this ephemeral element has a material structure. The vibrant colors are mystifying, and we couldn’t resist asking Scriba how he produced these fantastic images. All he would tell us was that he used the assistance of a pyrotechnics expert, his own knowledge of spectral colors and some proprietary tricks with his camera settings. No chemical substances were involved in creating the colors.

Patrons of the bar at Motel One in Stuttgart can see large-format glass prints from the *elements* series on the walls. Installations of this nature are Scriba’s method of financing his work, as there is little money to be made from the art business in its analog incarnation. “The traditional business model, artificially enhancing the



Beautiful Fear

Juergen Scriba on the Oktoberfest in Munich: "We humans behave strangely at times, don't we? It seems we seek out experiences that scare us in order to have fun. Some people get a huge kick out of being whirled around in a funny-looking machine."





Paternoster

The presence of a camera in front of a paternoster elevator disturbs the routine of office life. The camera stands motionless in front of the elevator for a whole day, extracting some form of acknowledgment from every worker who passes by. Some strike a pose; others try to pretend it isn't there.

'value' of a print of a photo by deliberately limiting its availability, makes no sense in the digital world." Rather than working with galleries, he favors cooperative projects with architects and interior designers.

Still photographs account for most of Scriba's output, but the multi-talented artist does not restrict himself to a single medium. He also composes videos from the tens of thousands of photos taken for his *situ art*

piece. Called *Timescapes*, the videos were used in a stage show put together by former Kraftwerk member Karl Bartos and make arresting viewing as large-format panoramas in a hotel bar in Berlin's main railway station. With his gigapixel images, videos and installations, Juergen Scriba certainly knows how to make the most of the opportunities digital technology offers today's artists. (jr)

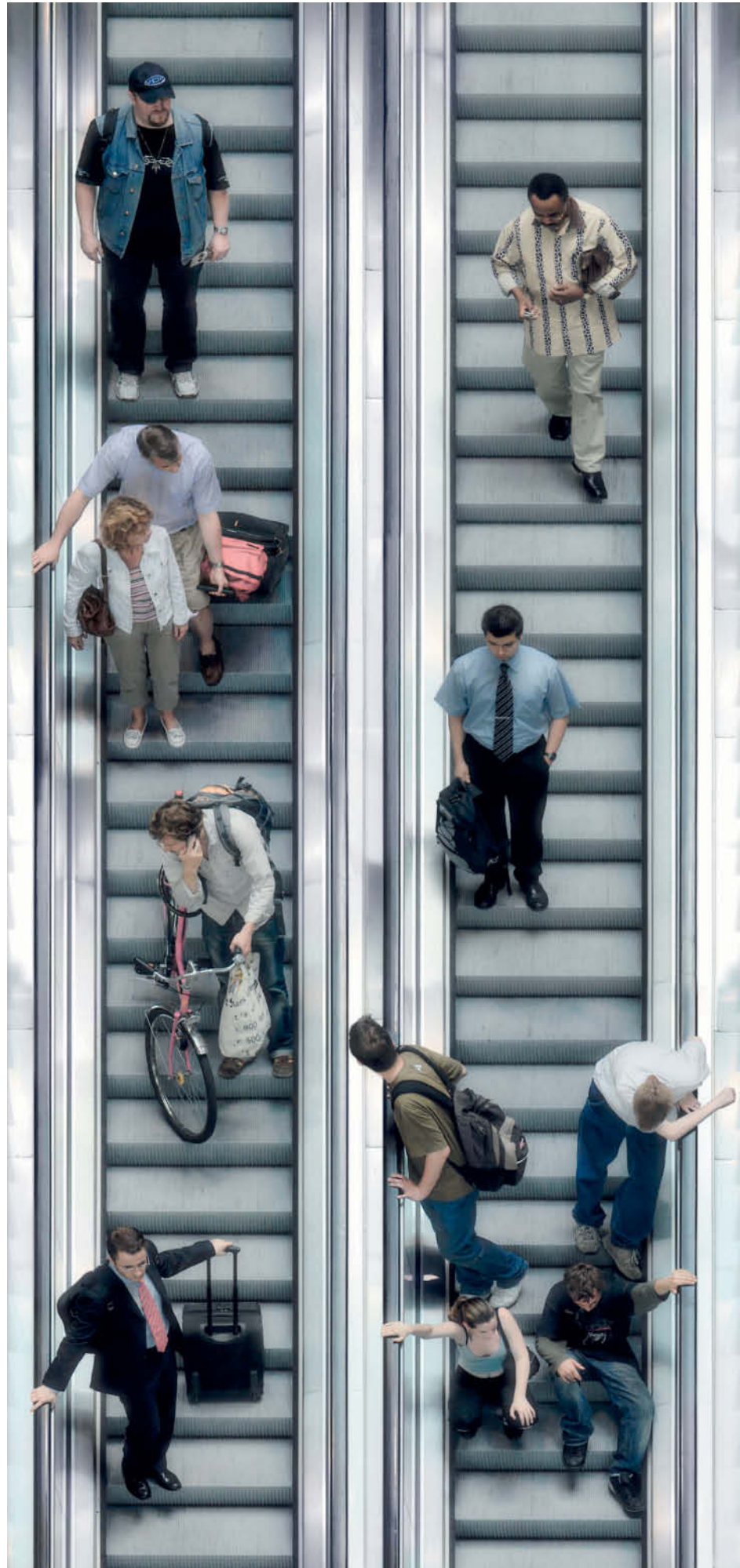
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www.jscriba.com

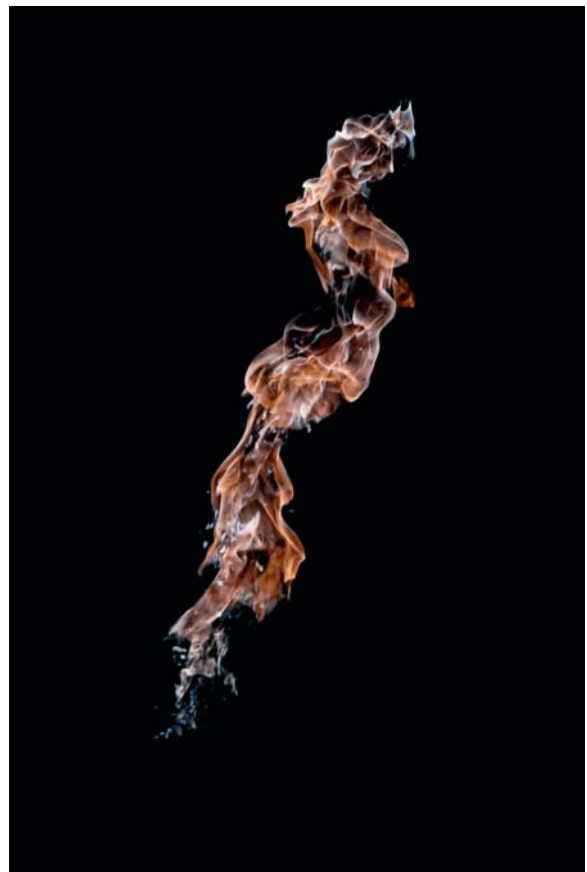
Recommended Reading:
Yesterday's Future
ISBN 3940396249

Video: *Timescape: I want*
<http://vimeo.com/21068457>

Escalators

Here, Scriba juxtaposes and contrasts our private and public worlds. There could hardly be a more public place than an escalator, yet, in response to forced passivity, people do not interact but instead retreat to their own space. "Their inability to communicate and their introverted body language tells us more about their real selves than they intend to reveal."





element_1

In his *elements* project, former physicist Juergen Scriba follows in the footsteps of the Greek philosophers who believed the world was made up of four basic substances: fire, water, air and earth. The 'fire' series, called *element_1*, is a spectacular success thanks to the help of a pyrotechnics expert and some secret camera settings that Scriba keeps to himself. All he will say is that as a physicist, his understanding of the spectral properties of light stood him in good stead.



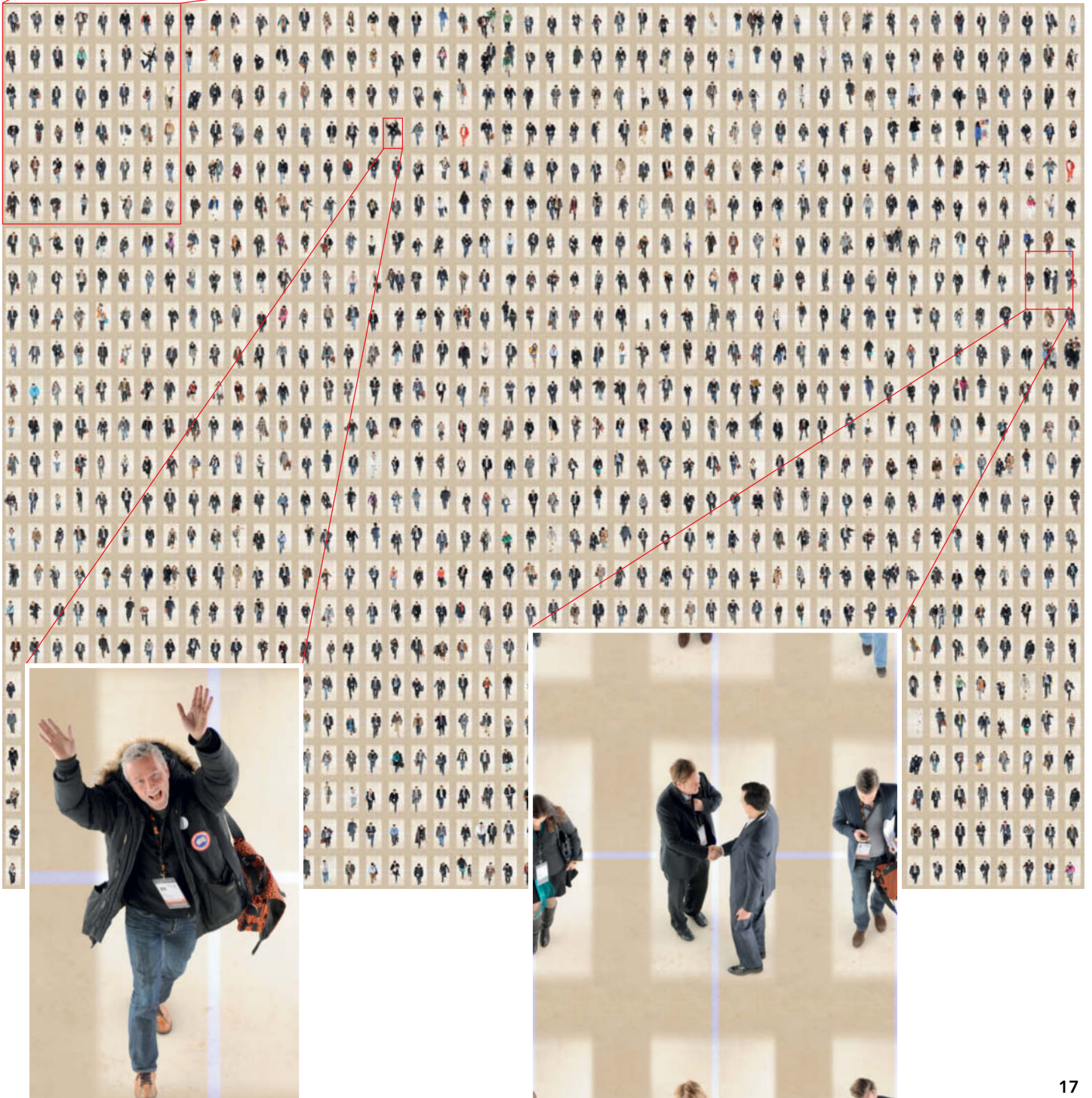
Motel One Stuttgart

Scriba prefers to use his photos in installations rather than line the walls of traditional galleries. This installation at Motel One in Stuttgart is printed directly onto safety glass and measures 70 square meters (750 square feet).



DLDscape

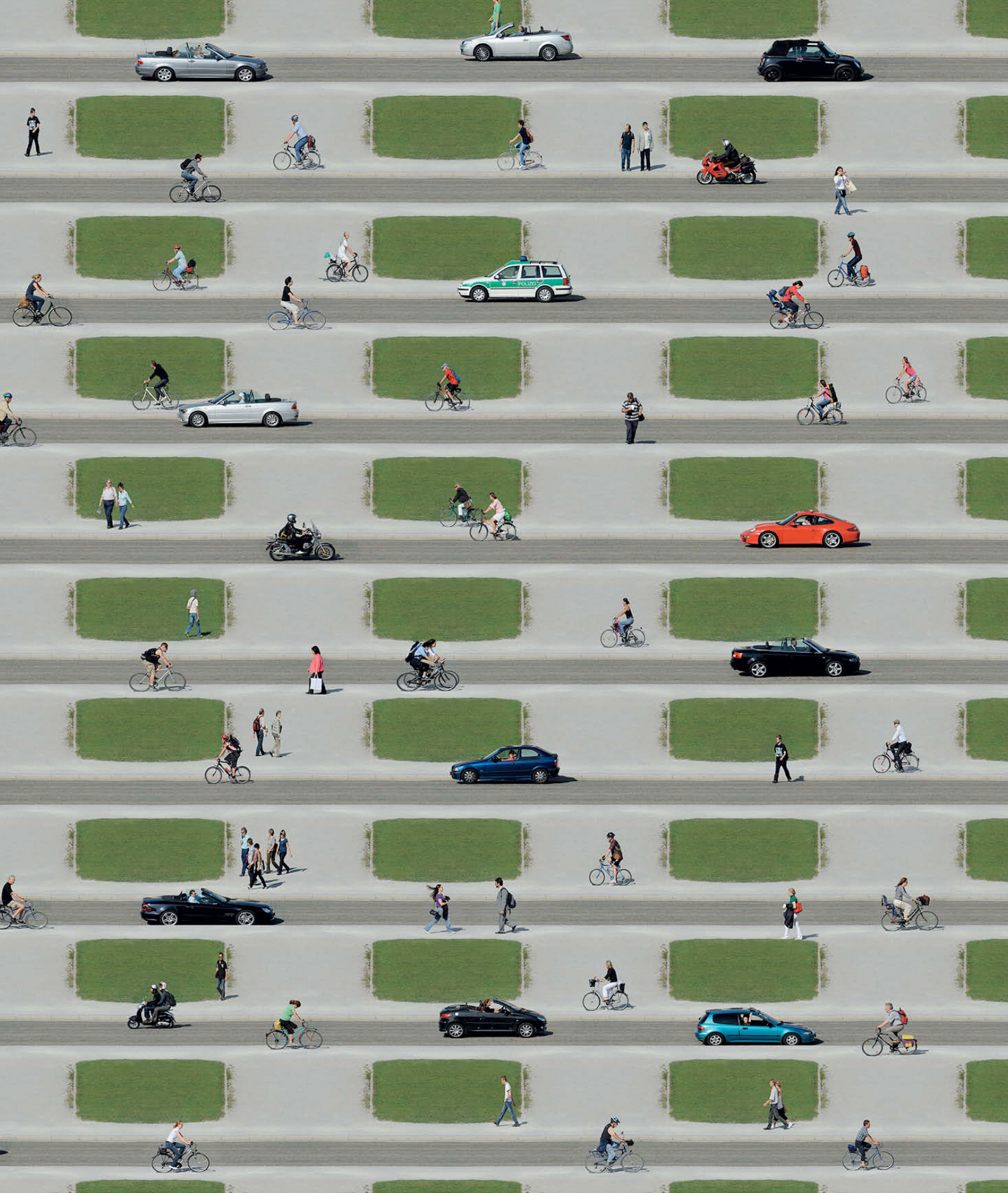
Scriba describes this project as his most complex yet. A camera took a photo of all the people at a conference as they moved from one room to the next. A team of 10 Photoshop experts merged the individual images into a single gigapixel image showing about 1,000 people in a single virtual space.

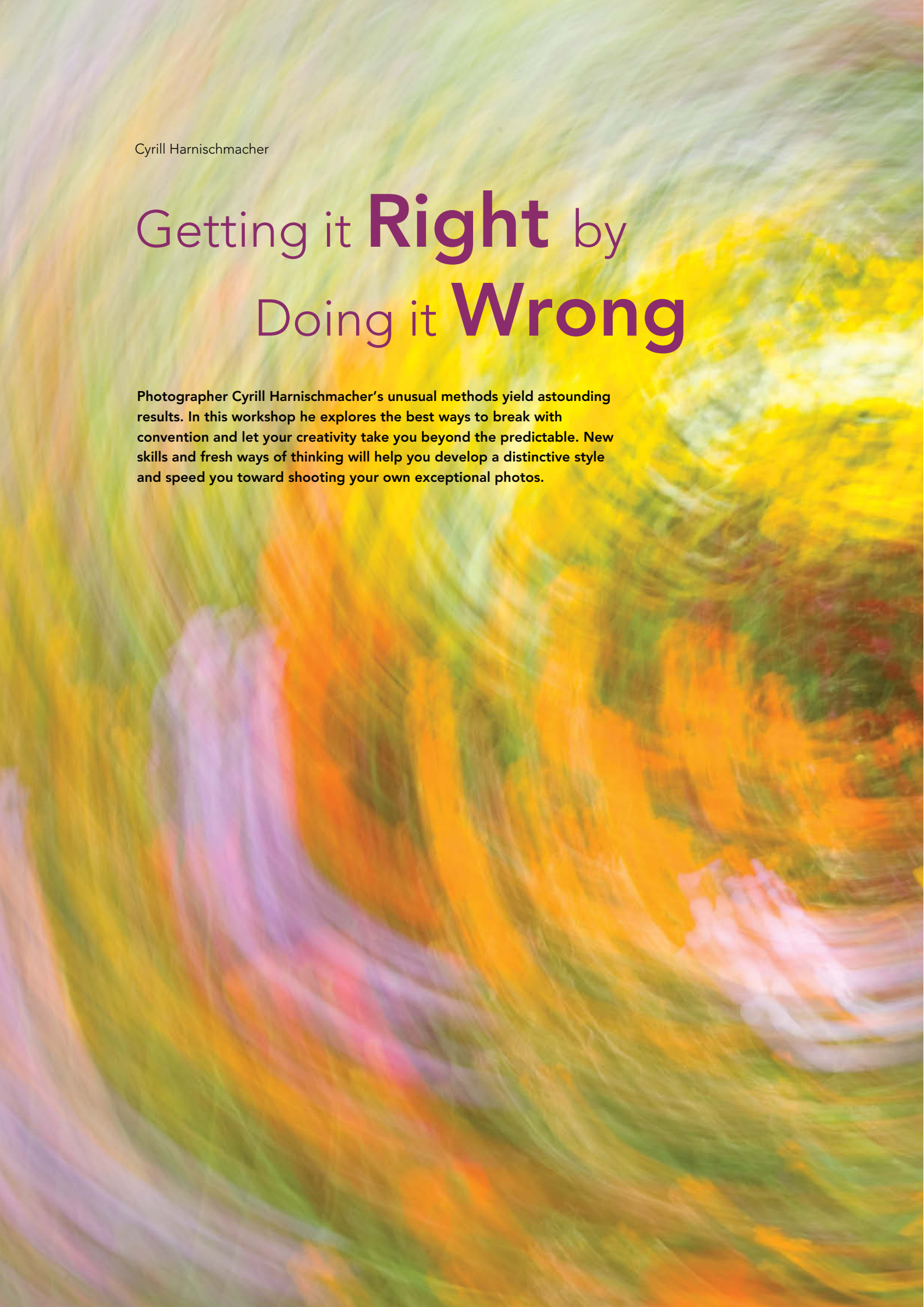




Summer City

It is difficult to get one's mind around this image, with the perspective of the ground contradicting that of the pedestrians and vehicles. Because some people were photographed more than once – when crossing the street, for example – the image also captures the passing of time. Scriba certainly doesn't object to 'filmstrip' interpretations of this particular work.





Cyrill Harnischmacher

Getting it **Right** by Doing it **Wrong**

Photographer Cyrill Harnischmacher's unusual methods yield astounding results. In this workshop he explores the best ways to break with convention and let your creativity take you beyond the predictable. New skills and fresh ways of thinking will help you develop a distinctive style and speed you toward shooting your own exceptional photos.

Photography has unwritten rules prescribing what is ‘done’ and ‘not done’. People are not always aware of these seldom-crossed boundaries, but their comments about photos reveal their assumptions: “The horizon isn’t level,” “Don’t put the horizon in the middle,” “The subject has been cropped,” “The focus isn’t right,” “That photo’s blurry,” “Try it again using noise reduction,” “The contrast is too high,” “Overexposed,” “Underexposed,” “The colors are too bright,” “Should have used a tripod,” and the list goes on. Granted, such comments are quite justified for many photos. It seems we’re always trying to achieve these ideals, assisted by a myriad of technical aids including autofocus, exposure metering, TTL flash control, programmed auto mode, tripods and image stabilizers. While these are all practical and helpful, they leave us very little room to have fun and do things differently, so the first step to greater photographic freedom is to turn off everything automatic and operate the camera entirely manually.

Working Conceptually and Experimentally

Unlike painting, photography cannot escape technical constraints. Furthermore, the photographic image creation process makes it much more difficult to intervene once work is under way, so for photographers, the most creative stage comes at the beginning of the

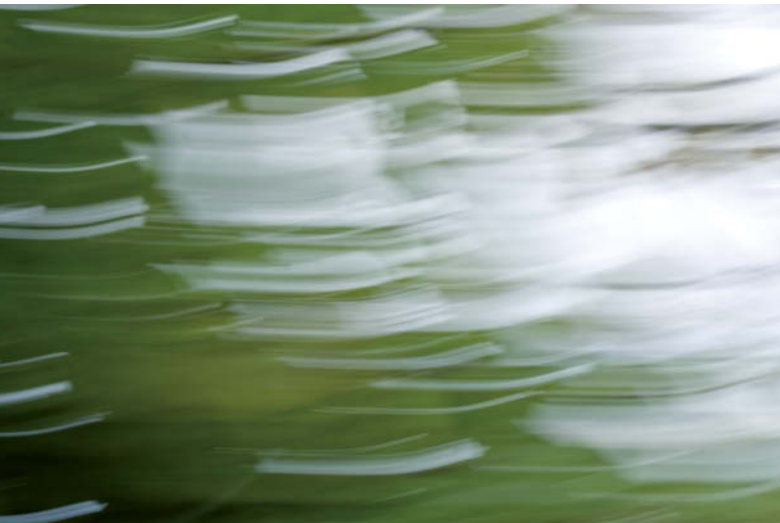
process as they think about the shot, prepare for it and set it up. This does not make photography any less creative than painting in terms of the artistic opportunities it offers; it simply requires a different mindset and methodology.

When you deliberately buck the trend, there may be some weird and wonderful results along the way, but gradually it becomes possible to create sequences of images that can help you define your own style. Be careful, however, not to allow breaking rules to become a rule in itself, or to fall into the trap of overestimating the possibilities offered by image manipulation, as happened in the 1970s and 80s with the overuse of zoom and multiple exposure effects. The truth lies somewhere between the extremes. In other words, it is important to experiment and go too far from time to time in order to be able to apply what you have learned to your later work.

Strictly speaking, there is no such thing as ‘doing it wrong’ in photography. The only limits are the technical requirements and the photographer’s ingenuity and imagination. The goal should always be to create an exciting photo, whether this is achieved by conventional or unconventional means. The ideas described here are not new rules to be followed, but are meant to stimulate your creativity and zeal for experimentation. Nevertheless, it is very difficult to avoid making your own rules, especially when you are practicing new techniques, working on sequences of images or developing your own unique style.



That abstract feeling: a blurry, overexposed image of an ordinary shopping mall

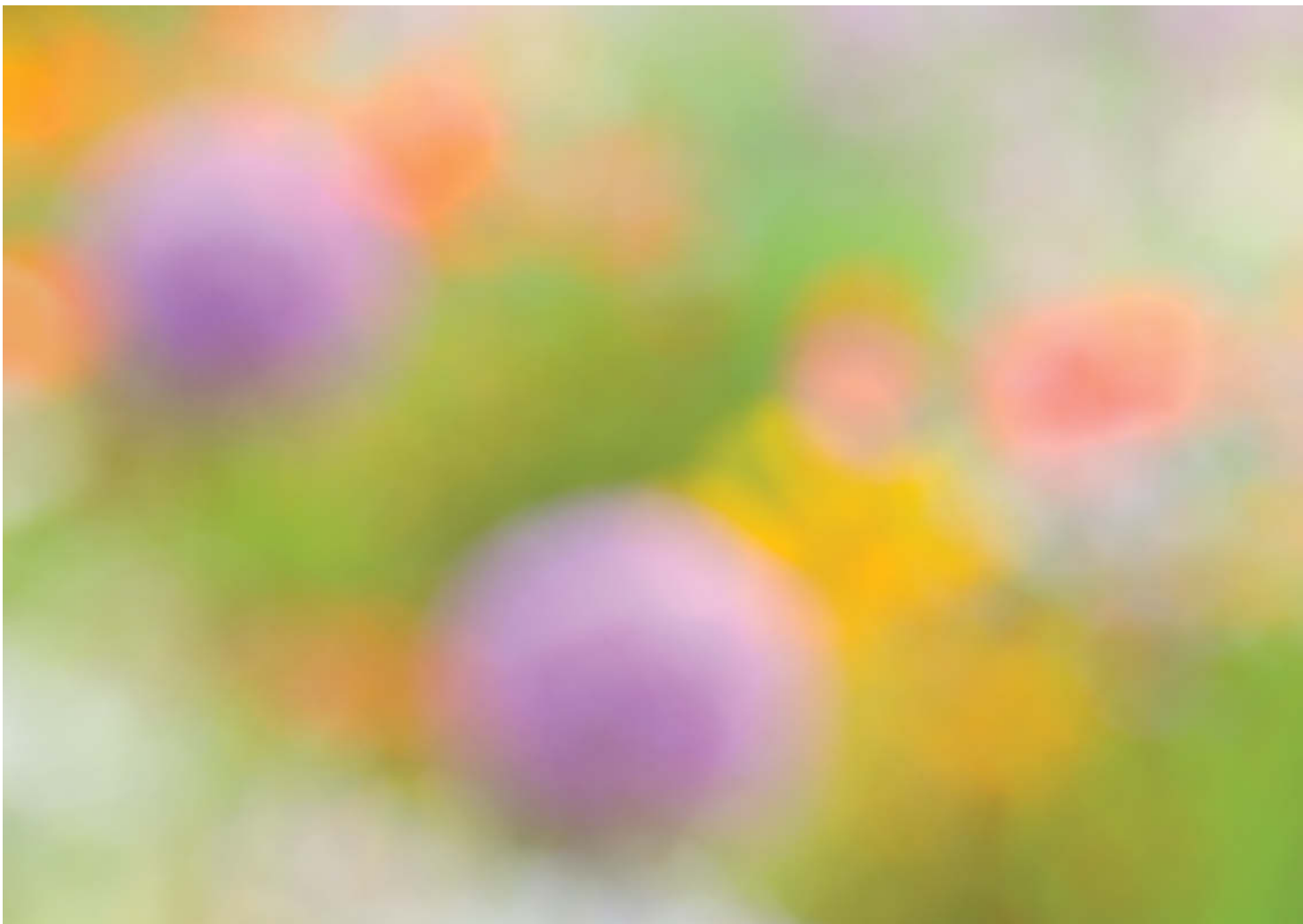


White brushstrokes on a green background or trees beside a lake? Look again: This photo is actually of peonies in a flowerbed.

The Beauty of Blur

Photographers are just as fond of the aesthetic effects of blur as artists are. The 'bokeh' of a lens has come to be regarded as a mark of its quality. Deliberate blur is generally used as a contrast to focused image areas – for example, to make a portrait subject stand out from the background. In this workshop, we will go a step further and dispense with focus altogether. Combined with a little (or a lot) of overexposure, this produces images ranging from barely recognizable to totally abstract, in which image composition and layout become much more significant than they are in conventional photos. Fine details and textures disappear completely, and it is the way the shapes and colors are arranged that brings the image to life.

Watercolor painting springs to mind, particularly in the case of images of flowers in bloom, but blur can also be used effectively in images of people and buildings. As a general rule, it is better to choose motionless subjects so that you have more time to compose your image. Technically, all you have to do is defocus the subject manually. This is easier to achieve with macro and telephoto lenses than it is with wide-angles.



A garden in summer provides the perfect opportunity for photographic Impressionism. We can almost feel the sun on our skin, smell the fragrance of the flowers and hear the bees buzzing.

Pan, swivel, zoom

With these techniques, the degree of blurriness in the image is the key factor, but movement comes a close second. The three basic techniques are:

Pan

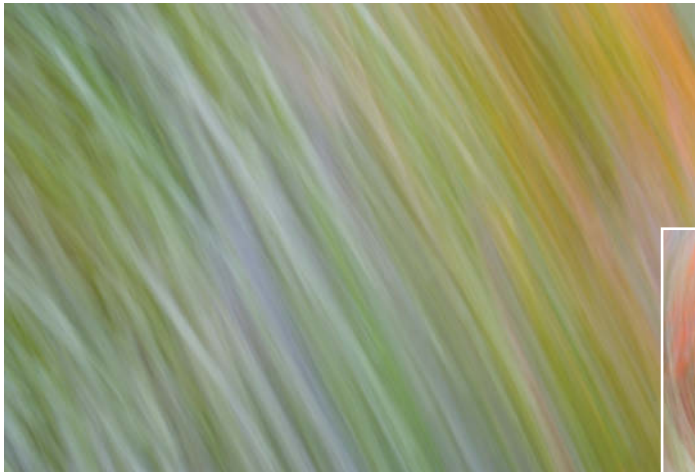
A short or long movement of the camera in a horizontal, vertical or diagonal direction produces a texture much like a brushstroke in modern painting. Depending on whether you have the subject in soft or sharp focus, the traces of color will be more or less precise. Other ways of changing how the subject looks include faster movement, longer exposure times and only starting to move the camera after the exposure has begun. Experimentation will soon give you more confidence as a 'stylist' and help you put your own twist on things. If it is very sunny, you can either stop the aperture right down or use a neutral density filter to lengthen the exposure time. Slight overexposure of about 1 EV is beneficial for most images because it makes the colors more intense.

Swivel

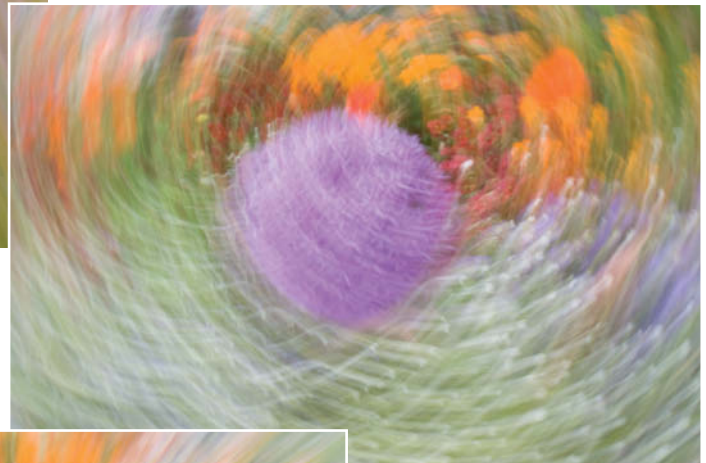
Swiveling works on the same principle, except that the camera is swiveled on its central axis during the exposure. This produces circular patterns that look like the inside of a swirling tunnel. Because it is difficult to control the camera by hand, the center of rotation in shots like this is often off center. If you want more control, use a tripod and a telephoto lens with a tripod mount that allows you to rotate the camera and lens as a unit.

Zoom

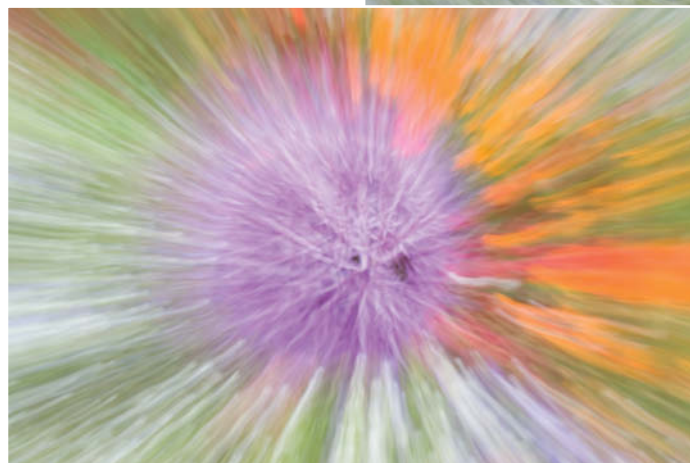
This effect was extremely popular in the 1970s, when the first affordable zoom lenses became available. To keep the effect as even as possible, mount the camera on a tripod and alter the focal length during the exposure. To get good results, you will have to use slightly longer exposure times. Plan for about 1/8 second in most cases, but much longer exposures are feasible. It is also possible to pan or rotate the camera while you are zooming.



The type of 'brushstroke' you produce depends on which way the camera is tilted. This shot was made using just a slight wrist movement.



Swiveling the camera around its central axis produces a tunnel-like effect



Color explosion: zoom effects became popular back in the 1970s. A hint of the original subject is usually still visible in the center of the image.

Multiple Exposures

Soft Focus Effects without a Filter

A combined focused/unfocused image can be produced using multiple exposures of the same subject, creating a highly pleasing soft focus effect. You will, of course, need a camera that supports multiple exposures. The DSLR we used here, a Fujifilm Finepix S5 Pro, lets you combine up to 10 individual exposures in a single shot. Similar models are available from other manufacturers. Simply set the number of exposures in the menu before making the first (focused) exposure. The camera then remains in a kind of standby mode to give you time to alter the focus setting and make the subsequent defocused exposures. The intensity of the final soft focus effect depends on how much you alter focus and how many of the source images are out of focus. You can have a lot of fun experimenting! The final step in the process is to press the OK button after the last exposure.

If your camera doesn't have a multiple exposure mode, try this workaround:

Step 1: Stop the aperture down as far as possible and set a long exposure time of 5 seconds or more. Focus on the subject.

Step 2: Immediately after beginning the exposure, hold a piece of black card in front of the lens. The camera will still be exposing, but almost no light will enter the lens.

Step 3: Reset focus and remove the black cardboard briefly, then put it back in front of the lens until the exposure has finished.

This version of multiple exposure technique can only ever be experimental, since the length of time the card is held in front of the lens cannot be precisely controlled. As a guide, consider 1/8 second as the shortest possible exposure time for this type of 'manual shutter'.

Multiple Focus

Another variation of multiple exposure is to change the subject between the individual exposures. This works particularly well if you combine images of textures such as leaves and flowers with high-contrast subjects such as backlit people or other dark objects in front of a light background. Combining the two images fills the dark areas of the first image with the textures from the second one.



Double exposure of a flower head and a tree on the lakeshore

The focused image is shown on the left and the second, blurred exposure on the right



Combined, the two images produce a highly photogenic soft focus effect without the use of a filter

Over- and Underexposure

Deliberate over- or underexposure can bring out the best in a subject. Simple or abstract subjects with little color are ideal for this treatment. Depending on the lighting, exposure correction of 2 to 3 stops will produce great results. Use the exposure compensation button on your camera to alter exposure and, if you are shooting TIFF or JPEG images, it is a good idea to shoot an exposure bracketing sequence to be sure of getting the result you are looking for. If you are shooting RAW, you can just as easily adjust exposure later during conversion. Most overexposed subjects benefit from an increase in saturation, while underexposed images tend to look better if saturation is reduced.

**Mysteriously moody:
underexposure by four stops
makes the subject almost
completely disappear**



The extreme overexposure in this shot burns out most of the highlights, giving the image a surreal feel



A shower at the beach, photographed against a cloudy sky. Three stops of overexposure separate the subject completely from the background, intensifying the colors and making the image much more dramatic.



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Books from Rocky Nook



Jack Dykinga

Capture the Magic

Train Your Eye, Improve Your Photographic Composition

November 2013, 188 pp., 10x10 Softcover
US\$ 39.95, CAN\$ 41.95

Capture the Magic uses a structured approach to teach the art of creating interesting, well-composed images. It provides solutions to problems that often get in the way of producing great photographs and emphasizes the importance of training the eye to exclude the extraneous. Examples of strong images are juxtaposed against flawed images, illustrating how to create a successful composition. Topics covered include light and shadow, lens choice, framing, negative space, and many more. Jack Dykinga encourages us to look at photography as a way to communicate. Dykinga says, "Photography is a marvelous language that crosses linguistic borders as a universal, powerful, and direct communication."

"This is perhaps the best, clearest, most enlightening book ever on seeing, composition, and use of light in photography of the natural landscape. ... Any passionate photographer interested in nature and landscape photography will treasure this book and refer to it again and again for lessons, reminders, and inspiration."

Justin Black

Perspective

In architectural photography, converging lines are considered a 'no-no', but sometimes breaking a rule is the route to success, and the secret lies in knowing when to do so. The neoclassical design of the concert hall in our example below virtually begs the photographer to 'push the envelope' and inject more energy into the architecture. The choice of a wide-angle lens and the inevitable distortion it creates makes it possible to break up the strict lines of the façade. Super wide-angle lenses with their high degree of distortion work best in these circumstances, and positioning the camera close to the building multiplies the effect. You will soon find out that changing your shooting position even slightly affects the resulting image a great deal. Lines that seemed insignificant before suddenly become the element on which the entire composition hangs, which just goes to show how important composition really is. Once again, exaggeration is a 'tutor' that helps you develop your capacity to express yourself visually.



Despite the tilted horizon – or perhaps because of it – the sense of confinement in this room is conveyed very effectively

The complete lack of converging lines make this extremely austere façade even less interesting to look at

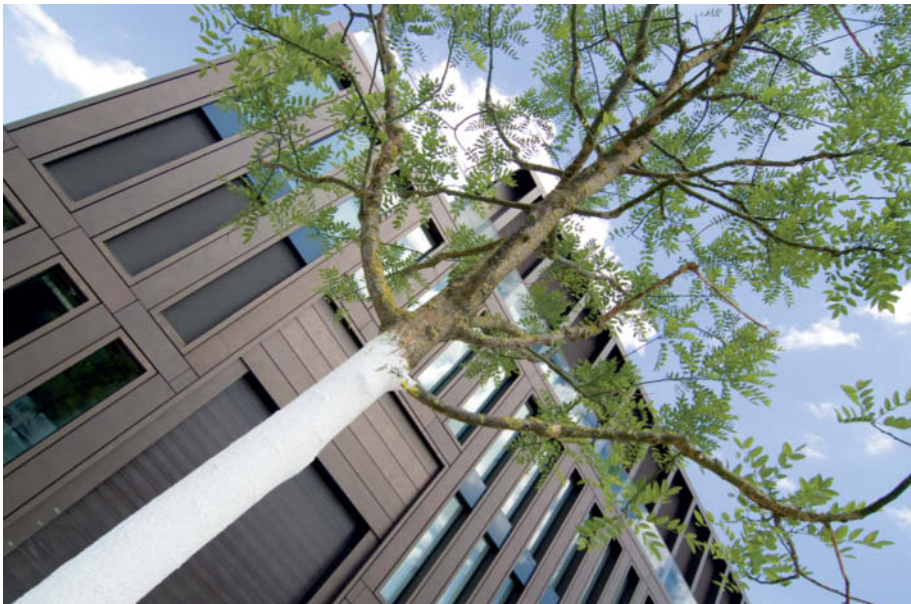




Adding tension by deliberately using lens distortion and shooting at an angle



Intentionally allowing lines to converge makes this photo more dynamic



Here, the sloping lines intersect in the center of the frame, but that's what makes the photo interesting

Motion Blur

Generally, photographers try to keep exposure times short so that the subject is in focus and there is no visible motion blur. As exposure times lengthen, focus is lost when the subject moves. Many photographers like to use motion blur to capture light trails from moving traffic in the evening or at dusk. Although motion blur effects are less effective in daylight, potential subjects include vehicles, people, flowing water and anything else that moves.

In most cases you will need to use a neutral density filter to keep exposure times sufficiently long, although sometimes simply stopping the aperture right down does the trick. If you set your camera to aperture priority mode, the exposure meter will automatically display the correct exposure time. It takes quite a bit of practice to get a feel for the right exposure time, but you will get the hang of it after a while. The next step is to set the camera to manual (M) exposure mode and select the aperture and exposure time values determined by the

camera's meter. The advantage of this approach is that the exposure time cannot be changed inadvertently if the lighting conditions change. If you want some parts of the image to remain in focus or the blur to be evenly distributed, you will have to use a tripod.

It is worthwhile experimenting with different exposure times, and you will get a different image each time you lengthen the exposure. A sequence of images becomes more interesting if you add some motion blur, and the possibilities are endless. Imagine reducing the different subway lines in a city to an abstract series of images of each train's colors as it whizzes by.

'Light painting' is a well-known application of movement blur that involves moving a light source against a dark background during a long exposure. Any self-illuminating source, such as LED lamps, candles, flashlights, sparklers or the display on a mobile phone can be used as a 'light brush'.



The combination of sharpness and blur gives this image a 'live' feel

In this infrared image, the ½ second exposure time ironically appears to transform the slowly rotating wind turbine into the familiar symbol for nuclear energy



Traces of a flickering LED lamp against a black background look like Chinese characters



A light curtain woven by an LED strip light

Mistakes as a Design Concept

The beauty of 'doing it wrong' lies not only in the deliberately different portrayal of a subject; it also demands to be displayed as a sequence, to draw our attention to the conceptual thinking and make the photographer's intentions truly visible. The critical factor is ensuring that all the images are shot similarly. In our case (see opposite), the horizon is always at the same angle and the colors are similar. In a lone image, the slanting horizon might look like a mistake, but when the images are displayed as a sequence, it is easier for the viewer to appreciate that the 'mistake' is actually a deliberate feature. Large-format prints underscore this effect.

There are just as many potential 'serial errors' as there are mistakes a photographer can make. Cut-off heads, portraits ruined by too much flash, a finger over the lens, somebody always just out of the picture – anything is possible in a sequence. 'Standorte' ('Standpoints'), the series shown here, shows only the ground and the photographer's shoes. On its own, any one of these images would not be particularly interesting, and you might even think the photographer had exposed the image by accident. However, displayed as a sequence, images like this have a different quality and become part of a modular whole that can be extended to include any scene you like – think, for example of the 'Abbey Road' pedestrian crossing from the Beatles' album cover, the famous floor in Cologne Cathedral or the topmost platform on the Eiffel Tower.

The whimsical 'Standpoints' series could be continued in any number of locations



Visiting friends



Gardening



Waiting for the bus



In the elevator



At home



A day at the lake. The washed-out colors and skewed horizon are the attributes that link this series of images. This relaxed way of looking at an unpretentious subject conveys serenity and calm.

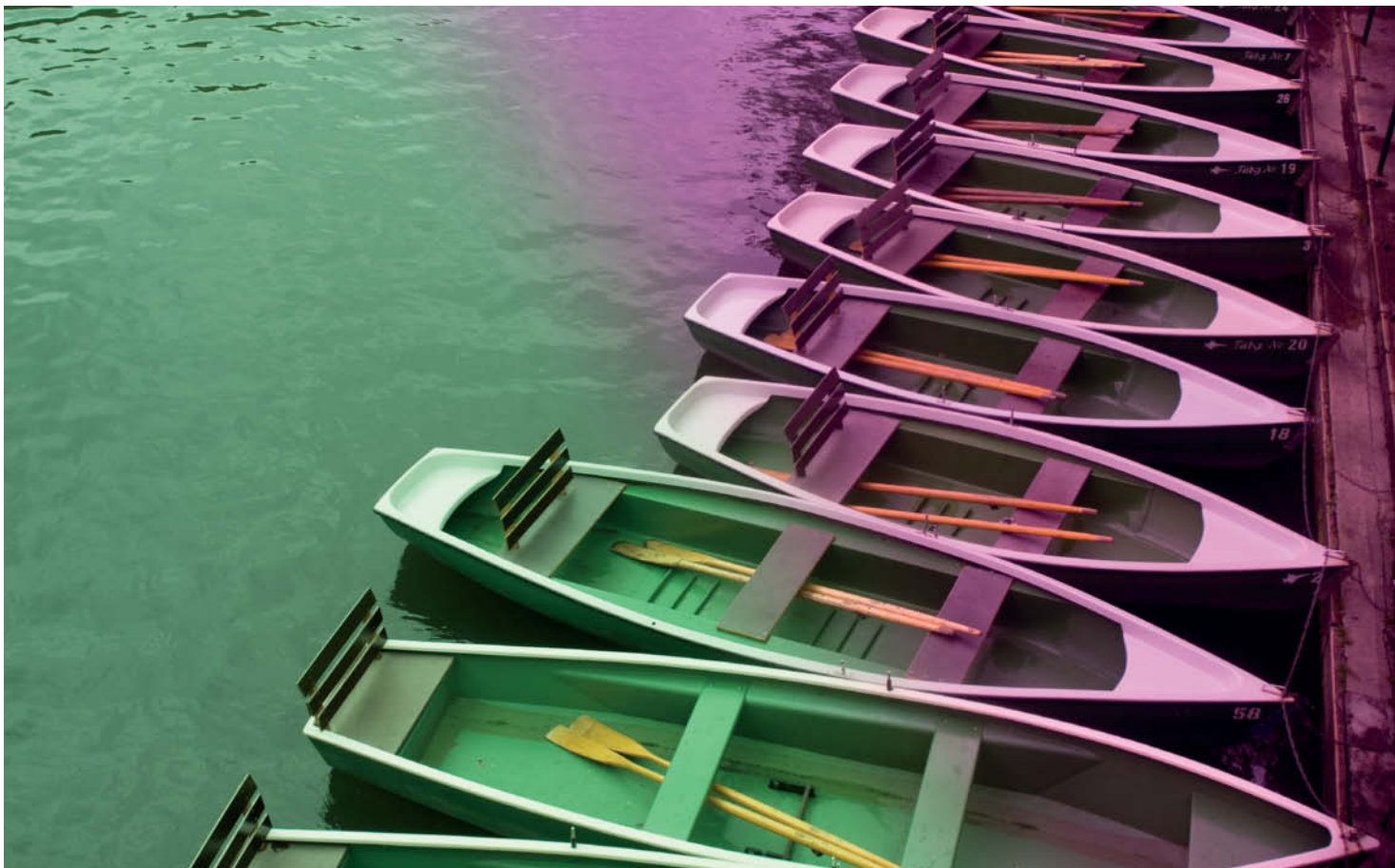


A pink foil makes the colors look faded, like a photo from the 1970s

Playing with Color

Even cameras can 'see the world through rose-colored glasses'. Colors convey moods, though not always rosy ones. Stunning effects can be created simply by placing a colored foil in front of the lens. Depending on the subject and the intensity of the foil's tint, the results range from strange, slightly off-key photos to almost monochrome effects. Photographic accessory and event management stores are good sources of suitable colored foils, which are used as filters for all kinds of lighting. The available colors range from soft tints to intense tones and can be used in almost any setting. For example, a strip of transparent gold foil makes a great alternative to a tobacco-colored graduated filter. And because foils placed directly in front of the lens aren't in focus, any scratches or blemishes on their surfaces don't appear in the final image. If you leave part of the lens uncovered, the transition between the tinted and untinted parts of the frame will be quite soft and you can vary it by tilting the foil. You can create endless combinations of looks by using multiple colored foils. If you want to experiment without shelling out money, just use anything that is transparent, colored and large enough to cover the lens. Colored glass or CD jewel cases are just two of the many possibilities.

Foils of different colors held in front of the lens create interesting color transitions. Since the colored foils are outside the field of focus, the transitions are fairly gentle.



This semi-demolished parking garage looks even more grimly dramatic when photographed through a red foil



Image Noise

In the early days of digital photography, image noise at high ISO values was considered a defect. Even though grain – the analog equivalent of noise – was seen as acceptable, noise produced by a sensor was not believed to have any aesthetic qualities. Opinion has changed over the years, shaped by the conceptual photography of artists like Harald Schwoerer, who has declared ‘noising’ to be an art form in its own right. Some of his highly successful works can be seen in my book *The Wild Side of Photography 2.0*, published by Rocky Nook.

Sometimes, however, modern camera technology actually makes it very difficult to produce an attractively noisy image and older cameras offer a lot more potential. Their lower resolution is irrelevant, since the aim is not to expose the subject accurately, but rather to manipulate the overall effect. To expose such an image, deactivate automatic noise suppression, select the highest ISO value your camera allows and stop the aperture right down. In most cases, the resulting exposure times are so long that you will have to use a tripod.

Most noise-based images require post-processing. If there is not enough noise, you can rescale the image to a lower resolution, sharpen it, scale it back up to the original resolution and sharpen again. Experimenting with increased contrast and increased or reduced

saturation also produces interesting results. Playing with the settings in the individual color channels – for example, using the *Photoshop* Channel Mixer tool – also produces fascinating and sometimes quite startling results.



This slightly underexposed image was lightened significantly during processing and saturation was increased to emphasize the noise



Noise is particularly attractive when used with bold colors

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Shooting from the Hip

Shooting on the spur of the moment without looking through the viewfinder can yield surprising results that you might never have captured had you stopped to think about it. An unusually low camera position combined with a small portion of luck often produces interesting photos. Compact cameras (with the flash switched off) are the least conspicuous and the easiest to use in this kind of situation. Since you will probably be taking photographs in public, bear in mind that you need to ask the subject's permission to publish any photos that contain recognizable faces.

Alongside the inevitable rejects, you are sure to find that a surprising number of your snaps lend themselves to telling a story, perhaps documenting a visit to a city. Because they are uncontrived and show subjects that you wouldn't normally think of photographing, spontaneous snaps often make better storytellers than staged documentary photos. The documentary character of snapshots can be further enhanced by printing them in black and white or displaying them as a collage. Using a medium telephoto as we did produces interesting crops and detail images.

Snapshots are often more interesting when displayed as a collage

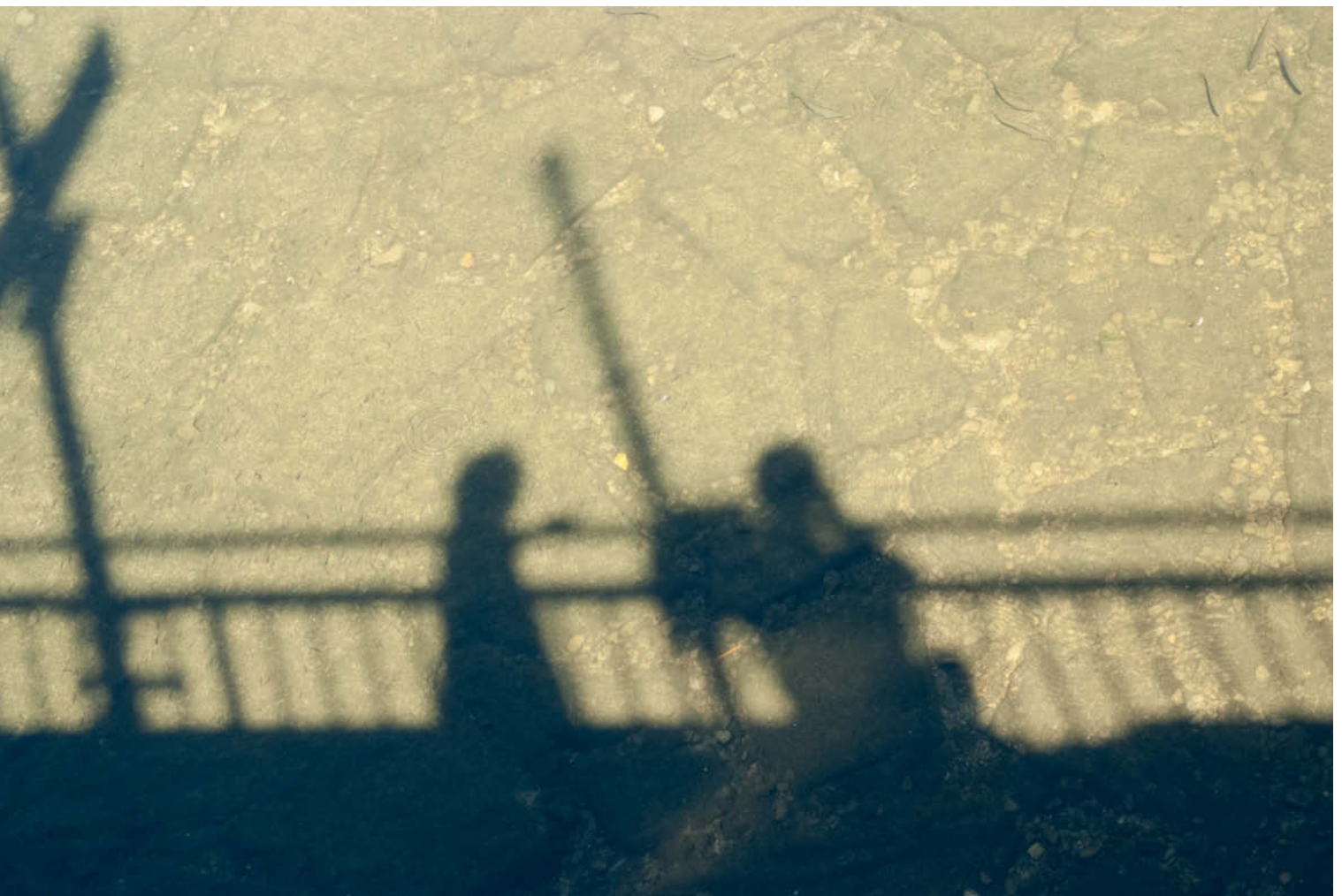


Shadow Games

Because it is a point source, the sun forms harsh shadows when it shines down from a cloudless sky. Photographers typically try to lighten these shadows at least a little, which is relatively simple to achieve in portraits or other small-scale scenes but not always easy for larger subjects. Bright sunshine is not the ideal weather for taking photos, unless, of course, you make the shadows themselves your subject. Such shots can be spontaneous or staged. Particularly in still lifes, you can subtly reinforce the message conveyed by a photo by including the shadow of an object that fits in with the subject's theme. If you do not have a suitable object to hand, you can always make do with a silhouette cut from a piece of card and placed outside the camera's field of view. Uneven ground or mottled backgrounds add an interesting textural element.



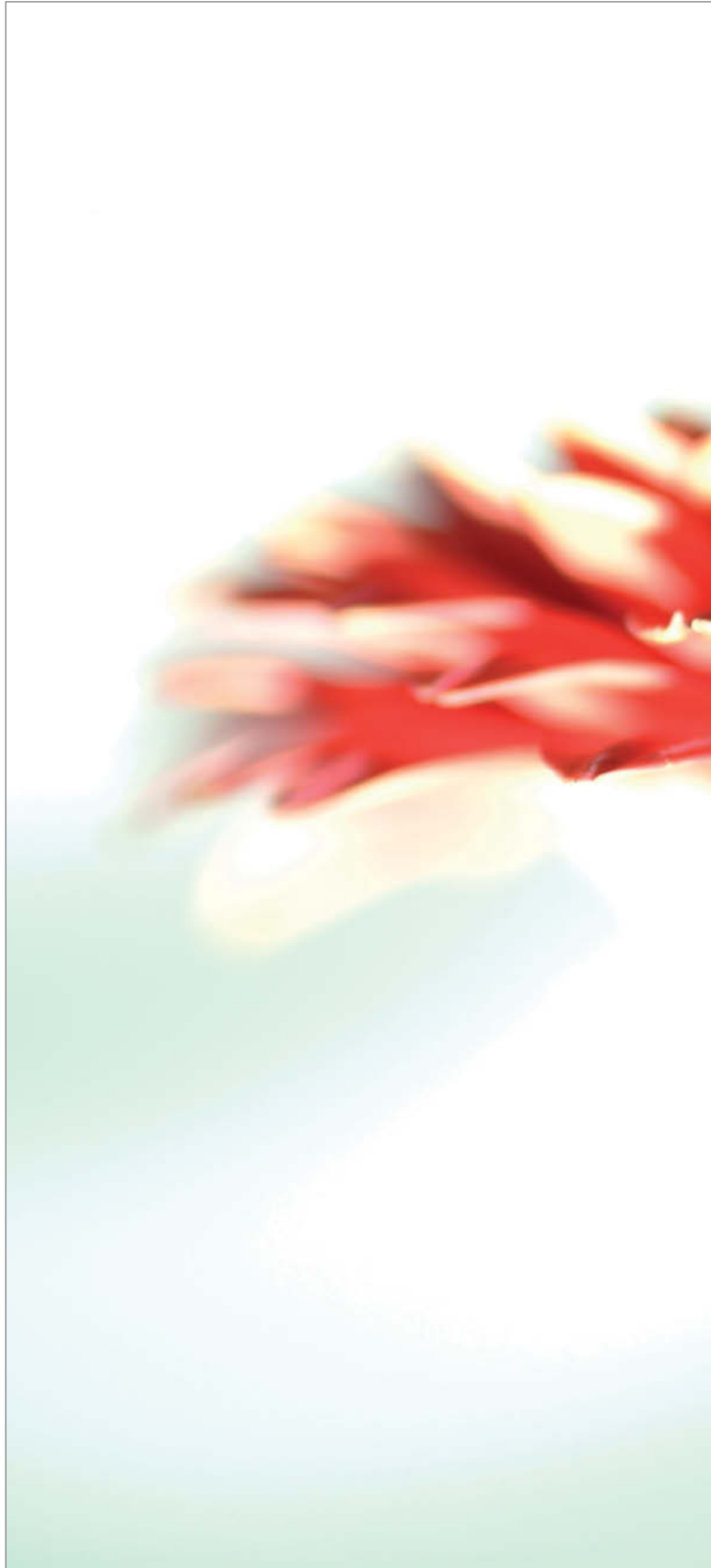
A house on the wall of a house. The shadows cast by the dormer window on the neighboring roof make the window look like the entry to an imaginary home.



The interplay of light and shadow against an uneven background adds an abstract note to a commonplace subject

Combining Techniques

You can, of course, combine the techniques we have described – perhaps mixing overexposure with blur or noise with unusual perspectives. Some of these combinations are quite well known, though they are usually used for a different purpose. For example, panning is in fact a combination of camera movement and motion blur, often used in sports photography. Try panning your camera in the opposite direction to the subject's movement to create two different types of intense blur in a single shot. Experimentation and imagination make a powerful combination! (sea) **c't**



This abstract image is not only blurred, but was also shot spontaneously without paying attention to the framing or exposure settings



The house next door, photographed out of focus through a window blind. Here, we increased saturation during post-processing.



This photo of a gerbera utilizes both overexposure and extremely tight focus



Jobst-H. Kehrhahn

Canon EOS 70D vs. Nikon D7100

This issue's camera showdown sees the Canon EOS 70D competing with the Nikon D7100 for the APS-C crown. Among other improvements, Canon has added Wi-Fi and new sensor technology to win over customers' minds and wallets, so we decided to see for ourselves which of the young pretenders is really the better bet.



Size matters – or at least it does when it comes to the sensor in a digital camera. Full-frame sensors are still top of the heap when it comes to reproduction and detail quality, but their smaller APS-C cousins are still capable of producing excellent results with regard to noise suppression, dynamic range and overall light sensitivity, and are significantly cheaper too. Many consumer and mid-range cameras are equipped with APS-C sensors and are in direct competition with Panasonic and Olympus, with their own Four Thirds and Micro Four Thirds sensor designs. The ‘class’ of a DSLR is today more than ever a function of its specifications and feature set rather than just pure sensor size.

The Nikon D7100 and Canon EOS 70D models compete directly at the top of the

semi-pro segment. They cost about the same, both have APS-C sensors and both are long-awaited follow-up models to their well established predecessors.

The D7100 hit the market in March 2013, more than two years after the introduction of the D7000, and Canon waited a further six months – and three whole years following the introduction of the EOS 60D – to unleash the EOS 70D.

Neither camera reinvents the wheel and both largely follow the concepts established by their older sisters, although various important features have been updated and there are a number of new additions, too, to whet your appetite.

The Candidates

Nikon D7100

Canon EOS 70D

Sensor resolution and size:

6400 × 4000 pixels	5472 × 3648 pixels
24 megapixels	20.2 megapixels
23.5 × 15.6 mm	22.5 × 15 mm

Monitor size and resolution:

3.2", static	3", tilt/swivel
1,229,000 dots	1,040,000 dots

Dimensions and weight:

136 × 107 × 76 mm	139 × 104 × 79 mm
765 g	755 g

MSRP (body only):

US\$1,199	US\$1,200
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Our macro test shot was captured using our Zeiss 100mm f/2 Makro-Planar T* reference lens and shows extremely fine detail rendition



Canon EOS 70D

Canon's latest top-notch APS-C camera offers a new sensor, a tilt/swivel touch screen monitor, faster Live View autofocus, faster burst shooting and is Canon's first DSLR with built-in Wi-Fi functionality.

The EOS 70D is visually very similar to the 60D, but its inner workings have changed significantly. Wi-Fi is one of its major new features and is not only trendy but also really useful. The camera can be connected wirelessly to an appropriately equipped TV or controlled remotely using Canon's proprietary EOS Remote App software. Controlling digital cameras using smartphones and tablets is an extremely popular way of applying current technology, as borne out by Sony's innovative QX modular 'lens cameras'.

The EOS 70D's light sensitivity has been increased by a whole stop compared to the 60D, and its range can be extended all the way to ISO 25 600, even if the results at this level aren't particularly good (see page 46). The shortest available exposure time remains 1/8000s.

The body is made of aluminum and polycarbonate and is dust and moisture sealed. The three-inch tilt/swivel touch screen monitor (called 'Vari-angle' by Canon) is new and offers gesture-driven zooming, shifting and scrolling during image playback. This is a surprisingly practical feature that we quickly got used to and now miss in other cameras that don't have it.

Burst shooting has been stepped up to seven (JPEG) frames per second with a UHS-I SDXC memory card compared to the 6fps maximum in the EOS 60D.

Like most DSLRs, the EOS uses phase detection autofocus in viewfinder mode, and

the 70D has a 19-point system (compared with the 60D's nine). All 19 focus points have cross sensors with a sensitivity range between -0.5 and 18EV. In live view mode, the camera uses Canon's new Dual Pixel CMOS AF system. Each pixel in the camera's sensor consists of two photodiodes that the phase detection system analyzes separately. The camera then uses the dual results to calculate the phase difference and focus on the subject. The advantage of this system is that the firmware doesn't have to extrapolate single-pixel results to calculate the subject distance and is thus able to focus much faster.

In movie mode, for example, you can use a silent-focus STM (stepper motor) lens and touch screen gestures to smoothly alter the plane of focus during a shot. This is a level of user control that was simply not possible with the EOS 60D.



Our Nikon macro test shot was captured using the same 100mm Zeiss Makro-Planar, but shows better overall resolution than the Canon version



Nikon D7100

Nikon's new top-of-the-range DX model is the successor to the highly popular D7000, and offers greater resolution, a larger monitor, new features and better image detail thanks to the lack of a low pass filter.

The introduction of the D7100 closed the gap between the older D7000 and Nikon's newer full-frame D610 and D800 models. This camera utilizes a sensor with Nikon's proprietary DX format that is, in fact, slightly larger than standard APS-C models but still has an effective crop factor of 1.5. At the time it was introduced, it was the only DX-series camera without a low pass filter. Since then, the D5300 has followed the trend, offering better detail rendition but a greater risk of moirés and other unwanted image artifacts.

The D7100 has a 51-point AF system (compared with the D7000's 39 points) with 15 cross sensors in the center of the frame that work all the way down to f8, keeping AF effective with less bright lenses and even with longer lenses used with a teleconverter. The AF module itself is the same as the one built into the D4 and the D300s, so we assume that it uses the same focusing algorithms.

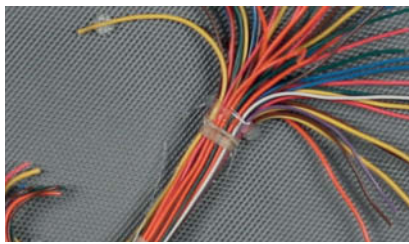
The D7100 has added a 1.3x crop factor focus area in the center of the sensor that reduces image resolution from 24.1 to 15 megapixels but increases burst shooting speed to a maximum of 7fps and provides a frame that is entirely covered by phase detection AF sensors. This mode can also be used to capture Full HD video at frame rates of up to 60 half frames per second. If you shoot video using the entire sensor, the maximum frame rate is 30 full frames per second.

New, Larger Monitor

The D7100's monitor has grown to 3.2 inches (compared with the D7000's three-inch model) and its resolution has been upped from 920,000 to 1.229 million dots. Because of the additional white pixels that provide increased image brightness, the actual resolution is equivalent to VGA – i.e., (640x480)x4 dots. Frame coverage is 100 per cent and Nikon claims a viewing angle of up to 170 degrees.

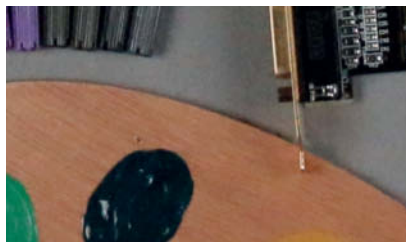
Unfortunately, Nikon has stuck to using a fixed monitor, which makes overhead and macro shooting more tricky than it needs to be.

Canon EOS 70D ISO Bracketing



ISO 100

These images show 100 percent crops from an ISO bracketing sequence of our c't test scene captured using a 100mm f/2 Zeiss Makro-Planar T*. Compared with the



ISO 3200

Nikon, the Canon did a better job of differentiating between red tones and produced better detail rendition in the texture of the sieve in the background (at



ISO 12800

ISO 100). These attributes are also visible in the woodgrain of the artist's palette at ISO 3200.

Performance Comparison

We put both cameras through their paces in the lab and in the real world to see which is the leader in a number of important respects.

Both cameras are extremely well balanced but, as expected, differ in their overall handling concepts. The Nikon's mass of features are organized in a fairly complex menu system with a large number of sub-menus, whereas the Canon system is

organized in clear, single-page menus that require no vertical scrolling – an approach that is much easier for newcomers to come to grips with.

The buttons and controls are arranged differently too. The Canon has six direct access buttons on its top plate, five of which are dedicated to various exposure parameters (ISO values, metering etc.), while most of the the Nikon's exposure-related buttons are located to the left of the monitor. At the end of the day, the system you prefer is a matter of personal taste.

Both test models have two main dials that, in spite of their differing positions on the

camera body, can be easily operated with your shutter finger and thumb. The dedicated buttons on the Nikon's top plate include settings for exposure compensation and metering mode.

In the monitor stakes, the Canon's tilt, swivel and touch-capable model is clearly miles ahead of the Nikon's fixed offering.

Lab Test Results

Resolution: While the Nikon's 24-megapixel sensor is theoretically capable of resolving up to 2,000 line pairs (lp/h), the Canon's sensor is

TEST RESULTS, PART 1

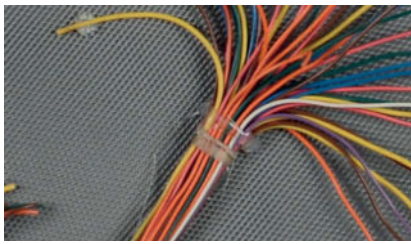
	Sensor resolution [lp/h] better >	Center resolution (ISO 100, wide-angle)/Sensor resolution [%] better >	Center resolution (ISO 100) [lp/h] better >	Center resolution (ISO 400) [lp/h] better >	Center resolution (ISO 1600) [lp/h] better >	Center resolution (ISO 3200) [lp/h] better >
Canon EOS 70D ¹	1824	86	1575	1554	1534	1368
Nikon D7100 ²	2000	90	1808	1685	1588	1506

TEST RESULTS, PART 2

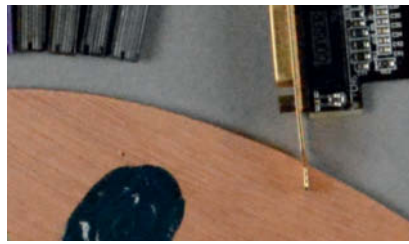
	Real image range [# of tonal values] better >	Color Checker SG ΔE ISO 100 < better	Signal-to-noise ratio [S/Nx] ISO 100 better >	Signal-to-noise ratio [S/Nx] ISO 400 better >	Signal-to-noise ratio [S/Nx] ISO 1600 better >	Signal-to-noise ratio [S/Nx] ISO 3200 better >
Canon EOS 70D ¹	255	12.2	65	47	31	28
Nikon D7100 ²	255	9.0	70	55	36	33

¹ Resolution tested using a Canon EF 50mm f/2.5, AF tested using a Canon EF 24-70mm f/2.8 ² Resolution and AF tested using a Nikkor AF-S 105mm f/2.8

Nikon D7100 ISO Bracketing



ISO 100



ISO 3200



ISO 12800

To make comparing the results easier, we shot our Nikon test images using the same Zeiss 100mm f/2 Makro-Planar T* lens. The Nikon exposes slightly more modestly

than the Canon and shows more natural color reproduction – for example in the metal parts of the PC card in the center image. Noise in monochrome image areas,

too, is less pronounced than it is in the Canon images.

‘only’ capable of a theoretical maximum of 1824 lp/h.

However, this nominal difference doesn’t really say anything about the actual amount of image data either sensor is capable of delivering and only defines a theoretical maximum that can be captured if every pixel always functions perfectly. To find out just how well both cameras reproduce the scenes they capture, we made test shots of a chart containing textures that are finer than the theoretical maximum resolution that each camera can reproduce. We then analyzed the resulting (camera JPEG) images using dedicated software to calculate the real resolution for each.

The results show that, measured absolutely, the Nikon has the edge over the Canon (see the table below). At ISO 100, the D7100 resolves just over 1800 lp/h of real texture, while the EOS 70D only manages about 1570 lp/h and continues to lag behind at higher ISO values too.

However, the difference is reduced if we express our measured values as a percentage of the theoretical maximum of 24 megapixels for the Nikon and 20.2 megapixels for the Canon. Measured this way, the Nikon is still in front at ISO 100, producing a value of 90% against the Canon’s 86%, although the differential disappears completely at higher

ISO values and shows the EOS with a clear lead.

To conclude, the Nikon wins the resolution shootout due to its better absolute values, although these are largely due to its higher nominal sensor resolution. The Canon utilizes its available resolution more effectively at higher ISO values. Whether these differences make any practical difference is a moot point, as they only become apparent at very high magnifications.

Noise characteristics: In this respect, too, our test candidates produced very similar results. Both showed very good noise behavior in the lab, although the Nikon is

Center resolution (ISO 6400) [lp/h] better >	Dynamic range ISO 100 [f-stops] better >	Dynamic range ISO 400 [f-stops] better >	Dynamic range ISO 1600 [f-stops] better >	Dynamic range ISO 3200 [f-stops] better >	Dynamic range ISO 6400 [f-stops] better >
1317	9.7	9.3	9.3	9.0	8.3
1525	10.3	9.3	8.7	8.3	7.7

Signal-to-noise ratio [S/Nx] ISO 6400 better >	Visual noise OECF20 ISO 100 < better	Visual noise OECF20 ISO 400 < better	Visual noise OECF20 ISO 1600 < better	Visual noise OECF20 ISO 3200 < better	Visual noise OECF20 ISO 6400 < better
22	1.1	1.5	2.2	2.5	3.4
29	0.9	1.4	2.1	2.4	3.1

once again just ahead of the Canon in the visual noise stakes throughout the entire ISO range. It also produced significantly better signal-to-noise ratios. Visually, this difference only becomes apparent at ISO 1600 and above. At values of ISO 6400 and more, both cameras produce obvious noise artifacts, although these are well within the acceptable limits for normal viewing.

When comparing the test shots of our chart, we noticed that the noise produced by the D7100 is more prevalent in darker image areas, while the EOS 70D also produced visible noise in the midtones. To help you study the differences in detail, we have included all of our test shots on this issue's free DVD.

Dynamic range: Our contrast tests reveal the absolute number of different tonal values that each camera can differentiate as well as the range of f-stops they can capture. At ISO 100, the Nikon is once again slightly ahead,

with a value of 10.3 f-stops compared with the Canon's 9.7. At higher values, both cameras produced very similar results, and the Canon nosed ahead from ISO 1600 onward, showing half a stop more contrast than the Nikon at ISO 6400.

Color reproduction: This test analyzes the accuracy with which a particular camera/lens combo reproduces colors. The greater the ΔE value, the less accurate the color reproduction. Our test showed that both cameras deliver values that border on being too high, with the Nikon once again nosing ahead of the Canon. We found that the Canon tends to increase color contrast too much at ISO 100, and that the Nikon produces more neutral and natural-looking images.

The D7100 also tends to underexpose more than the 70D, and we sometimes had to deliberately overexpose by as much as a whole stop to utilize the full range of the

histogram curve. This tendency gives you an additional degree of safety when shooting bright details but poses the risk of a lack of shadow detail, especially in JPEG-only mode. Any discrepancies are easy to counteract at the post-processing stage if you shoot RAW.

Conclusions

Judged by our test results alone, the Nikon is the clear winner on virtually all counts, although to be fair, the overall dynamic range and noise results are as good as a tie.

The EOS 70D scores much better in the 'value for money' stakes with its articulated touch screen, clear menus, built-in Wi-Fi and its fast live view autofocus that makes shooting video a lot of fun. (keh)

Canon EOS 70D

👍 Good:

- Wi-Fi
- Touch screen functionality
- Articulated monitor
- Easy-to-understand menus
- Fast live view autofocus
- Dust and moisture seals
- High build quality
- 7 fps (JPEG)
- Built-in electronic level
- Live histogram
- Additional help screens
- Large ISO range
- Great image quality at high ISO values

👎 Not so good:

- Wi-Fi setup complicated
- Only one memory card slot
- No remote video capture functionality
- Live view switches off during burst shooting

Nikon D7100

👍 Good:

- Image quality
- Great high ISO performance
- 1.3x (18:12) image area crop mode
- Twin SD card slots
- No low pass filter
- Two mode dials
- 6 fps burst shooting
- 7 fps burst shooting in crop mode
- In-camera RAW processing
- Advanced AF system from the pro-grade D4
- Weather and moisture-sealed body
- Huge range of shooting and editing options

👎 Not so good:

- Fixed monitor
- No live histogram

TECHNICAL DATA



Manufacturer/Model	Canon EOS 70D	Nikon D7100
URL	www.canon.com (www.usa.canon.com)	www.nikon.com (www.nikonusa.com)
Digitization		
Image resolution (max. for each aspect ratio/crop ratio – in pixels)	5472 × 3648 (3:2), 4864 × 3648 (4:3), 5472 × 3072 (16:9), 3648 × 3648 (1:1), 5472 × 3648 (RAW)	6000 × 4000 (24 × 16 image area), 4800 × 3200 (18 × 12 image area)
Color depth	42-bit	36-bit
Sensor type, Effective megapixels / Size	CMOS, 20.2 / 22.5 mm × 15.0 mm	CMOS, 24.1 / 23.5 mm × 15.6 mm
Image format(s) / Compression levels / Video format	RAW, JPEG, RAW+JPEG / 2 / MOV (H.264)	NEF (RAW): 12 or 14-bit, JPEG, NEF (RAW)+JPEG / 3 / MOV (H.264)
Max. video resolution (in pixels), fps	Full HD 1080p, 24, 25, 30	Full HD 1080p, 24, 25, 30, 50i, 60i
Memory card type(s)	SD, SDHC, SDXC	SD, SDHC, SDXC
Features		
Crop factor / Lens bayonet	1.6 / Canon EF	1.5 / Nikon F
ISO range	Auto (100-12 800), 100-12 800 (in 1/3 or 1/1 steps), extendable to 25 600	ISO 100-6400 in 1/3 or 1/2 EV increments. Additional settings of approx. 0.3, 0.5, 0.7, 1 or 2 EV above ISO 6400 (equivalent to up to ISO 25 600), Auto ISO user adjustable
Exposure times (sec.) / Shortest flash sync speed (sec.)	30-1/8000 s (in 1/2 or 1/3 EV steps), Long exposures (B) / 1/250 s	30-1/8000 s (in 1/2 or 1/3 EV steps), Long exposures (B), Timed exposures (T), X250 / 1/320 s
Focus	Autofocus: Dual Pixel CMOS AF (with face recognition and AI Servo AF for moving subjects, FlexiZone-Multi, FlexiZone-Single), phase detection AF (Quick mode); plus manual focus	Autofocus: Single-servo (AF-S), Continuous-servo (AF-C), Auto-servo (AF-A); predictive focus tracking (reacts automatically to moving subjects; plus manual focus
AF system / Focus assist lamp	19-point (all cross sensors) / ✓	51- or 11-point (51-point with 15 cross sensors) / ✓
Metering: Matrix / Center-weighted / Spot	✓ / ✓ / ✓	✓ / ✓ / ✓
Shooting modes	Scene Intelligent Auto (stills and video), Flash Off, Creative Auto, Special Scene Mode (Portrait, Landscape, Close-up, Sports, Night Portrait, Hand-held night Scene, HDR Backlight Control), Programmed Auto, Aperture-Priority AE, Shutter-Priority AE, Manual (stills and video), Bulb exposure, Custom	Auto modes (auto; auto [flash off]); programmed auto with flexible program (P); shutter-priority auto (S); aperture-priority auto (A); manual (M); scene modes (Portrait; Landscape; Child; Sports; Close up; Night Portrait; Night Landscape; Party/Indoor; Beach/Snow; Sunset; Dusk/Dawn; Pet Portrait; Candlelight; Blossom; Autumn Colors; Food); Special Effects modes (Night Vision; Color Sketch; Miniature Effect; Selective Color; Silhouette; High Key; Low Key); custom user settings U1 and U2
Exposure: Shutter priority/ Aperture priority / Manual	✓ / ✓ / ✓	✓ / ✓ / ✓
Exposure compensation (in EV)	±5 EV in 1/3 or 1/2 increments	±5 EV in 1/3 or 1/2 increments
Bracketing: Exposure / WB / Focus / Interval timer / Sound capture	✓ / ✓ / - / - / ✓ (stereo)	✓ / ✓ / - / ✓ / ✓ (stereo)
Self timer / Burst rate (JPEG) ¹	10 or 2 s / 7 fps (JPG) up to a maximum of 65 shots	2 s, 5 s, 10 s, 20 s / 6 fps (JPG)
Auto and manual white balance	✓	✓
Viewfinder: Type / Magnification / Coverage / Eyepoint	Pentaprism / 0.95× / 98 % / 22 mm	Pentaprism with fixed exit pupil / 0.94× / 100 % / 19.5 mm
Monitor: Swivel / Tilt / Touch	✓ / ✓ / ✓	- / - / -
Monitor: Diagonal / Resolution (dots) / Brightness adjustment	3.0" / 1,040,000 / ✓	3.2" / 1,228,800 / ✓
Live view	✓	✓
4-way selector / Multi selector / Command dials	✓ (8-way + center button) / 2 / 2	✓ (8-way + center button) / 2 / 2
Flash: Guide number (ISO 100) / Connector	12 / ✓ (E-TTL II)	12 / ✓ (i-TTL)
Memory card slots	1	2
Playback		
Grid (# of image) / Zoom / Histogram	9 or 4 / ✓ / ✓	4, 9, 72 / ✓ / ✓
Connectors / Dimensions		
Power source	AC adapter, Li-Ion battery	AC adapter, Li-Ion battery
Connectors	USB 2.0, PAL/NTSC video out (built into USB connector), Mini HDMI out, external microphone (3.5mm stereo)	USB 2.0, Mini HDMI (Type C), external microphone (3.5mm stereo)
Wi-Fi / GPS built in	✓ / -	- / -
Dimensions (W × H × D) / Weight (w/battery and memory card)	139 × 104 × 79 mm (5.5 × 4.1 × 3.1 inches) / 755 g (1 lb 10.6 oz)	136 × 107 × 76 mm (5.3 × 4.2 × 3.0 inches) / 765 g (1 lb 11 oz)
What's in the Box		
User manual	Quick start guide, manual, Wi-Fi guide, CDs	CD, manual
Supplied accessories	Li-Ion battery LP-E6 (7.2 V, 1800 mAh, 13 Wh), battery charger, body cap, shoulder strap, USB interface cable, eyecup	Li-Ion battery EN-EL15, battery charger, strap, USB cable, Nikon ViewNX 2 software, body cap, rubber eyecup, eyepiece cap, accessory shoe cover
Optional accessories	Dioptric correction lenses, eyepiece extension, angle finder, leather case, battery grip, remote release, hand strap	Wireless remote adapter, angle finder, Multi Power Battery Pack
MSRP: Body only / With kit lens	US\$1,200 / US\$1,549 (18-135mm f/3.5-5.6 STM)	US\$1,199 / US\$1,449 (AF-S DX Nikkor 18-105mm f/3.5-5.6G ED VR)

¹ Measured values ✓ included - not included

Sophia Sieber

OM-D E-M1

Watch out DSLRs!

The Olympus OM-D E-M1 presents a new kind of challenge to the dominance of traditional DSLRs. Looks-wise, this new Micro Four Thirds flagship model borrows heavily from traditional SLR design – read on to find out how it performed in our comprehensive test.



The OM-D E-M1 isn't just the successor to the OM-D E-M5 – it is also a genuine professional-grade camera with a feature set to match. Its built-in grip and huge range of buttons and controls make its target market abundantly clear, although its diminutive size and Micro Four Thirds lens mount make it an interesting contender in the compact system camera segment as well.

The reworked sensor in the new camera measures the same 17.3 mm × 13.0 mm as its predecessor but delivers 16.3 megapixels of resolution and is supported by the new TruePic VII image processor. There is now a LOW sensitivity setting equivalent to ISO 100

(i.e., below the low end of the Auto ISO range of 200-25 600) and a large 2.3 million-dot electronic viewfinder. The weatherproof body also has five-axis image stabilization, built-in Wi-Fi connectivity and a raft of other features including Live BULB shooting, focus peaking and burst shooting rates of up to 10 frames per second.

The bad news is that all these features don't come cheap. The US\$1,500 asking price for the body alone will buy you a Canon EOS 70D or a Nikon D7100 with a lens included. Olympus is proud of its latest baby and has entered the market with the clear intention of winning market share from the APS-C and

full-frame DSLR competition. We tested whether the E-M1 keeps it promise.

Handling: In spite of retaining the pseudo mirror box, the E-M1 has lost some of the 'retro' charm of the E-M5 and has traded some of its predecessor's good looks for a number of practical features. The built-in grip makes the camera easier to handle and provides more space for the camera's controls – obviously in response to user criticism of the first OM-D's fiddly buttons. The dedicated function buttons are now much bigger and give the user plenty of surface space to work with.

Olympus has made the two main control dials even more important, using them not only to control aperture and exposure compensation but also for optional ISO and white balance control. In combination with other buttons, the main dials can also be used to alter focus mode, metering mode and burst shooting settings. This means that, with a little practice, you can alter all the major shooting parameters without taking your eye away from the viewfinder. And what a viewfinder! It is large and clear and provides great contrast that we found to be just as good as most optical viewfinders. Our only real complaint is that some colors (especially greens) often appeared too saturated.

There are no major changes to the menu system, and all the most important shooting parameters can be altered directly in the main monitor display. In playback mode, the shooting parameters shift to the right-hand edge of the monitor. So far, so simple. However, things get more complex if you stray from the main settings into the depths of the other menus. Among the more 'hidden' features are the new Color Creator, which



The latest Olympus pro-grade camera is highly configurable and includes the new Color Creator feature, with which you can adjust the color temperature and saturation of your images

OM-D E-M1	
Technical Data	
Sensor	Live MOS, Micro Four Thirds (17.3 mm × 13 mm)
Resolution	16 megapixels
Viewfinder	2.36 million dots
Monitor	LCD, 3-inch, 1.04 million dots
Dimensions (W × H × D)	130 mm × 96 mm × 63 mm
Body type, Weight	Magnesium alloy, 443 g (15.6 oz.)
MFRSP	US\$1,500
Test Results	
Center resolution ¹	1738 / 1616 / 1548 line pairs
Signal-to-noise ratio ¹	57 / 44/ 33
Visual noise ¹	1.1 / 1.6/ 2
Dynamic range ¹	13.3 / 11/ 10
Shutter lag (with autofocus)	0.17 s
¹ at ISO 200 / 800 / 3200	

enables you to create your own 'art' filters and adjust image saturation and color. This powerful feature can present risks if used too generously, as it is all too easy to produce unintentional color casts. The tool can be accessed via a long press of the Fn2 button and its settings are adjusted using the front and rear dials. The Color Creator and the art filters are included in the mode menu, but likely as not, you will soon forget that they are there.

Built-in Wi-Fi is new too, and can be activated in several different ways, including via a soft button on the touch screen monitor. Tapping this button displays a QR code that you can scan using the *Olympus Image Share* Android/iOS app to automatically set up a Wi-Fi connection to your smartphone. The app can be used to share photos and remotely control P, A, S, M and Auto shooting modes, ISO settings, exposure compensation and white balance.

The app crashed a few times during our test, and we found that it worked better with some smartphones than with others. For example, the live view display on our HTC Sensation XE (with Android 4.0.2) was smooth and easy to use, while the app behaved jerkily and unresponsively when used on a Galaxy Note 2 with the latest software on board. If you want to avoid surprises, always try before you buy.

Test results: Olympus claims that the E-M1 produces the best ever image quality delivered by a Micro Four Thirds camera, and our test results largely bear this out. The E-M5 only produced slightly better noise characteristics in the lab. The E-M1 produced a signal-to-noise ratio of 57 at ISO 200 (compared to the E-M5's 69), which is OK but not spectacular. Visual noise was low in both



The new Live Bulb feature lets you precisely control the length of your long exposures

models, measuring 1 for the E-M5 and 1.1 for the E-M1. The E-M1's kurtosis value is lower than the ones we measured for the Fujifilm X-M1 and the Canon EOS 70D, indicating that Olympus has decided to go for only moderate in-camera noise reduction in the new model.

At more than 13 stops, the camera's dynamic range is truly impressive. It leaves even pro-grade full-frame cameras like the Canon EOS 5D Mark III standing and beats the Fujifilm X-M1 (12.3 stops) and the Canon EOS 70D (9.7 stops) hands down.



The built-in 'Art Filters' give you a range of image editing options that can be performed in-camera without using a computer at all

Detail from the c't studio test scene



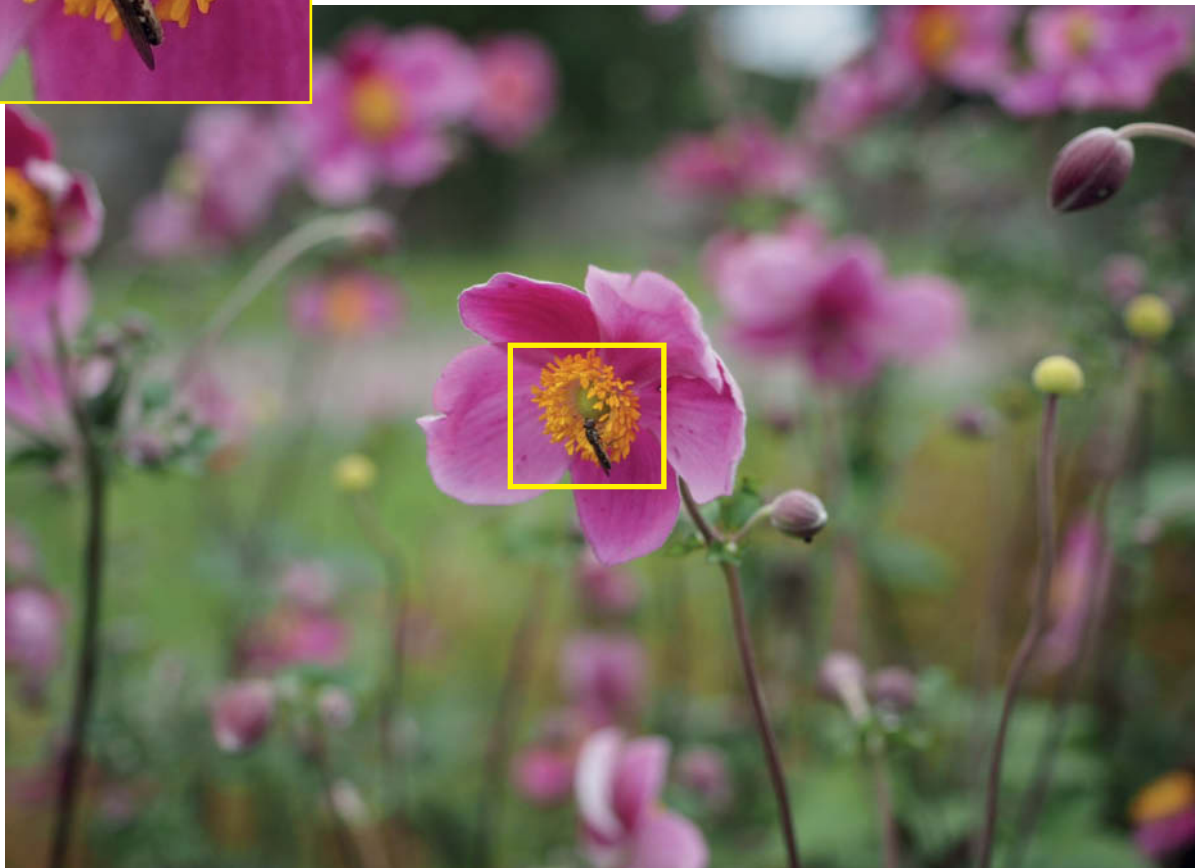
Resolution is faultless too. Using the M.Zuiko Digital ED 60mm f/2.8, we measured 1738 line pairs in the center of the frame at ISO 200, which is actually higher than

the theoretical maximum of 1728! This discrepancy is due to the pixel structure of the diagonal lines in the various segments of the Siemens Stars we use to measure

resolution, not to inaccuracies in our test system. As corollary proof, the E-M1 produced the same excellent results all the way up to ISO 6400.



This shot was captured using the new M.Zuiko Digital 12-40 mm f/2.8 PRO zoom. We didn't have time to perform a thorough lab test on the lens before going to press but, viewed subjectively, our images were extremely clear and sharp with great detail rendition.



ISO 400 | 32 mm | f2.8 | 1/800s

Image quality: Our lab and real-world imaging tests confirmed the excellent overall quality of the E-M1, which rewards its user with extremely sharp, detailed and well-exposed images across the entire aperture range, although we did notice a slight tendency toward JPEG over-sharpening at high ISO values (see below and the test images included on this issue's free DVD).

Olympus explicitly stresses the improvements it has made to the reproduction of skin tones at high ISO values, although we were only partially able to confirm this claim and found that skin textures begin to look too soft and unwanted artifacts and color casts begin to appear in portrait

shots at ISO 3200. These attributes are simply not as obvious in photos shot using cameras with larger sensors.

In the real world, we were unable to reproduce the fantastic dynamic range we recorded in the lab and the skies in some of our outdoor test shots were too white and lacked detail.

Conclusions

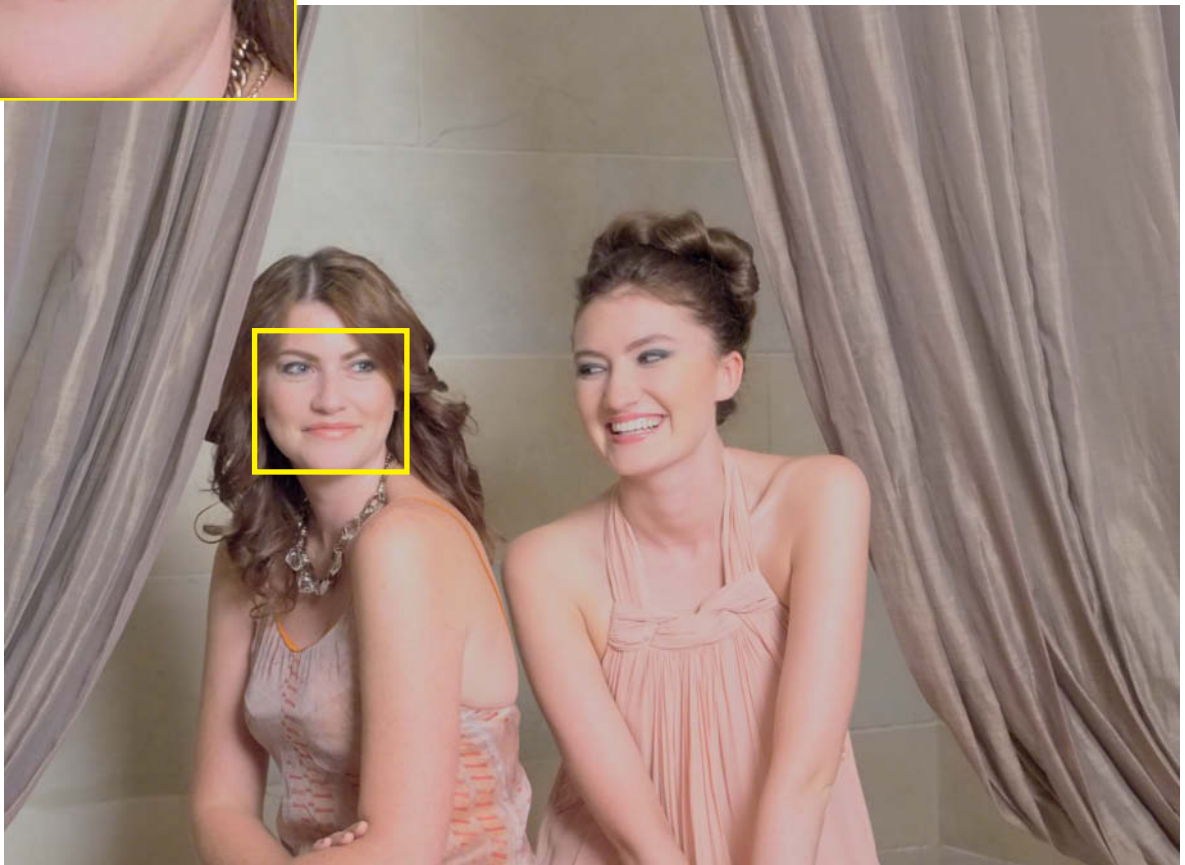
The E-M1 is a highly successful follow-up to the original OM-D and will satisfy even the most demanding photographers. Olympus has obviously listened to the community and made changes in all the right places.

The major improvements are the larger viewfinder, better handling and improved shooting speed. We measured shutter lag of just 0.17 seconds in autofocus mode – a value that many current DSLRs cannot equal, especially in live view mode. Weatherproofing and an articulated display add value to the package and the quality of the images the E-M1 produces leaves little to be desired. It is only in the noise stakes that the comparative weakness of the smaller sensor becomes apparent. It will be interesting to see how the E-M1 establishes itself in the marketplace, especially since the appearance of the Sony A7 full-frame mirrorless model at a similar price level.

(ssi) **c't**



For a mirrorless system camera with a relatively small Micro Four Thirds sensor, the E-M1 has highly civilized noise characteristics. In portrait shots, we began to notice blurred textures and color casts at ISO 3200 and above.



ISO 3200 | 35 mm | f4.0 | 1/40 s

Thomas Hoffmann

Zeiss Touit Lenses for Mirrorless ILCs

The lenses in the Zeiss Touit range are the first models from the high-end manufacturer designed for mirrorless system cameras from Sony and Fujifilm. We took a look at how these new electronic models stand up against their manual, full-frame cousins.

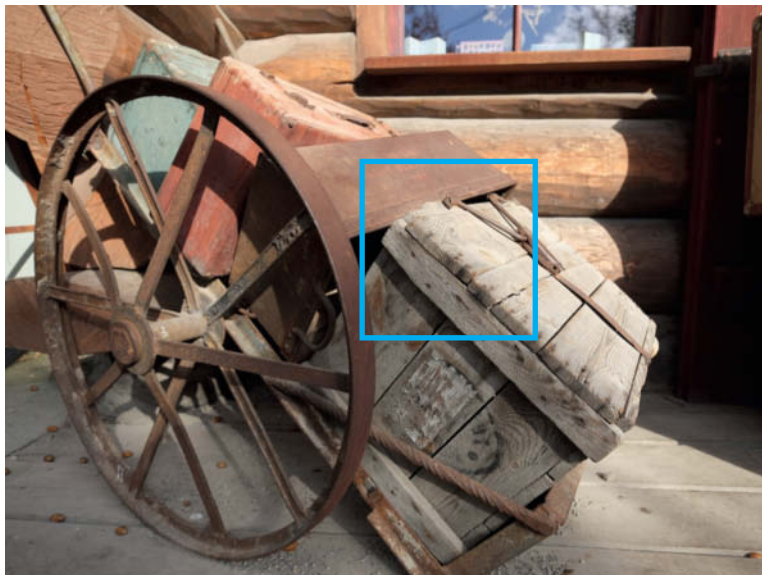
The lenses: Like the Zeiss lenses for Sony's A-mount, the new E-mount Touit lenses for Sony and X-mount lenses for Fujifilm ILCs are equipped with autofocus and electronic aperture control. The Sony versions have no built-in image stabilization, which makes them slightly shorter and lighter than their Fujifilm counterparts. Zeiss tells us that the necessary components were developed in cooperation with their manufacturing partners in Japan. We tested the 12mm f/2.8

wide-angle and 32mm f/1.8 standard models for Fujifilm cameras.

Unlike their manual cousins, the Touit lenses are not made completely of metal, and the overall build quality suffers due to the

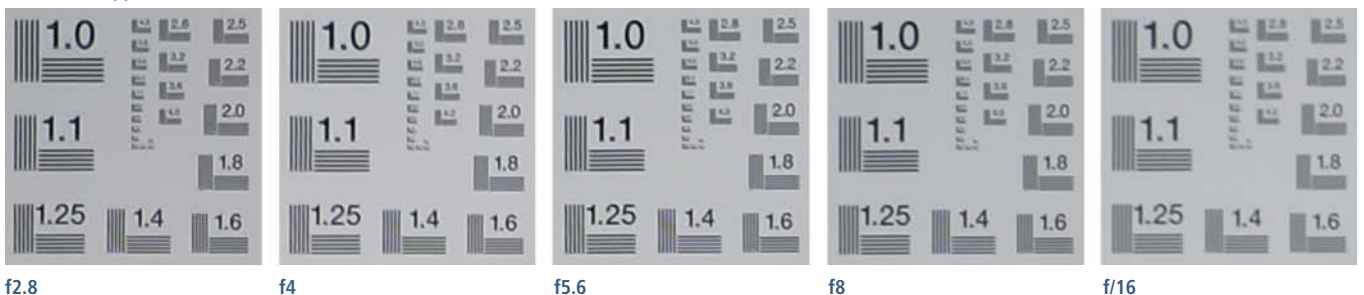


X-MOUNT TOUIT 2.8/12	
Technical Data	
Focal length (Equivalent)	12 mm (18 mm)
Aperture range	f2.8-f22
Aperture blades	9
Minimum focus distance	0.18 m (7 inches)
Length / Diameter	65 mm / 88 mm (2.55 / 3.46 in.)
Weight (with sunshade)	270 g (9.52 oz.)
Price	US\$999
Test Results	
Center resolution (open / +2)	1958 Lp/h / 1958 Lp/h
Edge resolution (open / +2)	1294 Lp/h / 1387 Lp/h
Distortion	0
Vignetting (open / +2)	1.1 / 0.6



Fujifilm X-E1 | ISO 400 | 18 mm | f2.8 | 1/2500 s

Below: The upper left-hand corner of the c't lab test scene



plasticky feel of some of the components. We would prefer to see a stiffer aperture ring with more distinct click stops and the focus ring, too, underscored our slightly disappointing initial impression. Otherwise, build quality is excellent, with smooth and reliable focusing by wire.

However, the high quality of Fujifilm’s own lenses makes it difficult to justify the price of the Zeiss newcomers based on build quality and design alone. A direct comparison with Fuji’s XF 14mm f/2.8R and XF 35mm f/1.4R

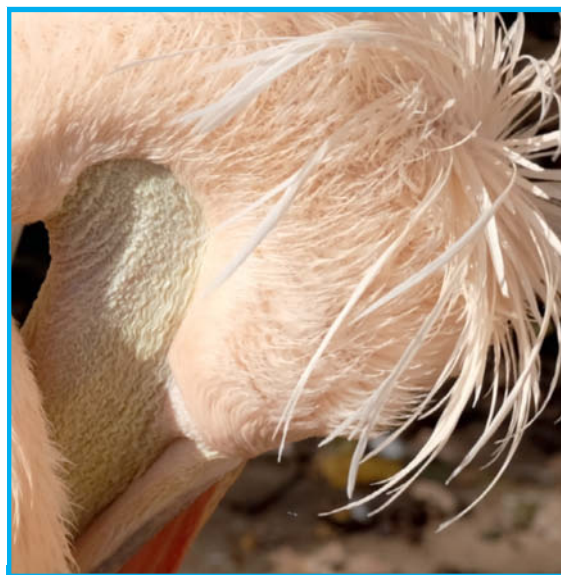
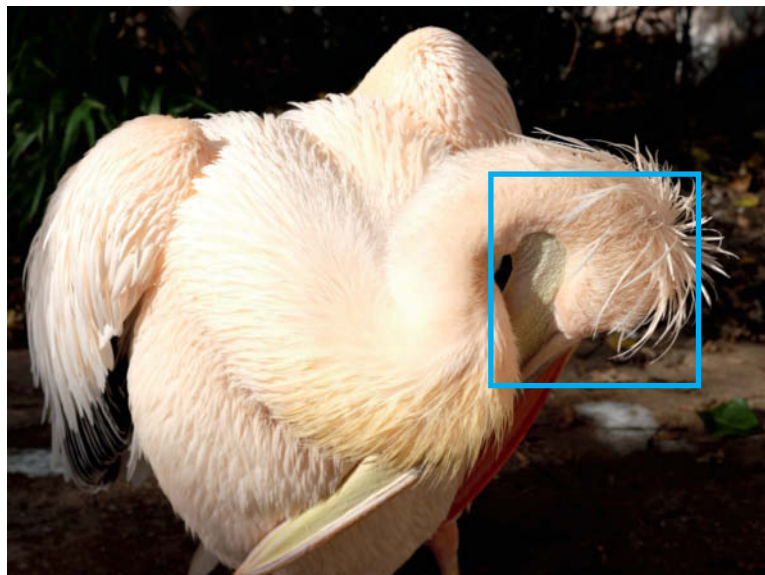
lenses sees the Japanese models as clear winners in the price stakes. Our lab tests should help you to decide whether the optical quality of the Zeiss models is worth the extra expense.

Image quality and test results: In the lab, the **Touit 2.8/12** produced extremely high center resolution that utilizes the sensor’s reproduction qualities to the full and captured images with great contrast. Sharpness drops off by about 20 per cent towards the edges, resulting in resolution of 1294 Lp/h and obviously lower contrast. Closing the aperture down by two stops improves contrast by about 100 line pairs and increases overall contrast, which in turn increases the subjective sharpness of the results. Our test chart shots have a highly tactile feel, even at maximum aperture, and things get even better stopped down. Landscape fans can stop the Touit right down to f16 without endangering image quality, and it is only at the very smallest end of the aperture range that image quality suffers.

Zeiss has done a great job of correcting distortion. Straight lines remain straight right up to the corners of the frame, making this lens a great choice for architectural



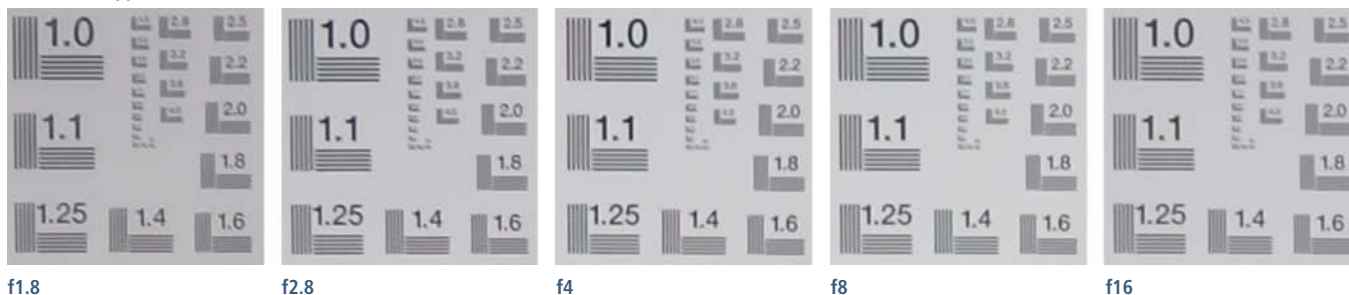
X-MOUNT TOUIT 1.8/32	
Technical Data	
Focal length (Equivalent)	32 mm (48 mm)
Aperture range	f1.8-f22
Aperture blades	9
Minimum focus distance	30 cm (12 inches)
Length / Diameter	58 mm / 75 mm (2.28 / 2.95 in.)
Weight (with sunshade)	210 g (7.4 oz.)
Price	US\$720
Test Results	
Center resolution (open / +2)	1745 Lp/h / 1958 Lp/h
Edge resolution (open / +2)	1172 Lp/h / 1068 Lp/h
Distortion	0.7
Vignetting (open / +2)	1.0 / 0.5



Photos: Thomas Hoffmann

Fujifilm X-M1 | ISO 200 | 48 mm | f5.6 | 1/750 s

Below: The upper left-hand corner of the c’t lab test scene



photographers. A chromatic aberration value of 1.1 pixels is not insignificant but is still not immediately obvious in our test shots. Vignetting of one stop wide open and half as much stopped down is a respectable result. Autofocus is pretty accurate but, just like the Fujifilm competition, is fairly slow.

The 32mm f/1.8 standard lens, too, produces high center resolution that exploits the Fujifilm X-Trans sensor's image capturing power to the full. Surprisingly, edge resolution falls off more with this lens than it does with the 12mm, measuring just 1172 out of a potential maximum of 1632 line pairs. Curiously, only the center of the frame benefits from stopping down, while the edges continue to lose resolution (1068 Lp/h) and also some contrast.

Like the wide-angle, vignetting registers a full stop wide open and half a stop with the aperture closed down. Focusing is slow and also less precise than the wide-angle, so it pays to check focus using the built-in monitor magnifier (provided of course that you are using the X-M1 like we were). Unlike the 12mm, the 18mm showed some distortion, registering a value of 0.7 per cent in our test. This is nevertheless a minimal issue that can be corrected quite easily. Our lab test results were mirrored by the shots we made of our test scene, with obvious differences in resolution between the center and the edges of the frame at all apertures.

Both lenses are high quality alternatives to their Fujifilm equivalents and provide spectacularly high center resolution. Landscape photographers in particular will have a lot of fun using the wide-angle stopped down to f16. (tho)

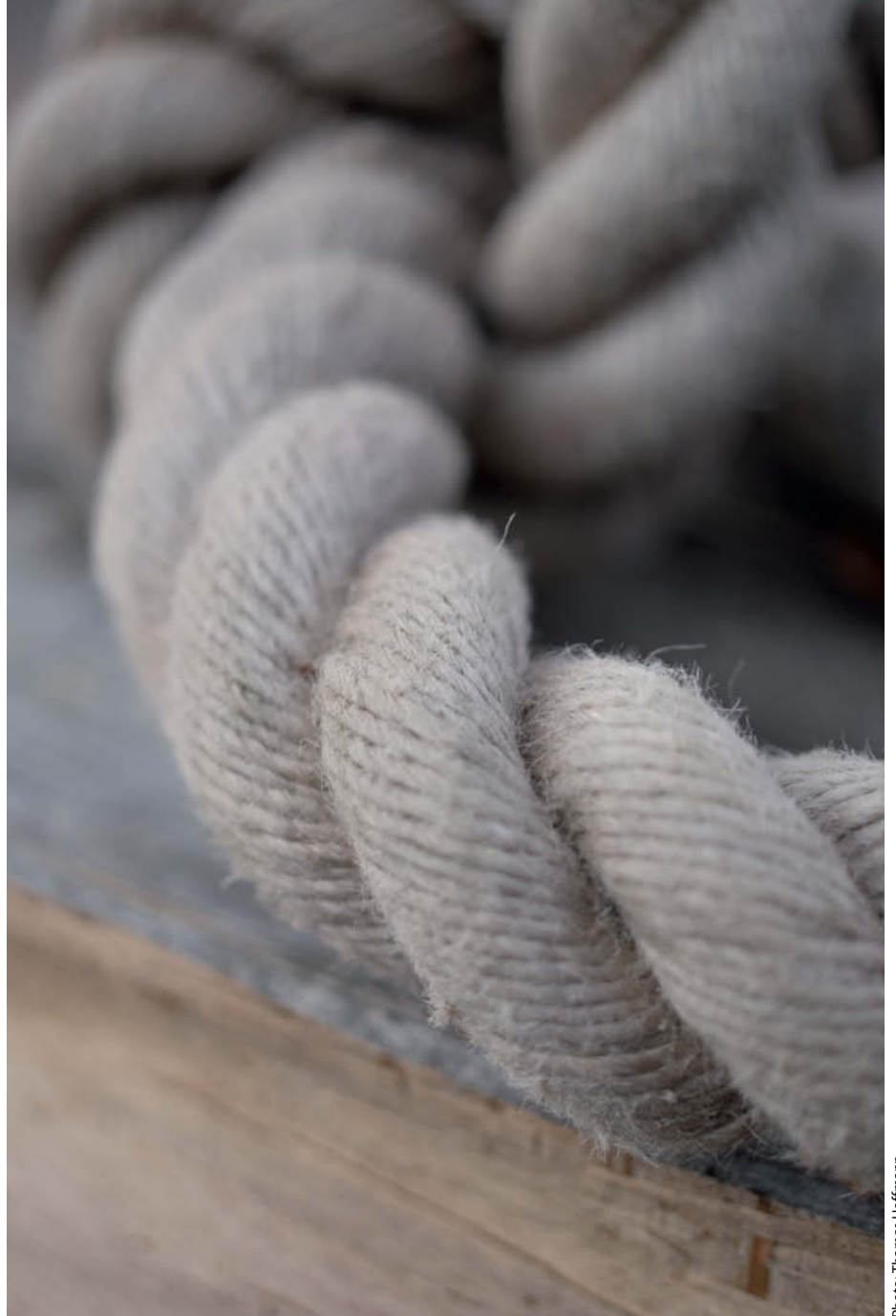


Photo: Thomas Hoffmann



Photo: Thomas Hoffmann

Wide open, the Touit 32 produces pleasing bokeh but requires precise focusing to make the most of the shallow depth of field

Fujifilm X-M1 | ISO 200 | 48 mm | f1.8 | 1/950 s | -0.3 EV

The wide-angle Touit 12 is perfect for capturing expansive outdoor scenes and interiors

Fujifilm X-F1 | ISO 400 | 18 mm | f2.8 | 1/3300 s



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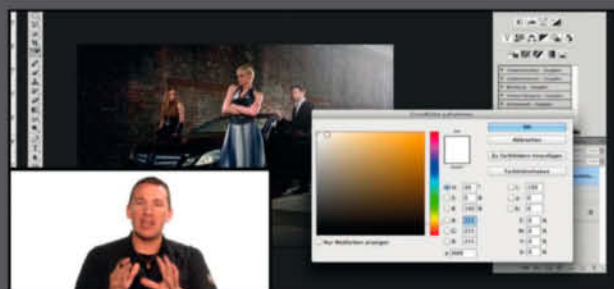


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Meet photo legends

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Sophia Sieber

Ultra-bright Prime for Micro 4/3

With its maximum aperture of an incredible f/0.95, the manual-focus Voigtländer Nokton offers skillful photographers plenty of creative potential.

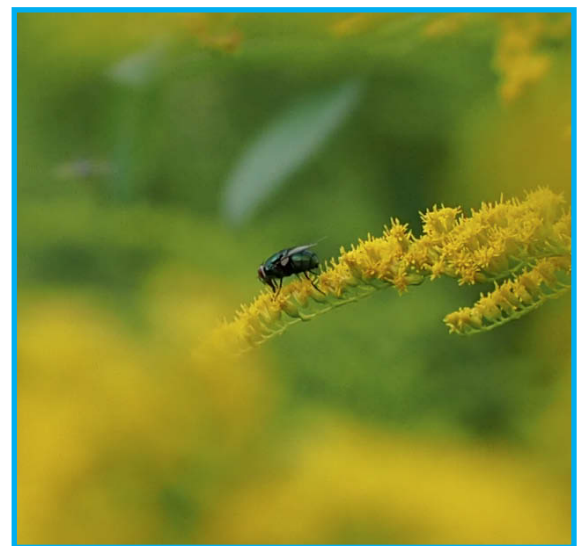
aperture, although edge resolution was around 20 percent poorer. Chromatic aberration measured an acceptable 0.8 pixels at f0.95. As we expected, vignetting turned



The lens: The Voigtländer Nokton 42.5mm f/0.95 is a manual-focus prime portrait lens designed for the Olypmus/Panasonic Micro Four Thirds (MFT) lens mount. Its maximum aperture of f0.95 and its all-metal build make it a pleasure to handle and a really exotic beast among the current crop of MFT lenses. Together with its custom sunshade, it weighs 620 grams, which is more than most Micro Four Thirds camera bodies!

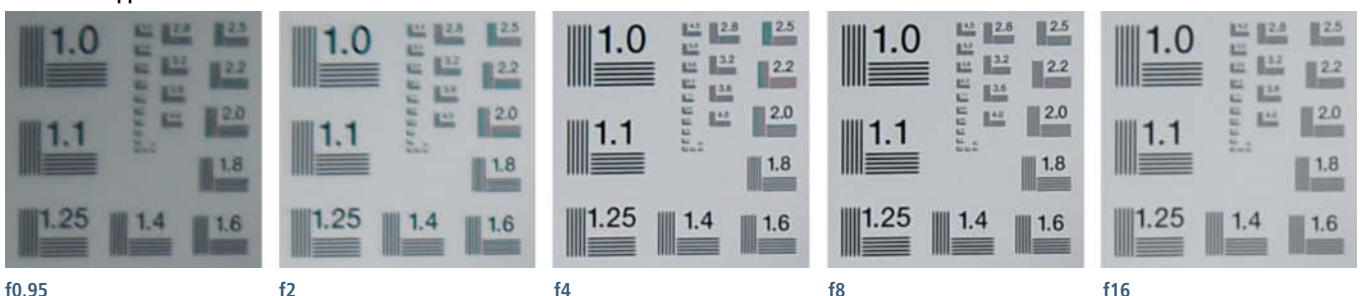
VOIGTLÄNDER NOKTON 42.5mm f/0.95	
Technical Data	
Focal Length (Equivalent)	42.5 mm (85 mm)
Aperture range	f0.95-f16
# of aperture blades	10
Minimum focus distance	23 cm (9 in.)
Length / Diameter	75 / 64 mm (2.83 / 2.51 in.)
Weight	620 g (21.9 oz.) incl.sunshade
MRSP	US\$999
Test Results	
zentrale Auflösung ¹	1627 lp/h / 1727 lp/h
Edge resolution ¹	1273 lp/h / 1471 lp/h
Distortion	-1.3
Vignetting ¹	1.5 / 0.2
¹ Wide open / Stopped down (-2 EV)	

Image quality and test results: The Nokton produced excellent results in the lab, delivering 94% central resolution (1627 out of a potential 1728 line pairs) at maximum



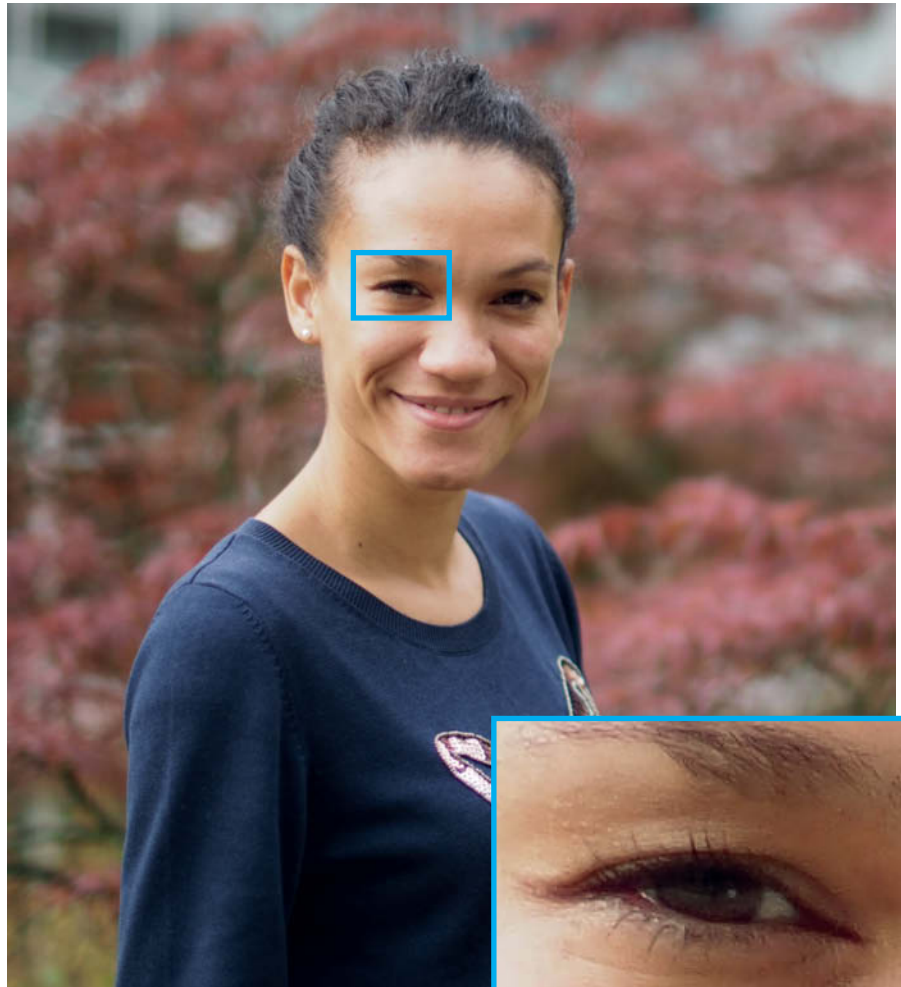
ISO 100 | 42.5 mm | f1.4 | 1/1600 s

Below: The upper left-hand corner of the c't lab test scene



out quite high at 1.5 stops. Stopping the lens down to f2 improves just about all its metrics, producing center resolution of 1727 line pairs (i.e., 99.9%) and virtually no vignetting at all. Our test shots (see the previous page and the archive on this issue's free DVD) clearly show that the lens produces its best performance between f4 and f8.

Our outdoor test shots were all extremely sharp, as illustrated by the maximum-aperture shot reproduced here. Using the Nokton slows you down a lot but rewards patient photographers with extremely pleasing, contrasty images with rich colors. Using its fantastic maximum aperture produces almost aura-like bokeh. (ssi)



The Nokton makes a fantastic portrait lens but requires a lot of skill and discipline on the part of the photographer and the model if you want to make the most of the shallow depth of field provided by its maximum aperture. The electronic viewfinder in our Olympus OM-D E-M5 test camera enabled us to magnify the area we focused on, thus ensuring perfect sharpness.

ISO 200 | 85 mm | f0.95 | 1/1400 s | Tripod



Low light situations, especially indoors, are where the Nokton shows its real strength, producing photos with a unique, almost dreamlike look

ISO 200 | 85 mm | f0.95 | 1/15 s | Tripod **ct**



Sascha Steinhoff

Similarity Searching in Image Archives

Searching for images using keywords is a poor technical solution that relies heavily on images being labeled correctly and comprehensively. Visual similarity searching, which uses an image as the basis for a search for other images, is more elegant and achieves better results. Many photo database applications now have this kind of functionality built in, so we decided to take a closer look at similarity searching in theory and practice.

The first recorded use of the adage "a picture is worth a thousand words" goes back to the 1920s, so it is obviously not a new insight. However, the idea has yet to gain a firm foothold in the world of information technology, and most digital photographers still search for images using keywords embedded in the name or metadata of the file in question.

Searching a database for keywords is relatively simple but is not particularly user friendly. Besides, adding keywords to archives is time-consuming, so most amateur photographers don't bother to do it comprehensively enough to make word searches effective. The next logical step is to dispense with the complex medium of words and use an visual starting point to find duplicates or different versions of an image, or other images that are similar to the original.

Similarity Search Software

Visually based search functionality has been part of various databases and standalone software for a number of years, but is still proving very difficult to implement effectively. Many such search tools have only limited capabilities and niche programs such as *iMatch* and *ThumbsPlus* have so far led the field. A number of standalone programs concentrate on finding duplicate images,

although many exist solely as platforms for distributing less useful freeware such as Amazon or Yahoo! toolbars.

Everybody's favorite image processing behemoth, Adobe, was unusually late to the game and only began offering visual search functionality a couple of years ago. Since then, *Photoshop Elements* has offered built-in visual similarity and duplicate searching tools that are a lot more useful than much of the competition. However, visual searching is still not a mainstream feature, and none of the market leaders, including *Lightroom*, and *Photoshop* include similarity searching functionality. *Aperture* offers face recognition but no visual similarity search functionality. Nevertheless, we are convinced that it is only a question of time before all the mainstream software manufacturers jump on board. This article takes a look at the most promising similarity search tools available and puts them through their paces. The 'Quick Test' table on page 64 details programs that didn't make it into our full test this time around.

How We Tested: Duplicates, Versions and Similar Images

We divided our test into three categories: duplicates, versions and similar images. Duplicate images (i.e., those containing exactly the same pixels as others) are the

easiest to find using software but are also extremely rare. Even output resolution varies from version to version, we have found, and different versions of an image are more common than true duplicates. Common editing steps such as cropping, tonal adjustments and unsharp masking alter the superficial appearance of an image but don't change the fundamental visual similarity between the original and the edited version. 'Similar images' as defined for the purposes of our test are not derived from a single source image and are more likely to be part of a sequence of images of a single subject, though they can stem from completely different sources too.

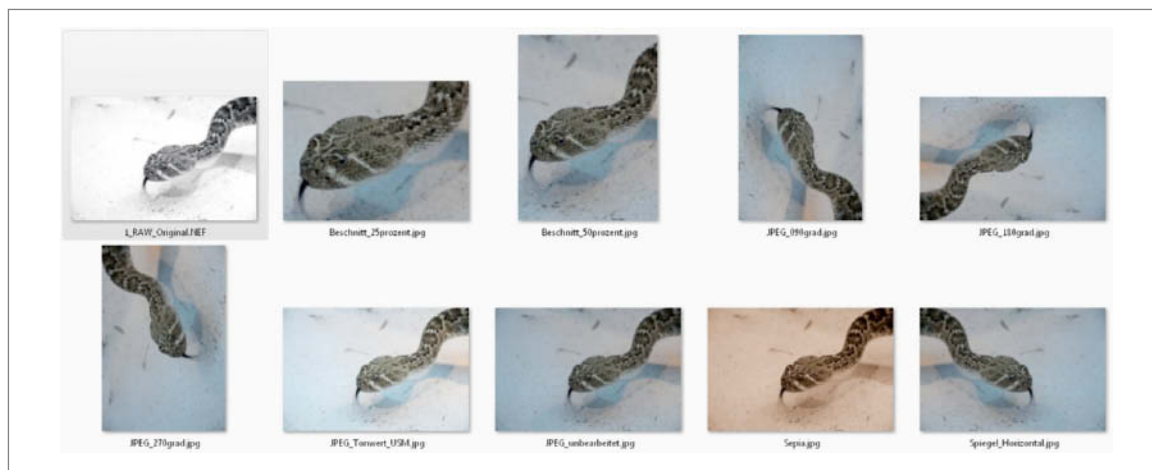
To test the ability of software to find duplicates and image versions, we used a benchmark that can be objectively defined and analyzed. To simplify the test process, we used a source image that was unique among those in our test archive.

In contrast, 'similarity' is a highly subjective attribute that is difficult to define clearly. To help judge the effectiveness of the test software, we performed our tests on common subjects that turned up more than once within our archive.

Our results show that programs perceive differences between duplicate, versions and similar images differently. Most programs allow you to set threshold values that are designed to help the software stick to a set



True duplicates of RAW files only exist if the original is not subjected to any changes. Every change of format produces a new version, even if you switch to a 'lossless' format such as 16-bit TIFF.



The more extensive the changes to an image, the more difficult it is for the software to identify similarities



The human eye can easily identify similar subjects within a series of differing images, while computers still find it difficult to perform the same trick. None of the programs we tested could reliably identify similar images.

degree of similarity, but that doesn't completely prevent them from dishing up some surprises. We used a variety of settings during our benchmarking process and selected the best for inclusion in our results. The lower the threshold value, the greater the number of matches and mismatches, so setting it too low makes it virtually impossible to tell the useful matches from the also-rans.

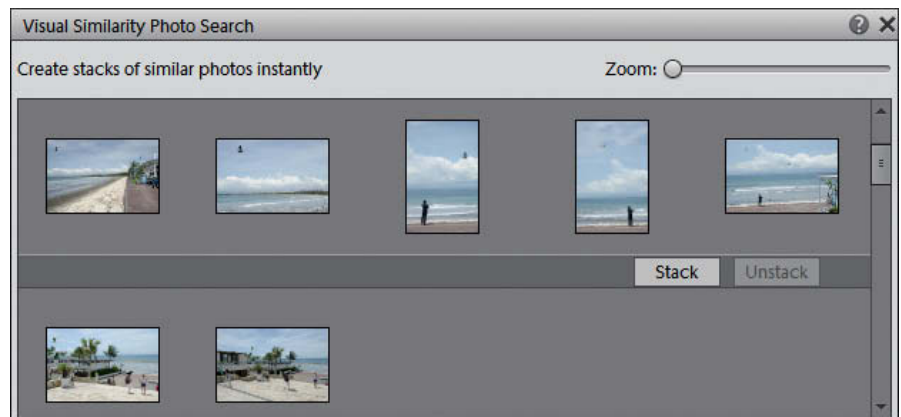
Search Parameters

The most common of the four main ways to perform a similarity search (and the only one offered by most small-scale standalone programs) is a non-specific duplicate search, which searches the specified archive without using any predefined input. All the images the program 'decides' are duplicates are then grouped according to their content. This is fine if you want to get an idea of all the duplicates in a particular folder or archive, but it is not much use if you are looking for duplicates of a specific image, as you will have to wade through multiple groups of duplicates to find the group you are looking for.

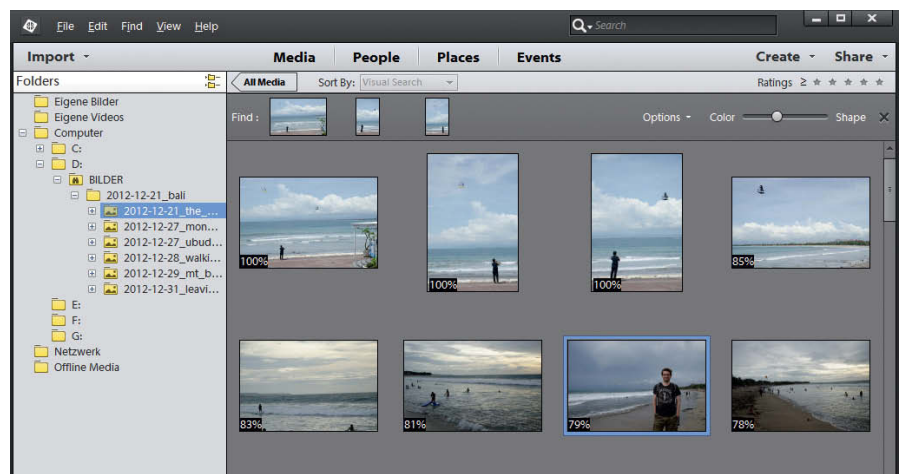
A specific similarity search is a more flexible option and a standard tool in many of today's higher-quality image and asset management programs. Taking a selected image as the basis, the program searches for images with similar content. The results are then listed according to their perceived degree of similarity, expressed as a percentage. *Photoshop Elements* and certain other programs allow you to use multiple source images as the basis for a search, which can increase the number of 'finds', especially if you are looking for images that are part of a sequence.

Programs like *iMatch* and *digiKam* allow you to search for images that contain elements of a hand-drawn sketch that you enter into a dedicated window. This is great if you are looking for an image to match a concept that you are working on. Although such 'fuzzy' search methods are not particularly accurate, this is a fun tool to experiment with. However, you will get better results if you perform a conventional image-based search using a precise sketch made using a dedicated drawing program.

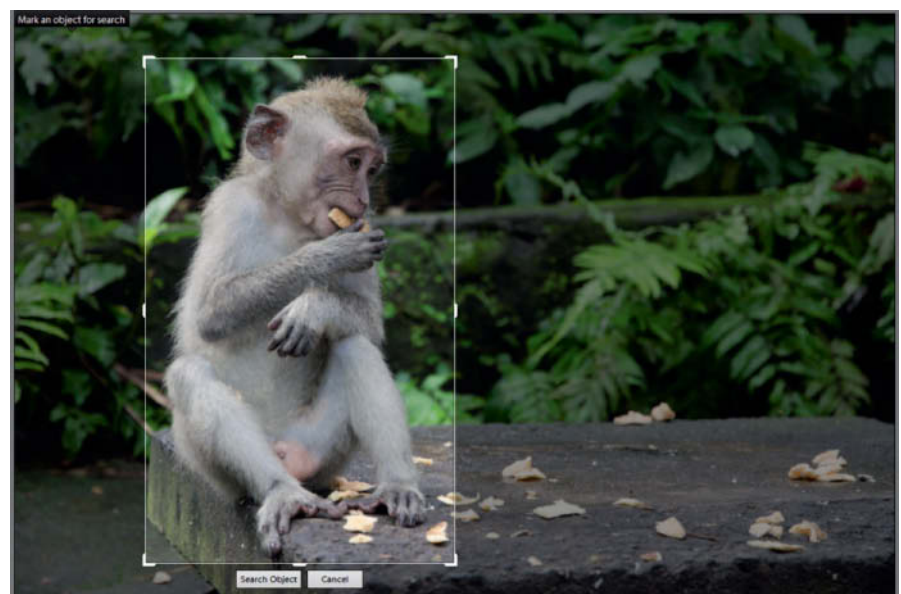
Object search is still a rare functionality, and *Photoshop Elements* was the only one of our test programs to offer it. To search for a specific object, you have to select an image and frame the object you are looking for using a rectangular marquee.



To perform a non-specific search for duplicates, you specify where the program searches, but not what it should search for. The results are then grouped, as shown here in *Photoshop Elements*.



Photoshop Elements can use multiple source images as the basis for a search, although using more source images don't necessarily mean more accurate results



The *Photoshop Elements* Object Search feature allows you to frame an object, which is then used as a search pattern



PhotoSweeper can search for bitmaps, similar histograms or timestamps, or any combination of the three

Search Methods

The accuracy of a similarity search depends on the algorithm it is based on. For obvious reasons, most software manufacturers don't release details of the inner workings of their tools, so the following sections give only a basic overview of how the various currently available search methods work. Because visual similarity is difficult to define precisely, most search algorithms look for similarities in tonal distribution, color or the tone curve in a set of images. Some also create a rough bitmap of the source image and search for similar patterns in other files.

PhotoSweeper, for example, uses bitmap patterns based on a rasterized version of the original or looks for similarly shaped histogram curves, which are assumed to belong to images that look similar. It can also search for similar Exif timestamps, although there is no guarantee that images shot within a short space of time are of the same subject.

These types of search algorithms are all relatively simple to implement and can be found in many current software offerings. The downside of their simplicity is that they do not achieve particularly good hit rates.

Object or subject-based searches are more accurate but more difficult – and therefore more expensive – to implement and hence less common. Face recognition is a special type of subject search that works well in specific situations but is useless for general searches, which is why we didn't include it in

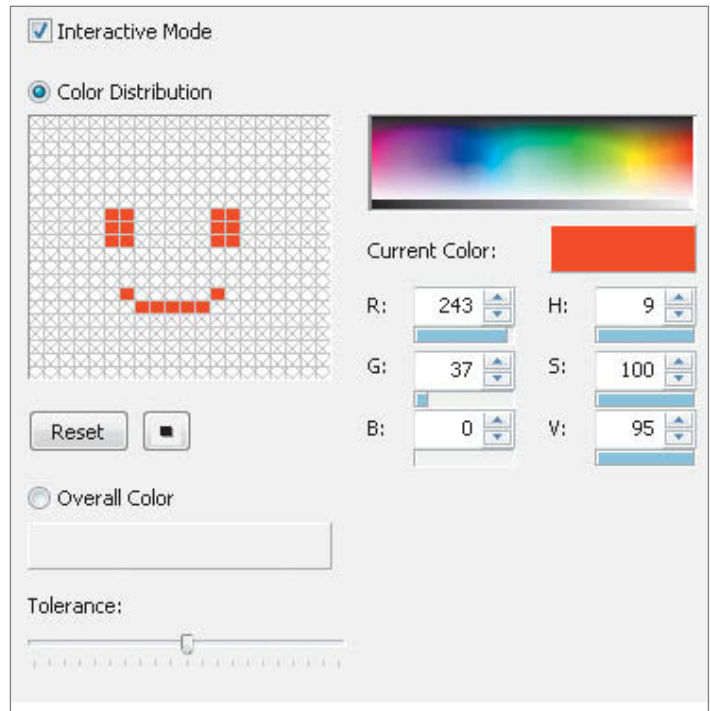
SIMILARITY SEARCH QUICK TESTS

Program	Windows/Mac OS/Linux	Price (full version)	URL	Notes
Anti-Twin	✓/–/–	Free	www.anti-twin.com	Byte-by-byte comparison of user-defined files. No indexing, similarity search very slow. Not updated since 2010.
Awesome Duplicate Photo Finder	✓/–/–	Free	www.duplicate-finder.com	Minimal settings options. Underpowered and stuffed with adware.
Duplicate Image Detector	✓/–/–	US\$29.95	www.blackbilby.com	Demo version does not allow file operations. Full version enables you to selectively delete, alias and label duplicate images.
Duplicate Photo Cleaner	✓/✓/–	US\$49.90	www.duplicatephotocleaner.com	Easy-to-use tool with cool interface. No info available on limitations of demo version.
Duplicate Images Finder	✓/–/–	Free	duplifinder.codeplex.com	Not updated since 2008. Delete function does not work.
DupDetector	✓/–/–	Free	www.prismaticsoftware.com	Old-school tool with clunky interface and features
FileDup	✓/–/–	Free	www.h84.net	Has no special search functionality but finds duplicates very quickly
Image Comparer	✓/–/–	US\$34.95	www.bolidesoft.com	Can highlight found differences between images. Copy, move and delete tools only available in the paid version.
imgSeek	✓ (old)/✓ (old)/✓	Free	www.imgseek.net	Simple Perl module for finding similar images. Can be loaded via Ubuntu Software Center but cannot be started from the GUI.
PixCompare	–/✓/–	Free	www.dreer.ch	Free Mac tool. Not clear as to whether compatible with latest OS X versions.
Picasa 3	✓/✓/–	Free	picasa.google.de	No similarity search. Finds only duplicates with identical filenames.
VisiPics	✓/–/–	Free	www.visipics.info	Not updated for a while. Can cause issues with 64-bit Windows
Visual Similarity Duplicate Image Finder	✓/–/–	US\$24.95	www.mindgems.com	Finds all similar and duplicate images in folders and sub-folders. Very limited demo version makes test before purchase impossible.
XnView	✓/–/✓	Free	www.xnview.de	Similarity search without indexing and therefore very slow. Navigation through long results lists tedious. Only useful for small archives.
GQview	–/–/✓	Free	gqview.sourceforge.net	Linux image viewer with similarity search functionality. Not updated since 2006.
SortPix XL	✓/–/–	Free	www.fotos-sortieren.de	Photo organizer with duplicate search and interesting sound effects

✓ supported – not supported

the tests we performed for this article. *Photoshop Elements* offers a tool called Object Search, which searches archives for objects similar to one selected using an adjustable rectangular marquee. Although it is difficult to tell from the results whether the program is genuinely capable of finding objects this way, it is still the only object search tool currently on offer.

digikam's sketch-based search function is fun to use but not particularly accurate



Conclusions

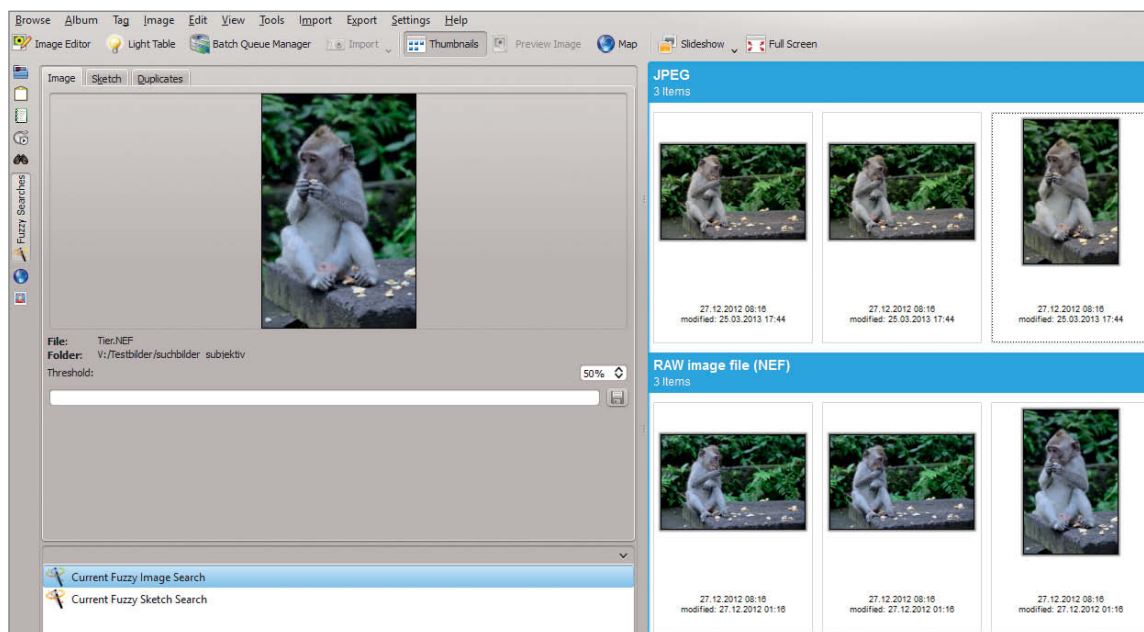
Similarity searching is not a new idea but, as our tests show, the technology is still in its infancy. While there is a large number of programs on offer, it is clear that they all use the same somewhat limited algorithms. For this issue's test, we picked the most promising database and standalone tools for Windows, Mac and Linux. The results are summarized in the table below, while the following pages go into the individual programs in detail.

At the end of the day, even if it is still a rather imprecise science, similarity search functionality already provides digital photographers with some useful tools to help them weave their way through the daily

digital workflow. Even if these tools are not as precise as the human eye, they are much

faster, and that is an important factor in these times of terabyte-sized image archives.

FULLY TESTED SIMILARITY SEARCH SOFTWARE								
	digikam	Duplicate Cleaner	GraphicConverter	iMatch	Magix Photo Manager	Photoshop Elements	PhotoSweeper	ThumbsPlus
Author/Manufacturer	Open Source	DigitalVolcano Software	Lemke Software	Mario M. Westphal	Magix Software	Adobe	Overmacs	Cerious Software
URL	www.digikam.org	www.duplicatecleaner.com	www.lemkesoft.de	www.photools.com	www.magix.com	www.adobe.com	photosweeper.com	www.cerious.com
Version tested (platform)	3.1.0 (Windows)	3.1.5 (Windows)	8 (Mac)	3.6 (Windows)	10.0 (Windows)	11.0 (Windows)	1.9.3 (mac)	9.0 (Windows)
Windows/Mac OS/Linux	✓/✓ (outdated)/✓	✓/✓/✓	-/✓/✓	✓/✓/✓	✓/✓/✓	✓/✓/✓	✓/✓/✓	✓/✓/✓
Price (full version)	Free	US\$32 (€23)	US\$48 (€35)	US\$64.95	US\$59.99	US\$99.99	US\$9.99	US\$31.95
Demo version	-	15 days with limited functionality ¹	No limit	30 days	30 days ²	30 days	Maximum of 101 images per search	30 days
Search Options								
Non-specific duplicate	-	✓	✓	✓	-	✓	✓	✓
Single source image	✓	-	-	✓	✓	✓	-	-
Multiple source images	-	-	-	✓	-	✓	-	-
Sketch	✓	-	-	✓	-	-	-	-
Object search	-	-	-	-	-	✓	-	-
Duplicate Recognition Tests								
NEF duplicate, same filename	✓	-	✓	✓	✓	✓	✓	✓
NEF duplicate, renamed	✓	-	✓	✓	✓	✓	✓	✓
Untouched JPEG	-	✓	-	-	✓	✓	✓	✓
JPEG (USM and tonal edit)	-	✓	-	✓	✓	✓	✓	✓
Untouched 90° rotated	-	✓	-	-	✓	✓	✓	-
Untouched 180° rotated	-	✓	-	-	✓	✓	✓	-
Untouched 270° rotated	-	✓	-	-	✓	-	✓	-
Flipped horizontally	-	✓	-	-	✓	✓	✓	-
Flipped vertically	-	✓	-	-	✓	✓	✓	-
Sepia toned	-	✓	-	-	✓	✓	✓	✓
B/W conversion	-	✓	-	-	✓	✓	✓	✓
Crop to 50% of original size	-	-	-	-	✓	✓	-	-
Crop to 25% of original size	-	-	-	-	-	✓	-	-
Overall hit rate	7.69%	61.54%	7.69%	15.38%	84.62%	84.62%	84.62%	38.46%
✓ supported - not supported n/a not applicable ¹ Free version does not have similarity search function ² Free version displays maximum of 10 results								



digiKam groups results effectively but still has trouble correctly identifying similar images. It misses some of the duplicates, even if you use its fuzzy search functionality.

Over the years, *digiKam* has developed into a powerful universal image archiving and editing tool with comprehensive built-in visual search functionality. You can select a single image or draw a freehand sketch as the basis for a search, or simply search your entire archive (or a selected folder) for duplicates.

The program indexes files using 'fingerprints' that allow the software to search quickly through large numbers of images. Its tried and trusted database is easy to use and allows you to sort search results according to various criteria. We particularly like its ability to separate JPEG and RAW images in the results window.

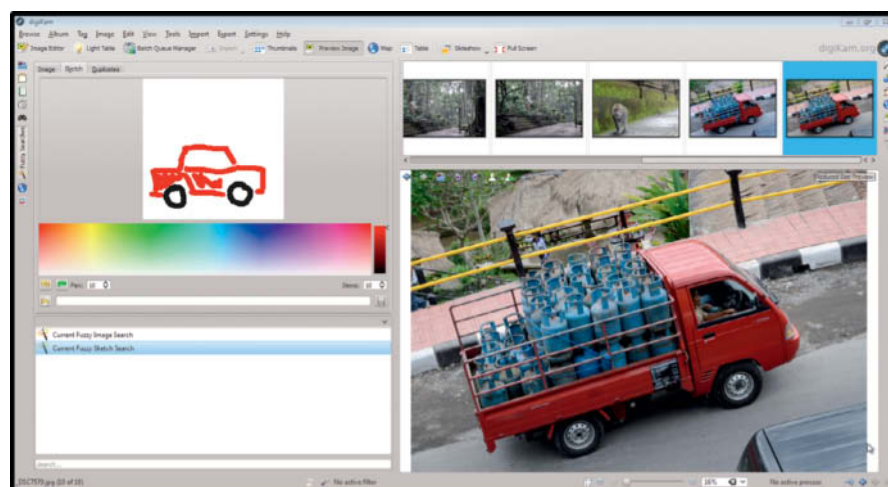
In spite of its promising specifications, *digiKam* disappoints when it comes to real-world searching. It failed to identify untouched original JPEGs when searching for duplicates and displayed only a single unnamed copy. Reducing the threshold value didn't really improve the situation and by the time we had set it low enough to include all of our duplicates, the search ended up 'finding' most of the other images in our archive too. Our sample JPEGs were stored at their original resolution and at maximum quality, so we can only assume that *digiKam* handles varying formats differently. When searching for duplicates in folders that contained the original RAW files and their JPEG counterparts, it didn't always find both. The same was also true for all types of alternative image versions, and we

were able to confirm this inconsistency not only using our benchmark but also when searching for alternative subjects. To find any similar images at all, we often had to reduce the threshold value almost to its minimum.

The sketch-based search function is more fun to use and we actually managed to get it to locate a red truck using the sketch reproduced below. Sketch-based searching is much better implemented in *digiKam* than in *iMatch* but still hasn't made the leap

from 'fun function' to 'genuinely useful search tool' status.

digiKam's great visual search specifications are let down by the weakness of the underlying algorithm. In its current iteration, the tool is of little practical use in the context of a real-world photo workflow. Nevertheless, thanks to its freeware status and the developer community, it remains an interesting and continually developing playground for digital photographers everywhere.



digiKam's sketch-based search is fun to play with. The results display updates in real time every time you draw a line on the sketchpad.

Duplicate Cleaner

Duplicate Cleaner is a universal file system cleanup tool that offers a wide range of options for finding redundant files. Our test concentrated on finding similar images in user-specified folders using the tool's non-specific duplicate search functionality.

Although it doesn't create its own index, the program searched our SSD-based archive quickly enough to be useful as part of the daily photo workflow, even if it wasn't as fast as *Photoshop Elements* with its index-based search engine. The relatively straightforward search options include a percentage-based similarity threshold setting and checkboxes for identical aspect ratios and resolution. You can also search for rotated

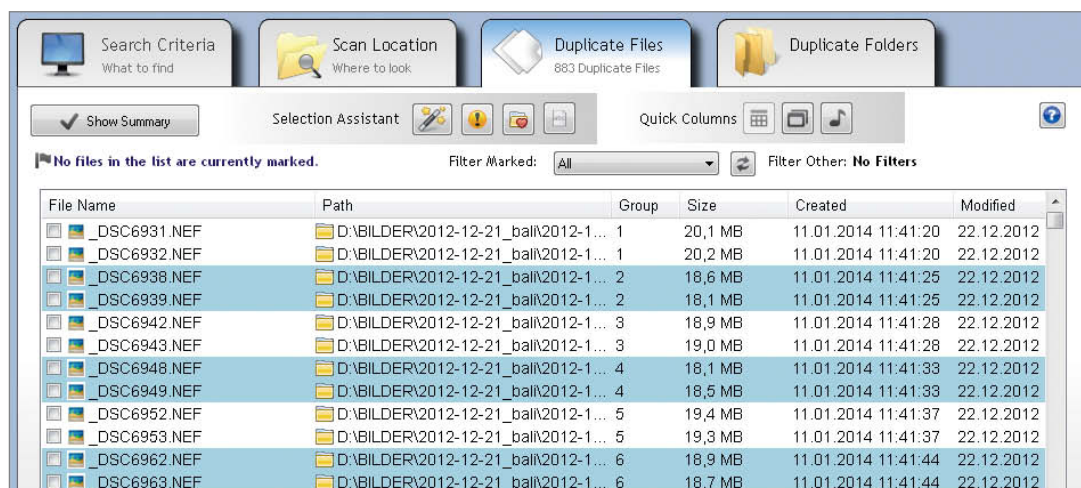
and flipped images if you want to, and the search options can be also be fine-tuned to include creation/modification dates and filenames.

Our benchmark test delivered pretty good results, although the software failed to identify cropped images and our NEF-format originals even though our test operating system included a dedicated NEF codec.

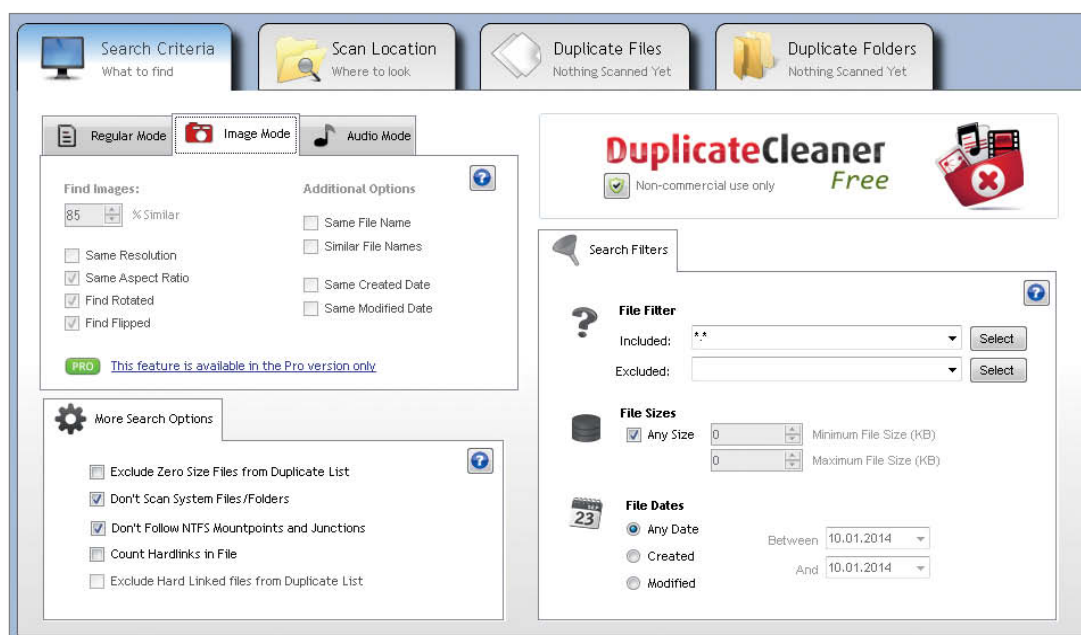
Search results are displayed as a list of filenames without thumbnails, although pressing the F3 key displays the currently selected group in a preview window. While not as visually pleasing as the gallery views provided by *PhotoSweeper*, this approach is ideal for managing large numbers of files. The grouped results are quite useful for finding

similar images, but, as its name suggests, the program's real strength lies in identifying duplicates. Its search options are too limited to be really effective and it lacks the ability to use an image as a search source. Having said that, *Duplicate Cleaner* is still pretty good at finding photos that belong to sequences in which the subject varies only slightly from shot to shot.

This tool is primarily aimed at users who wish to clean up duplicate images along with their entire file system and will suit photographers who work exclusively with JPEG files. However, other dedicated programs are more appropriate for photography enthusiasts with loftier aims and extensive RAW archives.



Duplicate Cleaner displays its results in an Explorer-style window that won't win any prizes for visual appeal but manages large numbers of files very well



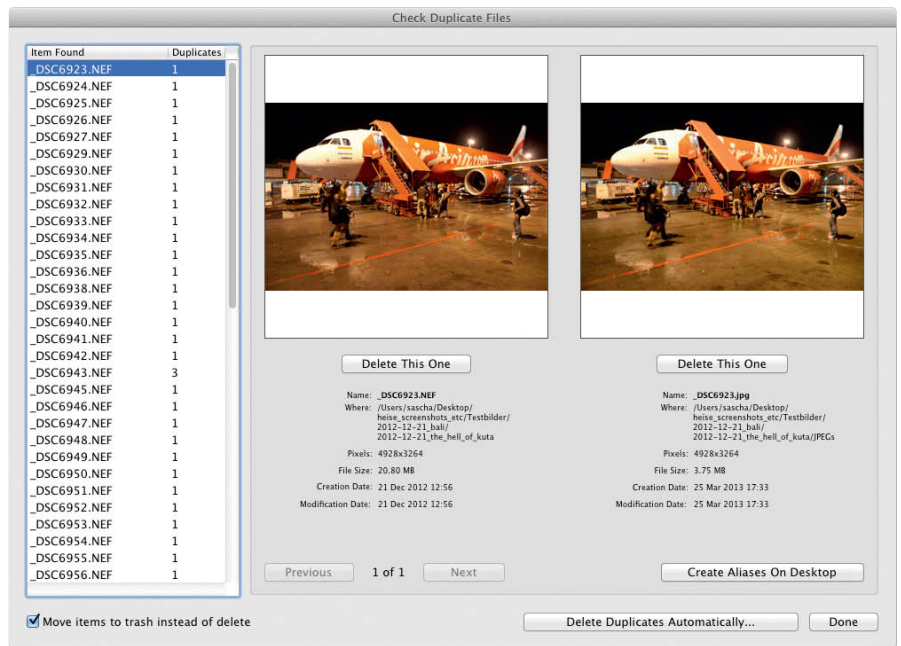
Designed for cleaning up file systems in general, the program also includes dedicated similarity search options

GraphicConverter X

GraphicConverter by Lemke Software is a powerful Mac-only image editing tool with built-in duplicate search functionality. Initially, we had a little trouble finding the function, but a quick look at the program's manual revealed that it is located under Edit > Find, Compare and Replace > Find duplicate files. User-controlled settings include a tolerance slider and the choice between searching for similar or identical images.

The lack of a dedicated index, means that the program has to open and compare each image individually to perform a similarity search, and this can take a long time. Using an SSD-based system speeds the process up significantly. The functionality is limited to non-specific searching within selected folders and sub-folders and there is no option for selecting a source image as the basis for a search. Search output is arranged in groups. The first file in a group is displayed in the preview window and the other files can be viewed by clicking on their details. The detail view includes the path with the filename, which makes spur-of-the-moment delete decisions easier than with the other products we tested. Path data is important, and we would like to see it displayed as standard in more image database products.

Searching large numbers of files provided slightly confusing results and we had trouble finding our test image among the many files the software dished up. This was mainly because the search engine also lists images that don't have duplicates and we had to make several time-consuming search runs using different settings until we came up with presets that no longer searched through every

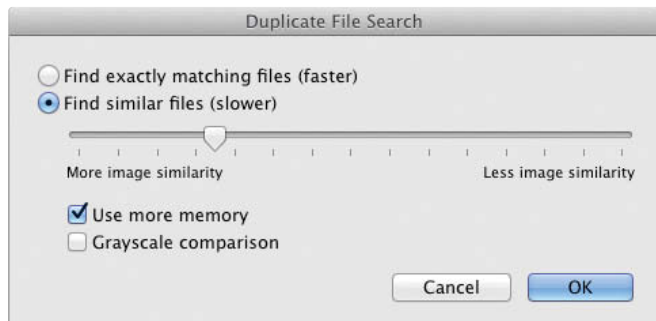


GraphicConverter sorts the duplicates it finds into groups, but its dual preview display makes managing large numbers of images more complex than necessary

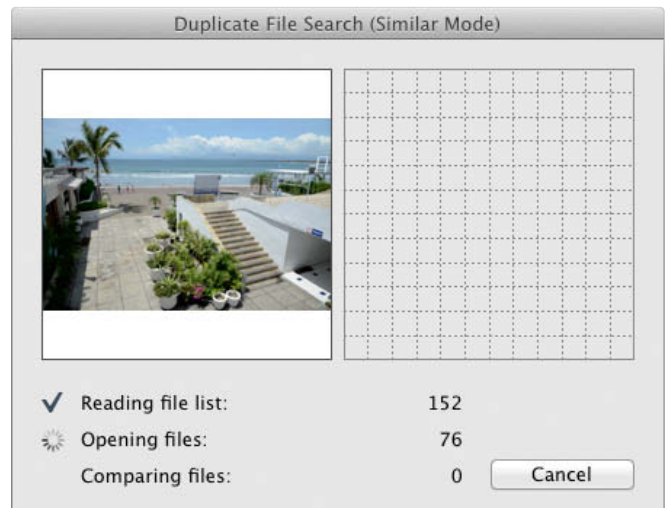
single image on our hard disk. In the end, we still couldn't set the function up to run our duplicate benchmark test properly and *GraphicConverter* produced the poorest hit rate of all our test candidates. Searches for similar images produced results that were comparable to those in our 'duplicates' test.

To conclude, the Duplicate File Search function in *GraphicConverter* only works fast

enough if you have an SSD-based system. Even then, the results we achieved were the least accurate in our test. Some kind of caching or indexing function that saves the program from having to scan every image each time a search is performed would improve things. Until such functionality is included, the usefulness of this particular tool will remain quite limited.



When searching for similar images, *GraphicConverter* opens and compares every image individually, which can take a very long time



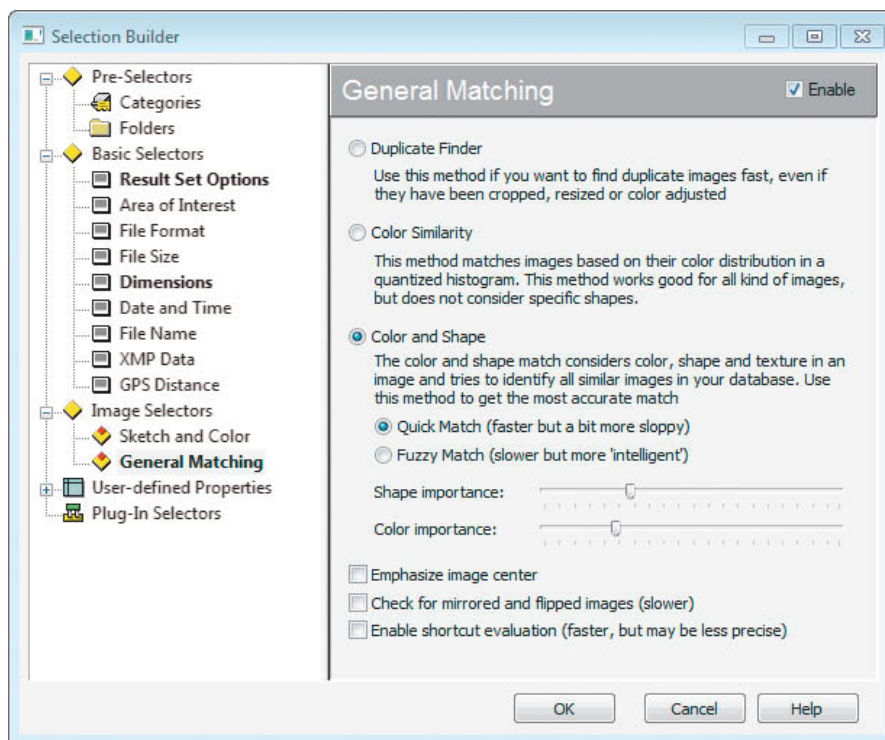
iMatch

This database tool from Photools offers a huge range of search options. In the course of our tests we tried them all and found it simple to locate identical files. Renamed files, which the program completely ignored, were the only exception. For a search to be effective every filename has to contain at least parts of the original.

When searching for visually similar images, the program displayed a selection of images that didn't match the quoted number of hits and the grouping of 'found' images was decidedly odd. The most relevant matches were listed at the end of a long list, and we quickly lost patience while scrolling through more than 200 poor matches. The Color Similarity search option proved virtually useless in spite of the dedicated sliders for altering the relative importance of shape and color during a search.

We then chose the slower but potentially more reliable Fuzzy search algorithm but ended up with exactly the same results as in our very first Duplicate Finder search. And, although we explicitly selected the *Check for mirrored and flipped images* option, the program failed to find our corresponding sample images. The results of our benchmark test were poor too.

The Sketch Match option, which uses a tiny mouse-driven sketch and a user-specified tolerance value to search for matches, piqued our curiosity but is actually little more than an experimental feature. The results aren't particularly good and don't match even the



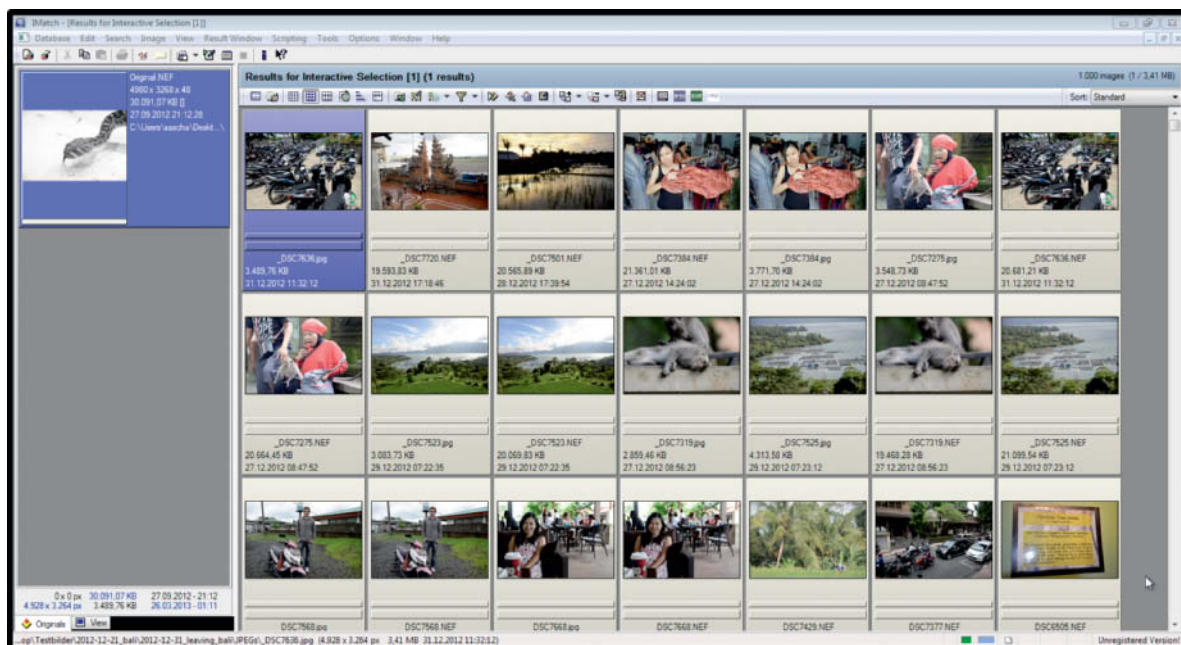
The Selection Builder window is designed to help you fine-tune your searches to include selected shapes and colors.

average accuracy of the *digikam* version of the same feature.

iMatch offers an interesting selection of tunable search options but doesn't deliver results to match. The 3.6 version that we tested leaves a lot to be desired, but the

reworked version 5 will be available by the time you read this. The version we tested can only be recommended for experimental use, as it is simply not reliable enough for use in a productive environment.

The search options in *iMatch* can be fine-tuned but our results were still poor. As you can see, the 'found' images have little in common with the original.



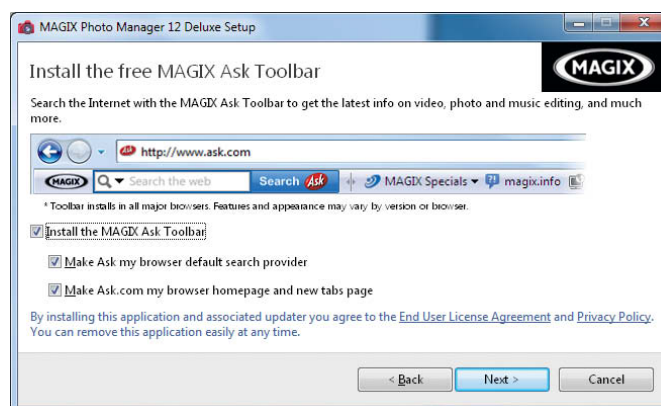
Magix Photo Manager

On paper, *Magix Photo Manager* performed duplicate searches just as effectively as *Photoshop Elements*, missing only a sample image that was cropped to 25 per cent of its original size. However, the Adobe program consistently presented the most relevant results at the top of the list, while Magix produced more mixed results.

Photo Manager's mixed results put the last relevant match in 75th position in the list. Such a coarse filter mechanism naturally means quite a lot of scrolling through irrelevant results, and the search options are basically limited to a simple choice of search location.

In spite of its slick interface, *Photo Manager* produced regular freezes, crashes and error messages, and often displayed irrelevant results. It even told us that we had run out of RAM when 13 GB of the 16 GB available were still free.

To give this software the benefit of the doubt, we performed various additional searches, all of which reinforced our initial impression of a less-than-reliable similarity search engine. Various apparently random events made life with the software difficult.



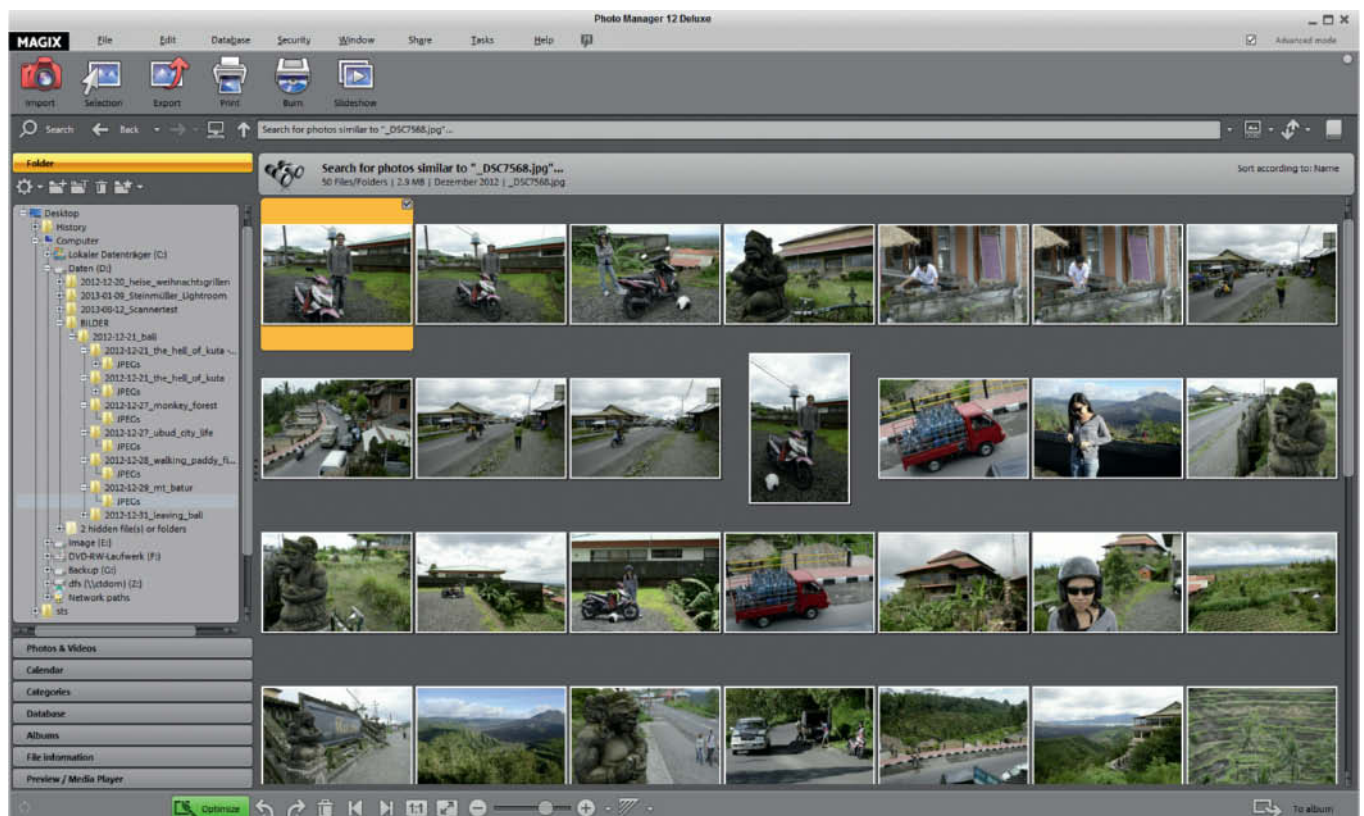
By default, *Magix Photo Manager* includes a lot of adware, although you can sidestep it by unchecking the appropriate options during installation

For example, it wasted a lot of time searching the trash (which we hadn't selected) while importing a folder full of images. It took several attempts to successfully import our entire test archive, and the competition was much easier to handle in this respect.

If you prefer software that simply does the job without any complications, you are probably better off giving *Photo Manager* a miss. We spent a lot of time troubleshooting, which is not really what programs like this

should be about. On inquiry, the manufacturer did, however, tell us that a patch is in the works.

The search feature is generally quite usable, but it is simply not as refined as the Adobe offering. Although the benchmark results produced by the two programs were theoretically comparable, the *Photoshop Elements* results were visually more accurate. The search function in the freeware version of the Magix software is limited to 10 matches.



In theory, *Photo Manager* produced quite good duplicate search results but actually included a fair number of misses in the final selection

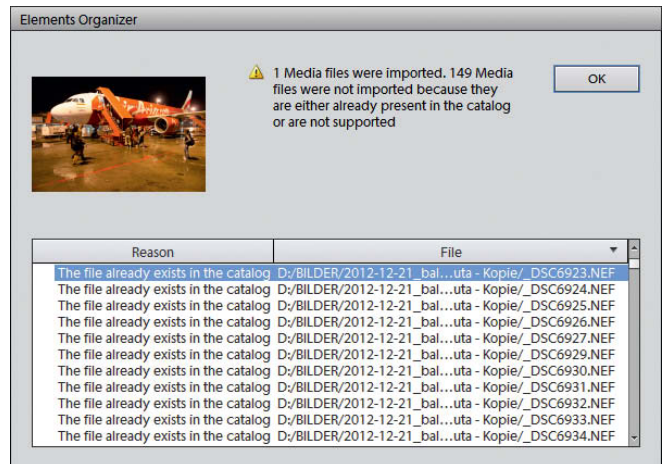
Photoshop Elements

The Organizer module built into *Photoshop Elements* offers Visual Similarity, Object and Duplicate Image search options. The Visual Similarity function doesn't work properly until the program has automatically indexed the contents of an archive. Depending on the size of your archive, the indexing process can take a while but, once it is done, searches are really fast.

Adobe's Duplicate Photo Search function is based on visual similarity rather than pixel-level matching. During our test, sequences of similar (but not identical) images produced a lot of false positives, so we had to filter the automatically generated results manually too.

The Visual Similarity Search function is more effective. You can select multiple sample photos as the basis for your search and a slider enables you to alter the weighting of the results according to color or shape. The preview window then displays a percentage value that corresponds to the degree of similarity between the source image(s) and the selected results. Searches performed using a single source images produced very good results, but the more source images we added, the vaguer the results became. This process also produced 100-percent matching

To prevent redundancy, *Photoshop Elements* doesn't import truly identical files into its database. On the downside, it cannot identify identical files that have been renamed.

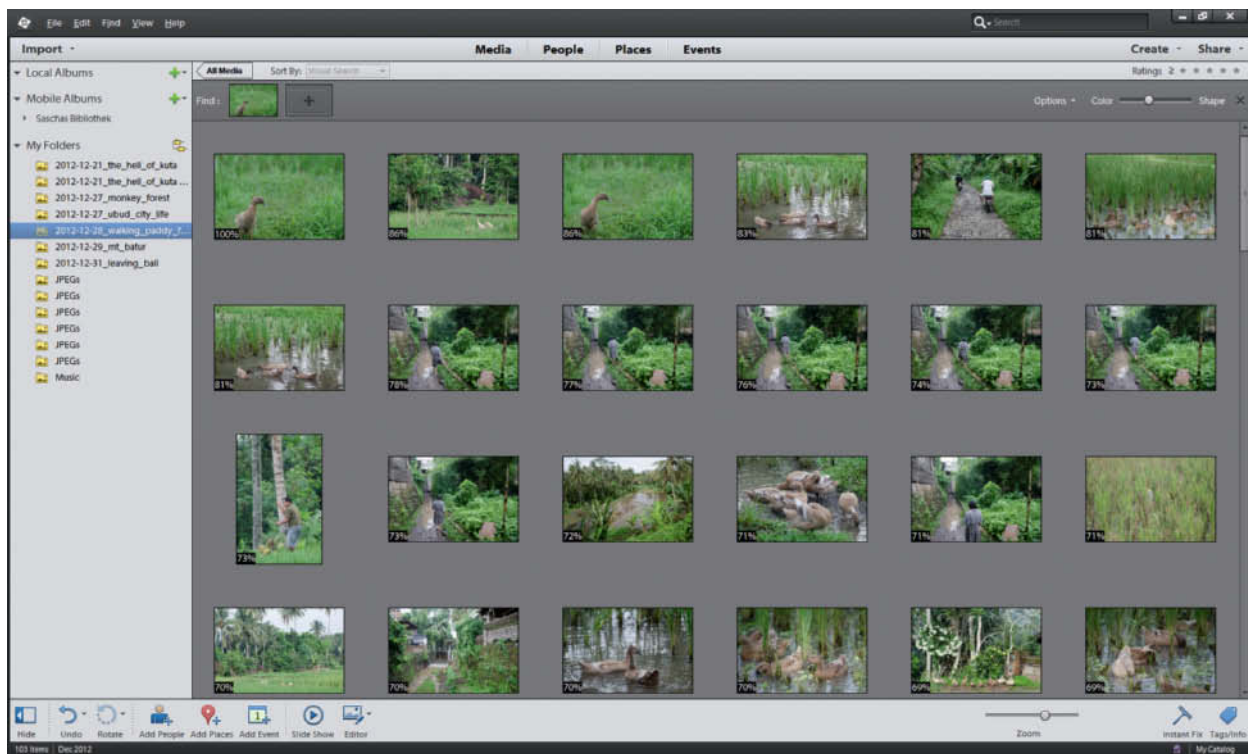


success for duplicates of the selected source images, but images that contained elements from all the source images were often at the bottom of the list.

The Object Search function is a bit of a mixed bag. To search for a particular image element, you simply outline it using a rectangular marquee before clicking the 'Search Object' button. Our tests produced results that ranged from excellent to completely useless.

Even though the results weren't perfect, *Photoshop Elements* passed our duplicate search benchmark test with flying colors, correctly identifying 12 of our edited versions and only skipping the one that we rotated by 270 degrees.

All in all, Adobe's take on visual search is a useful, relatively mature feature, although there is room for improvement when it comes to searching for combined source images and selected objects.



Unlike *Magix Photo Manager*, *Photoshop Elements* places duplicate matches at the top of the list of results. The percentage values largely correspond to the degree of visual similarity between the selected images.

PhotoSweeper X

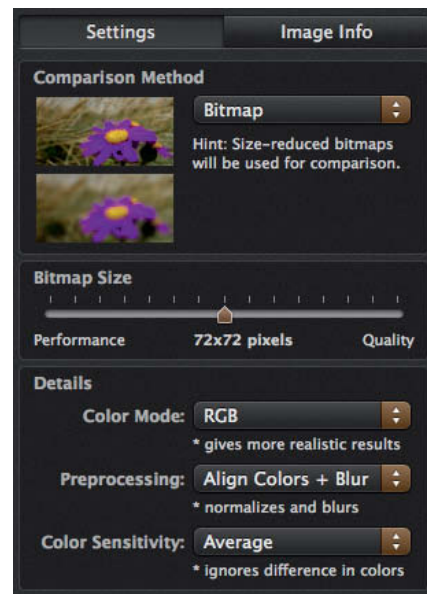
Aperture offers face recognition but no general similarity search functionality. You can also choose not to import duplicate images the same way as you can in *Lightroom*, but a change in filename is all it takes to render that particular failsafe mechanism useless. This is where *PhotoSweeper* comes in. This compact, standalone Mac-only program is great value and is capable of finding duplicate images on your hard disk as well as in *iPhoto*, *Aperture* and *Lightroom*. The free demo version is restricted to a maximum of 101 images per search.

You can search non-specifically for similarities between bitmaps, histograms or timestamps, but there is no image-based search functionality. *PhotoSweeper* scans the entire contents of the selected location and outputs well sorted results, where you can mark duplicates for deletion. Our benchmark test produced fast, reliable results, although the tool wasn't able to identify cropped duplicates.

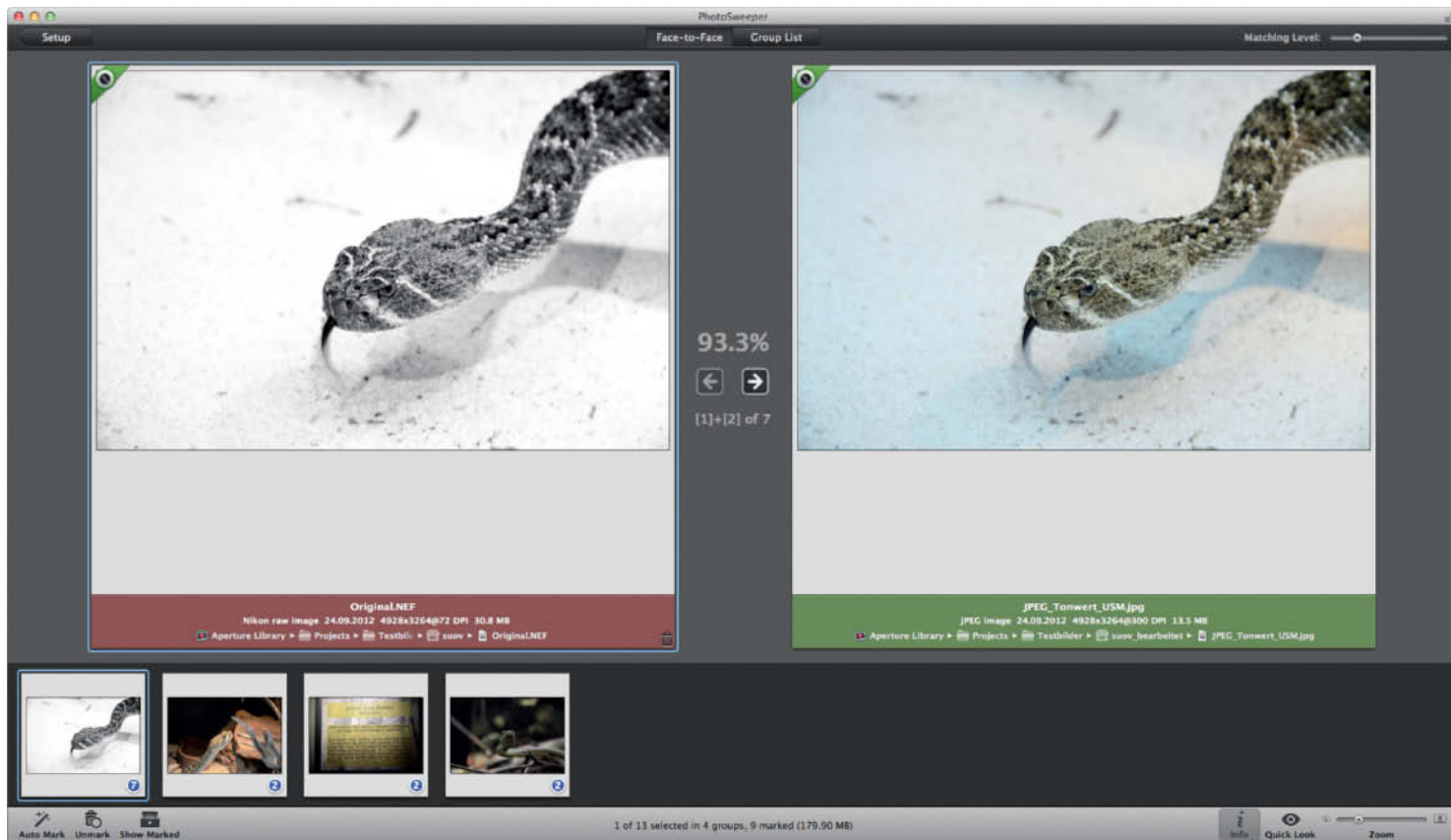
The results of similarity searches weren't as good and, even with the threshold value

turned right down, *PhotoSweeper* still had trouble recognizing the similarities between images from a single sequence. This function only worked for images that almost identical. You can work around this weakness by using the timestamp search function, which is better suited to locating all the photos in a series.

All in all, *PhotoSweeper* does a great job of finding duplicates, but you are probably better off using *Photoshop Elements* if you are looking for similar images too.



PhotoSweeper compares images based on variable-sized bitmap patterns and can also search for similar histograms and timestamps



The Face-to-Face view makes it easier to identify the differences between the original and found images

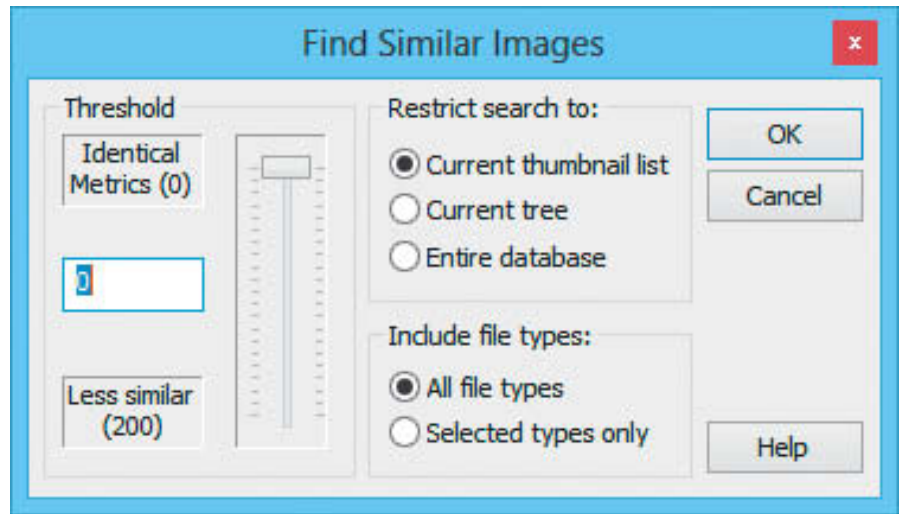
ThumbsPlus

ThumbsPlus has been around for a while, and version 9 is now available, providing super-fast image import functionality.

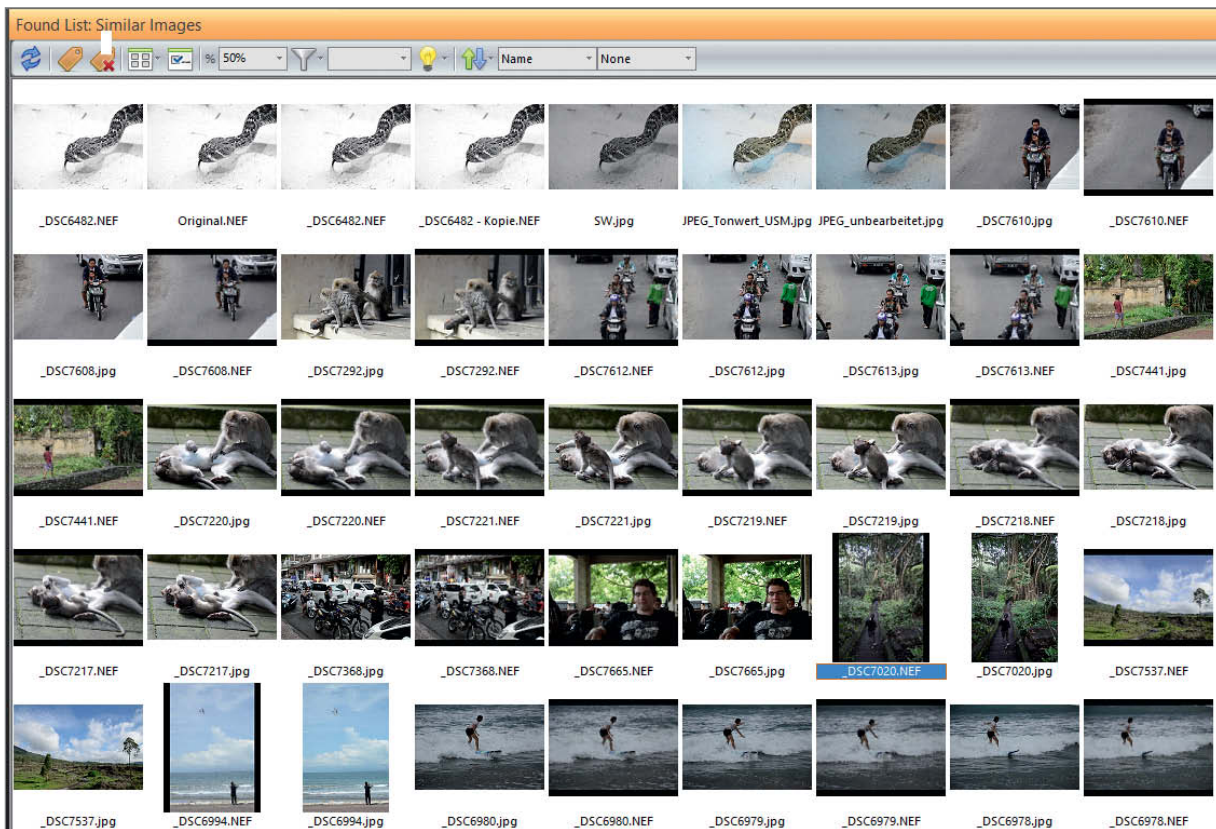
The similarity search function (located under Edit > Find Similar) is pretty fast too, and you can set your desired degree of similarity on a scale of 0-200. You can also limit searches to specific paths or file types. Results are displayed quickly and are fairly accurate.

The program reliably found duplicates with a high degree of similarity during our benchmark test, but had problems identifying flipped and mirrored images. There is no option for selecting an image as the basis for a search and the non-specific search algorithm groups similar hits in such a way that you have to scroll through a lot of irrelevant images to find the ones that really count. If you set up the software to search for JPEG and RAW files (a combination that is often present in image archives), the resulting output lists can be very long indeed.

The similarity search functionality built into *ThumbsPlus* is reliable, but its usefulness is restricted by the limits of its user-adjustable search parameters.



The non-specific search options in *ThumbsPlus* are limited but produce useful results



ThumbsPlus lists all the duplicates in an archive. Unfortunately, fine-tuning and image-based searches are not part of the package.

Similarity Search on the Web

Searching for similar images on the Internet is a lot more complicated than it is in local image archives. Whether online or offline, similarity searches require constant indexing and use huge amounts of resources in the process. The following sections introduce some of the dedicated Web-based similarity search services that we have come across.

Web-based similarity searching is a potentially huge market that can help photographers to track the online spread of their images and keep tabs on copyright issues. You can only charge licensing fees for your images if you know where they are being used and, if you don't actively search for your images, you will automatically give content pirates an easy ride. Basic commercial interests provide a good reason for many online stores to invest in similarity search technology. You have probably noticed that when you check out products online, the Web immediately produces corresponding tailor-made advertising and purchase suggestions from various suppliers. The next logical step for advertisers is to provide users with custom visual and text-based content.

The current crop of online search offerings are either free single-image search services like Google Image or commercial services that charge a fee for doing the donkey work involved in tracking large numbers of specified images.

One of the pioneers in this field, GazoPa, ceased offering its tools for private use in 2011 in order to concentrate on providing better services to its corporate customers. Picalike is following a similar business model.

Complete Packages

There are several tailor-made image tracking services available to individual photographers. According to its website, Germany-based Pixray has declared war on image theft and offers its online 'copyright management' services for a one-time setup fee, monthly fees that start at EUR99 (about US\$135) and a 33-percent share in any payments that result from using the service. Pixray also offers legal services and helps you to calculate the extent of potential damages caused by misuse of your work.

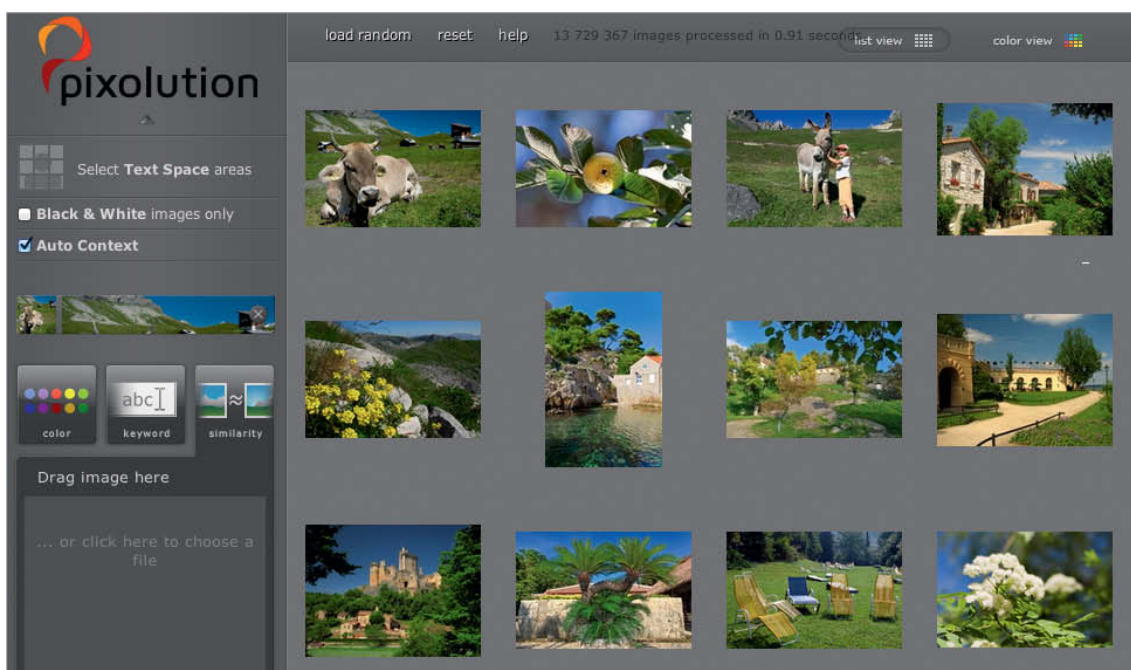
PicScout offers a similar service aimed at both licensors and licensees and not only enables photographers to track their work but also puts customers in touch with copyright holders.

Free Services

Microsoft's free Bing service is visually and functionally based on the much-discussed Metro ('Windows 8') interface. The downside of this offering is its functionality, which is obviously just as minimalistic as the interface design. You can opt to search for images that are similar to one you have already found, but that's all. Google's Image Search offering is more capable and allows you to use locally stored or online images as a starting point for a search. However, in spite of its strengths, Google's online search tool is not as capable as many of the dedicated desktop alternatives.

Browser Plug-ins

While image search functionality fills a small niche in the huge palette of services offered by Microsoft and Google, the TinEye Web service has been dedicated to 'reverse image search' tools, as the site calls them, since the late 1990s. Single use via the Web interface is free but mass queries made via the site's API cost an annual fee based on the number of



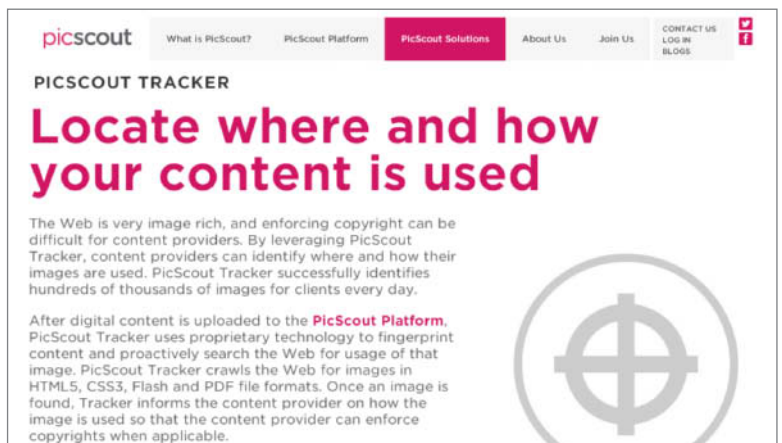
Pixolution offers searches based on keywords, colors or similar subjects. Matches come exclusively from the Fotolia Archive.

images and their size. TinEye’s two main algorithms search either for colors or visual similarities and are available as plug-ins for most major browsers.

Retrievr is a similar product that has never moved beyond the experimental stage. Although the website hasn’t been updated since 2011, the service itself still works.

Pixolution is a more recent project based in Berlin that makes no secret of the potential uses it sees for its service. The homepage shows a selection of shoes in a range of blue tones and emphasizes the ‘easy shopping’ aspect of image search capability. Check out piclikethat.com or demo.pixolution.de to try it out for yourself.

PicScout’s Tracker tool searches the internet for similar images, helping to track licensed images and find content distributed by unauthorized sources



Searching Your Own Online Archive

If you publish large numbers of images online, it is a good idea to offer your viewers and customers a site-based similarity search function. fotofinder.com is an example of an image agency that allows its users to upload local images as the basis for a search. This approach works very well if you are looking for images based on a certain color, and the results far exceed those obtained using a conventional keyword-based search. shotshop.com is another service that offers similar functionality.

The search page at the Bavarian State Library (also available in English at

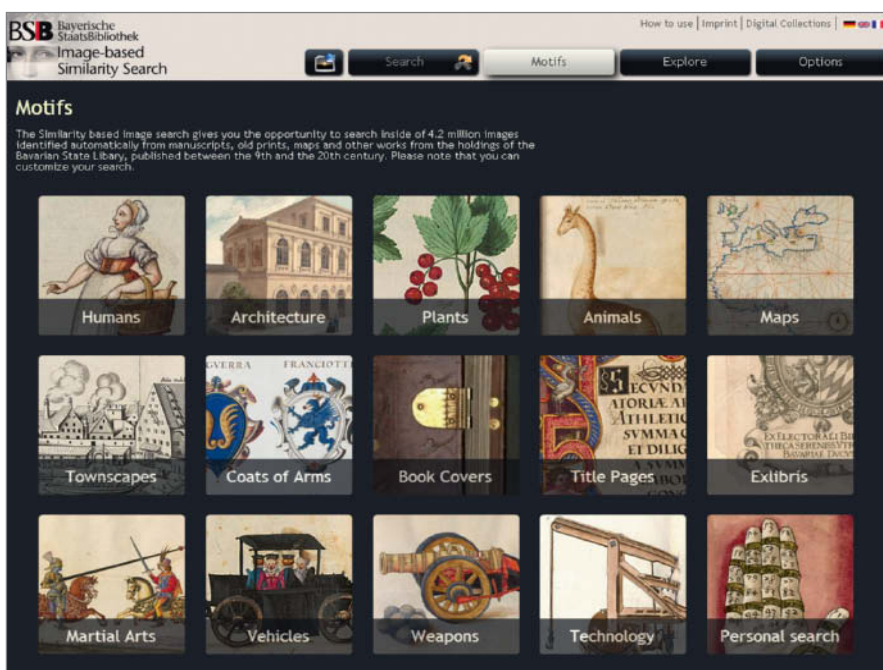
bildsuche.digitale-sammlungen.de) lists more than four million images that you can search using options including shape, color, contrast and texture. The page allows searches for images similar to one from the library’s own database or queries based on your own uploaded images. The library’s collection is comprehensively keyworded, so it is relatively simple to find an appropriate image among the millions on offer.

Similarity Search – a Useful Tool

It is difficult to escape the feeling that increasing numbers of wonderful images

end up unseen because they simply disappear into the depths of ever-expanding digital archives. Unlike keyword-based searches that force the user to think like a machine, similarity searches are easy to perform, even for computer novices, and have the potential to become a real mass phenomenon. The only thing preventing this technology from hitting desktops worldwide is that it is so complex to implement.

This relatively new technology has already begun to make accessing online image archives an everyday task, and we are really excited about the developments that surely lie just around the corner. (anm)



The image database at the Bavarian State Library in Germany is a heavyweight search service with flexible options that make it possible to find just the right image among the millions on offer





Ralph Altmann

GPS

for Photographers

GPS-based 'sat nav' devices are now a standard component in many cars and smartphones, while built-in GPS modules have become our constant companions on bike tours and hikes. Now that GPS has found its way into the world of photography in the form of cameras with built-in GPS trackers and accessory logger modules, location data is adding a new dimension to digital images. This article gives you the low-down on how GPS works and the gear and software you need to use it, and provides troubleshooting tips to help you work around some common geotagging pitfalls.

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Once location data has been saved in a file's Exif metadata, it is simple to use Google Maps (or some other map service) to find out where a photo was captured. The most obvious use for this type of data is linking travel routes with their corresponding images. For example, if you have been on a hiking tour in the mountains you can use this technology to find out the names of the peaks you can see in the background or where exactly you captured a photo of a particular bird. This process, called 'geotagging', is used commercially to document large industrial plants and construction sites as well as for archaeological and nature protection purposes. Location data is also a useful additional tool for managing and sorting images.

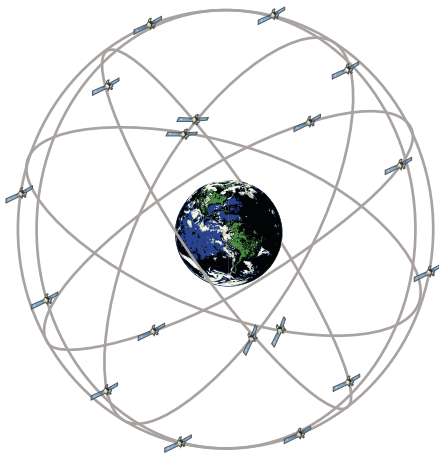
Geotagging an image involves recording latitude, longitude and altitude data in the appropriate Exif metadata fields. Sometimes the direction the camera was facing is included too. The actual capture of geodata is known as 'tracking' and is performed using devices called trackers or loggers. These record geodata and a time stamp in a log file at regular intervals. The technology required to geotag photos after capture has been available for about 10 years, but cameras with built-in GPS functionality are only now becoming commonplace. This article takes a look at models from Canon, Leica, Nikon, Olympus, Panasonic, Samsung and Sony. Casio does not currently offer cameras with built-in GPS, while Fujifilm and Pentax failed to respond to our request for test hardware.

We also tested a number of plug-in tracking devices (for cameras without built-in GPS functionality) and, for good measure, we took a look at Wi-Fi and Smartphone-based tracking technology. We used *GeoSetter* (freeware) for most of our tests and found it to be a powerful, flexible and user-friendly tool. But before we go into detail on the hardware, let's look at where geodata actually comes from.

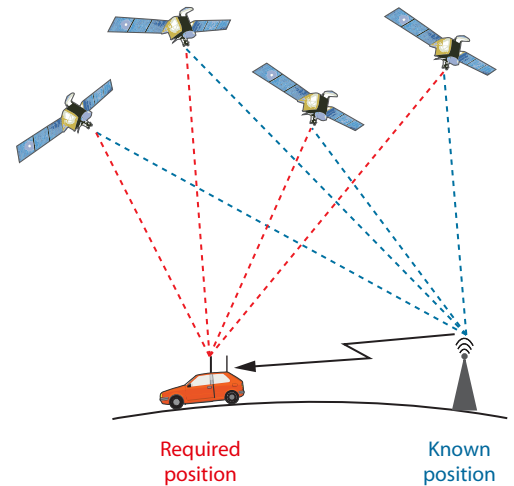
Location Satellites

There are about 100 geolocation satellites in orbit around the Earth. These belong to the US NAVSTAR-GPS and Russian GLONASS systems (each with about 30 satellites), the Chinese COMPASS system (with 20 satellites) and the





Cocoon GPS: The orbital paths described by the satellites are at 55 degrees to the equator and are organized so that multiple satellites are always visible from a given point on the Earth's surface. Positioning errors – for example, due to activity in the ionosphere – can be corrected using stationary reference transmitters.

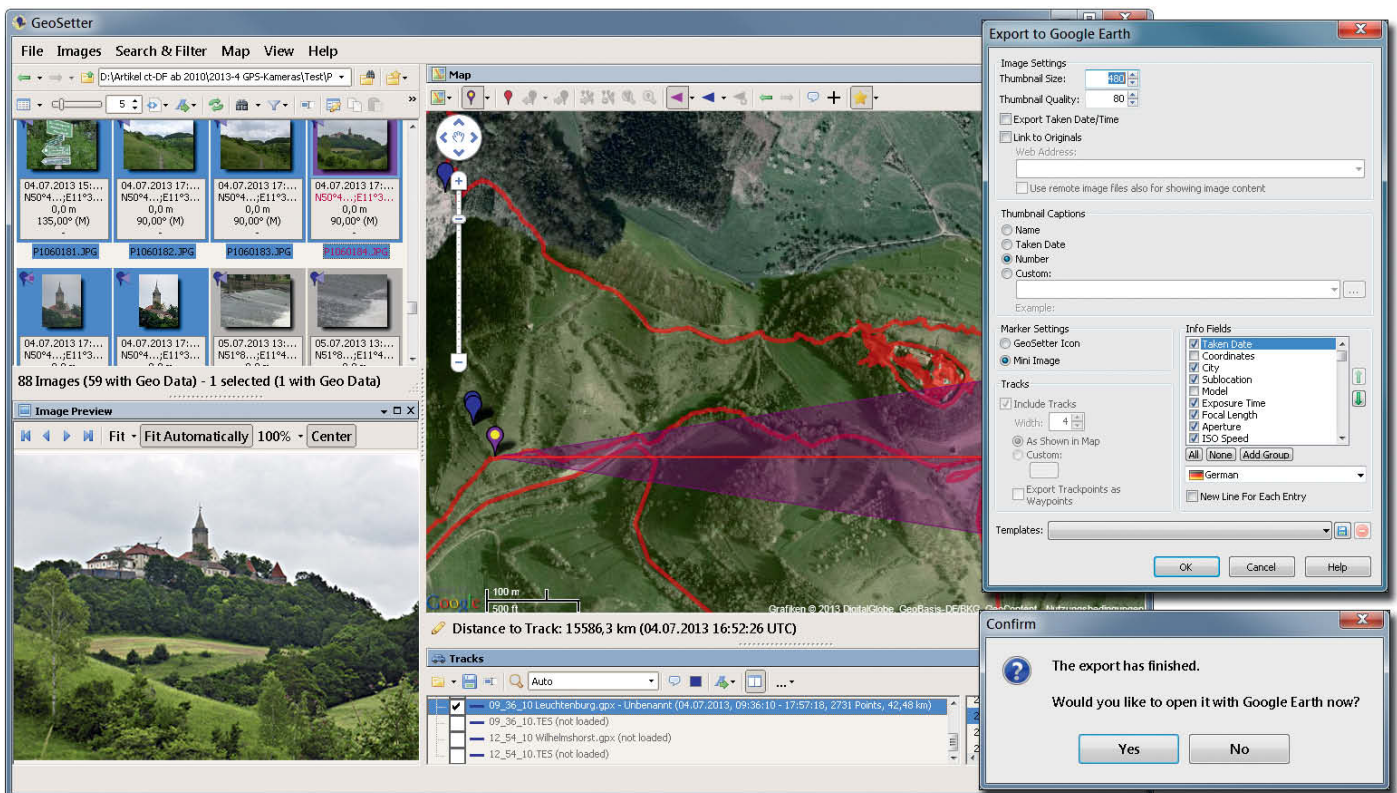


European GALILEO system, which has six working satellites and is due to become fully functional in 2018. All of these systems require at least 24 satellites for the entire surface of the planet to be covered by the necessary four locators at any one time. These satellites orbit the Earth at an altitude of more than 20,000 km (12,500 miles), continuously transmitting their own positions and the time, based on data from an atomic clock, as well as their orbital data (called the 'almanac')

at slightly longer intervals. The data is transmitted on two frequency bands called L1 and L2. L1 has a frequency of 1575.42 MHz and is cleared for civilian use.

A GPS receiver uses the time taken to send and receive these signals to calculate the distance between the receiver and the satellite. If the receiver can 'see' at least three satellites, its exact position can be triangulated. Because GPS receivers don't have access to atomic time, a time signal from

a fourth satellite is necessary if the time is to be tracked precisely too. Since May 2nd, 2000, when artificially generated signal impairments were switched off, civilian GPS positioning has been accurate to within as little as 10 meters (30 feet) on the ground and around 30 meters (100 feet) vertically. In order of importance, the main sources of inaccuracy are variable signal times in the ionosphere (which depends on factors like current solar activity), orbital deviation due to the positions of the



GeoSetter can create **Google Earth** tours using just a few clicks and data taken from photo and track files (on the left). **Google Earth** displays selected images as thumbnails or magnified with the additional data you have selected in the program's export dialog (on the right). **Google Earth** can also display camera direction (compass) data if you install additional tools.

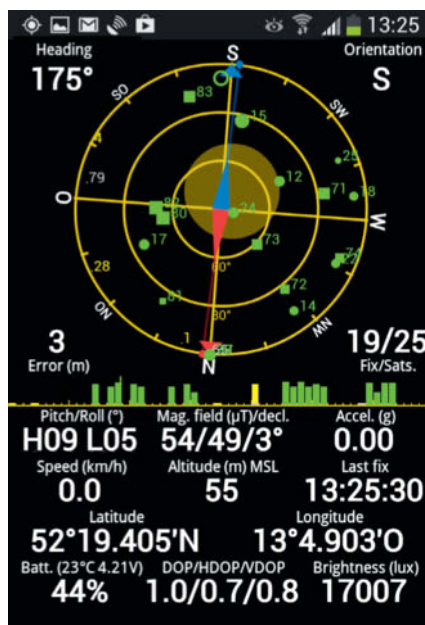
Sun and the Moon and inaccuracies atomic clocks in the satellites. The differences these inaccuracies produce are usually only a few meters or less, but they can accumulate to produce greater imprecision. The anomalies also increase if the satellites are positioned at too shallow an angle to each other. The greater the number of satellites and the further apart they are positioned, the more precise the positional data will be. This 'visibility' data is displayed by some GPS receivers in the form of numerical DOP/VDOP/HDOP (Dilution Of Precision) values.

Other unpredictable sources of positioning errors are unwanted reflection or loss of signal between rows of tall buildings. The satellite signals propagate in a similar way to light waves at low rates of 50 bits/second and low power (50 Watts). Indoor GPS reception is often impossible.

Apart from unwanted reflections, most signal arrival time errors can be effectively minimized to values of less than 1 cm (0.4 inches) using stationary reference transmitters. These LBAS (Local Based Augmentation Systems) use the signals they receive and their own known position to compensate for GPS errors and transmit the resulting data via the Internet or using radio frequencies. This technique is known as Differential GPS or DGPS. The closer you are to a DGPS transmitter, the more accurate the corrections will be. Use of DGPS data usually costs money and the more precise the signals you use, the greater the fees involved. The German OpenDGPS initiative (www.opendgps.de) aims to set up a network of free DGPS transmitters that work with the Ntrip protocol already built into most Internet-capable smartphones and provide 10cm (4-inch) GPS precision for everyone.

Satellite Based Augmentation Systems (SBAS) are also based on DGPS but are less accurate. EGNOS, the European SBAS system, and WAAS, the US version, transmit deviation correction (DC) data to geostationary satellites that re-transmit the data to earthbound receivers, providing positioning accuracy to within one meter (three feet). Appropriate DC data is also disseminated via the Internet.

The latest positioning technology is called PPP (Precise Point Positioning) and relies on real-time satellite orbit and antenna position data as well as a real-time data model of the ionosphere, the current shape of the Earth's surface (due to tides) and other atmospheric factors. The resulting profile enables the user to correct GPS location data to within a few centimeters. The correction data is applied either locally in the receiver or – if more computing power is required – in the cloud.



The free *GPS Status* Android app displays the positions and signal strength for currently visible NAVSTAR-GPS (circles) and GLONASS satellites (squares), as well as probable position error data, compass data and readings from your device's other built-in sensors

Photographers rarely require GPS accuracy greater than a few meters, whereas archaeologists and surveyors are eagerly awaiting the widespread use of improved location data. Other applications that benefit from increased positioning accuracy are self-driving cars, drones, robots and automated agricultural machinery.

GPS Receivers in Detail

A GPS receiver decodes the incoming signals to provide values for its current latitude, longitude and altitude above sea level. Velocity and direction can also be calculated for moving receivers but, without an additional (magnetic) compass, it is not possible to divine the direction a stationary receiver is facing. Most commercial receivers use the US GPS system, although increasing numbers of devices are also able to decode signals provided by the Russian GLONASS system, which improves the accuracy and availability of positioning data.

The low transfer rates of GPS signals mean that it takes 12 minutes or more to collect data from all the satellites in a system. Earlier receivers were not able to improve on this from a cold start, but more recent models use incomplete data to begin estimating a position as soon as two minutes after startup and also record the positions of the satellites they use to make restarting after a break in transmission (a 'warm start') much quicker. Assisted GPS (A-GPS) achieves much faster cold start times using pre-calculated satellite position (or almanac) data transmitted via mobile telephone networks or stored in a file

that can be loaded into a GPS-capable camera. Such files are only valid for a few days or weeks and have to be updated regularly. Some of the latest receivers are capable of calculating satellite positions themselves but require an additional, separate processor to do so.

A GPS logger records its current position either at the push of a button or at predetermined intervals to create a 'track' file. Track files can then be used to reconstruct the route taken by the logger later on. Loggers can record between tens of thousands and millions of waypoints and are perfect for recording your movements on long trips – provided of course that you keep the batteries charged. 'Geotate' technology is a radical geotagging technology designed specifically for use with digital cameras. It requires much less energy and records only basic data, which is enhanced using further data from dedicated servers at a later stage. u-blox purchased the technology in 2009 and, sadly, has not developed it further.

Programs like *GeoSetter* use timestamps to link a recorded track file with photos captured on the same trip, and deviations between the capture times recorded by the camera and the logger can be corrected manually. A more convenient approach is to use a dedicated GPS receiver that attaches directly to the camera and is connected via a cable or Wi-Fi. Such devices write geodata directly to an image file's Exif metadata while it is being recorded. A GPS-capable smartphone can be used to fulfill the same purpose if it can be connected to the camera via Wi-Fi. Of course, it is also possible to build a GPS receiver into

the camera itself, and increasing numbers of camera manufacturers are now taking this route. The following sections take a detailed look at the pros and cons of each approach.

Receiver Quality

The effectiveness of a GPS receiver depends largely on the quality of its antenna and processor chip. Modern chips have dozens of separate receiver channels that can process weak signals in parallel and reduce the Time To First Fix (TTFF) as well as increase the base sampling rate. Most receivers sample position data once per second (i.e., at a rate of 1 Hz), while high-quality devices work up to 10 times as fast – a rate that is, for example, extremely useful for the fast-moving receivers built into rally cars. A-GPS (see above) also reduces startup times and is supported by most modern receivers.

Receivers that support the precise terrestrial DGPS system are only available for high-end commercial applications. Free satellite-based (WAAS or EGNOS) DGPS signals are supported by most contemporary GPS chips, although the manufacturers of devices that include these chips usually keep quiet about whether DGPS is actually activated or not. A quick Web search for “DGPS Smartphone” came up with only two ruggedized smartphones with camera functionality, but we are pretty sure that many other models (and loggers) support DGPS signals as standard, even if they don’t shout about it. Support for GLONASS GPS signals is still fairly rare, which is a shame, as this additional support makes it much more likely that you will receive a signal and makes positioning more precise where a signal is available.

Some receivers have a built-in electronic compass to help determine which way you are facing while shooting. However, this only aids geotagging if the receiver is affixed to (or built into) the camera. We were surprised to find that a built-in compass is more often a standard feature of cheaper ruggedized compact cameras than it is in higher-end DSLRs. We can only assume that this is because moving metal parts tend to have a negative effect on a magnetic compass, so zooming a motor-driven lens, for example, could cause inaccurate compass readings.

Built-in, Always-on GPS

Built-in GPS is the most convenient solution but has disadvantages too. A metal camera body stuffed with sensitive electronic components is not the best place for hitch-free GPS reception and a GPS module

will quickly drain the camera’s battery, especially if it is programmed to permanently track its position to provide location data instantly when the camera is switched on. Some cameras counteract this effect by tracking their position at longer intervals while switched off.

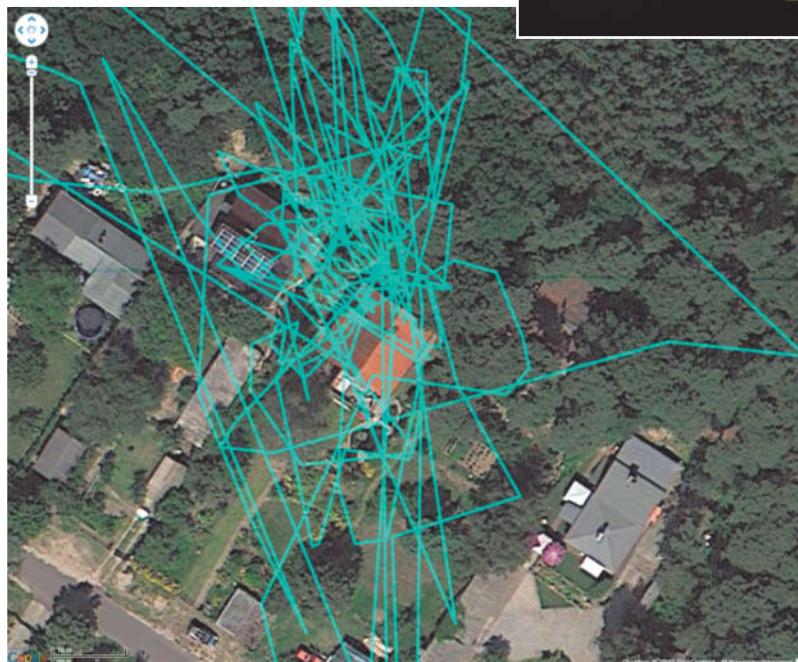
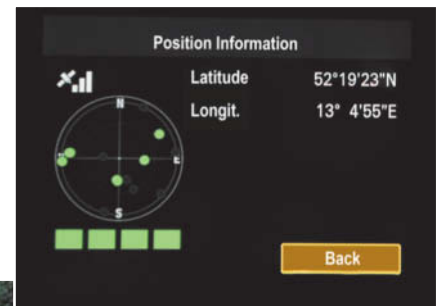
Most of the cameras we tested continue to track their position for a while after the GPS module is switched off, although manufacturers rarely specify the duration of this shutdown period. The Canon EOS 6D is a good example of a high-end camera with useful GPS functionality. The GPS module is always on and a dedicated icon in the LCD control panel on the top plate indicates its current status. The downside of this approach is that the camera battery drains after just few days of normal use. Reducing the GPS update interval improves the situation (one second is the shortest interval and five minutes the longest), and the camera then uses the same interval to log waypoints when it is switched off.

Time To First Fix (TTFF) is fastest in the open and, once the receiver has located a sufficient number of satellites, signals can weaken without actually interrupting reception. The only device we tested that managed a hitch-free indoor cold start was the Samsung Galaxy S4 smartphone. None of the other cameras, loggers and modules were up to the task at all, although some did retain position data for satellites they found when started out of doors even if they were moved inside later on. One of the more capable test models was the Sony DSC-HX50V 30x zoom compact, which also displays data relating to recently identified satellites. However, sub-optimum reception quickly produced errors that deviated by up to 50 meters from the camera’s real position.

External Data Sources

Because it is capable of always-on GPS tracking, the EOS 6D does not support A-GPS. All the other cameras we tested are

Most GPS-capable cameras don’t provide much visual information about the current status of the receiver. The Sony HX50V info screen shown here is one of the better examples we tested.



This visual GPS track isn’t the record of a steeplechase! What it actually shows are the deviations in track positions recorded by a stationary camera with weak GPS reception.



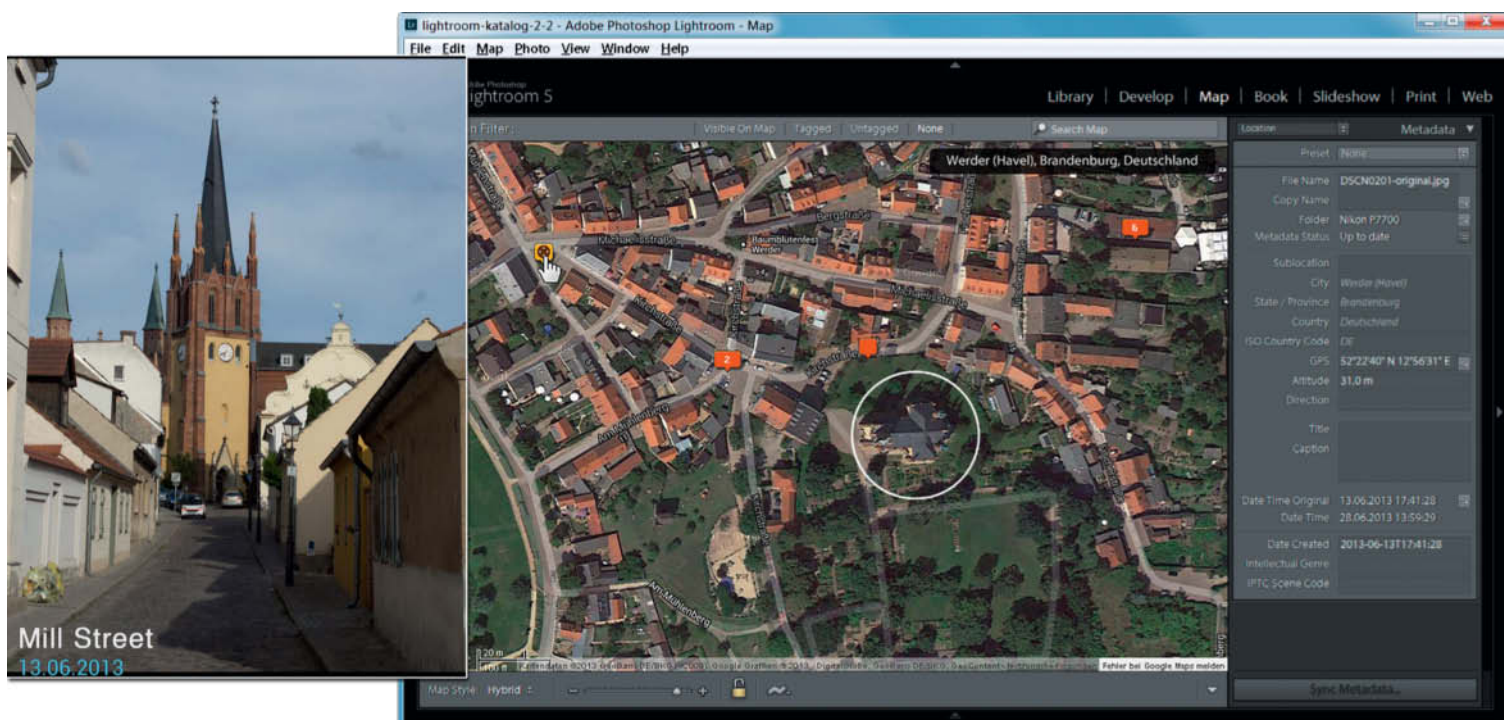
GPS Track Analyse (shown here), *GpsPrune* and other programs use logged position data to produce altitude profiles with varying degrees of usefulness

capable of utilizing this data, which provides much faster GPS start times. A-GPS data is generally uploaded automatically as soon as the camera is connected to an (online) computer on which the appropriate manufacturer's software is running. Nikon also offers the option of loading the data (updated daily) onto a memory card and

transferring it to the camera's built-in memory using a menu command. A-GPS data is valid for between seven and 30 days, after which it has to be updated manually. Smartphones and hybrid devices like the Samsung Galaxy Camera update their A-GPS data in the background whenever they are connected to the Internet.

'Flying Blind'

An important issue is what exactly the camera writes to a file's Exif data if there is no GPS reception or if reception was recently interrupted. Among our test models, the Sony cameras, the Nikon P330 and both Samsungs leave the GPS Exif fields



Lightroom indicates the camera position (the 'hand' icon in the screenshot shown here) using the position data recorded with each image, although the actual position of the subject (in our case the church) is not immediately obvious. Cameras with built-in landmark databases and/or Internet connections offer additional location-related data during shooting. The Galaxy S4, for example, displays the street name, although in our example the label is wrong because we were facing down a different street that led away from the intersection where we were standing. Additional data like this is not recorded with a file's Exif data.

empty, which initially seems logical but can be annoying in practice – for example if GPS reception is temporarily interrupted when you enter a building but your position hardly changes. The solution here is to use ‘indoor buffering’ technology, often referred to as LFR (Last Fix Repeat). The EOS 6D, the Panasonic ZS30 and the Galaxy S4 all support this feature. The Leica V-Lux 40 also writes the last known position to the next recorded image file, even if this takes place days after the camera was last switched off. This ‘pseudo fast start’ approach virtually guarantees that the first few images of any session you shoot while traveling will have false position data.

It wouldn't be so bad if such data were to be automatically marked as potentially false, so that you can check the validity of the resulting location tags. The only loggers we found that specifically do this are those made by Dawntech and Foolography, which set the 'GPSSatellites' Exif tag to 1 or 2. Reliable (horizontal) positioning data can only be ensured with a minimum of three satellites. In some models, you can also check the time stamp records in your GPS data, as the Canon EOS 6D, Panasonic ZS30 and Leica V-Lux 40

no longer update them during breaks in reception. The Olympus TG-2, which doesn't record GPS time at all, sets the 'GPSStatus' tag to 'V' (for Void) when there is no reception. The EOS 6D sets this value to 'A' (Active) during the 10-minute buffering period and then to 'V', but continues to write obsolete position data to the files it records. The problem with this approach is that most third-party GPS software cannot then display or evaluate the appropriate GPS status. The camera itself displays affected images correctly without position data, but *GeoSetter*, *Adobe Bridge* and *Lightroom* simply ignore the status field and display a false position as well as failing to display the number of satellites identified. *Photoshop Elements* displays both metadata fields but still displays location data in the Map view even if the status is set to Void.

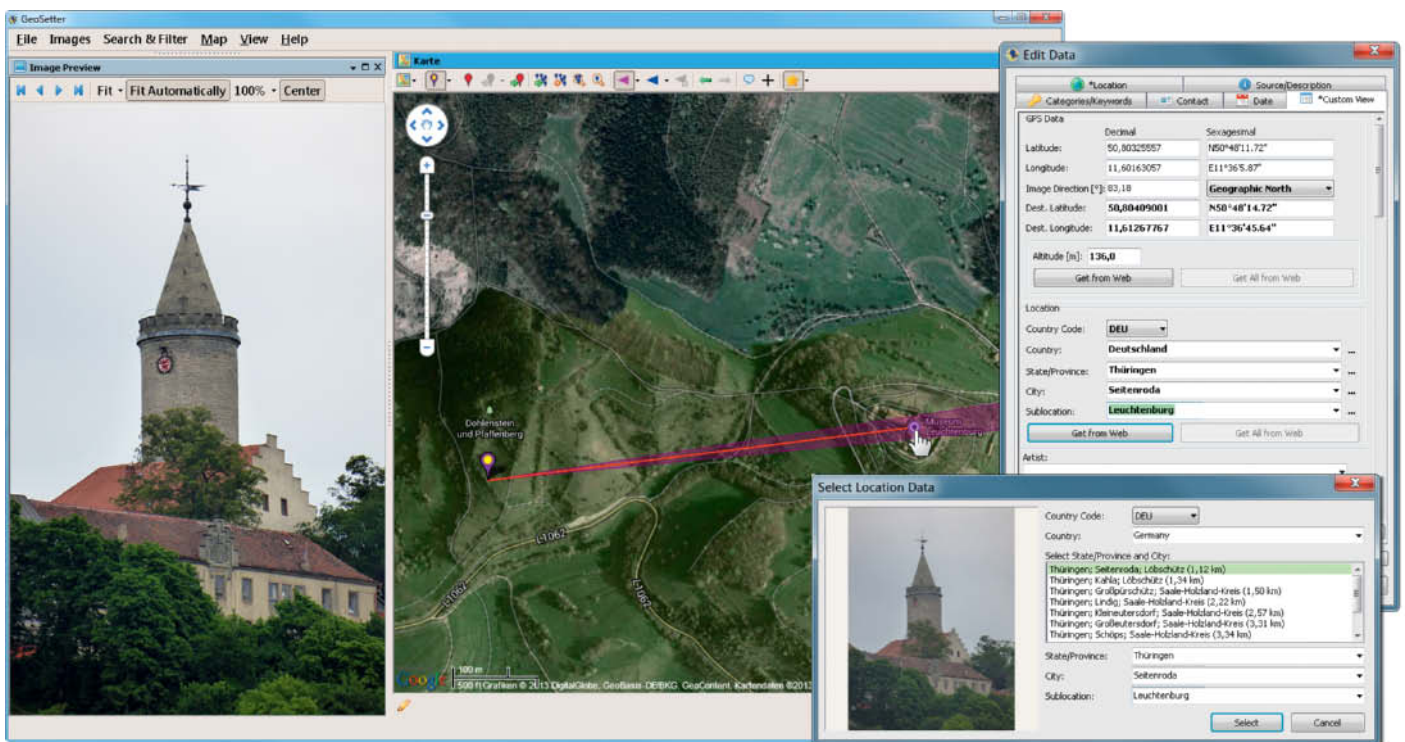
Indoor buffering is, of course, only a makeshift solution. Many smartphones use available Wi-Fi and mobile communications networks to fill gaps in the notoriously unreliable GPS coverage and, theoretically, can also use their built-in gyroscopes to calculate their position without the help of radio signals. Many GPS processors have input

channels for gyroscope signals but, as far as we know, the gyroscopes built into most cameras as image stabilization aids are not (yet) used this way.

Altitude Sickness?

When GPS reception is less than perfect, altitude signals are even less reliable than position data. Successful determination of altitude requires at least four 'visible' satellites, and some cameras switch the GPS icon to '2D' instead of '3D' when this happens. A conventional barometer relies on deviations in local air pressure to determine altitude and works independently of satellite signals. However, the accuracy of such an analog device depends on the weather and the corresponding air pressure at sea level, which can be calibrated out of the resulting figures if necessary.

Among our test cameras, only the ruggedized (and waterproof) Nikon AW110 and Olympus TG-2 models had built-in barometers that also measure dive depths down to 20 meters. These barometers can be calibrated by manually entering the current altitude value or by using the automatically



GeoSetter helps you augment the meager GPS data that some cameras provide. You can add camera heading and subject data using your mouse, while altitude and local points of interest can be provided automatically via the Internet or added manually. The data is recorded in the appropriate Exif or IPTC data fields. The program automatically calculates the angle of view based on the aperture setting and crop factor and displays it graphically as a wedge.

Image: Samsung



Geotaggers that attach to the flash shoe are great as long as you don't need to use flash. Nikon's shoe-mounted solution requires an additional cable. The illustrations here show (from left to right) the Samsung GPS10 (for NX cameras), the Nikon GP-1A mounted on a high-end compact and the Solmeta Geotagger Pro 2.



Image: Solmeta

provided GPS altitude value (if available). The AW110 buffers the last known position data when you switch it to underwater mode – a function that is not available in 'normal' mode.

Neither camera recorded altitude values with their Exif data, making the technology used to determine them a bit of a waste. However, both allow you to 'stamp' the data into the image itself, and the Nikon can be set up to record barometric altitude data in a log file at hourly intervals. During our test, neither the Samsung NX300 nor the Leica V-Lux 40

recorded altitude values, although the Panasonic ZS30 that the Leica is based on did.

Missing altitude data can be gleaned from online services such as SRTM or GTOPO and added manually to a file's metadata. The *GeoSetter* software package offers similar functionality for single or multiple images, although about half our test images produced error messages claiming that altitude data for the selected location(s) was not available. If this happens to you, you can always resort to entering altitude data manually and transferring it to your other images as

appropriate. In such cases, *GeoSetter* offers a great range of metadata editing options. Some GPS programs are also capable of creating detailed altitude profiles from the available data – a functionality that gets really interesting if you use it in conjunction with the logging function in your camera or an add-on logger that records your position every second.

Every Step You Take ...

The EOS 6D can log track points for up to 100 days at intervals of 30 seconds or more and the resulting log remains intact if you have to swap the battery during a session. A log file is written to the camera's built-in memory once a day and can then be transferred manually to a memory card or computer using the *Canon EOS Utility* software. Take care when saving log files to the memory card, as there is no way to prevent a file with the same name (i.e., recorded on the same day) from overwriting an existing one.

The Nikon P330, Lumix ZS30 and the Sony HX50V have built-in tracking functionality but offer only rudimentary settings. All three stop the logging process if the battery loses power or has to be changed but write track data to built-in memory, which protects the saved data if you swap out your memory card. On the downside, using built-in memory limits the amount of data you can record. Both Samsung devices can record tracking data if you install an appropriate app.

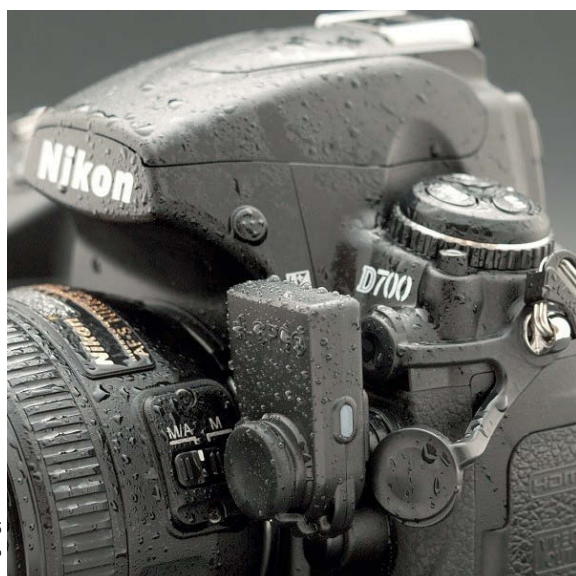


Image: gps-camera.eu

The Dawntech Eco Geotagger attaches directly to the 10-pin terminal built into many Nikon DSLRs and is available in prosumer and professional versions that cover most of the Nikon range

Log files usually have the LOG filename extension and can be opened by *Google Earth* and other GPS-capable programs. If, like GPSBabel, your software doesn't recognize the LOG extension, simply change the extension to one such as the widely used, text-based NMEA (National Marine Electronics Association) format.

You can, of course, create a track using the waypoints you recorded along with your GPS-tagged images. *GeoSetter* and the Java-based *GpsPrune* include appropriate functionality and also enable you to locate any photos that don't have geotags by setting a marker on a digital map.

Now, Where Was I?

You will not usually use 'naked' geo-coordinates to describe a photo's location, and 'real' details such a street name or the name of the town are much easier for most people to understand. Five of the cameras we tested have built-in landmark databases and are capable of linking the contents to GPS coordinates you record along your way, while the Leica V-Lux 40 and the Panasonic ZS30 also list points of interest (POIs) and allow you to add up to 50 landmarks of your own. However, the latter feature is almost useless in most cameras due to the fiddly nature of entering data via the monitor and the fact that the data you enter isn't actually written to the appropriate IPTC data fields, even when the user manual says it is. User-entered landmark data is only displayed on the camera monitor and (sometimes) if you view your images using the manufacturer's proprietary viewing software. Only the Leica and the Panasonic actually write landmark data to a dedicated GPS Exif data field that can then be read by programs like *Lightroom*.

The maps built into the Panasonic, the Leica and the Nikon AW110 are similarly nonsensical, with a low degree of detail and no street names, which makes them almost useless for navigation and photo location purposes. In order to achieve reasonable resolution, you have to pre-load regional maps onto your memory card and take great care not to overwrite, remove or format it while you are using them. Smartphones with camera functionality and cameras with smartphone capabilities don't suffer from these shortcomings, but the larger monitor on a computer (or at least a tablet) is still the best tool to use when it comes to linking photos with maps. Dedicated programs like *GeoSetter* offer excellent mapping services (via Google, Bing and OpenStreetMap) and also provide manual or automatic functionality for filling

Exif and IPTC data fields with appropriate data – a process known as reverse geocoding. IPTC location data is standardized and is usually supplied via the www.geonames.org website.

Direction of View

The final polish for any location data is inclusion of the direction the camera was facing (i.e., the heading) at the moment an image was captured. Unfortunately, not many GPS-equipped cameras have a built-in compass too. Among our test cameras, the Nikon AW-110, the Olympus TG-2 and the Panasonic ZS30 were the only ones that did. In view of the fact that both Samsung devices have a compass built in as standard, it is rather disappointing that neither uses the data provided as part of the image metadata it records. You can accurately calculate the direction a moving GPS receiver is facing without using a compass, even if it is only moving at bicycle speed. Both Sony cameras make use of this functionality but write the resulting data to a proprietary Exif field called 'GPSTrack' rather than to the standardized 'GPSDestBearing' tag. Neither *GeoSetter* nor Sony's own *Play Memories Home* software then makes use of the 'GPSTrack' data.

Heading data becomes more interesting when it is linked with the angle of view provided by the aperture used to shoot a photo – data that is simple to calculate using

the aperture and crop factor Exif values. In map view, *GeoSetter* even superimposes a wedge-shaped graphic on the photo that shows the field of view covered by the camera, providing an additional degree of granularity to the tracking data involved. You can add heading and angle-of-view data in *GeoSetter* by dragging the camera standpoint toward the subject with your mouse and selecting the *Add/Move Point of View* option in the dialog that follows. This point the camera was focused on when the photo was captured is then marked.

Add-on GPS

If your camera doesn't have a built-in receiver of its own, a plug-in or add-on receiver is the next best choice and, if the camera's software then allows you to import the tracked data directly to your images, this type of solution is no less practical than the built-in approach. Most add-on modules are designed to be attached to the camera's flash shoe and often provide better reception than built-in modules which are covered by the camera housing. Canon, Nikon and Samsung cameras support direct shoe-mounted data transfer and/or connection via the multi-purpose connectors built into the camera body. GPS pioneer Nikon introduced the GP-1 receiver in 2008, triggering a wave of copycat products.

GPS data is transmitted via a continuous NMEA data stream. Power for the GPS module

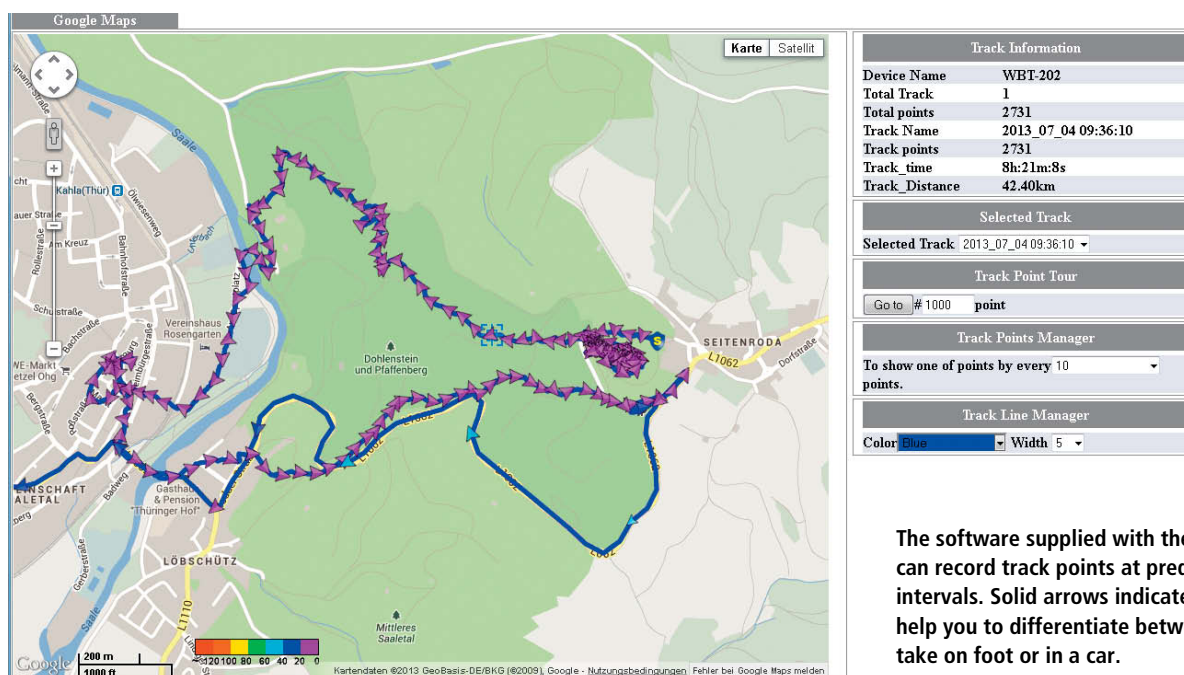


Image: Columbus



Image: Wintec

Geologgers function independently of your camera and can continue logging for as long as the battery has power. Models with a microSD slot like the Columbus V-990 (on the left) can record up to 100 million track points. The Wintec WBT-202 (on the right) has built-in Bluetooth connectivity. Both devices use built-in gyroscopes that help to save battery power and both cost around US\$75.



The software supplied with the Wintec WBT-202 can record track points at predetermined intervals. Solid arrows indicate slow speeds and help you to differentiate between routes you take on foot or in a car.

is usually provided by the camera battery. Some devices have their own built-in battery, which not only saves camera power but also ensures that the unit continues to log position data when the camera itself is switched off. This approach also ensures that GPS data can be logged immediately as soon as the camera is reactivated. To achieve the same effect, many of Nikon's current DSLRs supply the 10-pin connector socket with power even when the main camera circuitry is switched off.

The Coolpix P7700 high-end compact that we tested unfortunately doesn't share this functionality and even interrupts GPS logging when the camera switches to standby mode, which is a serious drawback for photographers who take their geotagging seriously. The only way to ensure that you can continue shooting tracked photos is to extend the camera's auto-standby time to its maximum of 30 minutes, although this uses much more power than the GPS unit would if it were simply allowed to continue logging. The Samsung NX300 showed similar behavior when used with the GPS10 add-on module.

With the P7700, you can only work around this issue if you use a GPS module with its own battery. Dawntech and Solmeta are two reputable manufacturers of Nikon-compatible units. Third-party units often include additional functionality that is missing in Nikon's own GP-1 module and usually consume less power and offer better reception. Third-party solutions are nevertheless responsible for some unwanted surprises – for example, the Columbus

nGPS module didn't write any geodata at all to our P7700's photo files, even though a functioning connection was displayed on the camera monitor. If you are planning a purchase, check that the model you are considering is compatible with your camera and that it offers indoor buffering functionality – another function that the GP-1 lacks. Most third-party modules also include the remote release that you need because the GPS module is using the socket. Some also have a built-in compass, some have built-in logging functionality and some even have built-in wireless remote release functionality. The Solmeta Geotagger Pro 2 offers all of these features in a single compact package for about US\$290.

An alternative solution that frees up the flash shoe and doesn't require an annoying cable is the tiny Bluetooth-enabled Unleashed model from foolography.com (for about US\$170 via mail order), which attaches to the camera's accessory terminal and uses log data supplied by a separate logger. The di-GPS Eco Geotagger from Dawntech is only slightly larger than the Unleashed and also attaches to the camera's accessory terminal. It does not have compass functionality but includes a compatible remote release.

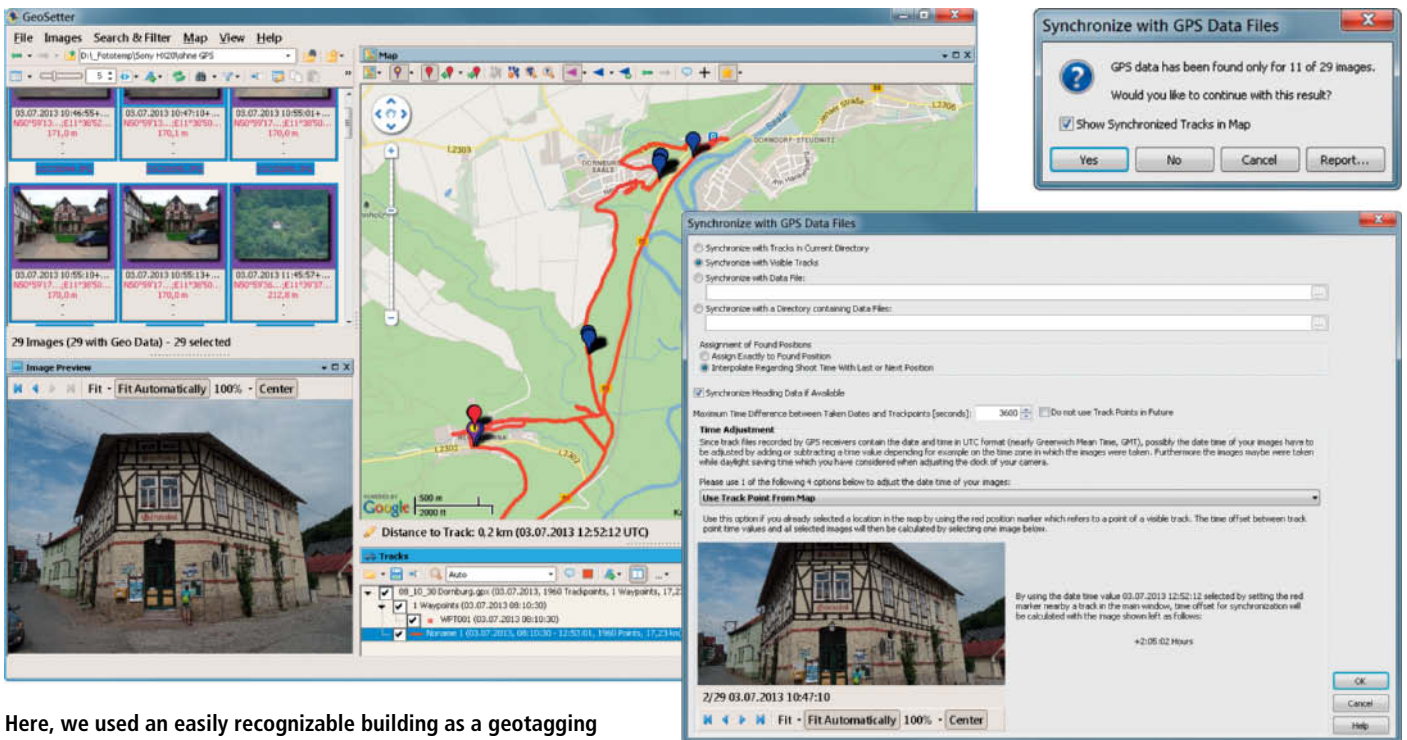
Canon's GP-E2 module transfers data directly via the flash shoe in compatible high-end DSLRs but requires a separate cable if you need to use flash. The EOS 1DX has its own dedicated GP-EP1 module that attaches to the system extension terminal on the side of the camera body. Both models have a

built-in compass and cost about US\$240. The GP-E2 has its own batteries and can be used separately as a standalone logger.

Off the Leash ...

A geologger works with any camera and does not require a direct connection. Photos can be tagged later on a computer using the data recorded by the logger and, depending on which software you use, tagging can be either manual or automatic. Loggers are usually about as sensitive as add-on GPS modules and do their job properly from just about anywhere – just make sure your logger doesn't end up right at the bottom of your backpack if you want to be sure it is recording track points. Loggers record location data at intervals as short as one second and can be set up to record data only when you change position or reach a certain speed. One of the major advantages of using a logger is that you aren't distracted by the wait for GPS signals while you shoot. If you lose reception while you are out and about, the resulting track will simply contain a short straight portion where no signal was available for which you will have to tag your photos manually.

If you press the POI (point of interest) button every time you take a photo, the logger will record a waypoint that you can then transfer to the file's Exif data using GPS software. This process can be performed automatically or manually and is based on the time stamps of the photos and the waypoints.



Here, we used an easily recognizable building as a geotagging reference point for a whole sequence of photos. To use such a photo as a reference, simply set a red position marker in the appropriate place on the *GeoSetter* map.

For this type of logging and tagging to be successful, the camera and logger clocks have to be perfectly in sync. In practice, the two clocks usually display different times, but you can compensate for this by using a single reference photo whose time and position you enter manually in the track. If you take this approach, you only need to record a single separate waypoint together with a randomly picked subject as a reference for the start of your track.

You can perform the same function in *GeoSetter* without having to worry about time settings. All you have to do is mark the place on the track where the reference photo was taken (a dedicated waypoint makes this even simpler) and select it in the Synchronize dialog. The other way to achieve the same result is to manually match a photo to a reference waypoint selected from the list.

If your logger doesn't support waypoints, make sure your reference shot is of an easily recognizable landmark that you can pinpoint on a map. Remember not to hang about for too long at your reference location, as this will cause your logger to record too many track points in the same place and make any subsequent time synchronization less accurate.

Alternatively, you can use *GeoSetter* to synchronize your photos and the track

numerically to the nearest second based on the time signal provided by your computer (and, of course, taking any differences in time zones into account). All you have to do is correct the program time to match the time recorded by your camera using the figures in the appropriate boxes.

The *gps4cam* app (available for Android and iPhone) cleverly makes geotagging fully automatic by converting the clock time in your handheld device into a QR code that you can capture in a photo at the end of your track. This ensures that the track time and the time recorded by your camera are both recorded in a single image file. A desktop application then reads both timestamps and automatically uses the difference between the two to assign the photos to the correct points on the track. The standard version of the app records track points at a minimum interval of 30 seconds, so if you shoot a lot of photos, this might not be precise enough to accurately locate all your shots. The Pro version of the app (currently only available for iPhone) offers intervals as short as 10 seconds.

Smartphone + Camera = Great Team

Most smartphones offer GPS reception that is just as good as that provided by most

dedicated loggers and are streets ahead of any of the GPS-equipped cameras we tested. If you own a smartphone and a camera with built-in Wi-Fi functionality, it is a great idea to combine the two. Among our test candidates, Samsung and Canon are the manufacturers who maximize this approach. Canon's PowerShot S110 even does without the GPS module built into its predecessor and specifically targets use with a smartphone. We tested the S110 and the Samsung NX300 together with the Samsung Galaxy S4 smartphone.

Connecting the two Samsung devices is a snap thanks to their built-in NFC technology. All you have to do is switch the camera on, press the 'Direct Link' button and touch the left-hand side of the camera body with the back of the S4 smartphone. The Google Play Store then opens automatically and offers the Samsung *Smart Camera* for you to download and install. The same button is also used to establish Wi-Fi contact between the two devices. The default setting is AutoShare mode, which automatically transfers every photo you capture to your smartphone, where it adds geotags and saves the tagged files. Any files that the camera saves to its own memory card are not tagged. Keeping track of the two sets of photos can be tricky, especially if you are



The image on the left shows the Canon *CameraWindow* app running on a Galaxy S4. This app records tracking data independently of camera activity.

travelling and the memory in your smartphone isn't large enough to store copies of all the photos you take.

Sadly, Samsung hasn't integrated GPS tagging into Smart Viewfinder mode. In this mode the screen on your smartphone is transformed into a remote, touch-screen camera monitor with a limited but useful range of camera functions. Here too, all your photos are transferred automatically to the

smartphone's memory, but only in the form of low-resolution copies with no Exif metadata.

Permanent Wi-Fi contact quickly depletes the batteries in both devices – probably more than a GPS module would. Canon's solution requires a connection only at the beginning and end of a tracking session, but its Wi-Fi setup is more complex and poorly explained in the user manual. The Canon app is called *CameraWindow* and has a library mode for

accessing all the photos stored in the camera and a separate mode for geotagging. Before heading out, you need to set up a Wi-Fi connection and set the app to 'Location log' mode.

Your smartphone will now track your route until you tap the 'End' button. Finally, you have to tap the 'Add locations to images on camera' button, which requires the Wi-Fi connection to be re-established. The actual tagging process is very fast, as only the geotags (and not the image files) have to be transferred to the camera and the image files themselves stay put. There is no remote control mode. We also noticed that the altitude data recorded to the image files was 50 meters higher than the value displayed by the GPS Status smartphone app. In contrast, the NX300 always entered an altitude of 0.0m, regardless of whether we used the Galaxy S4 or the GPS10 module to record data.

The Canon workflow is simple, and the second (syncing) step is automatic and essentially the same as the step you have to make on a computer when you sync your images and tags anyway. The drawbacks of the system are that it is easy to forget to start tracking and that you have no control over the consistency of the GPS signal. There is also no way to intervene during synchronization or repeat the process if it doesn't work properly. At the end of the day,



Hybrid camera/phone devices such as the Samsung Galaxy Camera shown on the left solve a lot of remote communications issues, but still don't always use the data provided by the built-in compass to enhance geotags. On the right is the Samsung NX300 – a system camera based on the Android operating system.

HARDWARE TEST: CAMERAS WITH BUILT-IN GPS										
	Canon EOS 6D	Leica V-Lux 40	Nikon Coolpix AW110	Nikon Coolpix P330	Olympus TG-2	Panasonic Lumix DMC-ZS30	Samsung Galaxy S4	Samsung Galaxy Camera EK-GC100	Sony DSC HX50V	Sony A99V
Camera type, (equivalent focal length range)	20-megapixel full-frame DSLR	14-megapixel compact (24-480 mm) (Same internals as the Panasonic DMC-ZS30)	16-megapixel ruggedized compact (28-140 mm)	12-megapixel compact with wide maximum aperture (28-120 mm)	12-megapixel ruggedized compact (25-100 mm)	18-megapixel travel zoom (24-480 mm)	Smartphone with 13-megapixel camera (31 mm)	16-megapixel Android-based camera (23-483 mm)	20-megapixel 30x travel zoom (24-720 mm)	24-megapixel full-frame DSLR with articulated monitor
Hardware										
GPS / Glonass	GPS	GPS	GPS	GPS	GPS	GPS+Glonass	GPS+Glonass	GPS	n/a	n/a
Barometer	-	-	✓	-	✓	-	✓	✓	-	-
Compass	-	-	✓	-	✓	✓	✓	✓	-	-
Wi-Fi	✓	-	✓	-	-	✓	✓	✓	✓	-
Features										
GPS status display	Icon (also when switched off)	LED and icon	Icon	Icon	Icon	LED and icon	Icon	-	Icon	Icon
Update interval	1 s-5 min. in 8 steps	15 s	n/a	n/a	n/a	n/a	n/a	n/a	n/a	15 s
A-GPS / Validity	-	✓ / 30 days	✓ / 14 days	✓ / 7 days	✓ / 14 days	✓ / 30 days	✓ / n/a	✓ / n/a	✓ / 30 days	✓ / 30 days
GPS reception with camera off / How long?	Always on (in 'Internal GPS' mode)	✓ / 15 min.	max. 6 h	max. 6 h	Always on	✓ / n/a	n/a	n/a	-	-
Indoor buffering (Last Fix Repeat, Last Position Retention)	Approx. 10 min	Always	Only in under-water mode	-	Until power off	Until power off	✓ / n/a	✓ / n/a	-	-
Camera time uses GPS data	✓ auto	✓ auto	✓	✓	✓ auto (in World Time mode)	✓ auto	-	n/a	✓ auto	✓ auto
Geologger capacity	Approx. 127,000 positions or 100 days	-	GPS: 6-72 h, Altitude: 1 h	6 h, 12 h, 24 h	24 h	6 h, 12 h, 24 h, 48 h, endless	Optional (via app)	Optional (via app)	24 h	-
Log data format	Log (NMEA-0183)	-	Log (NMEA-0183)	Log (NMEA-0183)	Log (NMEA-0183)	NMEA, KLM	Depends on app	Depends on app	Log (NMEA-0183)	-
Log interval	1 s-5 min. in 8 increments	-	15 s-10 min.	15 s, 30 s, 60 s	30 s	15 s, 30 s, 60 s	Depends on app	Depends on app	15 s	-
Map functionality	-	✓ (via SD card)	✓ (built-in)	-	-	✓ (via SD card)	Optional (via app)	Optional (via app)	-	-
POI data	-	✓	✓	✓	✓	✓	✓	✓	-	-
Editable GPS data	-	Position and POI selectable	POI selectable from map or list	POI selectable from list	POI selectable from list	Position and POI selectable from map, list or other image	-	-	-	-
Exif GPS Data										
Latitude and longitude / Altitude	✓ / ✓	✓ / -	✓ / -	✓ / ✓	✓ / -	✓ / -	✓ / ✓	✓ / ✓	✓ / ✓	✓ / ✓
Heading (compass)	-	-	✓ (precise)	-	✓ (precise)	✓ (16 increments)	-	-	-	-
GPS Track / Speed	- / -	- / -	- / -	- / -	- / -	- / -	- / -	- / -	✓ / ✓	✓ / ✓
# of visible satellites / Sat. time	✓ / ✓	- / ✓	✓ / ✓	✓ / ✓	- / -	- / ✓	- / ✓	- / ✓	- / ✓	- / ✓
POI data	-	✓	-	-	✓	✓	-	-	-	-
GPS Status / GPS Mode / DOP	✓ / ✓ / ✓	✓ / ✓ / ✓	- / - / -	- / - / -	✓ / - / -	✓ / ✓ / ✓	- / - / -	- / - / -	✓ / ✓ / ✓	✓ / ✓ / ✓
Data recorded without GPS	Last position (GPS Status void)	Last position and GPS time	Zero values for position and time	-	Last position or nothing (GPS Status void)	Overflow values (GPS Status void)	-	-	-	-
✓ included - not included n/a not applicable										

our impression was that the drawbacks outweigh the advantages of using a built-in or add-on GPS module. The lack of heading data is also a needless oversight, as most smartphones have a built-in compass that is easy to tap into, although the camera and the smartphone would have to face in the same direction all the time for such a function to be genuinely useful.

Conclusions

Geotagging is great when it works, but patchy reception and long startup times are drawbacks that often make it frustrating to use. GPS receivers that use little power but still support multiple satellite systems and additional functions such as SBAS and dead reckoning already exist, but they are not yet

being built into commercially available devices. Smartphones are in the lead in the GPS reception race but don't always use all the data they gather to tag the photos they capture. The idea of combining smartphone GPS functionality with in-camera Wi-Fi capability is promising but not yet well enough developed for mass market use. We found ourselves wondering whether a simple

GPS Data Formats and Exif Tags

Standard geodata consist of latitude and longitude values with optional altitude and heading data. Latitude is measured using values between 0 and 180 degrees east or west of the Greenwich Meridian in London, and longitude is measured using values between zero and 90 degrees north and south from the equator. The applicable directions are given using the points of the compass E (East), W (West), N (North) and S (South). According to Google, the Heise offices in Hanover, Germany are located at N52° 23' 8.97" / E9° 48' 35.75" measured in degrees, minutes and seconds (equivalent to 52.385825 / 9.809931 in decimal notation). Positive decimal values stand for North or East, while negative values stand for West and South. Some systems also use decimal minute values, which in our case gives us values of N52° 23.1495 / E9° 48.59583.

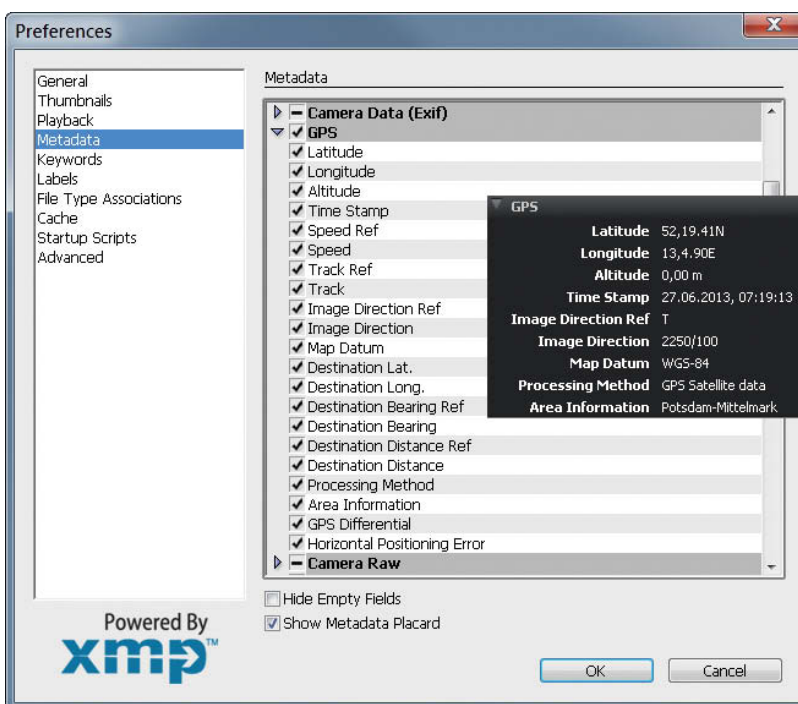
These coordinates define map reference points on an ellipsoid model of the Earth (which isn't a perfect sphere) according to WGS 84 (the 1984 World Geodetic System). Heading data is defined either in relation to True North (T) or Magnetic North (M). A total of 31 Exif tags are reserved for these and other GPS data. If you want to use all of these, we recommend that you use the *ExifTool* software in conjunction with the *ExifTool GUI* add-on. Most other Exif editors omit one or more of the available tags.

Cameras write GPS data directly to the Exif header of an image, whereas dedicated GPS software usually only does this for JPEG and TIFF-format files and uses a separate XMP sidecar file to record GPS data for RAW images. *GeoSetter* allows you to select which of these options you use.

Geologgers save tracks in one of a number of different formats that are not compatible with all GPS software. The most widely used formats are GPX (GPS Exchange) and NMEA (National Marine Electronics Association), a plain text-based format supported by all the logging-capable cameras we tested. Some cameras write log files using the LOG filename extension, which some programs

don't support. The KML (Keyhole Markup Language) and KMZ formats are Google proprietary, although *Google Earth* itself also supports other formats.

GPStabel (gpsbabel.org) is a universal GPS data format converter that you can download and install locally, while services such as gpsies.com and gps-data-team.com perform data conversion online.



Of the 31 available GPS Exif data fields (shown here in the background), *Adobe Bridge* analyzes a maximum of 21 for any given photo (shown in the foreground for the Panasonic ZS30). The 'GPSStatus' tag that indicates the validity of a reading and the number of satellites that were 'visible' when the photo was shot are not included.

logging app that synchronizes its data with your photos later on a computer is perhaps a simpler and more reliable solution. The major advantage of this approach is that it is automatically compatible with just about any camera.

The most useful of the GPS-capable cameras we tested were the Nikon AW-110, the Olympus TG-2 and the Sony HX50V, all of which located signals within seconds of startup. The Nikon P330, the Panasonic ZS30 and the Leica all took much longer to latch on to the system. The EOS 6D is a fast starter too,

but its always-on approach uses masses of battery power. In contrast, the Sony A99V takes several minutes to find a signal every time it is powered up and wasn't able to hold a signal at all when traveling at 60 mph (100 km/h) on the freeway. The other compacts had no problems receiving signals at speed. Add-on GPS units and loggers are clearly more reliable than built-in modules but have more compatibility issues. If you can, try out the module you are thinking of acquiring under real-world conditions before parting with your money.

It will probably be some time before location data is saved as standard with digital images the way date and time stamps are today. The location is a much more private aspect of a photo than the date it was taken, which raises the question of whether automatic recording of location data is a good idea at all. Practical, user-friendly metadata editing functionality is still a rarity. Once again, *GeoSetter* comes to the rescue, offering a raft of useful functions. It's not perfect, but it is definitely one of the best all-round GPS solutions currently available. (sea) **ct**

WE ARE NOT ONLY GEAR HEADS



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Martin Haeusler

Beauty Shoot

in the California Desert

In this workshop, star photographer Martin Haeusler lets us look over his shoulder during a shoot with Jessica Sutta, a former member of the Pussycat Dolls girl group. He describes the setup he used to shoot into the sun in the Californian desert and talks about the challenges involved in combining sunlight with artificial light on set.

Natural surroundings with plenty of atmosphere and unusual lighting were the main points of the brief for this shoot with Jessica Sutta. We wanted, of course to produce unforgettable photos, and my search for the right location took me to a spot in the Mojave Desert, about two hours outside of Los Angeles. I already knew the area from earlier shoots, so I knew what kind of atmosphere the unique desert light could provide.

Preparations

We had already agreed with Jessica and our stylists on the props and costumes we wanted to use the day before the shoot. Going through a 'fitting' like this in advance of a shoot is well worth the effort, as it ensures that the overall styling fits in well with the lighting and planned backgrounds on set.

The following morning, I set off for our chosen location at seven o'clock along with

the crew – a hair and make-up specialist, a stylist, two photographic assistants, Jessica's own manager and assistant and, of course, Jessica herself.

The client, Jessica's record company, had ordered images for us in marketing and cover artwork as well as other media, so we had to shoot portraits, medium close-ups and some long shots. We had plenty to do and the temperature was forecast to hit 46 degrees in the shade!

Desert Shoot

The Job: Promo and cover shoot for the new single by Jessica Sutta

Dateline: High summer

Photographer: Martin Haeusler

Model/Artist: Jessica Sutta

Location: Joshua Tree, California in the Mojave Desert



Our first setup included an old bathtub that we found on set and a water tank, which we shot using a wide aperture and relatively 'flat' lighting



The desert provided a fantastic backdrop for a truly striking subject

Canon EOS 5D Mark II
with a Canon EF 50mm f/1.2L |
f2.2 | 1/125s | ISO 100

Daytime light in the desert can be really 'hard', so we decided to begin shooting in the afternoon, which is the time of day that usually provides the most atmospheric light. We spent the time between arriving and starting the shoot perfecting the styling and thanking our lucky stars that the house we had rented had air conditioning!

The Shoot

In our first setup, we used an old bathtub and a metal water tank as props. To keep the focus on Jessica, we worked with relatively 'flat' lighting and a wide aperture. It was important to use the desert and the silhouettes of the Joshua trees as a backdrop rather than letting the landscape divert attention from the real subject of the photos. We kept the wind machine we had planned to use for hair effects switched on the whole time to keep us cool.

We took along a Hasselblad H3D-39 II and a Canon EOS 5D Mark II with a selection of prime lenses for both. To keep image quality as high as possible, I usually work exclusively with prime lenses made by the camera manufacturer. In the past, my trusty Hasselblad has sometimes failed to work properly at such high temperatures, and we didn't really need 39-megapixel images anyway, so I decided on the spur of the moment to do the whole shoot using my EOS 5D. My favorite Canon portrait lens is the EF 50mm f/1.2L, which I used for about 90 percent of the shots we captured on this particular day. The other lens I used (for some close-ups) was my EF 135fmm f/2L. I have since acquired a Hasselblad H5D-40, which copes much better than the H3D with desert climates.

We shot the main set in the late afternoon using an old hippy bus that had been lying around rotting for at least 20 years as our main prop. The purple metallic paint it had been sprayed with made a perfect background for our dusk session.

To get the atmosphere looking right in such harsh backlight, you have to set your reflectors and accent lights just right. The sketch below shows how we set up our session and how we made sure that the resulting images didn't end up looking too dark and two-dimensional. We used a large, gold colored Scrim Jim reflector to keep the overall lighting warm and balanced.

We also used pink and purple foils to tint our lights and emphasize the hippy-esque colors in the scene. A white Profoto beauty dish provided a main light that lit Jessica nicely without making her skin tones look too harsh. To keep the bus in focus and reduce the effect of the strong backlight, I used small apertures for all of these shots.

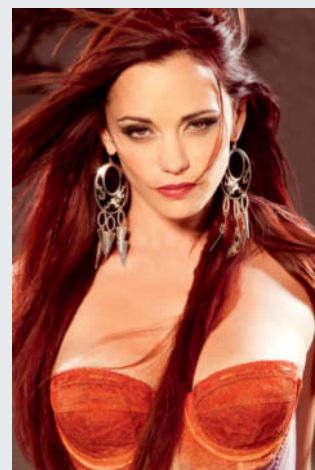
Post-production

Once the client had made a selection, we edited our photos to give Jessica's hair and skin tones their final polish. We also accentuated some of the color and lighting effects while making sure we stuck to the look we created on set. I have always found that artificial lighting effects created on a computer produce artificial-looking photos, which is why I work so hard with so many lights to get things right during the shoot, even if it means that I sometimes have to work against the clock.

I usually sharpen the final images to match the output media and, if necessary, mask or soften any skin tones that don't fit the bill. (jr)

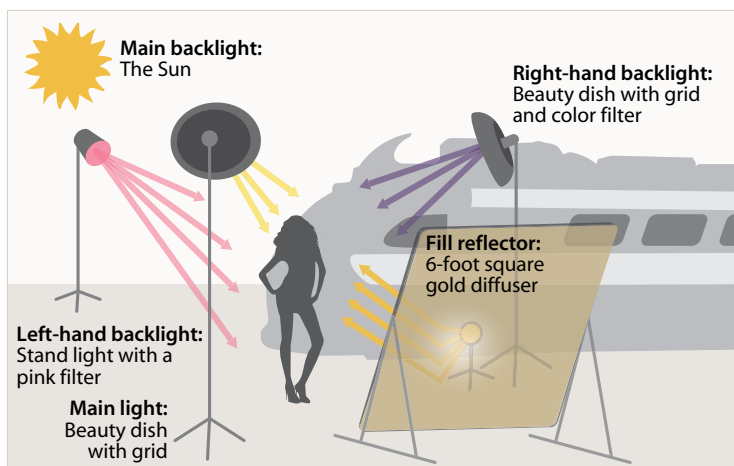
Jessica Sutta

Jessica Sutta came to fame as a member of the Pussycat Dolls pop and dance troupe, which she belonged to between 2002 and 2010. Since then, she has been concentrating on her solo career, which actually began while she was still with the group.



Canon EOS 5D Mark II with a Canon EF 135mm f/2L prime lens f13 | 1/125s | ISO 100

Martin Haeusler lives in Germany and the US, where he is a sought-after photographer in the music and film industries. To see more of his work, visit www.martinhaeusler.com or [facebook.com/MartinHauslerPhotographer](https://www.facebook.com/MartinHauslerPhotographer). c't



This setup involved shooting directly into the sun, so we had to be extremely careful setting up our reflectors and accent lights in order to avoid producing images that were overly two-dimensional

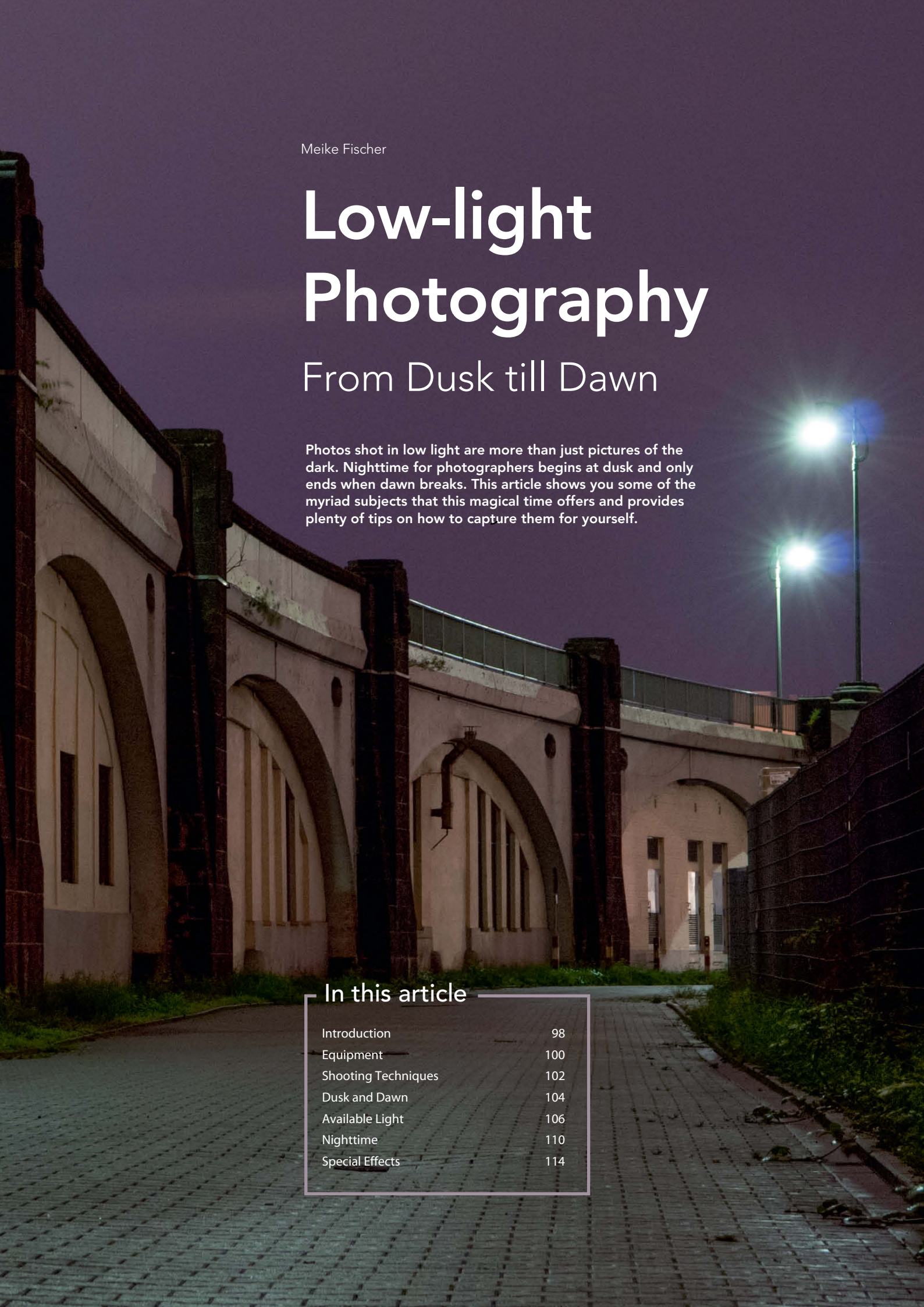


Tinted foil covering our lights underscored the pinkness of the old bus and evoked a wonderful hippy-esque 70s feeling.

The main light in this shot was a white Profoto beauty dish.

Canon EOS 5D Mark II with a Canon EF 50mm f/1.2L set to f16, 1/125 s and ISO 100, with an ND2 filter to neutralize the strong backlight





Meike Fischer

Low-light Photography

From Dusk till Dawn

Photos shot in low light are more than just pictures of the dark. Nighttime for photographers begins at dusk and only ends when dawn breaks. This article shows you some of the myriad subjects that this magical time offers and provides plenty of tips on how to capture them for yourself.

In this article

Introduction	98
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Shooting Techniques	102
Dusk and Dawn	104
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On a clear night, the sky changes its color from bright blue to black and all shades in between. Equipped with a solid tripod, you can use such evenings to capture wonderfully radiant cityscapes, and cities always look more inviting at dusk than they do during the day. However, if the sky is cloudy, it can take on all manner of colors in nighttime photos, from red to gray and even green, depending on the lights that are reflected by the clouds. Even

the darkest corners are usually lit by enough residual light to help you capture that special nighttime feeling.

Whether you prefer to work with long exposures or available light, night shoots are perfect for transcending the limits of normal vision and capturing unusual images that captivate the viewer.

The unique mood of the evening and nighttime makes shooting such photos a

really special experience. You will often find yourself alone and able to concentrate perfectly on your work without any distractions. Working alone in the dark can be slightly creepy, but that's part of the fun too!

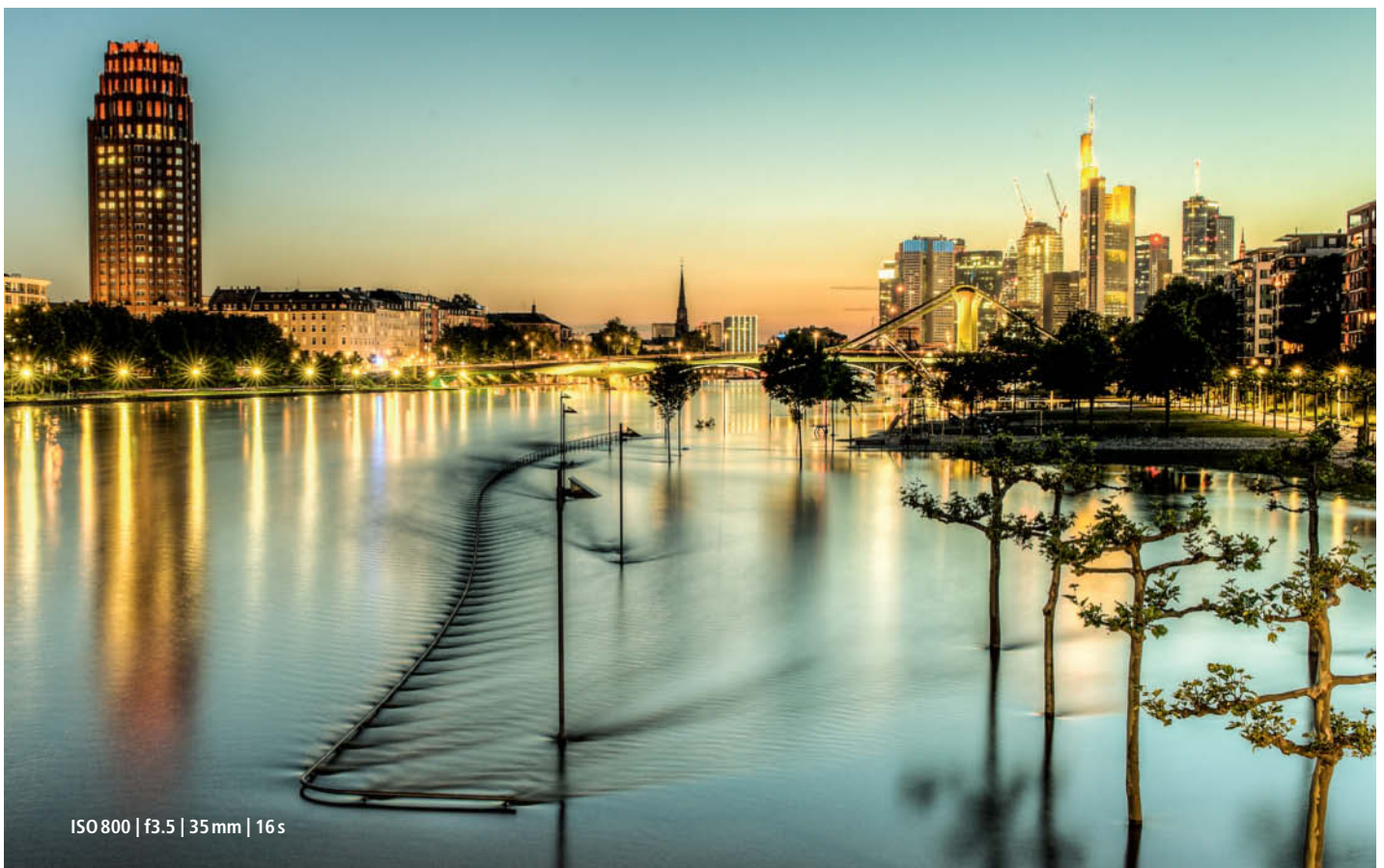
The long exposure times that nighttime photography demands mean that you also have to work carefully if you want to avoid having to repeat your shots. Exposure times

This shot appears to turn night into day. This urban wasteland with its view of the Frankfurt skyline was captured as night fell. The relatively small aperture provided sufficient depth of field and the long exposure contributed to the surreal effect. Shots like this require a solid tripod.

ISO 160 | f8 | 35 mm | 30 s



High water shot during the 'blue hour' on the banks of the River Main. Here too, a long exposure has brightened the sky and the water to perfectly complement the city lights.



ISO 800 | f3.5 | 35 mm | 16 s



The colored lights in the background provide a fantastic contrast to the romantic river scene in the foreground, producing a dreamlike effect

ISO 500 | f9 | 24 mm | 60 s

of up to several minutes make shooting in the dark a particularly meditative pursuit.

Many photographers are disappointed when they view their first attempts at night photography, and often find that the best shots are happy accidents rather than the result of a carefully planned image working

out as they expected. The problem most often lies in the use of inappropriate auto settings. Solid manual exposure technique is essential on a night shoot, although even experienced daytime photographers find that their tried and trusted techniques don't always produce the results they were

expecting when applied to nighttime scenes.

The following pages provide tips on the right equipment to use and illustrate a range of situations that span the time between dusk and dawn, explaining how to capture them in atmospheric photos.

Equipment

Cameras and Lenses

You will only be able to retain complete control of every situation if your camera has a fully manual exposure mode. If you use a tripod, you will be able to use long exposure times and all of the lenses you normally use to shoot in the daytime.

However, if you wish to use 'available light' techniques to shoot handheld in the dark (see page 106, you will need to use the brightest lenses you have (i.e., the ones with the largest maximum aperture). It makes an enormous difference to a night shoot if you have access to a lens with a maximum aperture of f1.8 or f1.4 rather than having to shoot at f5.6 or less. Large apertures give you the freedom to shoot using much shorter exposure times.

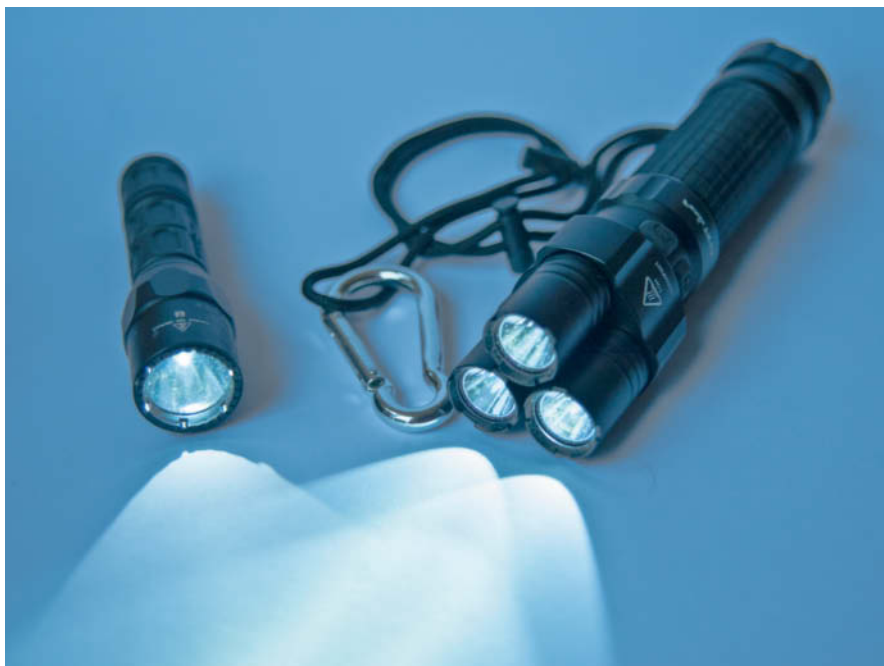
Bright, fixed-focal-length lenses are the best choice for available light photography and usually have a distance scale, too, which is a great aid to focusing in low light.

Tripods and Remote Releases

If you want to shoot beyond the confines of available light, you will need a stable tripod and some kind of remote shutter release. A tripod with a built-in spirit level is ideal and will help you to set your camera up correctly even when the view through the viewfinder or on the monitor is too dark. A remote release prevents unwanted camera shake by making it possible to release the shutter without actually touching the camera.

Lighting

Pocket flashlights are great not just for adding detail lighting or making light paintings, but also for focusing in low light or manipulating your camera's controls in the dark. I use a small flashlight for close work (and camera control) and a larger one for lighting more distant details. Surefire and LED LENSER are reliable brands of LED flashlight. The larger Fenix model shown in the illustration above has an adjustable brightness setting and a built-in strobe mode.



Two lamps that will help you get the results you are looking for. A small flashlight is great for setting up your gear, while a large one can be used to add lighting accents to a scene.





This shot was captured handheld at the end of the 'blue hour'. A bright lens used wide open and a high ISO value helped to prevent camera shake, but the large aperture significantly reduced the available depth of field, as is often the case in 'available light' shots.

ISO 800 | f1.8 | 50 mm | 1/4 s

Shooting Techniques

ISO Values

If you want to be in complete control of your results, you should always set the ISO value manually, whether you are shooting during the day or at night. I recommend that you use the lowest possible value offered by your camera to preserve detail and prevent unwanted noise artifacts from spoiling your images. Quite simply, the higher the ISO value, the more noise the firmware will produce while amplifying the signals captured by the sensor.

Cameras that produce little noise at high ISO values (1600 or more) are ideal for night shooting and enable you to use short exposure times. Generally speaking, the size of the sensor determines the number of noise artifacts you will end up with, so a camera with a full-frame sensor is the best option.

Reducing Noise During Long Exposures

Activating your camera's auto noise reduction function creates a 'dark frame' that takes just

as long to produce as your original exposure, and the camera will be inoperative during this time. In other words, if your exposure takes 40 seconds, you will have to wait for 80 seconds before you can continue shooting. Once the dark frame has been created, its noise patterns are subtracted from the image data, which cancels out the noise artifacts the image contains.

White Balance

The white balance function's main task is to prevent color casts and keep colors neutral. Unlike a digital camera, the human eye automatically adapts to different light sources, enabling us to see white as white, even if it shows a color cast when captured mechanically. Because low light and night subjects are almost always illuminated by artificial light sources, setting white balance is trickier in the dark than it is in natural light.

Auto white balance functionality cannot usually cope with mixed artificial light sources and, if the light sources within the frame have

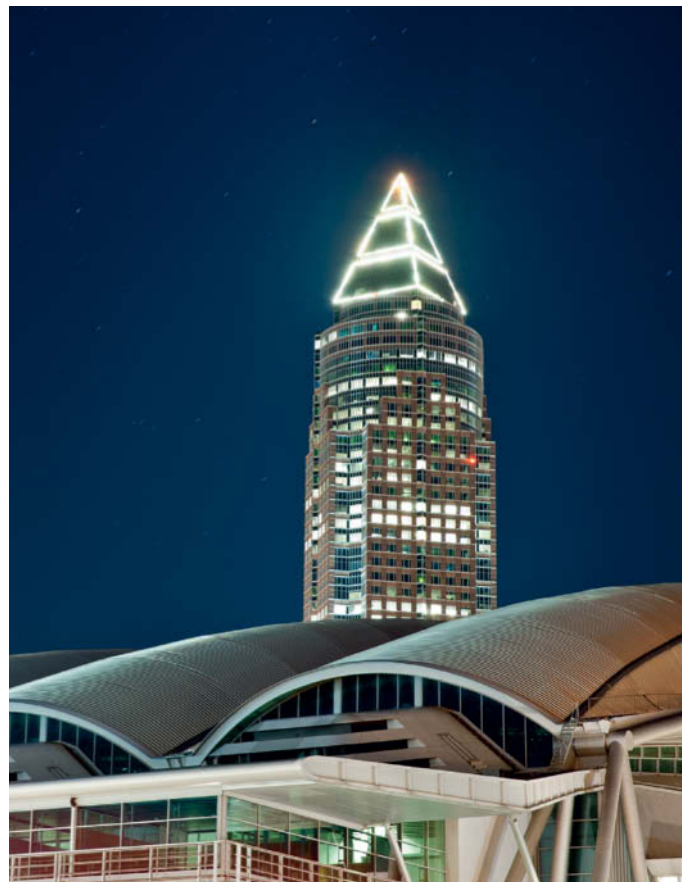
different color temperatures, it is simply impossible to produce a neutral-looking image. However, since the lights can make nighttime images so interesting, it would be a shame to 'correct' their colors to represent an artificial standard.

Nighttime Monochrome

If a scene is illuminated by a single light source like the one shown below, its monochromatic nature will cause most automatic white balance functions to fail immediately. Because the RGB sensor doesn't detect any other colors as a comparison, it reproduces the actual color of the light source more or less accurately. You can, of course, alter the white balance at the image processing stage (shoot in RAW mode if this is what you wish to do), but it is always better to adjust white balance to a setting close to the one you wish to capture before shooting. This way, the effect of varying color temperatures on the individual color channels – and thus on the dynamic range of



ISO 400 | f8 | 28 mm | 5 s

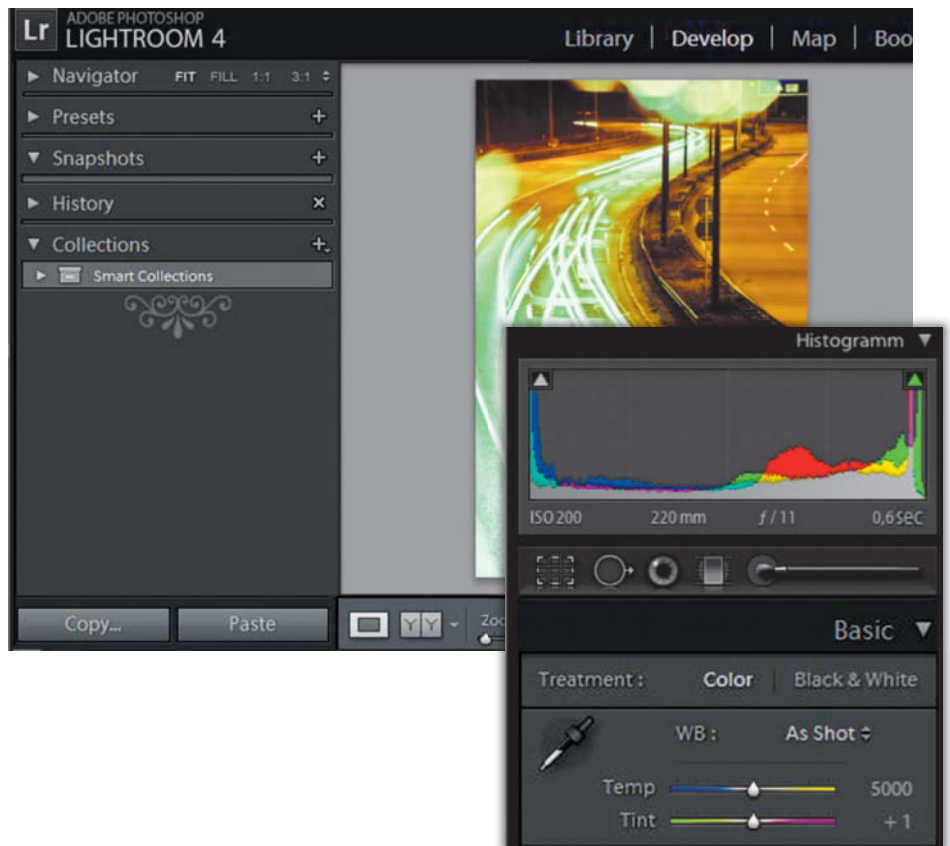


ISO 400 | f8 | 28 mm | 5 s

the resulting image – is kept to a minimum. If you adjust white balance after the event, your image may suddenly show clipped tonal values that weren't there before. Selecting the correct color temperature before shooting eliminates this type of problem.

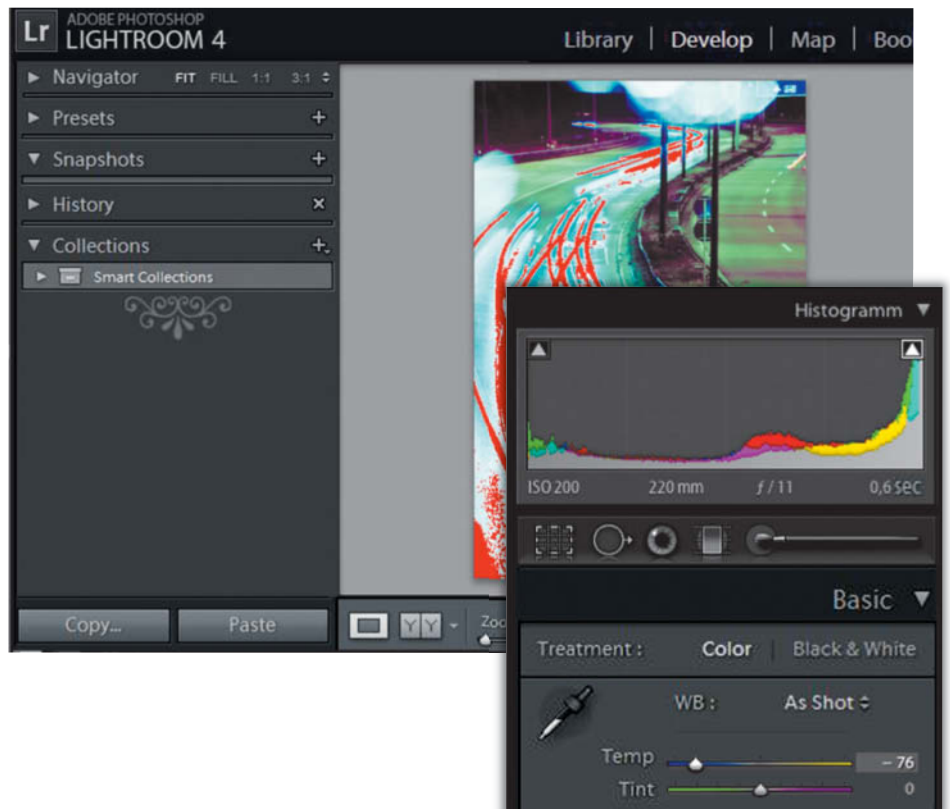
Setting White Balance Manually

There is no 'correct' color temperature for an image, and the value you set will depend on the mood you wish to communicate. Photos captured during the 'blue hour' just after sunset often benefit from a setting of 3000 K, which emphasizes the 'blueness' of the moment, whereas setting 6000 K will produce a warmer-looking version of the same scene. The value you set will always depend on the result you wish to achieve and the temperature of the light sources you have to work with. The golden glow in the sunset skyline shown on the next page was captured using a white balance setting of 8000 K.



Previous page:

The image on the right was captured using a white balance setting of 3300 K (Kelvin), resulting in cool colors. The left-hand image was captured at 7600 K and is much 'warmer' and more atmospheric.



Clipped colors:

The histogram for the upper image shows tonal values that push the limits of the available range without becoming burned out or swamped.

Shifting the Temp slider a little to the left produces 'cooler' colors and obviously burned-out highlights. These areas are indicated in red if you activate the highlight clipping preview (the triangular button in the top right-hand corner of the histogram).

Shooting at Dusk

Most photographers have heard of the 'blue hour' at some point or other. This is the time between sunset and the moment when the last scraps of residual sunlight disappear from the evening sky. At dawn, the equivalent blue hour ends when the Sun rises above the horizon. The low position of the Sun just before sunset (or just after dawn) produces a reddish-orange light that appears to flow over the landscape like liquid gold. Many photographers call this period the 'golden

hour' and use it to capture warm images that are often glamorous too.

In contrast, the 'blue hour' just after sunset (or just before dawn) bathes a scene in a cool but lush blue that makes photos taken at this time just as eye-catching as their 'golden' cousins. The 'blue hour' lasts only 30 or 40 minutes and begins in the late afternoon in winter and late evening in summer.

Various smartphone and tablet apps can help you calculate the time of sunrise or

sunset for locations all over the world. See the box on the opposite page for more details.

A mixture of artificial light sources and deep blue evening sky can create a really invigorating cool/warm contrast in a photo.

In winter, you can capture these types of scenes in the late afternoon when many people are already switching on the lights at home. After the late dusk of summer, you will often find that office buildings are not lit up at all at night.



On a clear day, the minutes just before sunset are perfect for capturing images with an almost ethereal mood. In this photo, the 'golden hour' bathes the Frankfurt skyline in wonderfully warm-looking light, creating an atmosphere that is impossible to capture in daylight.

ISO 200 | f7.1 | 24mm | 1/10s



In this shot, the blue of the sky provides a strong contrast to the yellow street lamp. To prevent the scene from looking too cool, I manually selected a color temperature of 5000 K.

ISO 200 | f11 | 60mm | 2.5s

Tips and Tricks: Mixed Light Sources during the Blue Hour

On a clear day, photos shot during the blue hour benefit enormously from the cool/warm contrast between the sky and the artificial light within the buildings. Any house or office building that is already (or still) lit from the inside makes a great subject.

Find your location in the afternoon and look for suitable shooting positions in the daylight. If you mark your chosen locations with chalk (and it doesn't rain in the meantime), you will find them again easily in the evening.

You can select your aperture and work out your framing in daylight too and make notes so you don't waste time getting set up when shooting time comes.

Don't try to shoot too many different subjects in one session, but instead choose subjects that you can reach comfortably on foot. If you spend too much time moving between subjects, the blue hour will be over before you have a chance to use it to the full.

Decide on your ISO, aperture and shutter settings at home and check them again on location before you shoot.

Apps for Smartphones and Tablets

Blue Hour (iPhone and Android)

A utility that computes the time and duration of the 'blue hour' for your current position. The application computes the hours for the next 5, 15 or 30 days.

Exposure Calculator (iPhone and Android)

This app tells you which camera settings to use if you have already taken a perfect test

shot but you want to experiment with alternative apertures or exposure times.

Photo Buddy (iPhone and Android)

As well as the functions provided by the previous two apps, this free app offers a built-in depth of field calculator, an exposure time calculator that automatically displays the change in exposure time caused by altering the ISO

or aperture settings and a graphical hyperfocal distance calculator. It also includes a database of the circles of confusion for various camera models.

LunaSolCal (iPhone and Android)

Calculates the time of sunrise, sunset, moonrise, moonset and more for your location at any given date – all very useful information when you are planning a photo trip.

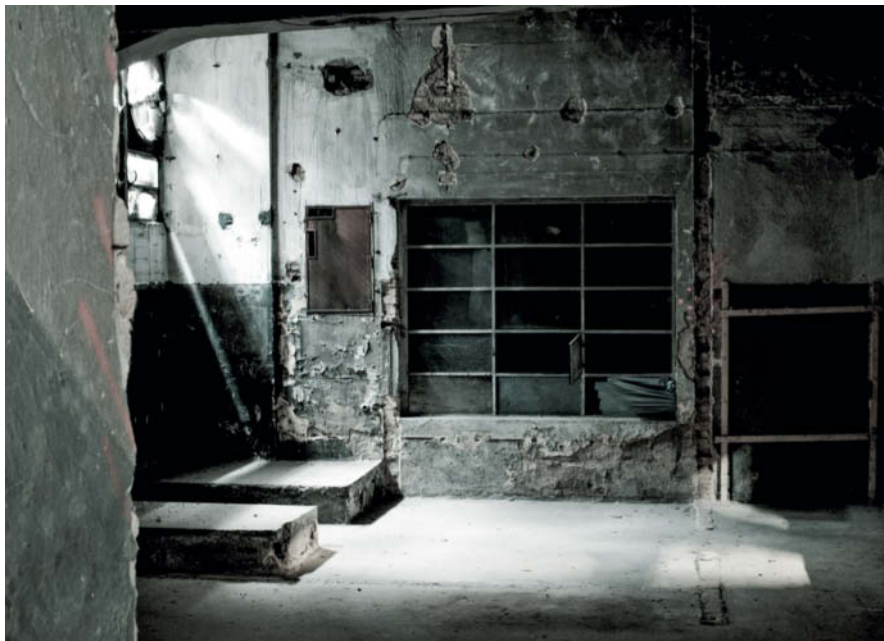
Available Light Photography

Shooting in 'available light' usually means shooting without a tripod or flash in low light at dusk, at night or indoors. Such situations require you to set a high ISO value (or use a sensitive film) and use the largest aperture your lens provides.

Available light photos often show spur-of-the-moment scenes that cannot be

captured using a tripod and often include moving objects that have to be recognizable. You can, of course, use the raw charm of an available light scene as a creative tool in its own right, but remember that a dynamic shoot in residual light is very different from the meditative pastime of taking tripod-based long exposures.

The last cool rays of dawn and dusk or artificial street lighting are perfect for spontaneously capturing all kinds of street scenes. Street lighting and twilight is an evocative mix. The rain, fog and snow in fall and winter often 'swallow' so much light that you can begin low light shooting in the middle of the afternoon.



The atmosphere in this shot of a disused cellar is created by the lateral light coming through the window on the left

ISO 600 | f4 | 40 mm | 1/60 s

Glancing light from a street lamp emphasizes the subject's profile and the smoke and gives this image a highly three-dimensional look. The 2800 K white balance setting suggested by the camera was too cool, so I raised it manually to 3400 K to liven up the colors.

ISO 640 | f2.8 | 85 mm | 1/8 s

Available Light Settings and Techniques

If you use a high ISO value to reduce your exposure time, always activate high ISO noise reduction if your camera has it. Most mid-range and high-end DSLRs have this feature built in, as do many of today's system cameras (such as the Panasonic Lumix and Sony Alpha ranges). If you are planning to buy a camera and you want to shoot at night, make sure that the model(s) you are considering have this feature.

Activate your camera's image stabilizer (if available) but remember to switch it off again before you shoot using a tripod.

Use the widest possible aperture. Bright prime lenses are perfect for available light situations. The standard 50mm f/1.8 lenses offered with many full-frame DSLRs are great low light tools, and an f/1.4 model is even better if you want to spend a little more. You will need to practice focusing manually if you want to shoot at wide apertures in low light. Large apertures provide only shallow depth of field, so you have to be sure you focus on exactly the right element in your subject if the image is to end up in correct focus. Using motion blur or

deliberate camera shake as a stylistic device gives you more leeway with regard to focusing accuracy.

Make test shots using different exposure times to check where camera shake sets in, and avoid settings below this value if you want to be sure of capturing sharp results. Practice will reveal the limits of your technique, and you will soon get to know which settings are best suited to your particular shooting style.



Tips and Tricks: Available Light

This is an exercise for anyone who prefers to work with a minimum of gear while testing the limits of their photographic prowess.

Nighttime photographers who work without a tripod have to learn to deal with high ISO values and shallow depth of field. Underexposed or even completely black image areas are part of the package too. Available light photography is all about creating heavily atmospheric images that are anything but mainstream.

The best type of lens to use is a 50mm (fixed focal length) with a maximum aperture of f1.8 or f1.4. If you plan to weave a tale with a human aspect, you will need someone to act as your model. A nighttime sequence can be shot over the course of multiple sessions if necessary.

To keep the exposure time short and the subject sharp, select the widest possible aperture and a high ISO value. Motion blur is definitely not taboo in the context of available light photography and can even be positively welcome if used as a deliberate stylistic device. Who says blurred images belong in the trash? *Paradiso* by Lorenzo Castore is a wonderful photo book in which all the images are characterized by a slight blur that makes them all the more powerful and revealing.

Blur can also be used to add authenticity and underscore the spontaneity of a moment that would otherwise have remained uncaptured.

To use darkness as an element of design, use spot metering mode to meter for the gray elements of the subject. The aim is not to produce images that look as bright as day, but rather photos that retain a degree of mystery.

Try to include stray light sources in your compositions and allow them to

illuminate parts of your subject to add a three-dimensional feel to subjects that would otherwise look flat and lifeless.

Nighttime images are especially effective when displayed as a sequence of six or seven images that share a mood or tell a story.



I captured this photo of a construction site handheld in the rain. The slight blur is caused by the long exposure time, and the condensation on the front element of the lens gives the shot an apocalyptic feel.

ISO 2500 | f1.4 | 85 mm | 1/30 s



In this sinister-looking portrait, a nearby street lamp was the only light source illuminating this cemetery wall and the human subject

ISO 1600 | f1.8 | 50 mm | 1/15 s



The raindrops on the car window add an interesting abstract element to this spontaneous night shot

ISO 800 | f3.5 | 50 mm | 1/15 s



The high ISO value I used to shoot this posed 'thriller' style shot emphasizes the bleak surroundings

ISO 1600 | f2.8 | 50 mm | 1/30 s

The Dark of the Night

The night offers its own exciting range of light sources and photographic subjects. The examples on the following pages show that impressive nighttime photos aren't always of city lights.

Darkness makes a great stage for trying out ghostly and ethereal effects that don't so much portray a subject as suggest it. Small towns off the beaten track, industrial ruins,

empty cityscapes and cemeteries make perfect training grounds for your nighttime experiments.

Tips and Tricks: Shooting in Moonlight

A full moon not only lights up the night sky but also acts as a light source that adds depth to nighttime landscapes.

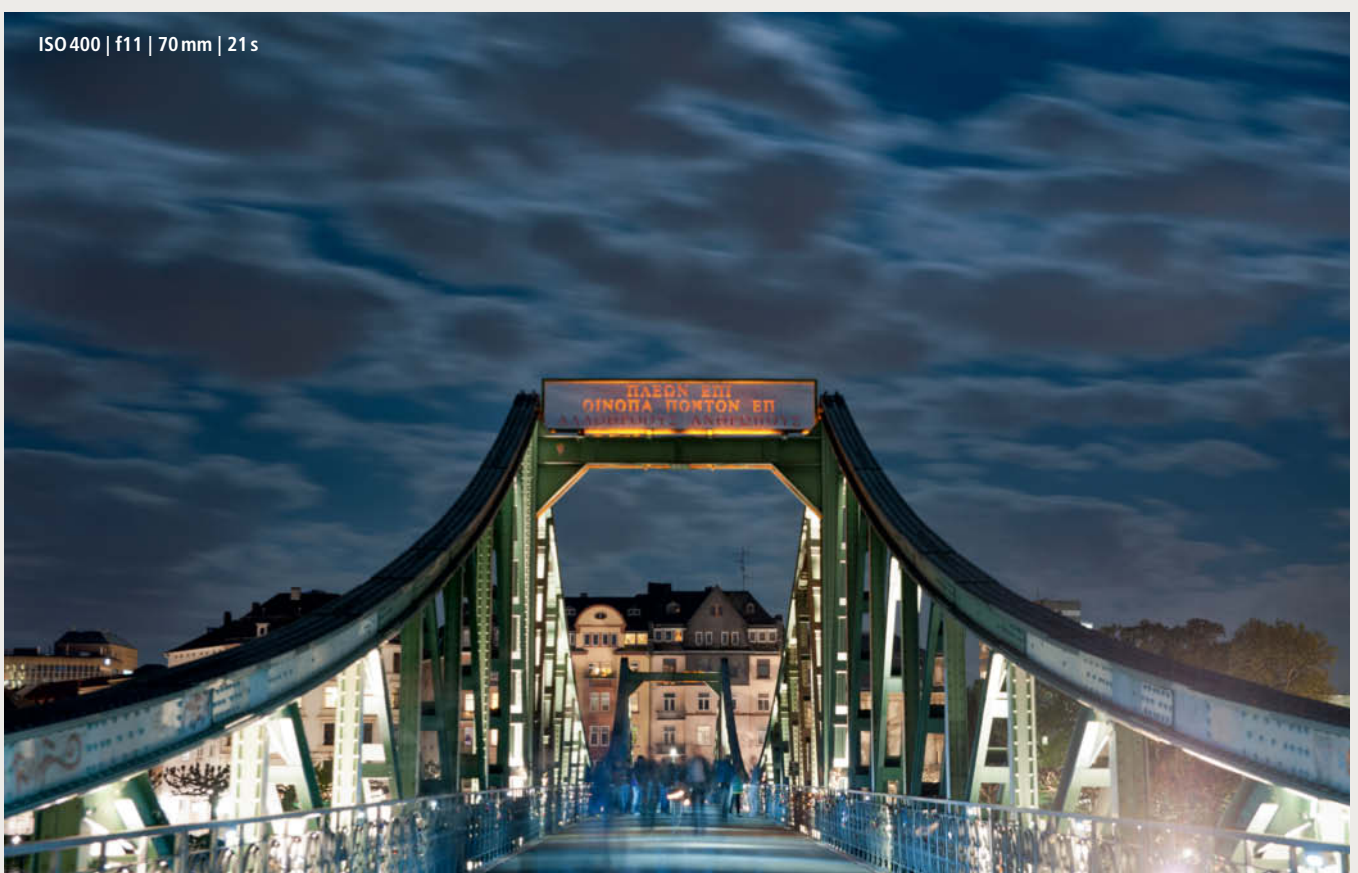
To avoid the Moon itself appearing as a bright white circle, it is often better to leave it out of the frame or at least obscure it.

Standard focal length lenses provide little or no magnification, so you will need to use lenses with equivalent focal lengths of 300mm and more if you want to use the Moon as the main subject. To fill the frame, you will have to use a teleconverter too. It is essential to use a tripod when using such long lenses at night.



ISO 400 | f11 | 70 mm | 21 s

In the image above, the moonlight was used to silhouette the tree against the sky, while in the image below, it brightens the entire sky and gives the scene an HDR-style look. Although the Moon in the image above is 'hidden' behind a branch it is immediately obvious that the photo was taken at night.



ISO 400 | f11 | 70 mm | 21 s

Tips and Tricks: Dark and Spooky

Nighttime lights offer plenty of opportunities to shoot striking photos of easily recognizable subjects. However, the real joy of shooting in the dark lies in using the darkness itself to emphasize the mystery and eeriness of a scene.

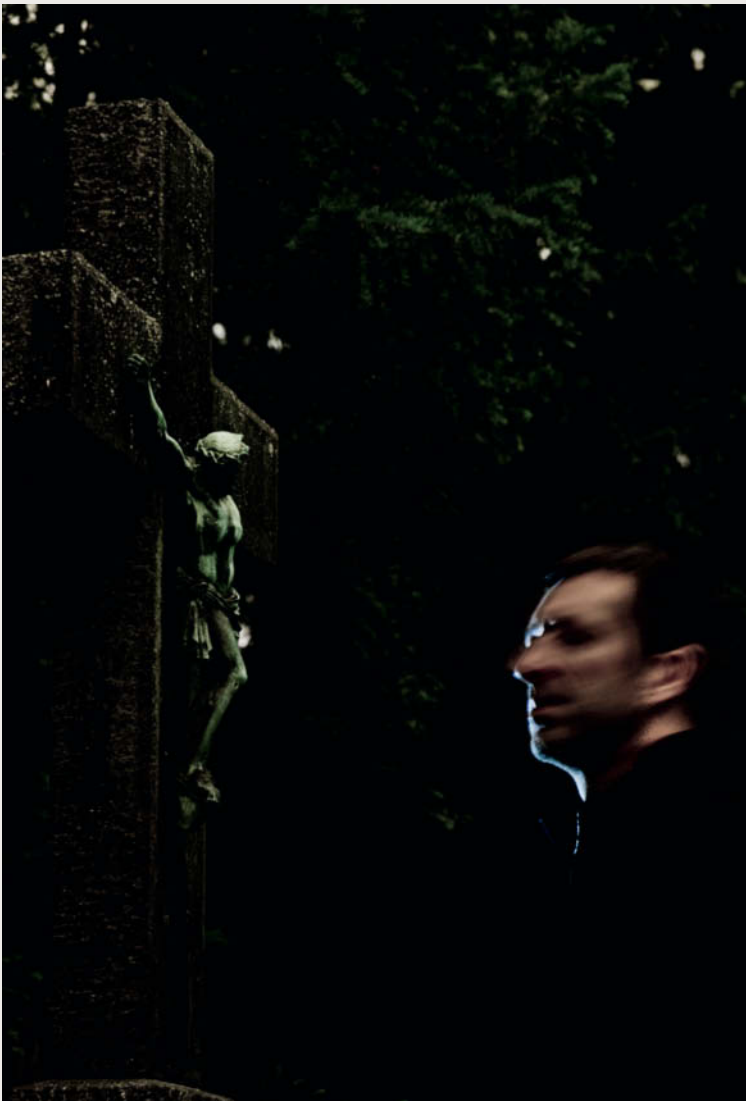
I like to shoot sequences of images in dark, deserted locations, especially if it has recently been raining and the moisture on the ground provides additional random reflections.

Set your camera up on a tripod, attach a remote release, set it to manual (M) mode and

set the exposure time to B ('Bulb'). Once you have framed your subject (if necessary, with the help of a flashlight), take a test shot using a wide aperture and a high ISO value. To keep your images nice and dark, use spot metering mode to meter for the brightest grays in the frame. You may have to experiment to find just the right combination of exposure values, but don't be afraid to include really black areas with no visible detail in your compositions.

Once you have found the right exposure settings, you can shoot away and capture as many spooky-looking shots as you like.

The opposite effect involves using ultra-long exposures to make nighttime scenes look as bright as day. Such photos often look surreal and captivate the viewer with a mixture of bright lights, strange colors and apparently brightly lit subjects. See the next page for an example.



ISO 500 | f7.1 | 70 mm | 42 s



ISO 400 | f5.6 | 24 mm | 40 s

These graveyard scenes were shot at night with the help of a pocket flashlight used as an accent light



An ultra-long exposure makes this nighttime winter scene appear as if it was captured in the daytime



ISO 500 | f7.1 | 45 mm | 42 s

Tips and Tricks: Turning Night into Day

A cloudy sky and a subject with just a few artificial light sources are the perfect ingredients for this type of shot. The more evenly distributed the gray tones, the better the result will be.

Set up your camera on a tripod with a remote release and frame your image to include as few light sources as possible, as the highlights they produce will tend to burn out during extremely long exposures.

Once again, select a high ISO value and a large aperture and spot meter the darkest parts of the frame. Then recalculate the values you end up with to incorporate a low ISO value and a small aperture. If your test image appears too dark, use the same ISO and aperture settings but double the exposure time and try again. Remember to check the histogram for burned out highlights too.

The results of such long exposures are often quite surreal, thanks to the apparent brightness of the scene and the unusual colors.

Apart from a small increase in overall contrast, the photo shown here is reproduced exactly as the camera captured it.



ISO 500 | f7.1 | 45 mm | 15 s

Special Effects

There are no limits to how many 'found' or original effects you can use when shooting in low light.

Reflections

In the city, multi-colored reflections in windows (see page 109, bottom left),

puddles and waterways (see pp. 98/99) are obvious candidates for inclusion in your compositions. If you wish to include the clouds in a nighttime cityscape, you have to decide whether to use a shorter exposure time to 'freeze' their movement or a longer exposure time to allow the movement to become part of the effect. Stationary clouds often contrast effectively with the darkness

of the sky, while moving clouds can be used to create subtle, other-worldly effects like the one shown below.

If the available light isn't quite to your liking, you can always use a pocket flashlight to add 'light painting' elements to your images or to add lighting accents like the one we used to illuminate the pylon in the image below.

Tips and Tricks: Create Your Own LED Effects

In addition to a tripod-mounted camera, this exercise uses a powerful pocket LED flashlight like the one shown on page 100.

Begin by making a slightly underexposed test shot without using your flashlight. This will ensure that the image doesn't appear too bright when you light the subject separately.

Brightening a subject using a flashlight requires a little practice. You will achieve even-looking results if you keep the lamp moving during the exposure, but you can also add 'drops' of light by switching the flashlight on and off while you work.

Ideally, your flashlight should be able to light the subject from behind the camera. If it isn't powerful enough or if you prefer to light your subject from the side, you will have to move quickly in and out of the frame during the exposure in order to avoid appearing in the final image yourself.

In this shot, we illuminated the subject using the Fenix flashlight shown on page 100 positioned directly behind the camera. The mist did a great job of diffusing the light from the flashlight

ISO 500 | f9 | 30mm | 20s



Light Sources as Subjects

Fascinating effects can result if you use the light sources in your image as part of the composition. If you use a small aperture, point light sources look like tiny stars, whereas a wide-open aperture creates more abstract effects like the one shown in the image of the spider on the right.

Moving light sources provide an additional degree of abstraction, and the examples on the following pages show how to capture subjects like fire, car lights and funfair rides.

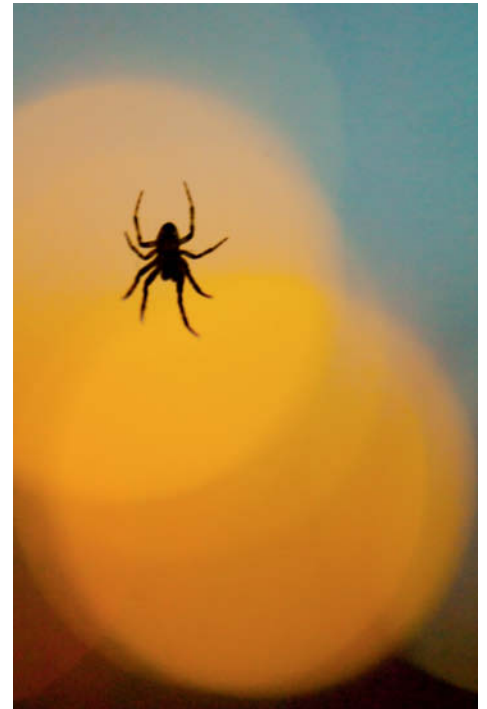
Using long exposure times, you can capture the lights of a moving car in the shape of 'light trails' that sweep through the frame and underscore the movement of the subject (or become part of the subject themselves).

Funfair rides, too, are great subjects for experimenting with movement and light

trails. Be sure to use a tripod and a remote release and shoot in manual mode for shots like this, as auto mode will usually 'counteract' the movement that makes them so exciting.

The high magnification used to capture the spider has turned the city lights in the background into abstract circles of light. We used a macro lens to capture this image, and the slight blur in the subject is the result of using such a long exposure time.

ISO 800 | f3.3 | 105 mm | 1/20 s



The movement of the clouds during the exposure gives this image an eerie look. The red tones in the foreground and the artificial light from the street lamps illuminating the scene enhance its 'science fiction' feel.

ISO 125 | f6.3 | 24 mm | 30 s

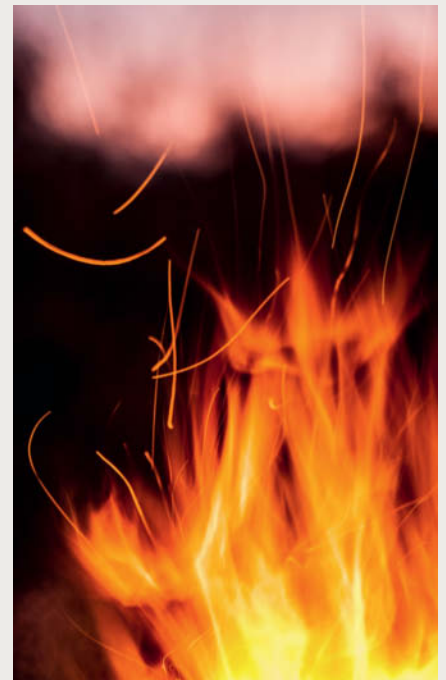
Tips and Tricks: Photographing Fire

Flames usually look their best when captured against a dark background. These two examples show the difference between an image that captures flames as we see them and one that captures a 'flowing' movement and the individual sparks flying out of the fire.

Both were captured using 1EV underexposure to emphasize the contrast between the flames and the dark background; the main difference lay in the exposure times. Both were captured using a tripod.



ISO 400 | f4.5 | 150mm | 1/1800s



ISO 400 | f7.1 | 300mm | 1/10s

Tips and Tricks: Capturing Light Trails

To capture the light trails produced by car lights, you can position your camera directly on a street or intersection or higher up on a pedestrian bridge or overpass.



We covered this CD spindle pack with gaffer tape and used it to cover the lens during long exposures

It is easier to zero in on the right exposure values by starting with a high ISO value and a wide open aperture and then adjusting your parameters step by step until you arrive at the required exposure time.

A CD spindle pack covered with gaffer tape makes a great lightproof shade for covering the lens while no cars are passing. This reduces the risk of the trails you have already captured being canceled out by too much ambient light. Take care not to jog the camera when covering and uncovering the lens.

You will need to time the periods during which the lens is covered and add the accumulated time to the end of your exposure to be sure of keeping to your calculated exposure parameters. For example, if the

required exposure time is 60 seconds and you cover the lens for a total of 40 seconds during this period, you will have to keep the shutter open for 100 seconds to achieve the correct exposure.

The red light trails in this shot are actually the rear lights of cars moving along a freeway at night. The bright headlamps of the cars on the opposite side of the road threatened to overexpose the image, so we simply covered the lens with our homemade shade whenever there were no cars driving by on 'our' side of the road.

ISO 200 | f16 | 85mm | 50s



Tips and Tricks: All the Fun of the Fair

Funfair images work best on a clear night when the sky provides a really dark contrast to the bright lights of the rides.

Here too, you will need to experiment to see which settings work best for you and your camera, but you can always start with a low ISO value (to keep noise levels down) and a smaller aperture of f11 or f16 to stop the highlights from burning out.

If you prefer not to include blurred passers-by in your images, simply tilt your camera slightly upward while you shoot. Always shoot multiple versions of each shot using different exposure values (one, two and four seconds are good values to begin with) to give yourself the best choice of images once you are done. For rides that loop the loop, be sure to keep the shutter open long enough to capture the whole movement. (anm)

ISO 200 | f18 | 35 mm | 2 s



Some rides move so fast that an exposure time of just two seconds is enough to produce a completely abstract image



Long exposures produce effects that look like luminous brush strokes



ISO 200 | f18 | 35mm | 4s **ct**



Ralph Clevenger

Paths to Creativity

Pro photographer Ralph Clevenger provides you with the tools to turn looking into seeing and encourage growth in photographic creativity.

Photographers often struggle with creating successful images simply because most photography workshops, books and articles suggest that how the image is made, the tools that are used and composition are more important than the subject. However, a photographer is essentially a subject chooser. A photographer's first decision has to be about what to photograph. Your curiosity, fascination and empathy for what you choose to photograph can then be shared with others through the images you make. The degree of success with which your photograph communicates is intimately tied to your ability to capture and interpret your vision of the subject – in other words, how you see it. Learning how to isolate a subject from the surrounding clutter, seeing it

differently than anyone else and composing it within the frame provided by the camera are all conscious decisions. Seeing is critical to creating better images.

As National Geographic photographer Jim Richardson said; 'If you want to be a better photographer, stand in front of more interesting stuff.' Everything can be more interesting if you learn to shed your preconceptions and see things in more interesting ways. So how do we find our subjects and how do we make them more interesting? There is a difference between looking and seeing. We all look at things – lots of things – all the time. But looking is different than seeing. Looking is easy, while seeing takes effort and understanding and requires awareness of the world around you as well as constant practice.

The path to seeing and creating meaningful images involves first finding the subject then using compositional tools like the camera frame, your choice of lens, depth of focus, the 3D rule of thirds and a sense of balance to arrange the subject within the viewfinder. The final step is recognizing visual cues such as natural and artificial patterns, s-curves and figure eights, groups of three, triangles and the relationships between colors to help make your images more interesting and more successful at reflecting your vision. Following this path will help you to develop an awareness of the simple and powerful image that lies within the complex views you point your camera at. The following pages detail some ideas about how to change looking into seeing, how to envision possibilities and how to create images that share your unique view of our world.

Ralph Clevenger

Ralph Clevenger grew up on the coast of North Africa and went on to study zoology at San Diego State University. He worked as a diver and biologist for the Scripps Institution of Oceanography in La Jolla, California before attending Brooks Institute of Photography.



Image: Misty Schmidt

He holds a BS degree in zoology and a BA degree in photography. Ralph has followed his passion for the natural world by specializing in location photography and video projects of eco-travel, environmental portrait, landscape, wildlife and undersea subjects.

The Frame Provided by the Camera

The camera's view of the world is constrained within the frame of the viewfinder. We can rotate the frame but we can't change its size unless we change the size of our camera's sensor. And with only one 'eye', the camera can't perceive depth the way humans can. Our two eyes and brain see a three-dimensional panoramic view, but we rely on a one-eyed box to recreate what we see. The two views just aren't the same.

When we stand and look at a scene, our eyes move around, focusing on elements that grab our attention and moving to the next element, looking up, down, near and far. If we move our heads, we take in a wider scene and our eyes are still moving the whole time. In other words, our impression of what we are looking at is based on movement. The camera doesn't see this way. Of course we can move the camera, but once we stop, whatever is currently in the viewfinder is what we will capture, and it's always two-dimensional.

Whether you view a photographic image on a computer or as a print, it has only height and width, but no depth. It's up to the photographer to use composition and light to create the illusion of depth within the framework of a two-dimensional image. This may all sound obvious, but few people are conscious of this difference between how we see and how the camera sees when taking pictures. The camera frame is what the photographer uses to subjectively control the composition of a photograph.



Using the camera's frame to exclude the paddler helped me simplify the composition of this scene (Wonder Lake, Denali National Park, Alaska, USA)

ISO 200 | f5 | 24mm | 1/500 s

Placing the frame inside the corner creates a sense of depth by forcing the viewer's eye to follow the wall of this old mission building (Pueblo Missions National Monument, New Mexico, USA)

ISO 200 | f16 | 24mm | 1/40 s





Grape vines send out tendrils to support the weight of the grapes. The curly ends have a beautiful curve that immediately caught my eye. Checking the background and foreground for distracting elements, choosing a shallow depth of field and isolating just one tendril makes a better composition.

ISO 200 | f4 | 105 mm | 1/500 s

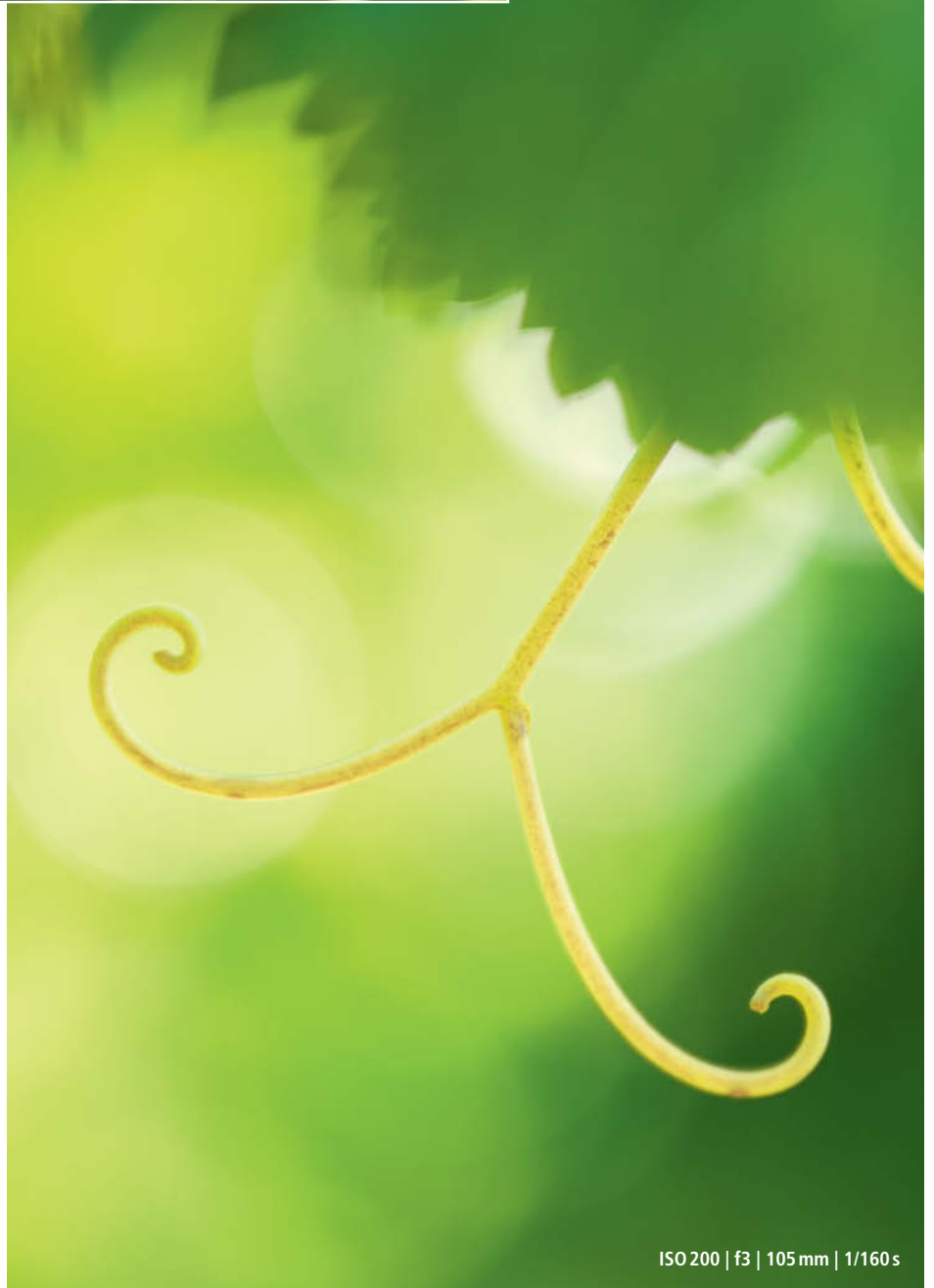
Composition

Many photographers think composition is based on a set of 'rules', and that following them miraculously produces perfectly composed images. However, things don't seem to work that way. Good composition has to be learned if you want to understand why some images work and others don't. You have to understand how to create balance or imbalance in an image, how to use color and contrast, how to use lines and shapes within the frame and you have to develop a feeling for proportion and perspective. All these elements of composition will help you create images that you'll be proud of.

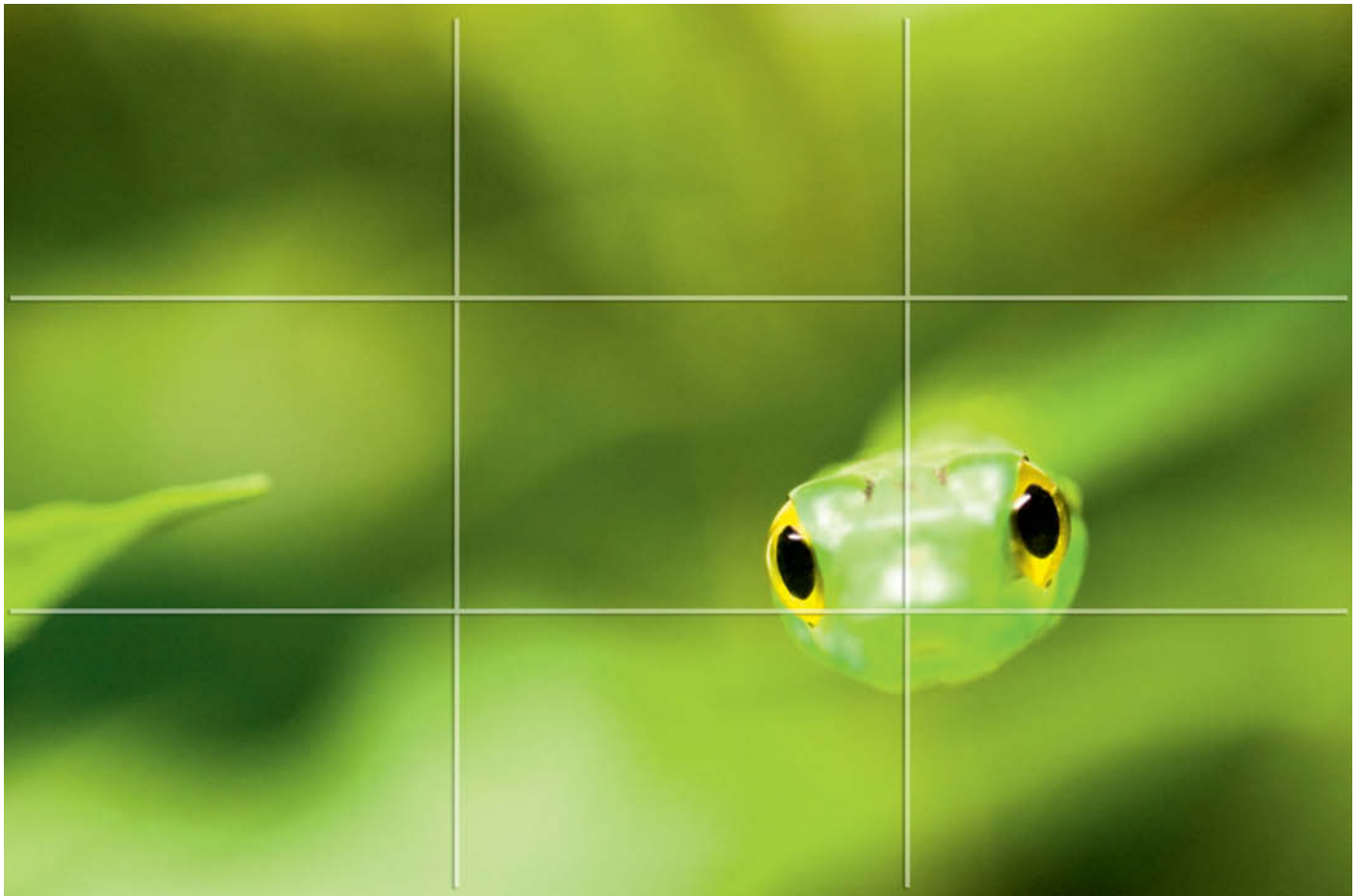
I define composition as merely the arrangement of objects within the frame, and again, the frame is critical. What's in the frame? What's out of the frame? Is the frame vertical or horizontal, or somewhere in between? We photographers must learn to see the subject through our camera's unique eye.

Keep things simple. Reduce your composition to include just the essence of the subject. Only include things that support the subject and get rid of or de-emphasize everything else. The concept of good composition is to photograph the subject to include any necessary supporting elements but with as few distractions as possible.

Remember that the viewer's eye is automatically attracted to the lightest thing it sees and zooms in on that before looking for what's in focus. Using light and focus allows you to control how the viewer looks at your image. To put this into practice, simply look at your composition, think about what you have in focus, think about the brightness of the different objects and make sure you arrange things so we look at what you want us to see.



ISO 200 | f3 | 105 mm | 1/160 s



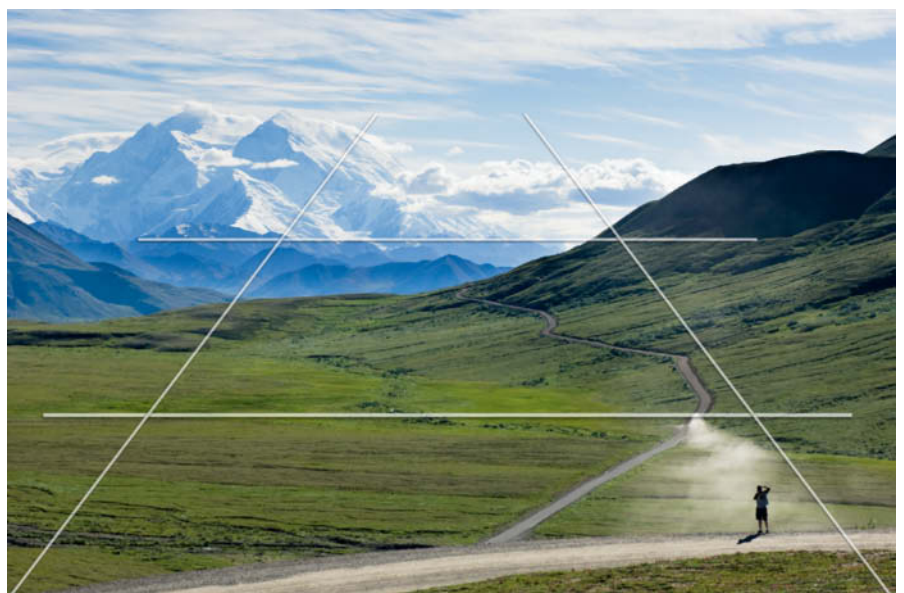
Visual balance is achieved by putting this Green Parrot Snake's head close to the intersection of two of the grid lines (Costa Rica)

ISO 400 | f3 | 105 mm | 1/60 s

3D Rule of Thirds

The rule of thirds is a visual arts guideline that helps us to distribute objects within a frame. Placing your subject away from the center of the frame is one of the quickest ways to improve composition, but the rule of thirds only deals with two dimensions. The rule of thirds grid viewed on a computer screen or a print is a two-dimensional view that contains only width and height but lacks the third dimension, namely: depth.

The real world is three-dimensional, so it makes sense to use the rule of thirds for the third dimension too. If you imagine 'laying the grid down' within the frame, you have an effective compositional tool that works with foregrounds, middle grounds and backgrounds. If one area of the grid is empty, try re-composing, choosing a different lens or changing your point of view to make a connection between the foreground and background. Composing with the 3D rule of thirds helps you create that critical sense of depth in your photographs.



Laying the grid down showed me the importance of the road in connecting the figure in the foreground to the mountain in the background (Denali National Park, Alaska, USA)

ISO 100 | f5 | 56 mm | 1/1000 s

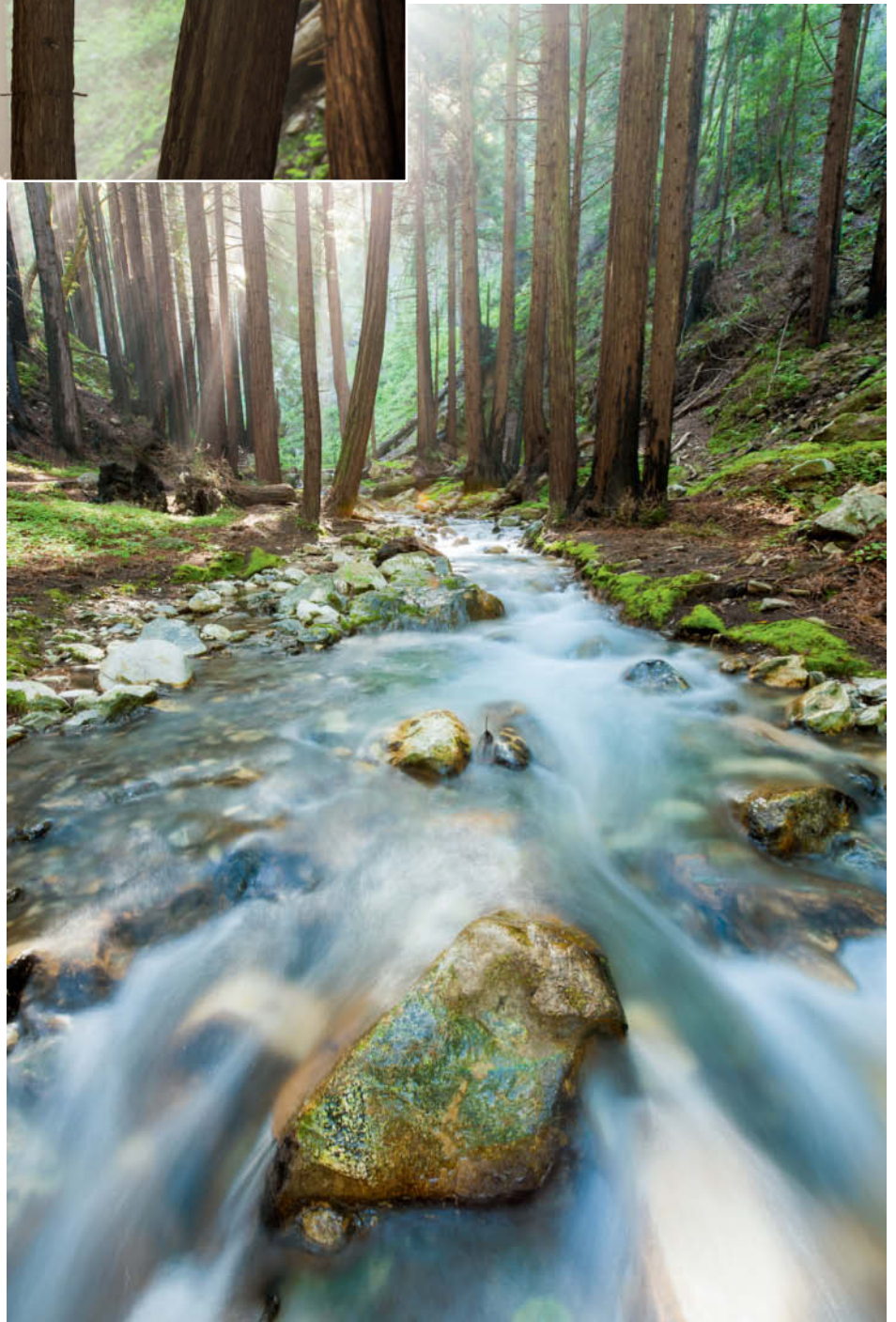


Both images were shot from the same place but with different lenses. The telephoto view extracted the pattern made by the Coast Redwood Trees in the background (Big Sur, California, USA).

ISO200 | f5 | 200 mm | 1/10 s

The wide-angle view tells the story of where we are by emphasizing the foreground and connecting the stream to the trees. Two different lenses, two different stories (Big Sur, California, USA).

ISO 200 | f16 | 14 mm | 2.5 s



Choosing a Lens

There is a huge difference between what you see with a wide-angle lens and what you see with a telephoto. Each provides a totally different view of the scene within the frame. Wide-angle lenses 'de-magnify', making things look smaller and exaggerating the distance between the foreground and background, while a telephoto lens magnifies the subject and brings the background closer, thus compressing distance and making objects within the frame appear 'stacked' and closer to one another than they actually are. Images produced using macro or close-up lenses have many of the same visual characteristics as telephoto shots.

When selecting a lens, I ask myself whether the subject is in the foreground or the background. If it's in the foreground, I consider using a wide-angle lens, while I tend to choose a telephoto for background subjects. Remember that the foreground doesn't have to be at the bottom of the frame and can just as well be located at the top or the sides of an image.



Depth of Focus

Usually, our eye is attracted to the various elements in a photograph in succession, starting with bright elements, then moving on to what's in focus. The elements that are in focus are strongly influenced by your choice of lens and aperture, as both affect the depth of focus or depth of field. By using shallow depth of focus you can isolate a subject against the background. Longer lenses, wider apertures and getting closer to your subject will help create a shallow depth of focus. Images in which everything is sharp use a large depth of focus to visually connect multiple objects. This is a great technique for telling a story within a single image. Wide-angle lenses and small apertures help create greater depth of focus.

In this scene, I wanted the canoe and the mountain to be in focus so the viewer can 'see where we are going'. Using a wide-angle lens and a small aperture gave me maximum depth of focus (Denali National Park, Alaska, USA).

ISO 100 | f16 | 24 mm | 1/60 s

This Ensatina Salamander could easily get lost amid all the distracting elements surrounding it. Using a longer lens and a wider aperture enabled me to narrow the depth of focus to cover just his face (Big Sur, California, USA).

ISO 400 | f11 | 105 mm | 1/60 s



Visual Balance

Each element in your composition has its own weight. To balance the visual weight within the frame you need to pay attention to the arrangement of light and dark elements. Balance within a photograph is tied to our natural sense of above and below, up and

down, and to our visual habits, which tend to class dark objects as 'heavy' and bright objects as lightweight. Nearly all light in the natural world comes from above, so shadows naturally appear below subjects. Have you noticed how shadows that point upward

make an image look unbalanced? The same is true of light. Light areas in images – especially landscapes – usually feel more comfortable if they are at the top of the frame. This balance may seem obvious, but being aware of it within the photographic frame is less so.



During post-production, I performed a lot of dodging (brightening) and burning (darkening) on this forest scene. I wanted to emphasize the light areas to balance them against all the surrounding darkness (Big Sur, California, USA).

ISO 200 | f16 | 24 mm | 0.8 s

Giving the bright lotus flower a large presence in the frame helps balance it against the weight of the dark leaves and the background. This feeling of balance is intuitive, you just have to be aware of it (California, USA).

ISO 200 | f4 | 105 mm | 1/200 s



The Art of Searching

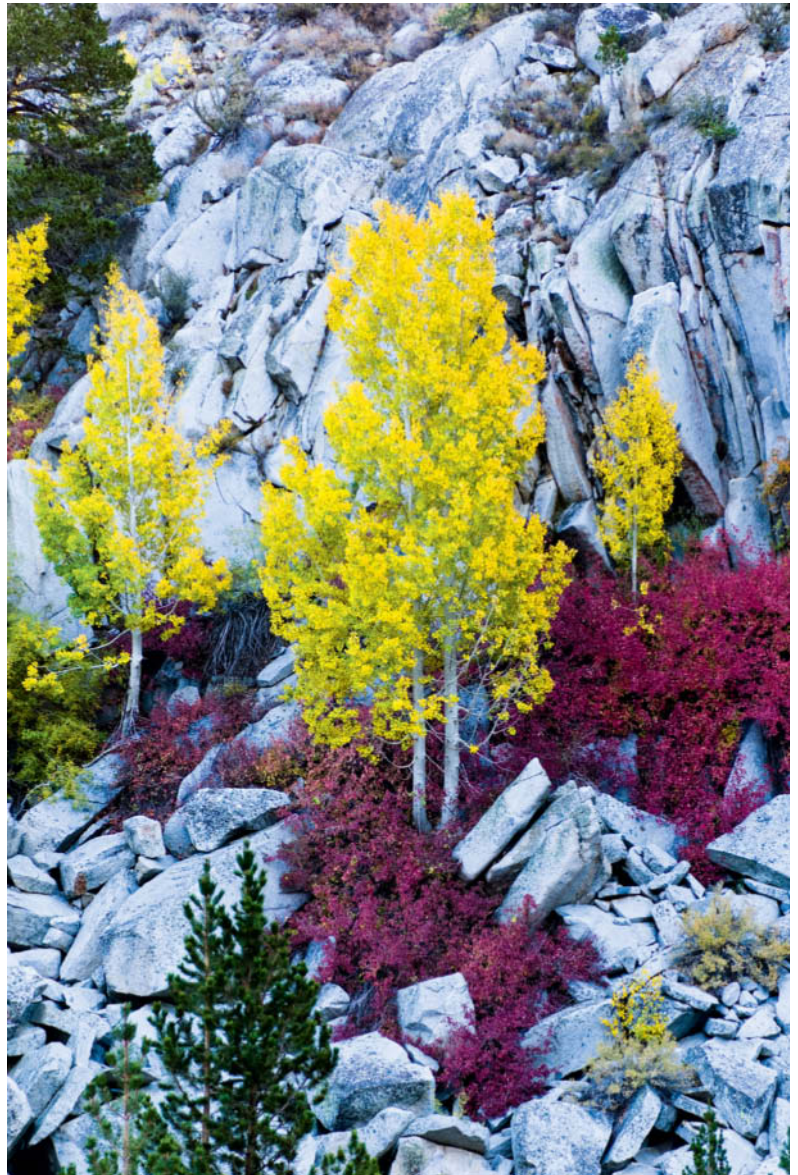
One of the most important parts of the process of seeing is the art of searching. Although many think otherwise, photographs don't just happen. You have to actively search for them, whether you happen to be carrying a camera or not. Finding great subjects means always looking photographically. There are many cues that can help you see this way. The following pages explain a few of the ones that I use.



ISO 200 | f5 | 14 mm | 1/40 s

There was a lot of beautiful color along this mountain road but it was all green and yellow. The splash of red was the detail that made me stop and start searching for a photograph (Sierra Nevada Mountains, California, USA).

ISO 200 | f5 | 70 mm | 1/40 s



ISO 200 | f16 | 105 mm | 0.4 s

Groups of Three

When it comes to pleasing the human brain, three seems to be a magic number. Whether in storytelling, poetry, comedy, organization or the visual arts, three of anything is a pervasive structure. Elements grouped in threes are so widely used in our culture that it's likely we've been preconditioned from childhood to respond favorably to 'all things three'. Three is the smallest number of elements needed to create a pattern and, as we'll discuss later, patterns are an important part of seeing.

A storm had knocked hundreds of flowers from a large Strawberry Snowball Tree onto the ground. Spending time searching for interesting patterns helped make visual sense of the chaos lying under the bare tree (Santa Barbara, California, USA).



Over many winters, water in cracks froze, expanded, and split this large rock at a truly amazing angle. Triangles are a powerful graphic element in any composition (Mojave Desert, California, USA).

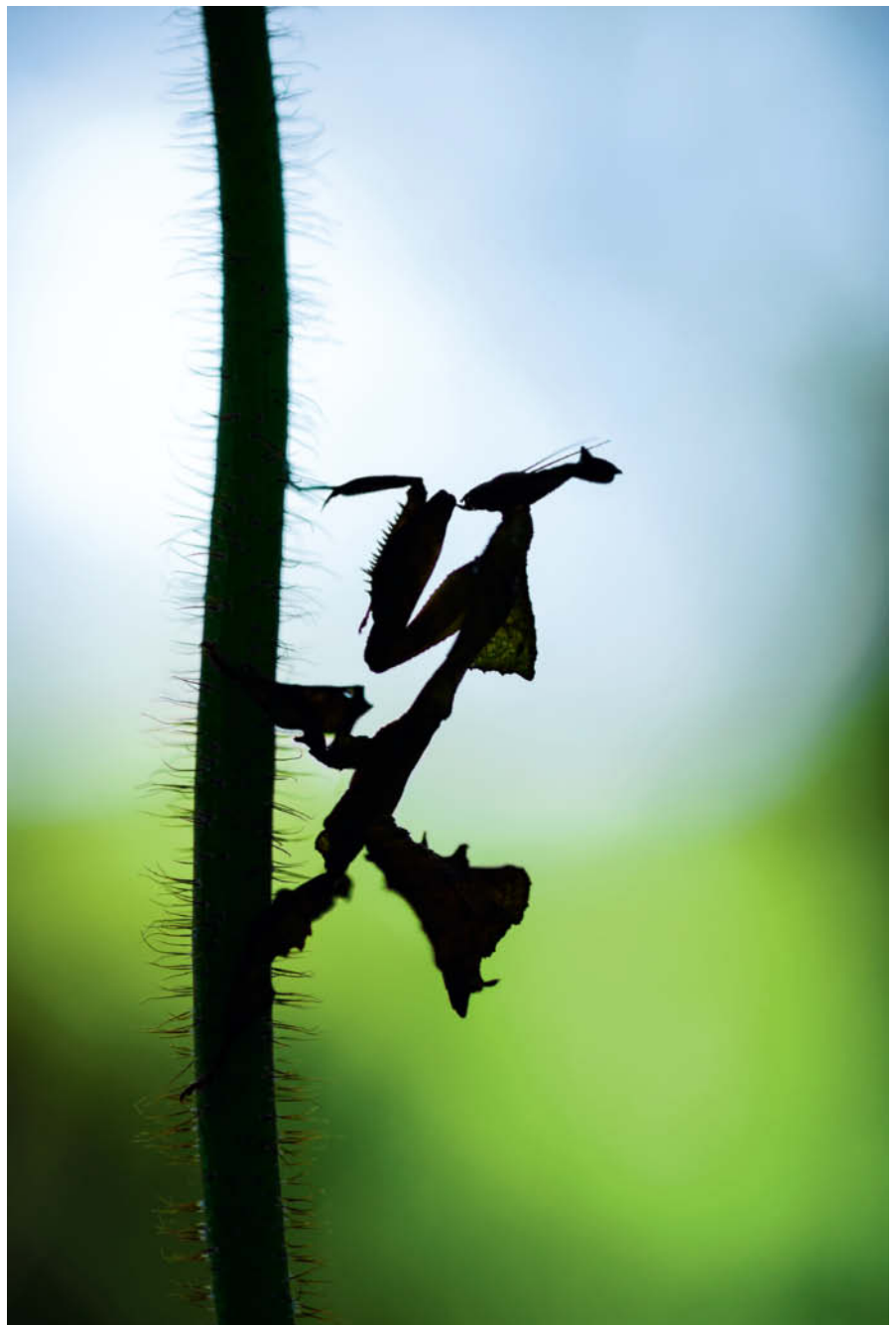
ISO 200 | f6 | 12 mm | 1/400 s

Triangles

Gestalt, or the human compulsion to visually connect things, is a fundamental compositional tool. If we see three points arranged in a pattern, our brain instinctively wants to connect them as a triangle. This desire to add meaning to seemingly random elements in a scene seems to be hard-wired into our way of looking. Once we recognize that triangles make our compositions more interesting, our photographs become more creative. Triangles occur naturally in our subjects as well – looking for and using naturally occurring triangles can add an extra dimension and balance to an image.

Once I learned to look for them, I started seeing triangles everywhere. The arms and various body parts of this Ghost Mantis all form triangles.

ISO 200 | f5 | 105 mm | 1/250 s



S-Curves

Curved lines carry a lot of meaning. Soft, shallow curves suggest comfort, relaxation and a pleasing, sensuous quality. Think of the bends in a river or the parts of the human body: it's the curves that appeal to us. Even mathematics uses curves to define natural processes. The S-curve is a powerful compositional tool and can be used to lead the viewer into the frame, connecting the foreground to the background and creating balance.

Most snakes have to create S-curves with their bodies in order to move. The unique point of view looking upward at this snake allowed me to show off the curve against a less distracting background.

ISO 400 | f7 | 105 mm | 1/200 s

S-curves are very common in nature. These were made by the fibers of a Yucca plant. When I began photographing it, I noticed how the shape resembled a musical treble clef (Mojave Desert, California, USA).

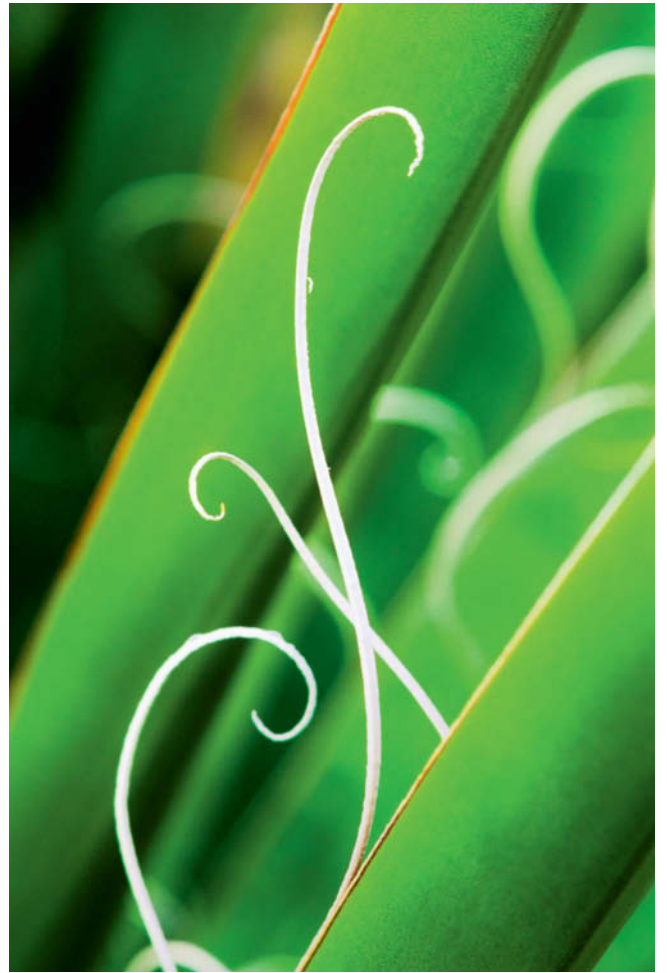


Figure Eights

I was fortunate enough to assist the renowned photographer Ernst Hass during his visits to the Brooks Institute in Santa Barbara, California during the 1980s. He was giving a photographic seminar and one of the

attendees asked him what he looked for when he was out taking photos. Ernst replied that, among other things, he sometimes searches for the figure eight. He explained how he saw an '8' as nothing more than two conjoined

S-curves and that such shapes are actually quite common once you starting actively looking for them. From that point on, I realized that learning to see has a lot to do with recognizing patterns.



Figure eight patterns can be harder to see than triangles because we're not naturally tuned in to pairs the way we are with threes. This rose shows a great example of conjoined S-curves.

ISO 200 | f5 | 105mm | 1/200s

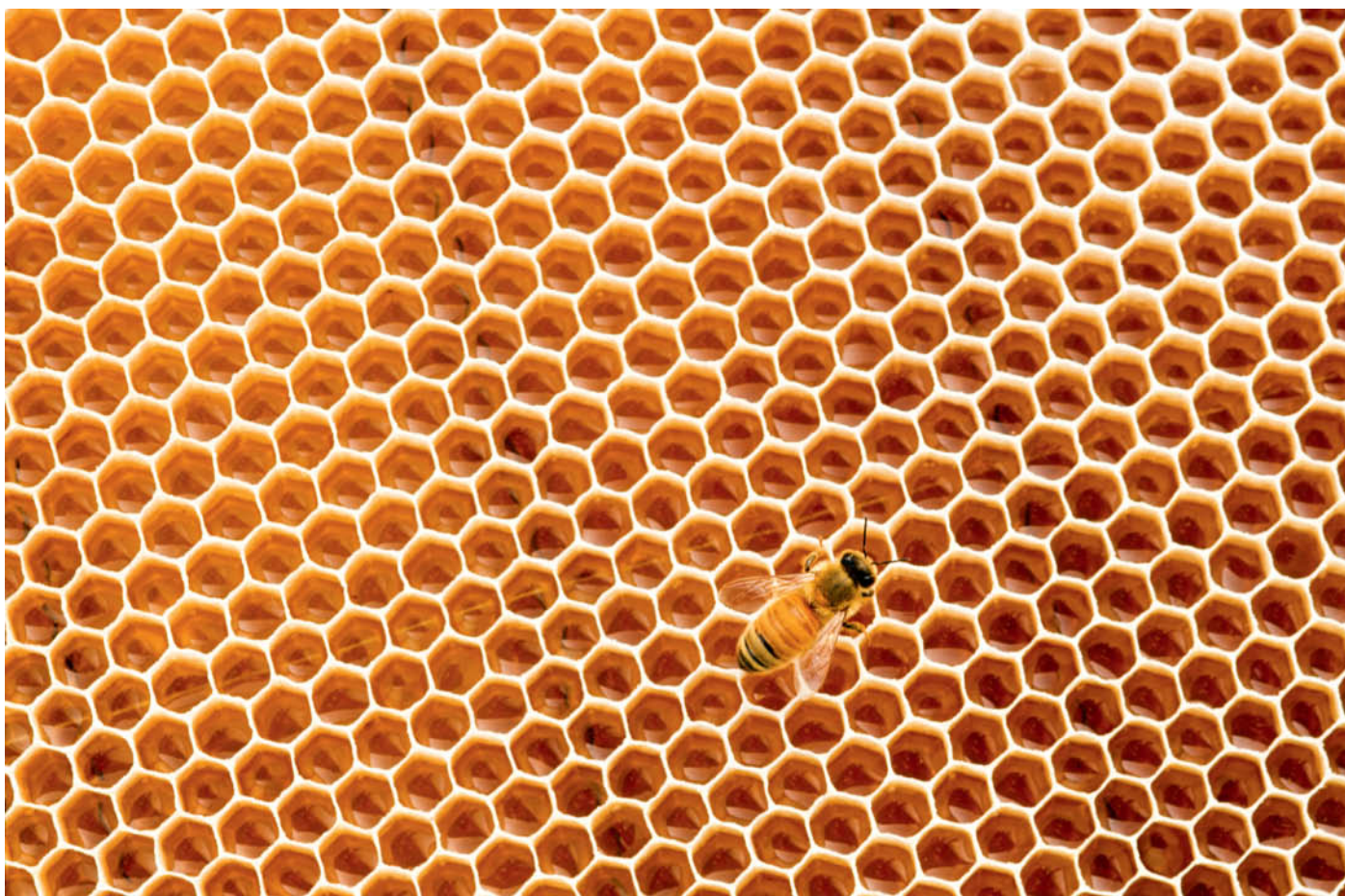
Patterns

We humans, and I suspect many animals too, are proficient at recognizing patterns. Recognizing the pattern of a snake lying on the ground or a predator concealed by trees was, at one time, critical to the survival of our species. Recognizing patterns helps us remember how to get home, helps us pay attention to important things and helps us to create art. We use patterns to make sense of a chaotic world. Patterns are not random, and learning to perceive the connections that patterns create is crucial to learning to see. When we begin to recognize patterns, we have begun to master the art of searching. Our images resonate with the viewer on a subconscious level because our choice of subjects has become clearer and our compositions more succinct.

There are many patterns in nature that repeat themselves in seemingly unrelated subjects. Breaking the pattern with the lone bee helps focus our attention on the story told by the bee and its honeycomb (California, USA).



Camouflage is based on patterns and it's often fascinating to see just how effective it can be. Canada Lynx are rarely seen in the wild and this shot makes it easy to understand why (Montana, USA).



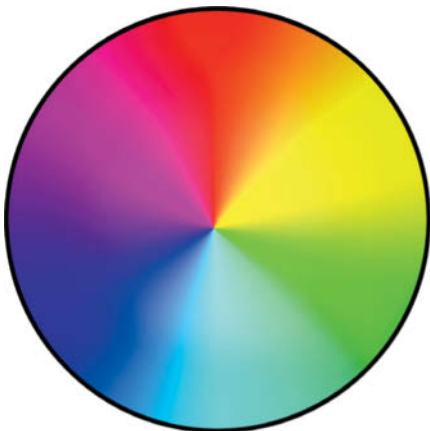


ISO 200 | f7 | 420 mm | 1/180s

The colors of this Scarlet Macaw certainly make it stand out. Using a green background helped make the reds stand out while the yellow feathers blended with the green, providing a softer transition.

The wilderness cabin on the right uses the contrast between blue and yellow to make the warmth of the cabin interior inviting to the viewer

ISO 200 | f5 | 42 mm | 2s



In photography, red, green and blue are called primary or 'additive' colors, while cyan, magenta and yellow are the secondary 'subtractive' colors

Color

Reds make our heart beat faster, greens have healing properties, blues calm us down, yellow gives us hope, and browns and grays can make us sad. Of all the visual elements we've talked about, color is one of the strongest. Color catches our eye, and a spot of color is often the reason a photographer stops to take a picture. Our reaction to color is instinctive and is part of how we interact with the world.

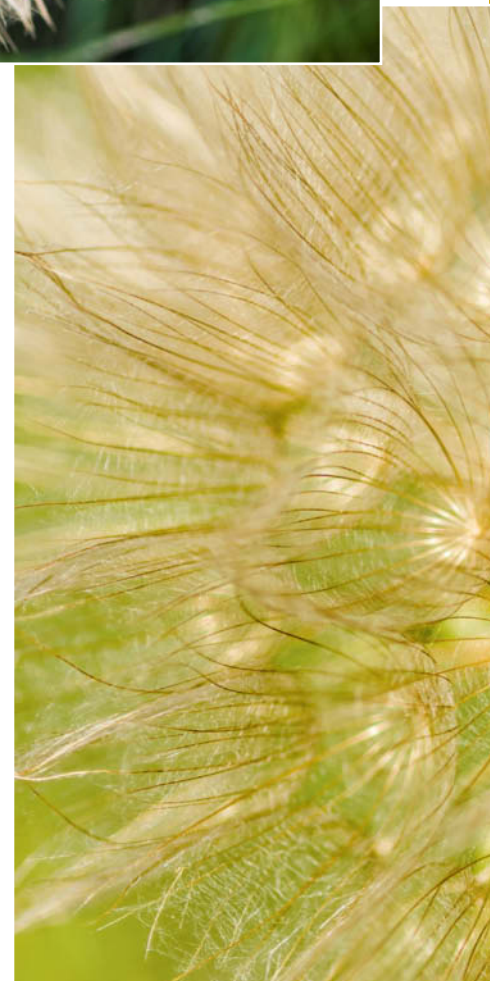
In photography, understanding how colors work together to produce harmony or

tension will help you choose subjects and compositions that are more dramatic or pleasing. To create color harmony, look for colors that are adjacent on the color wheel. Harmony gives a photograph a sense of balance and helps to provide a connection between the elements in a scene. Scenes that contain opposing colors jump out at us, making a bold statement about the subject and forcing the viewer to follow the colors that make up the composition.

ISO 160 | f3 | 105 mm | 1/500 s



ISO 200 | f4 | 105 mm | 1/1600



ISO 160 | f4 | 105 mm | 1/1250 s

Learning to See

We are born looking. Looking at things isn't difficult – all you have to do is point your head and open your eyes. We never give it a second thought, we just look. In a photographic context, the problem is that just looking doesn't make good pictures. We have to get beyond looking and start seeing, and seeing is something you have to learn. Like creativity, seeing is not innate.

If the photographer relies only on the subject matter to make a successful image, the result will often be a photograph that only shows what the photographer was looking at, not what he or she was seeing. Pictures like this are taken without thinking – something we all do now and again.

The next time you stop to take a picture, simply go ahead and take it. Push the button and get it out of your system. Once you have done that, you can take the time to figure out why you took the picture in the first place. Ask yourself why the scene is interesting and why it made you stop. To take a great photo, you need to be able to see the finished image in front of you, not just the subject.

Creative image-makers think in terms of possibilities. They are not content with the first image they take and have a natural curiosity that drives them to look for the next picture and to experiment with their tools, composition, and choice of subject. This is what enables truly creative individuals to risk failure, make mistakes and try again, and to keep on shooting until they get it right. (sea)

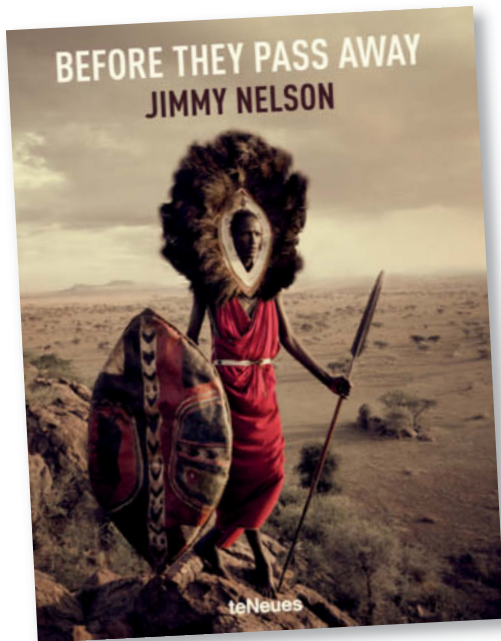


ISO 160 | f3 | 105 mm | 1/500s

I was photographing cracks in dried mud along a road and noticed some Common Salsify plants that had gone to seed. I liked the radial symmetry of the seed head, so I started photographing close-ups. The second and third shots show the subject well but don't go beyond 'looking'.

After a few more shots, I noticed how delicate the ends of the seeds were. These little wings are what carry the seeds on the wind. After several minutes of shooting I had finally seen the subject and the fourth shot, which includes a change in color balance to warm it up, shows what I saw – delicate wings that were ready to fly. **ct**

Book Reviews



Before They Pass Away

by Jimmy Nelson
Published by teNeues
408 pages, 402 color illustrations
Text in English, German and French
14.8 × 11.8 inches
Hardback
US\$150
ISBN: 978-3-8327-9759-1

Jimmy Nelson's images are carefully staged but nevertheless communicate a high degree of realism that gets the viewer thinking hard about what is familiar and what is truly foreign

The Last of Their Kind

Before They Pass Away

Advertising photographer Jimmy Nelson spent two years in some of the remotest places on Earth capturing the photographs for this book, subjecting himself and his team to Arctic cold, oppressive Amazon jungle heat and everything in between. He was searching for peoples and ethnic groups whose place in the modern world is increasingly threatened, either because the land they call home harbors valuable resources or simply because their societies are unlikely to survive the inevitable collision with the global consumerist economy that is lurking just around the corner.

Before They Pass Away performs a delicate balancing act that offers a timeless document with possibly some of the last ever visual records of cultures that will soon be forgotten, yet views its subjects with an artist's eye, producing subjective impressions that lack any feeling of distance.

Nelson's approach makes it difficult to differentiate between his own artistic concept and the degree to which his subjects represent

their authentic selves in their everyday surroundings.

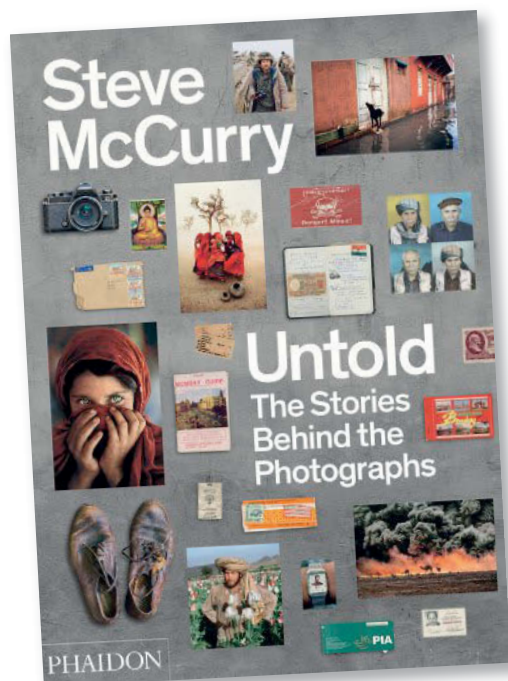
The book nevertheless manages to solve the potential conflict between art and documentation, thanks largely to Nelson's obsessive nature. He managed to establish a bond with all of his subjects, resulting in photos of unparalleled intensity. These unequivocal portraits present the viewer with clear, self-confident gazes that could only have been captured with a high degree of trust between the subjects and their photographer.

In spite of the wealth of exotic clothing, jewelry and archaic body paint on show, Nelson manages to compel us to countenance the unknown but somehow familiar individual at the heart of each image.

This concentration on the human angle makes it easier to contemplate the distinctive features of each of these endangered societies in an intuitive, non-scientific way, and the result is an impressive show of respect for cultural differences. (Robert Seetzen/tho)



Image: 2013, Jimmy Nelson, teNeues



**Untold:
The Stories Behind the
Photographs**

by Steve McCurry
Published by Phaidon
264 pages, 500 color illustrations,
English text
13.5 × 9.5 inches, Hardback
US\$59.95
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In the Thick of Things

Untold: The Stories Behind the Photographs

Steve McCurry is doubtless one of the most successful photojournalists of the past four decades. His pioneering coverage of the run-up to the Russian invasion of Afghanistan earned him a Robert Capa Gold Medal, and many more awards – including Magazine Photographer of the Year – have followed in a career that now spans more than 30 years. McCurry's work has been published widely in Time Magazine and National Geographic, which used "Afghan Girl", his most famous image, as its cover shot in June 1985.

Nearly 30 years after it was originally published, that iconic image has lost none of its impact or aura, even though few people actually know how it came into being. Fittingly, *Untold* dedicates an entire chapter to this unique image and goes into captivating detail, also telling the equally fascinating stories behind many of McCurry's other images, which are perhaps less famous but no less breathtaking. The narratives are often told in the photographer's own words, as he describes his trips and tells of the risks he sometimes had to take to get the job done.

The immediacy of his adventures is enhanced by the inclusion of handwritten notes, travel documents and newspaper cuttings from the times of the assignments. A closer look at these additional materials

often reveals more about McCurry and his work than any accompanying text could convey.

The covering letters that McCurry carried with him on many of his earlier travels are a good example of the sheer amount of effort involved in traveling and the decidedly old-school means of communication that he had to use back then.

Untold effectively combines these and many other impressions in a large-format conglomerate of history and powerful images.

If you don't yet own a Steve McCurry photo book, *Untold* is a great introduction to the man and his work. Fans might be disappointed at the largely predictable choice of images, but are nevertheless given a new and fascinating insight into the life and work of one of the greatest living photojournalists.

(Robert Seetzen/tho)

Image: 2013, Steve McCurry, Phaidon



"Keep going when others give up" has always been Steve McCurry's guiding motto – a philosophy that is clearly reflected in the intensity of his images

Coming up in Issue 16

● ● ● ● ● available from June 26

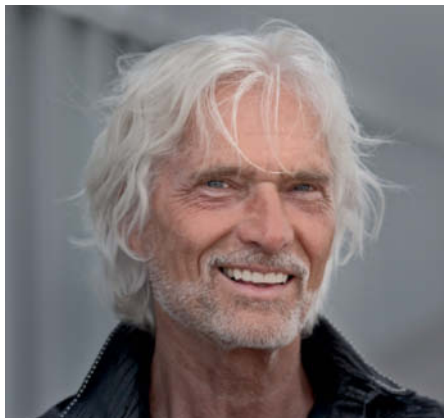


Photo: Michael Jordan

Daylight Workshop

■ Sunlight is the most widely used photographic light source. Anyone who has a feel for the way light behaves can learn to utilize its characteristics in many different ways. Our workshop provides a wealth of tips and tricks for working with available light and explains how to use natural light sources to create arresting images in a variety of situations, including landscapes, still lifes, architecture and portraits like the one shown here.

Sony Alpha 7R: The Full-frame Revolution

■ With its 36-megapixel full-frame sensor packaged in a seriously compact body, Sony's Alpha 7R represents a huge step forward in digital photo technology. The big question is whether the new camera, priced at around US\$2,300 (body only) can really match, or even exceed, the performance of the DSLR competition, represented first and foremost by the Nikon D800E. Our test provides some answers.



Photo: Sony

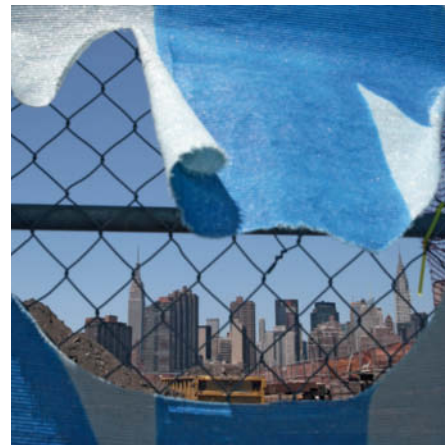


Photo: Torsten Andreas Hoffmann

Learning to See

■ Great photos rely not only on the photographer reproducing a scene, but also on the ability to express emotions visually. This aspect is essential if the viewer is to be able to understand what the photographer was feeling at the moment an image was captured. Shooting such images requires great timing, compositional skill and the right attitude. This workshop details strategies for producing genuinely powerful images.

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Issue 15

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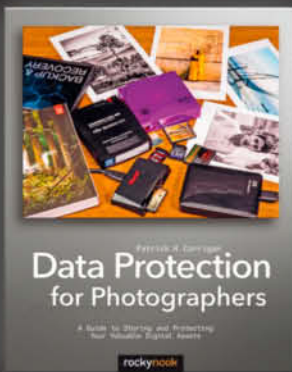
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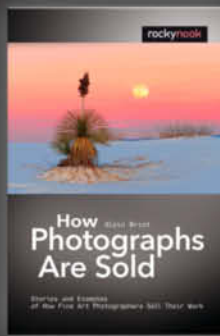


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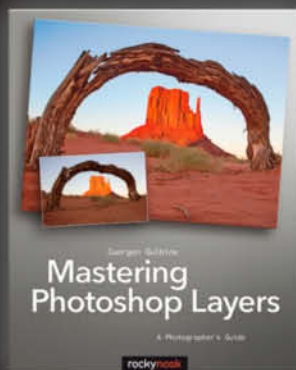
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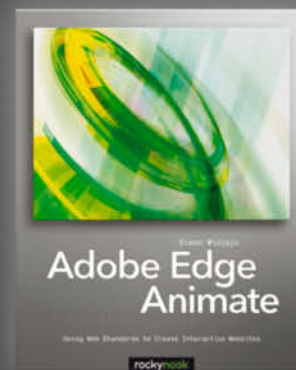


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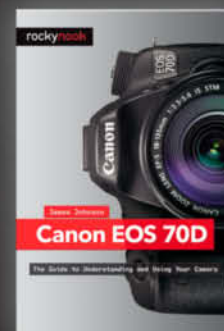


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