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c't Digital Photography

Free DVD!
Photo Optimizer 2.02
Video Tutorials
Adobe PS Lightroom 3
Adobe Photoshop CS5
Image Processing
Photo and RAW Tools
Images and Videos

The Beauty of Blur
How to get great bokeh, lens test

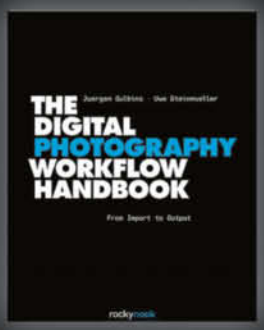
Noise Know-how
Causes, remedies, camera modding

Cameras vs. Camcorders
DSLR Video
Accessories review
Inside info

Remote Control
via USB, Wi-Fi, iPhone

Creative Corner
Image Composition
Black and White
Hi-res Moon Panorama

Image Retouching and Cool Effects
GIMP Master Class
Digital depth of field, photomontage, advanced object selection



Juergen Gulbins · Uwe Steinmueller

The Digital Photography Workflow Handbook

From Import to Output

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NK Guy

Mastering Canon EOS Flash Photography

March 2010, 432 pages
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US $ 44.95, CAN $ 53.95

Mike Hagen

The Nikon Creative Lighting System

Using the SB-600, SB-800, SB-900, and R1C1 Flashes

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Mastering HD Video with Your DSLR

March 2010, 240 pages
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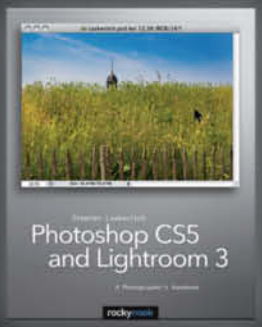
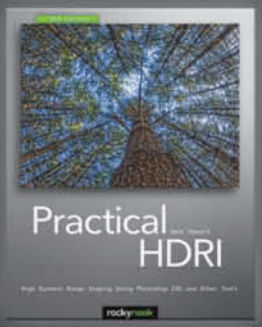


Stephen Laskevitch

Photoshop CS5 and Lightroom 3

A Photographer's Handbook

July 2010, 289 pages
978-1-933952-67-3, 8 x 10 Softcover
US $ 39.95, CAN $ 49.95



Jack Howard

Practical HDRI, 2nd Edition

High Dynamic Range Imaging Using Photoshop CS5 and Other Tools

August 2010, 240 pages
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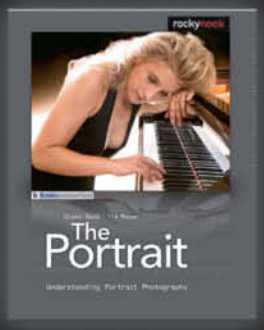
US $ 34.95, CAN $ 43.95

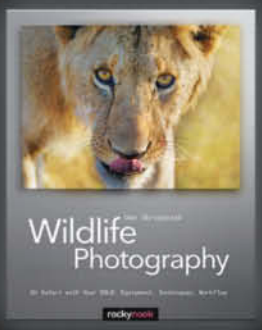


Glenn Rand · Tim Meyer

The Portrait

Understanding Portrait Photography

December 2009, 200 pages
978-1-933952-46-8, 8 x 10 Softcover
US $ 34.95, CAN $ 41.95



Uwe Skrzypczak

Wildlife Photography

On Safari with Your DSLR: Equipment, Techniques, Workflow

June 2010, 236 pages
978-1-933952-56-7, 8 x 10 Softcover
US $ 39.95, CAN $ 49.95

Cyrill Harnischmacher, Editor

The Wild Side of Photography

Unconventional and Creative Techniques for the Courageous Photographer

July 2010, 224 pages
978-1-933952-51-2, 10 x 8 Softcover
US $ 29.95, CAN $ 37.95

So you have learned to take photographs as well as snapshots, but are you making movies too?

Now that even entry level DSLRs include HD video mode, a whole new playground of possibilities has opened up for digital photographers everywhere. Full-frame image sensors and a wide range of interchangeable lenses make digital cameras superior to camcorders in many ways. Increasing numbers of professional film-makers are using DSLRs for their day-to-day work, and this issue of c't Digital Photography includes an interview with a pro camera operator on a digital advertising shoot.

DSLR video is still in its infancy but, even if manufacturers still need to improve camera handling and sound quality, video-equipped digital cameras add an exciting new dimension to every photographer s repertoire. Practice, experience and having fun while learning are the most important ingredients if you want to produce technically and artistically polished video, so a number of major articles in this issue are dedicated to giving you the information you need to start shooting your own digital movies.

Photography, too, has its fair share of column inches: our Master Class shows you how to make the most of GIMP's free image processing power, we show you how to shoot better photos and J Henry Fair's Industrial Scars portfolio perfectly bridges the gap between art and photojournalism. Fair's photos show us the terrible environmental destruction caused by events like the 'Deepwater Horizon' disaster while serving up aesthetics that are at home in art galleries all over the world.

Have fun reading and discovering!

Jürgen Rink

Bokeh – The Beauty of Blur 16

DSLR Video 32

Portfolio

The beauty of J Henry Fair's images disguises their true nature. These breathtaking photos document environmental disasters, including the BP oil spill in the Gulf of Mexico.

Bokeh – The Beauty of Blur

Which bokeh looks best and which lenses produce the most desirable blur are both subjects of hot debate. We provide you with tips on how to get great bokeh effects, and we compare the bokeh produced by a range of popular manual and autofocus lenses.

DSLR and EVIL Video Special

Shooting HD video with digital stills cameras is becoming increasingly popular, especially now that high-end DSLRs are getting some competition from consumer DLSRs and EVIL cameras.

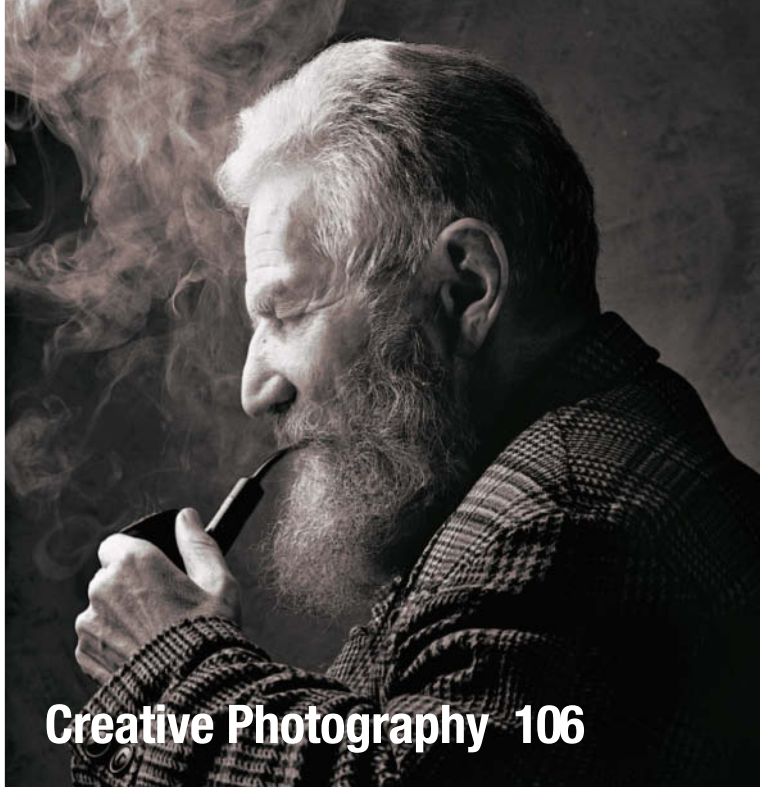
GIMP Master Class

This collection of workshops shows just how powerful and flexible the free GIMP image processing suite can be. From beginners to advanced users, everyone can learn something new with our GIMP master class.

Image Noise Know-how

All digital cameras produce noise, from consumer compacts to high-end DSLRs. There are many ways to digitally reduce the effects of noise artifacts, but the best remedy is to avoid producing noise in the first place.

GIMP Master Class 56



Creative Photography 106

Remote Camera Control

Cable release was yesterday! This article shows you how to control your camera remotely by wire, wirelessly, or even using your iPhone.

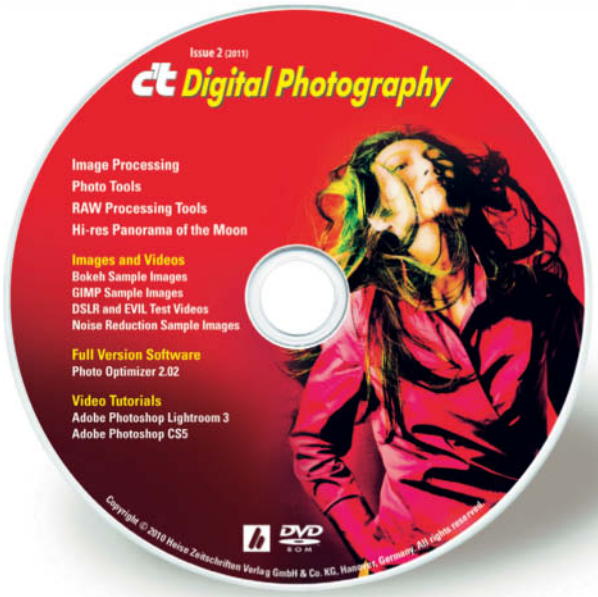
Creative Corner

Which is more important – your creative skills or the equipment you use? Whatever you think, the goal is always to produce better photos. We look at the magic of traditional black-and-white images and the charm of photos shot using low-end cellphone cameras. We have also included a large format panorama image of the Moon for you to keep and print.

About the Magazine

Free DVD

The DVD includes two video tutorials. The first explores Photoshop Lightroom 3's image management and processing functionality, and the second discusses RAW image processing and image correction using Adobe Photoshop CS5. There are also numerous sample images and videos relating to various articles in the magazine and, to round things off, we have included a package of free image processing and photo tools as well as a full version of Ashampoo Photo Optimizer



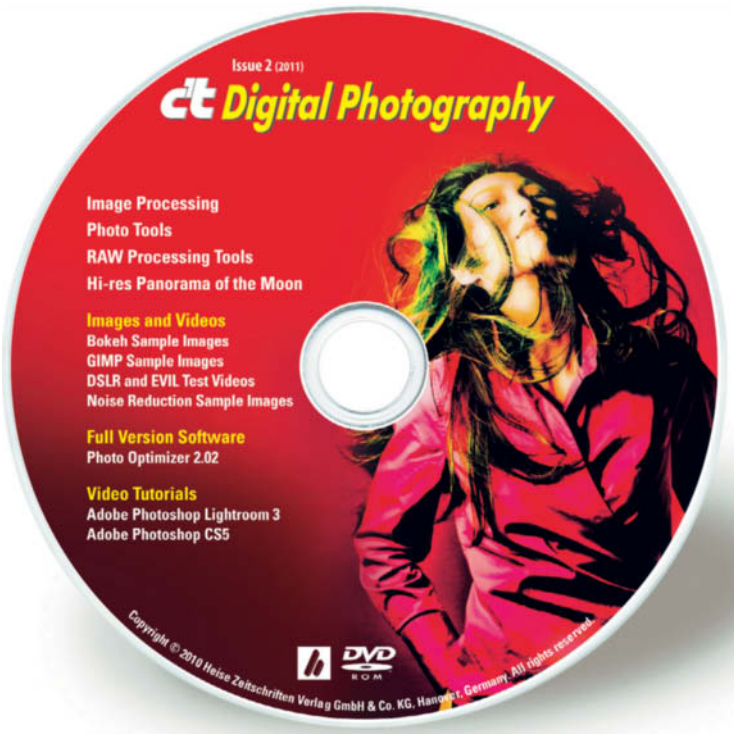


Image Processing

Windows

FastStone Photo Resizer 3.0
FastStone Photo Resizer Portable 3.0
GIMP 2.6.10
GIMP Portable 2.6.10
Image Analyzer 1.32
ImageMagick 6.6.4-8
ImageMagick 6.6.4-8 (64-bit)
Inkscape 0.48
Luminance HDR 2.0.0
Paint.NET 3.5.5
Photo Pos Pro 1.82
Picasa 3.6
RegiStax 5.1.9.2
TSR Watermark Image Software 1.8.3.4

Mac

GIMP 2.6.10
Inkscape 0.48
Picasa 3.6

Linux

Luminance HDR 2.0.0

Photo Tools

Windows

Absolute Color 1.0
Awesome Duplicate Photo Finder 1.0
Curves 1.0
Edges Fx
Eraser Classic 1.01
Exif Eraser 1.0
ExifTool 8.34
Foto-Mosaik-Edda 5.6.2
GeoSetter 3.3.60
i3D Photo 3.4.0.190
Image Resizer Powertoy Clone for Windows 2.1
Image Resizer Powertoy Clone
for Windows 2.1 (64-bit)
IrfanView 4.27
IrfanView PlugIns 4.27
IrfanView Portable 4.27
JetPhoto Studio 4.9.2
Local Equalization
Namexif 1.5
Panorama Perfect Lite 1.6.2
Perspective Transformations 8.0
PhotoRazor 2.5
Pictomio 1.2.31.0
Tint 1.0.4
XnView 1.97.8

Mac

ExifTool 8.34
JetPhoto Studio 4.9.2
PhotoGPSEditor 1.6
PhotoInfoEditor 1.2
Sofortbild 1.0.1
Tint 1.0.4

Linux

ExifTool 8.34

RAW Tools

Windows

Raw Therapee 3.0 alpha 1
RawDev 22.04.2009
UFRaw 0.17
XDepth Raw Converter 1.5.1

Linux

Raw Therapee 3.0 alpha 1

Sample Images and Videos

Bokeh Sample Images
GIMP Sample Images
Noise Reduction Sample Images
Moon Panorama
Sample Videos shot using
Interchangeable-lens Cameras

Full Version Software

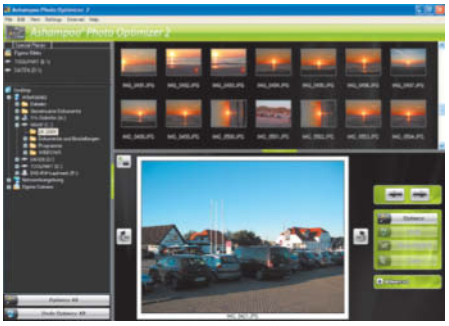
Photo Optimizer 2.02

Video Tutorials

Adobe Photoshop Lightroom 3
Adobe Photoshop CS5

DVD Highlights

The DVD's many highlights include a full version of Ashampoo Photo Optimizer 2.02, as well as video tutorials on Adobe Photoshop Lightroom 3 and Photoshop CS5.



Full Version: Ashampoo Photo Optimizer 2.02

Perfect for beginners and great for anyone in a hurry! With Ashampoo Photo Optimizer 2.02, you can optimize your digital images with a single mouse click.

Ashampoo Photo Optimizer automatically optimizes contrast, brightness, color strength and image sharpness at the click of a single button. Before and after views help you to judge the effects of optimization and adjustments can be undone at any time.

The program's batch mode allows you to simultaneously optimize all the images in a folder, also using just a single mouse click. Batch adjustments can be undone for individual images or the whole folder. The program saves every step you apply, and if you are not satisfied with the results of the automatic optimization, you can fine-tune your image manually by clicking the Color Correction button. The effects of your adjustments are displayed in real time in the image preview window.

In order to use the full version of the software, you will need to enter the registration code that you can download via the link included on the DVD or from within the program's interface. The registration process requires you to enter a valid e-mail address. Once you have entered your address, you will receive a confirmation mail. Clicking on the link in the confirmation mail confirms the validity of your address and automatically sends you a valid license key. (keh)

Video Tutorial: Adobe Photoshop Lightroom 3

This video2brain video tutorial explores the basics of image management and processing using Adobe Photoshop Lightroom 3.

Adobe Photoshop Lightroom was released in its third iteration in the summer of 2010. In just three years, the program has developed from an enhanced RAW converter into one of the today's leading all-in-one digital photo workflow tools.

Tim Grey and Mikkel Aaland begin this 145-minute tutorial with an overview of the program's functionality and the basic approach to working with Lightroom. The following sections include quick start guides for converting slide shows into video files, creating custom print layouts and producing web galleries with just a few mouse clicks. The emphasis here is on simplifying basic tasks without going into detail on the software's more complex capabilities.

A large part of the material deals with the program's built-in database, importing images into the Lightroom system, the locations and formats they are saved in, and how to organize your Lightroom libraries to help you find your way around later. Subsequent sections go into more detail on the production of slide shows and HTML web galleries for publication on the Internet. Grey and Aaland use clear examples to illustrate each point, and include a wide range of useful tips for everyday use of the software. (pen)

Video Tutorial: Adobe Photoshop CS5

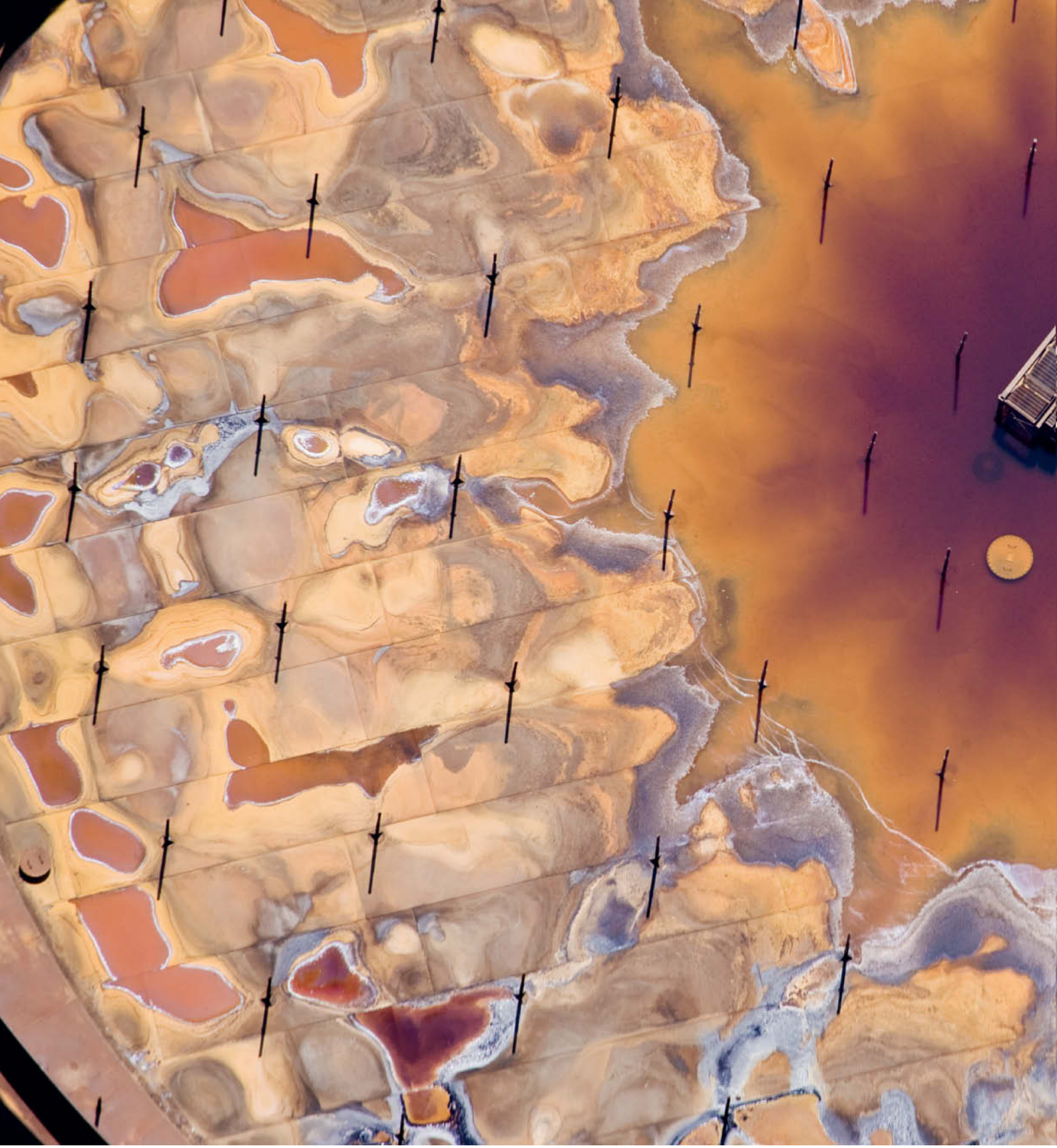
This tutorial addresses basic functionality as well as some of the new features offered by the latest version of Adobe's flagship image processing package.

Adobe is calling Photoshop CS5 a „milestone" and the most important upgrade in the company's history. The most significant improvements are in the program's object selection, image manipulation and lens correction tools.

Tim Grey and Mikkel Aaland are experienced Photoshop users and great fans of the program. They guide you through more than two hours of material, starting with how to use the Photoshop interface and tips on how to structure your workflow. They use a range of examples to demonstrate the program's new features and explain how to use Adobe Bridge.

The section on Adobe Camera Raw addresses all of the most important aspects of RAW image processing, including color corrections and tonal value adjustments using Curves. Aaland and Grey go into detail on using the Shadows/Highlights tool to make additional tonal adjustments, as well as color correction using selective gamma settings.

The authors close with examples of how to correct everyday image errors, such as red-eye effects, image noise, and using the Clone Stamp tool to remove spots caused by dust on the image sensor. (pen)



Inside an Oil Sands Upgrader
Fort McMurray, Canada
The first step in the oil sands process after extraction is upgrading, which separates particulate matter from the mined bitumen and prepares it for refinement.

Portfolio: J Henry Fair

Industrial Scars

JHenry Fair started photographing rusty machines and broken-down buildings in his youth, before going on to study media and embarking on a stellar career as a fashion photographer in the 1980s. His clients back then included Issey Miyake and Ralph Lauren, and his photos graced the pages of Vogue and Vanity Fair. He also shot ad campaigns for Sony/BMG, RCA, Polygram, Deutsche Grammophon and Warner Brothers that included noted portraits of classical stars like Yo-Yo Ma, Cecilia Bartoli and Pierre BoulezJ Henry Fair started photographing rusty machines and broken-down buildings in his youth, before going on to study media and embarking on a stellar career as a fashion photographer in the 1980s. His clients back then included Issey Miyake and Ralph Lauren, and his photos graced the pages of Vogue and Vanity Fair. He also shot ad campaigns for Sony/BMG, RCA, Polygram, Deutsche Grammophon and Warner Brothers that included noted portraits of classical stars like Yo-Yo Ma, Cecilia Bartoli and Pierre Boulez.

Fair rediscovered his passion for recording the legacies of consumer society 10 years ago, when he began publishing sequences of photos that document dilapidated warehouses and industrial ruins. These were all taken at ground level, but it was the aerial photos in his Industrial Scars series that finally gained him recognition in the art scene and introduced his work to a broader public.

In order to produce these pictures, Fair charters flights over chemical plants, fertilizer factories and power stations to gain photographic access to things that are normally fenced in or hidden behind high walls. The ruined landscapes in the photos are not initially recognizable for what they are – the high-contrast colors combined with varied and often diffuse forms are more reminiscent of abstract paintings than of documentary photographs. The comparison between Fair's photos and abstract expressionist paintings by Mark Tobey, Mark Rothko or Willem de Kooning is immediate and obvious.

Small wonder, then, that his photos were soon being shown in galleries normally dedicated to fine art. It is only at a second glance

Sisyphus
Texas City, Texas, USA
Bulldozer pushing petroleum coke

that the viewer begins to realize that the pictures are actually of rivers that have turned to sewers, or of contaminated earth and polluted lakes. The fact that these photos don't wag a finger makes them all the more effective. Fair leaves the interpretation entirely to the viewer, which can have controversial results. Don't these pictures also portray the beauty that industry can create in a landscape? Do they perhaps illustrate the aesthetics of destruction?

Fair knows and respects the boundaries between art and documentation. He produces his photojournalistic work in cooperation with United States and international environmental organizations, giving the resulting images the necessary political support. The images come not only from the United States, but also from Spain, Sardinia, Poland and Kenya. He is particularly interested in Germany's lignite and coal industries and the enormous industrial plants in the Ruhr area, and closely follows the intense environmental debate that is an integral part of everyday German politics.

During the preparatory discussions for this portfolio and the interview that follows, Fair was deeply involved in a new project covering the oil disaster in the Gulf of Mexico. One of the first major images of the events in the Gulf is included here. (jr)

J Henry Fair on the Web:
www.jhenryfair.com
www.industrialscars.com
http://soapboxhenry.blogspot.com/

The Last Stand
Kayford Mountains,
West Virginia, USA
Blasting spoil being removed by machine. Modern mining operations work around the clock and at amazing speed. This lonely stand of trees disappeared in less than a day.

Pulp Waste at a Tissue Factory
Terrace Bay, Ontario, Canada
This factory produces pulp for the USA's most popular brand of facial tissue. The wood fiber comes from the Kenogami National Forest in Ontario, Canada, where the government subsidizes deforestation for the sake of just a few jobs. After logging, this ancient, diverse habitat is replaced by monoculture.

Rio Tinto Mine
Rio Tinto, Spain
Rio Tinto, literally "red river", is one of the oldest and most productive mines in the world, having produced a wealth of different metals over the centuries. It is thought to have been "King Solomon's Mine" and the reason the Moors invaded Spain

Ship Trail in the Oil-bound Gulf of Mexico
"If you haven't witnessed the devastation yourself, it's impossible to understand the Deepwater Horizon disaster. It is worse than anyone can imagine."

Interview mit J Henry Fair

Thomas Saur (Art Director c't): You're a well-known fashion and music photographer – what inspired you to get on a flimsy light aircraft and take aerial shots of industrial wastelands?

J Henry Fair: I have always been deeply concerned with the environment and our impact on it, simply because the environment is the system that supports life on our planet. Ironically, the people that are doing most to destroy this system – while generating vast personal wealth for themselves – have managed to create the impression that the "tree-huggers" are the radical minority, while "business" is good for everyone. I have been shooting images of pollution and decay at ground level for years, but it was only when I saw the world from the window of an airliner that I realized how I could produce really effective images. Shooting from a light aircraft for this type of project is hot, cramped and tiring work, but I still have to be on the ball. There is no time to think on an aerial shoot, and I often have to simply go ahead and press the shutter release.

People look at your work in art galleries and are deeply impressed by its aesthetic qualities. Does the inherent beauty of the photos distract viewers from the destruction they portray?

If the images are not beautiful enough to produce a response, they will not be effective. We were already suffering from sensory overload before use of the Internet became widespread and today, only something that triggers a pause and a question gets through our everyday filters. My audience has to reach its own conclusions, but art always helps to bridge the gap between knowledge and understanding.

Which of your shoots has had the most impact on you?

On any given shoot, I try to meet the people fighting the real battle on the ground, and that always makes an impression. They are the first ones to realize that a problem exists, and they are the ones who can provide the most accurate and timely information. Shooting the BP oil spill in the Gulf of Mexico has probably had the most impact on me, because of the sheer scale of the situation, the vast deception involved and the willingness of people everywhere to accept the official story.

Can you tell us more about your experiences there?

Photographing the BP Deepwater Horizon spill has become something of an obsession for me, but it is difficult for people who haven't actually experienced it to comprehend it. People ask me what it's like, but all I can say is, "It's worse than you can possibly imagine." No matter what I say, I know I won't be understood, because understanding the situation involves questioning every single aspect of the normal, day-to-day existence that we take for granted. The BP crisis is so monumental on every level, I am amazed that people aren't already protesting on a grand scale – not only against BP, but against the use of fossil fuels at all. c't

Shot using a Hasselblad HC 80 lens at f2.8

Thomas Saur

Bokeh

The Beauty of Blur

When a group of photographers starts to rave about "bokeh", you might be forgiven for thinking you have ended up at a wine tasting by mistake. What they are talking about is, however, not the aroma of a wine, but rather the often neglected out-of-focus parts of photographic images. This article describes bokeh in detail and gives tips on how to control the bokeh in your own images. We have also included a comparison of the bokeh effects produced by a range of currently available autofocus and manual lenses.

The term "bokeh" comes from the Japanese word *boke* which means "haze" or "blur". The word is used to describe the aesthetic qualities of the out-of-focus areas in photos.

In photo magazines, it is often only mentioned in passing in the course of lens tests that go into great detail on the subjects of sharpness and contrast. However, bokeh is often the subject of intense debate in online forums and photo blogs due to the twin facts that it cannot be measured but nevertheless has a significant effect on the overall quality of an image. Successful images often owe their effectiveness to the emotional impact of their out-of-focus elements. Blur can be effectively used to emphasize certain parts of an image, and the transitions from sharp to blurred often add to the feeling of space and depth in a photo. The deliquescence of blur can give a picture an almost musical quality, and lively bokeh can give a background a subtle rhythm of its own, as if it were breathing.

Images that are in sharp focus from the near foreground right up to infinity automatically take on a documentary character and often include too much unimportant detail that distracts the viewer and muddies the picture's message.

Factors that determine the Character of Bokeh

Circles of Confusion

A camera and its lens project points on the object plane onto the image plane (i.e., the film or the image sensor). A point in a subject is only in focus if all the rays of light emanating from it converge at the same point on the image plane, as shown in the illustration below. Foreshortening the cone of light for points that lie either in front of or behind the image plane displays these as discs rather than points. These discs are known as "circles of confusion". The further the subject is located from the focal point of the lens, the larger the corresponding circle of confusion at the sensor plane will be. It is this relationship that determines the degree of blur in an image. Using a smaller aperture extends the depth of the field of focus. The look and feel of bokeh is also influenced by the size, shape and distribution of brightness within the circles of confusion that a lens produces. Circles of confusion are, in fact, optical projections of the aperture opening, and their shape is dictated by the shape of the aperture blades in a lens. A lens that has six aperture blades will produce hexagonal circles of confusion; the more blades it has, the rounder the circles of confusion will be. Some lens manufacturers deliberately round the inside edges of their aperture blades to produce more pleasing bokeh.

Aperture and Depth of Field

The maximum working aperture of a lens – often described as its "brightness" – is represented by the smallest number on the aperture scale. At maximum aperture, bright lenses produce images with very shallow depth of field and larger circles of confusion than they do at smaller apertures. Large apertures thus produce more obvious bokeh. The maximum aperture setting is always part of the name of a lens. For example, the size of the aperture opening in an 85mm f/1.8 lens at maximum aperture can be calculated by dividing 85 by 1.8. This lens is then "brighter" (i.e., has a larger maximum aperture) than an 85mm f/2.8 lens. The depth of field and resulting intensity of the bokeh a lens produces also depend on the shooting format and reproduction ratio of the camera/lens combination you are using. These factors are, in turn, influenced by the focal length of the lens and the subject distance. The formulae for calculating the depth of field in a particular situation can be found at Wikipedia or other websites.

If that sounds too complicated, you can also use one of the many depth-of-field calculators that are available for PC, Mac or iPhone. There are some useful links listed in the box on page 21. We particularly recommend the *DoF Plus* iPhone App, which is based on a comprehensive database of camera/lens combinations.

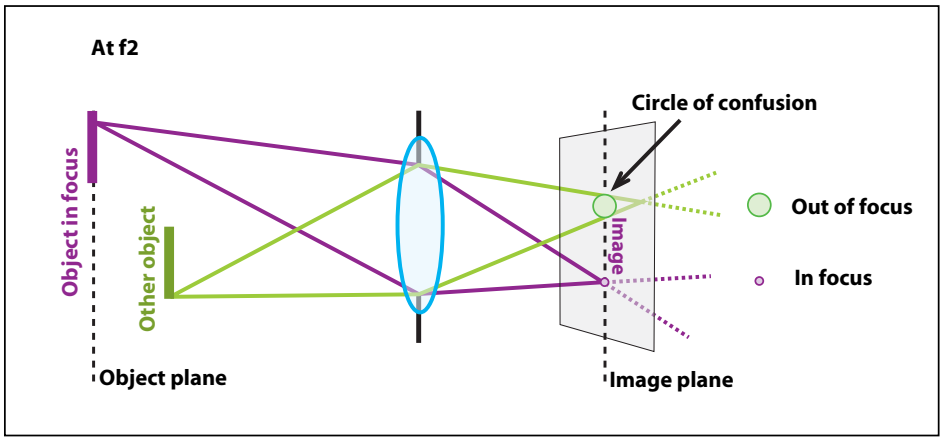
Depth of Field and Shooting Formats

Used with smaller image sensors, lenses cover a larger field of view and therefore produce greater depth of field than when they used with larger image sensors. The opposite is also true, and you can produce more foreground or background blur using 35mm or medium format cameras.

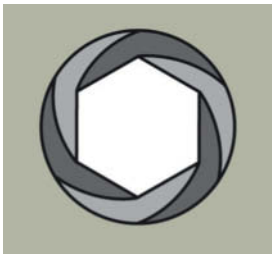
If you compare the results produced by a Canon 85mm f/1.2 L lens mounted on a full-frame camera with those produced by the legendary Leica Noctilux 50mm f/1.0 used with a Four Thirds format Lumix GF1, the Canon lens displays much more pronounced blur.

We calculated the depth of field for the Noctilux to be 10.6 cm (4.2 inches) for a subject located three meters from the camera and photographed at f1.0. A 100mm lens used with a full-frame camera covers the same angle of view but already has a depth of field of just 10.4 cm at f2.0. A medium-format Hasselblad H3D requires a 135mm lens to cover the same area and produces depth of field of 10.8 cm at f2.8.

Hard-core bokeh fans often use medium format or even large format cameras to get the best out of the out-of-focus areas in their images. Digital compacts, with their tiny image sensors, are not at all suitable if you want to produce any kind of visible bokeh effect.



A cross section of the light path in a camera with the aperture wide open. The further an object is located from the object plane, the larger the circle of confusion it produces at the image plane and the more out of focus it will be.



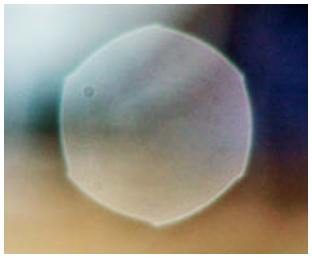


Diagram of an aperture with six blades and the hexagonal circle of confusion it produces

Home-made Bokeh

It is easy to experiment with the shape of the circles of confusion your camera produces. Simply use a fine modeling knife to cut an alternative-shaped opening in a piece of black card and mount it in front of your lens. This can be a star or a polygon, or any other shape you like, and will directly influence the shape of the bokeh patterns in your images. The examples below show the kinds of effects you can achieve.

"Good" or "Bad" Bokeh?

Photographers (and photography critics) often talk about "good" and "bad" bokeh, but opinion is divided as to what these terms actually mean. Ideally, the out-of-focus areas in an image should serve to separate objects in the foreground from the background. This is why many photographers prefer to use lenses that

Home-made bokeh: it is easy to make your own bokeh filters out of ordinary black card. The images here show some results produced this way.

The Distribution of Brightness in Circles of Confusion

The distribution of brightness within the individual circles of confusion influences the overall bokeh effect and depends on the degree of spherical aberration correction built into a lens. The following are the most common types of circles of confusion:

Soft edges

A low level of spherical aberration correction causes soft circles of confusion. Ideally, this form corresponds to a normal Gaussian distribution and is considered by many photographers to be pleasing. This type of bokeh is relatively unsharp and has low contrast characteristics.

Evenly lit

Balanced, well-corrected lens geometries will produce evenly-lit circles of confusion

Emphasis on the outer edge

Some viewers find this type of high-contrast bokeh irritating. Uncorrected lenses tend to produce double contours at object edges that are located outside the plane of focus.

produce "soft" bokeh with the circles of confusion displaying no discernible edges.

Some older lenses with less pronounced spherical aberration correction fit into this category and are still very popular. However, aesthetic judgments have a lot to do with personal taste and perceptual habits, making "edgy" bokeh that accentuates the transition from sharp to out of focus more pleasing to some viewers. Some photographers particularly like the polygonal circles of confusion produced by older lenses that have only a small number of aperture blades.

Special Lenses

Special lenses with specifically designed bokeh characteristics are particularly popular with portrait photographers. The Minolta/Sony STF 135mm f/2.8 [T4.5]* lens uses a built-in apodization filter to suppress the formation of the visible outer ring in the circles of confusion it produces.

Nikon manufactures two Defocus Control portrait lenses (the 105mm and 135mm f/2.0 DC-Nikkors), which have manually adjustable spherical aberration correction elements. The results they produce are not particularly natural-looking and using them to optimize background focus usually worsens foreground focus, and vice versa. The donut-shaped rings of confusion produced by mirror telephoto lenses are generally considered unattractive.

Classic and Exotic Manual Lenses

Certain older, manual focus lenses are particularly popular with demanding digital photographers. Lenses manufactured by Leica, Zeiss, Yashica and Nikon can be attached to modern, high-end DSLRs using special adapters (see also our high-end lens test in issue 1 of *c't Digital Photography*). Lenses constructed using the even older M42 thread can also be adapted for use with contemporary cameras. There are many treasures to be discovered out there, especially among lenses manufactured in Eastern Europe.

Some exotic lenses have found fame in various Internet forums due to their bokeh characteristics, and it is often optical errors and anomalies that produce some of the more sought-after effects. For example, the Pentacon 135mm f/2.8 is said to have an especially soft, "creamy" bokeh. The Russian Helios 40 (85mm f/1.5) and Helios 44 (58mm f/2.0) models are good examples of cheap lenses with very unusual bokeh, and can be found on the used market for less than US$15. Impressive sample images can be

found in the various flickr user groups that have formed around these often legendary lenses. For more information, see the *Useful Links* section below.

Digital Bokeh

While there are various programs and plug-ins available that produce artificial bokeh effects, including *Photoshop*'s own Lens Blur filter and Alien Skin *Bokeh 2,* none of these tools can produce results as effective as bokeh that is produced optically. Applying digital bokeh usually involves producing a mask to protect the parts of the image that you want to remain unaffected, and the resulting images lack the layered transparency that characterizes an original, unprocessed photo.

Leica lenses are optimized to produce the best possible contrast and image resolution, and provide balanced correction for a wide range of optical errors, too. This is a combination that produces fine transitions between in-focus and out-of-focus areas and bokeh that has many loyal fans. This photo was taken using a Leica 80-200mm Vario-Elmar-R set to f4.

Shot using a Zeiss 50mm Makro-Planar ZE lens set to f2. Zeiss macro lenses are renowned for their extremely clear definition and are usually corrected to produce extremely good microcontrast. This can cause slightly unsettling bokeh with obvious circles of confusion. The deep, three-dimensional look that these lenses produce has its own special appeal. Zeiss is one of a handful of professional movie camera lens manufacturers, so it is no coincidence that this look is reminiscent of cinema films.

Useful Links

Formula for calculating depth of field:

http://en.wikipedia.org/wiki/Depth_of_field#Derivation_of_the_DOF_formulas

Calculating depth of field online:

www.dofmaster.com/dofjs.html

General information:

http://en.wikipedia.org/wiki/Bokeh

Sample images:

www.flickr.com/search/?w=all&q=bokeh&m=text

www.flickr.com/groups/finest_dof/

www.flickr.com/groups/bokehoftheday/

M42, manual focus and other older lenses:

www.retrocamera.net

http://forum.manualfocus.org/

www.flickr.com/groups/m42_lenses_and_dslrs/pool/

www.flickr.com/groups/m42/

Russian (especially Helios) lenses:

www.flickr.com/groups/helios44/

www.flickr.com/groups/helios_40-2/

www.flickr.com/groups/russianlens/pool/

The space around the subject is completely out of focus and the bokeh underscores the overall atmosphere in this shot. The photo was taken using a Zeiss 50mm ZE lens set to f2.

Bokeh can also help to emphasize the emotional impact of portrait shots. This photo was taken using a Hasselblad HC 100mm set to f2.2. The larger format produces a much stronger bokeh effect than equivalent 35mm format lenses.

The focal length of a lens has a significant effect on the resulting bokeh. The shot on the left was taken with a Leica 80-200mm Vario-Elmar-R zoomed in to 200 mm and with the aperture set to f4. The image above was taken using a Leica 35mm Summicron-R set to f2. The longer lens produces much more pleasing bokeh.

The shallow depth of field in close-up shots emphasizes the bokeh characteristics of a lens. This image was shot using a Zeiss 50mm ZE lens at f2.

How to Produce Great Bokeh

1. Image sensor size

The larger your camera's image sensor, the longer the focal length of your lens has to be in order to successfully reproduce an object located at a certain distance from the camera. This means that larger sensors have shallower depth of field and generally produce more impressive bokeh.

2. Focal length

The greater the focal length of your lens, the shallower the depth of field will be for a constant frame size.

3. Aperture

The larger the aperture (i.e., the smaller the number on the aperture scale), the shallower the depth of field will be.

4. Subject distance

The closer you are to your subject, the shallower your depth of field will be at a constant focal length. This effect is especially prevalent in the field of macro photography, where the field of focus is usually only a few millimeters deep.

5. Distance between subject and background

The greater the distance between the focused subject and the out-of-focus background details, the more obvious the separation between subject and background will be. Portrait shots benefit from placing the subject as close to the camera and as far from the background as possible.

6. Unusual circles of confusion

Background light sources and reflective metal objects, or light that is filtered through foliage, produce particularly pleasing effects. It is always worth taking a close look at the defocused background of your scene before you decide on your final composition.

7. Reproduction ratio

Bokeh effects can be enhanced by cropping and enlarging image details or simply by making large prints. They are less obvious in postcard-sized prints.

It is not only the shape of the circles of confusion, but also the overall plasticity of the transitions between focused and defocused areas that can give an image an almost three-dimensional look, as this shot taken with a Zeiss 50mm f/2.0 Makro-Planar ZE strikingly demonstrates

Bokeh Comparison Test

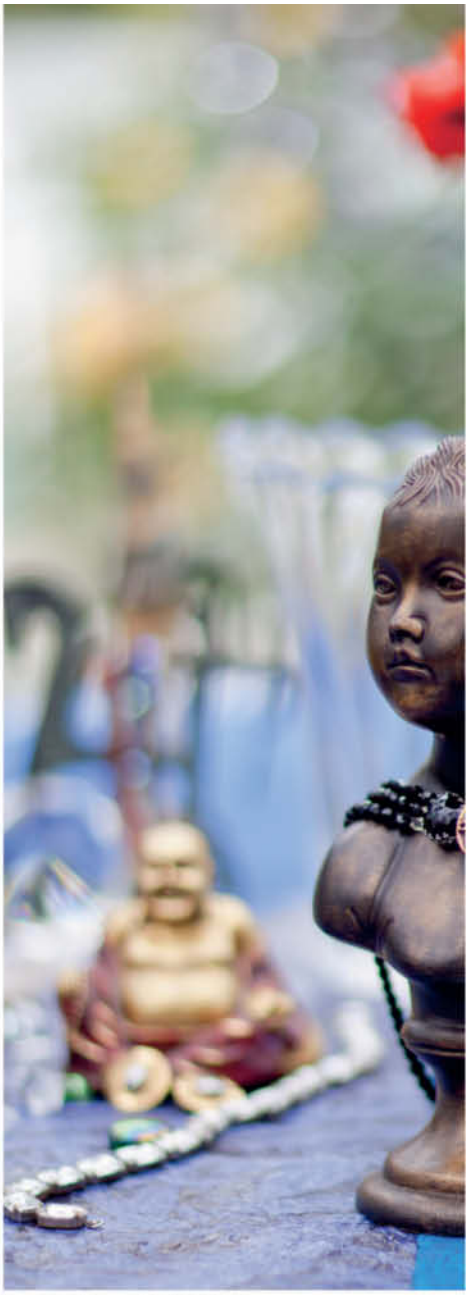
The following pages include test shots that allow you to compare the bokeh effects produced by various lenses. The lenses we tested have focal lengths ranging between 70 mm and 200 mm, and include fixed focal length and zoom models manufactured by Canon and Leica. They were the Canon EF 85mm f/1.2L II USM, EF 135mm f/2L USM and EF 70-200mm f/4L USM lenses, and the Leica Elmarit-R 90mm f/2.8, APO-Macro-Elmarit-R 100mm f/2.8, Vario-Elmar-R 80-200mm f/4.0 zoom and Vario-APO-Elmarit-R 70-180mm f/2.8 zoom models. This issue's free DVD includes all of the test shots shown here, plus others made using a Canon EF 35mm f/1.4L USM, a Leica Summicron-R 35mm f/2 and Leica Elmarit-R 35mm f/2.8 lenses.

The test shots all focused on the choker around the neck of the bust, and our test scene included various other objects as well. Note the circles of confusion produced by reflective objects and objects edges. The transition between focus and blur along the diagonally positioned necklace deserves particular attention.

The test shots were all taken in daylight, so we weren't able to completely eliminate fluctuations in the overall lighting conditions, but we nevertheless reached some clear-cut conclusions, namely: bright lenses are worth the extra bulk and expense. We also wanted to test the Sigma 28-200mm super-zoom, but found that its small (f5.6) maximum zoom aperture and low-contrast reproduction characteristics do not produce useful bokeh. The bokeh it does produce is plain and uninteresting. However, the brighter zooms we tested prove that zoom lenses can produce pleasing bokeh effects if they have appropriate geometry and aberration correction.

Generally speaking, fixed focal length lenses, with their larger maximum apertures, produce more obvious and more pleasing bokeh. Nevertheless, some of the zooms we tested produce great results, and we were particularly interested to see the results produced by the now legendary Leica70-200 f/2.8. The

Leica Elmarit-R 90mm f/2.8 is an interesting lens that is available quite cheaply on the used market. Well-cared-for examples of this particular model produce very pleasing results at moderate apertures (around f2.8) and produce extremely sharp, high-contrast images at smaller apertures. Versions with serial numbers in the 3xxxxxx range (and above) and the newer ROM versions have a particularly good reputation. Many photographers prefer the bokeh that the older 90mm Elmarit-R produces to that produced by the apochromatically-corrected (and much more expensive) APO-Summicron version of the lens. This is an excellent example of the discrepancies that exist between the demand for technical excellence and the aesthetic effects a lens produces.



Canon 85mm f/1.2 at f1.2

Canon 85mm f/1.2 at f2.8

Bokeh at f1.2

Bokeh at f2.8

Canon 85mm f/1.2 at f4

Canon 85mm f/1.2 at f8

Leica 80-200mm f/4.0: 80 mm at f4

Bokeh at f4

Bokeh at f8

Bokeh at f4

Bokeh at f8

We started with the 85mm f/1.2, which is, due to its extremely large maximum aperture, something of an exception. Due to space limitations, we have printed only one image detail and one enlarged detail for maximum and slightly stopped-down apertures for each lens. The entire high-resolution sequence for each lens is included on this issue's free DVD, so that you can decide for yourself which effects you prefer before you go out and buy a new lens.

Canon 85mm f/1.8 at f1.8

Leica 70-180mm f/2.8: 85 mm at f2.8

Canon 70-200mm f/4.0: 85 mm at f4

Bokeh at f1.8

Bokeh at f2.8

Bokeh at f4

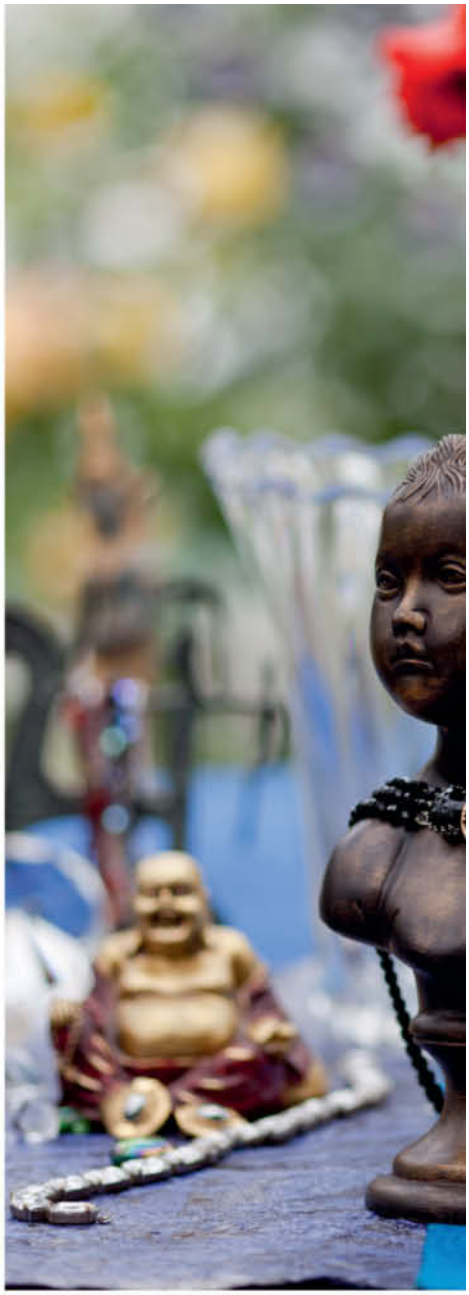
Bokeh at f4

Bokeh at f4

Bokeh at f8

Leica 90mm f/2.8 at f2.8

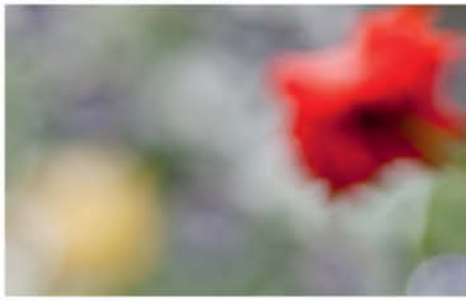
Leica 100mm f/2.8 at f2.8



Canon 135mm f/2.0 at f2

Bokeh at f2.8

Bokeh at f2.8



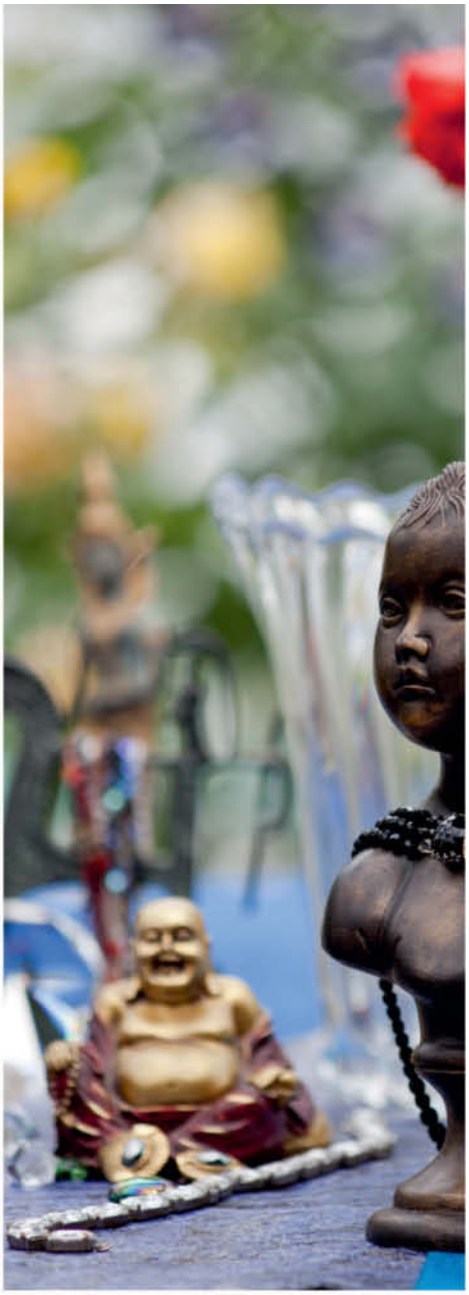
Bokeh at f2

Bokeh at f4

Bokeh at f4

Bokeh at f4

Canon 70-200mm f/4.0: 135 mm at f4



Leica 70-180mm f/2.8: 180 mm at f2.8

Leica 80-200mm f/4.0: 200 mm at f4

Bokeh at f4

Bokeh at f2.8

Bokeh at f4

Bokeh at f8

Bokeh at f4

Bokeh at f8

Martin Biebel

Shooting Video

with interchangeable-lens cameras

Introduced in 2008, the Nikon D90 was the world's first DSLR with built-in HD video functionality. This was an important milestone in the development of digital video as a medium and, for the first time, allowed hobby and professional film-makers to shoot video using interchangeable lenses. Today, many entry-level DSLRs and high-end mirrorless cameras can record high-quality video. This article provides an introduction to the subject and includes a detailed test of six video-capable cameras as well as a review of some useful video accessories.

Choosing the Right Camera

Moving pictures are great, but which camera is best for recording the films you want to make? Today's video-capable cameras range from mirrorless Micro Four Thirds compacts to top-of-the-range DSLRs with full-frame sensors. Here, we show you which system is best suited for use in various situations.

Film-makers have begun using digital stills cameras to shoot video for a number of different reasons. Professional camera operators use DSLRs to shoot films one scene at a time, while advanced amateurs are simply discovering the wonder of moving pictures as soon as they see the astonishing quality of the video clips that their cameras can produce. New technology has opened up a whole new field of creativity for photographers to experiment with. The documentary film-makers among you might want to film plays or birthdays or weddings, while YouTube bloggers upload videos to the Internet for fun or for professional reasons. People shoot video for very different reasons and require different types of equipment to get the job done.

Professional Film-makers

Camera operators often dream about the "good old" look of analog cinema film, and have begun to shoot footage with DSLRs because of the large image sensors and the wide range of available lenses that are said to produce "film-like" effects. This assumption is, however, only partially true.

One widespread half-truth is the idea that a larger image sensor produces better images. A slightly different (but just as misleading) idea is that the larger a sensor's surface, the larger – and therefore more light-sensitive – its individual photoelectric receptors (i.e., pixels) will be. This is only true if the number of pixels remains constant with increasing sensor size. For example, the Canon EOS D550 (or Rebel T2i, as it is known in some markets) has 18 megapixels packed onto a relatively small APS-C format sensor. However, a video-maker requires only two megapixels of resolution to record Blu-ray quality Full HD video at a quality level good enough for large-scale presentations. The deciding factor is, therefore, the number of pixels per unit of sensor surface area – a value that is also known as "pixel density".

The "large sensor = shallow depth of field = more film-like results" myth has already caused many film-makers to write off the Micro Four Thirds (MFT) format in favor of the APS-C sensors built into most of today's DSLRs. The MFT format's crop factor of 2 suggests that it will produce one-and-a-half times as much depth of field as a Canon/Sigma APS-C sensor with its crop factor of 1.6, or a Nikon APS-C sensor with a crop factor of 1.5.

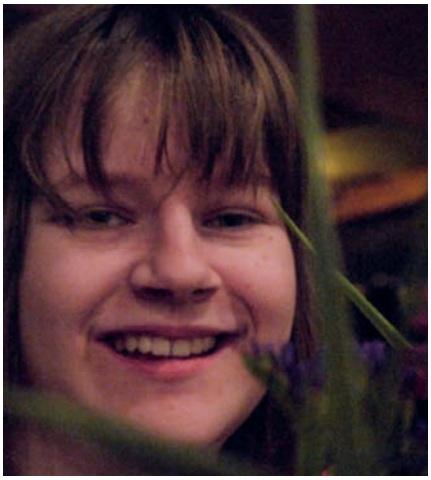
In fact, the only direct effect of crop factor is on focal length. The field of view covered by a 25mm MFT lens is the same as that covered by a 50mm lens mounted on a full-frame camera, such as the Canon EOS 5D.

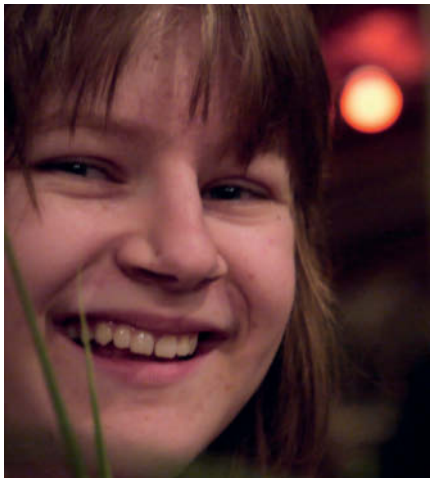
The critical factor governing depth of field is the working aperture. The smaller the aperture, the less peripheral light will enter the lens, so the depth of field is increased. For example: a 32mm lens used with an APS-C camera to photograph a subject located three meters away will produce a depth of focus of about 72 centimeters (28 inches). A lens with (adequate) focal length of 25 mm used with an MFT camera like the Panasonic GF1 in our test will produce about 87 centimeters (34 ¼ inches) of focus depth. If you open up the aperture in this lens to f1.4, the depth of focus will be reduced to about 62 centimeters (24 ½ inches) and the lens "wins" when pitted against the 32mm APS-C lens.

The same rules apply at f8. In this case, an APS-C lens produces 4.26 meters of focus. An MFT lens would produce an enormous focal depth of 6.1 meters at f8 and 2.9 meters at f5.6. So you see: if you want to experiment with shallow depth of field, you will need to use a lens with the widest possible maximum aperture. Video is often shot in daylight, requiring you to use an aperture of f8 or smaller and immediately negating any advantage your lens may have in terms of depth of field. This is why professional film-makers often use neutral density (gray) filters when shooting in daylight. A gray filter allows you to use a wider aperture than normal without changing the look of a scene.

Full-frame is not a Must-have

Full-frame sensors are often "too much of a good thing" when it comes to shooting video. The depth of field produced by the brightest lenses is so shallow that video shot with them and projected onto large-format screens (50 inches and more) often has an unnatural look – for example, the available





A comparison of image quality and depth of field characteristics. The image on the left was shot using the Panasonic GF1 with its standard zoom lens set to f5.6 and with ISO sensitivity set to 1600. The image on the right was shot at ISO 400 using a 45mm fixed focal length lens set to f2.8.

Bright lenses and selective focus: full-frame cameras like the Canon EOS 5D Mark II are capable of producing atmospheric video clips in low light

depth of field might not be sufficient to keep a person's eyes and ears within the field of focus. Which part of a face should the camera operator focus on, and how? A large monitor is essential if you want to catch this kind of focus discrepancy during a shoot. Even then, pulling focus quickly tests the practical limits of using tape measures and depth-of-field tables to keep your focus accurate.

This is one of the reasons why professional camera operators are starting to use APS-C cameras instead of full-frame models. Cameras like Canon's EOS 7D, or even the entry-level Rebel T2i, offer the same range of focal lengths that many people are familiar with from the 35mm world. An added "bonus" of using these cameras is that you can often use your old 35mm lenses with them too.

These shots underscore the differences in depth of field that can be produced using different cameras. These images were shot using (from left to right) a full-frame Canon EOS 5D, an APS-C camera and a professional video camera with a 2/3" sensor.

If you are prepared to void your camera's warranty, some specialist film companies – for example, FGV Schmidle (www.fgv-rental.de) – offer to swap out the standard lens mount in a Canon EOS 7D for a 16mm movie camera C-mount. Whichever sensor size you decide to use, the difference in depth of field between full-frame, APS-C and Mico Four Thirds cameras and mid-market video camcorders with 1/3" sensors is extremely obvious.

Twenty-five Frames per Second are Enough

Although most camcorders record at 50 frames per second (fps), the lower 25 fps frame rate that most video-capable DSLRs shoot at is usually sufficient for most professional film-makers, who only occasionally shoot handheld and don't usually make sudden camera movements. The slight judder that a 25 fps rate produces is barely noticeable when the camera is panned carefully. Professionals don't usually use automatic exposure systems either, making constantly changing white balance or exposure values less of a risk. Most professional film-makers are happy to shoot using any camera that can be manually controlled.

As our accessories feature on page!!! shows, many serious film-makers jump through all sorts of hoops to achieve their cherished movie-like look, including constantly monitoring the image being recorded, using exactly the right lens to shoot each individual scene and using an assistant to pull focus. And remember, changing lenses often means readjusting the entire camera setup. Some accessories, such as a radio-controlled follow focus, often cost much more than the camera itself. Most drama productions will only manage to complete one or two shots per day, and it is generally accepted that three minutes of finished material is a good day's work. It is exactly this complexity that motivates many students and film-makers and, now that film development itself is no longer a high art, shooting high-end video has become one of the last bastions of artistic image-making.

A camera set up to record a dawn scene using available light only. Cameras with tilt/swivel monitors have a camcorder-like feel.

Creative Film-makers

Which advanced photographer hasn't, at some time or other, felt the urge to make moving pictures? Many photographers don't necessarily want to tell stories or edit scenes together, but prefer to simply show their usual subjects and moments in time in the form of a bright, moving presentation on some kind of screen.

Nowadays, most creative photographers display their work using LCD monitors or projectors. These types of devices produce brilliant, high-contrast images – a resolution of 1920 × 1080 pixels is greater than that which can be perceived by the human eye if it is projected at a distance of double the screen's diagonal. You can also use the overall resolution of an image to zoom right into specific details. If you have ever viewed digital images saved on a memory card using a Sony PS3, you will know how fluid and video-like the experience of zooming in and out of your pictures can be.

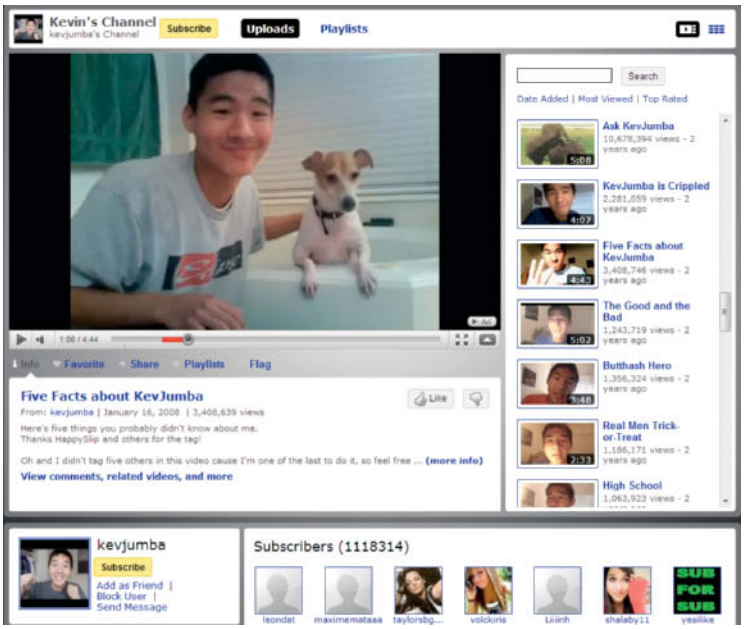
Most people who attach an Olympus or Panasonic camera to a television for the first time are equally amazed. The camera displays any photo and video material in the order it was saved on the camera's memory card to the accompaniment of soothing music produced by the camera's firmware. The colors and sharpness of both video and photos are astonishing. At the latest, this is the point at which the effectiveness of moving pictures becomes tangible. For example, shifting focus from a bee to the bloom it is feeding on and back again gives a scene an incomparably vivid look, while the sound of rain on a window pane emphasizes the atmosphere of a dreary November day. A creative user is sure to conjure countless miniature movies in her mind's eye when confronted with this kind of technology, although it has to be said, not many of the cameras currently available offer this degree of simplicity when it comes to displaying mixed photos and movies.

Many creative photographers and videographers are prepared to put up with a certain degree of complexity to get the results they want, but the simpler the solution, the more intensively it will be used. This is where the latest generation of compact EVIL (**E**lectronic **V**iewfinder **I**nterchangeable **L**ens) cameras comes into play. These cameras also have built-in microphones that are usually of adequate quality, even if they do pick up some unwanted noise whenever the camera's body is touched or nudged.

Depth-of-field effects are an integral part of the creative image-making process, so an image sensor can never really be big enough for creative use. If you prefer to shoot video handheld, your camera will need to have a built-in image stabilizing system that doesn't produce additional noise. One way to avoid recording unwanted camera noise and to ensure "clean", atmospheric soundtracks is to attach an external accessory microphone to the camera's microphone socket. Videographers will often look for a quiet place near the scene of a shoot where the true audio atmosphere can be recorded once the accompanying images are safely "in the can".

Video Bloggers

Huge numbers of people enjoy shooting low-quality video using cellphones or digital compacts and posting the results to the voracious giant known as *YouTube*. This mass of users includes a number of genuinely talented people who have learned to use the YouTube platform to develop their own particular brand of art. Spoof music clips of famous artists are a particularly popular type of video blog (or "vlog"), which work only if the cameras used to film them work quickly, automatically and without interference from the user. People who need to shoot photos as a log or as part of their business (architects or insurance adjusters, for example) often use video as a way of making more precise records with audio comments. Camcorders might produce better video, but a device that can shoot stills and video is even better for this type of application, or for participating in social networks like *Facebook*.



Video artists like *KevJumba*, with their own YouTube channels, show just how effective and popular short "trash" videos can be

Using Full-Frame DSLRs to Shoot Adverts

Kumaran Herold is a professional camera operator who uses Canon DSLRs to shoot advertizing clips. In this interview, conducted on set, Herold explains how he came to discover the new medium and tells us where it is irreplaceable and when he prefers to leave his DSLR at home.

c't Digital Photography: You are currently shooting an advertizing clip using a Canon DSLR. What's the clip about?

Kumaran Herold: The clip is an image film for a large dairy products company based in the Black Forest. The clip shows the happy cows in their idyllic environment and people enjoying the products and the surroundings. Apart from the cows, which never do exactly what a director wants, the most difficult shots are the ones of people drinking milk. In these "beauty shots", I have to get the main product (i.e., the milk) and the people looking as good as possible. I am shooting the high-end, outdoor footage in available light with a little help from some spotlights. The footage will be edited together with studio-based material during post-production.

Isn't a shoot like this a job for a 16mm or 35mm film camera?

I love to shoot on film. Film footage looks more three-dimensional than video, and the color depth and post-production color adjustment potential of film is fantastic. Nowadays, the shooting format we use is restricted by the client's budget, and we often have to make do with a smaller team and simpler equipment. I chose a Canon EOS 7D because of its large image sensor, which allows me to produce depth of field the way I am used to doing with film, while the camera itself costs a fraction of the price of an equivalent film camera.

I can also review the footage I have shot immediately on set, instead of having to wait for rushes to be developed and printed. Rushes can take as long as a whole day to produce, which can cause a sleepless night or two if I'm shooting particularly tricky scenes.

Why are you using your EOS 7D for this particular shoot?

Silke Gebauer (the director) and I had a long debate over whether to use the EOS 7D or the more sophisticated EOS 5D Mark II. The 5D has a larger sensor and produces even shallower depth of field, making precise focus pulling more difficult. The field of focus is only a few centimeters deep at full aperture, so it's impossible to keep both of the performer's eyes in focus at once. That can be quite irritating for viewers. We also only have access to small monitors on some of the sets, which makes it difficult to precisely monitor the sharpness of the shots. Under these circumstances, the 7D's smaller sensor gives us an extra margin of focusing safety.

The clincher for the 7D is its 50 fps shooting capability in 720p mode, which allows me to shoot in slow motion. Fifty frames can easily be resampled to create two 25-frame, slowed-down seconds of footage. This is great for producing atmospheric shots of slow-flowing water or wind effects. Take a closer look at advertizing clips in future and note how many scenes have been shot in slow motion.

Can you achieve satisfactory results using a 7D with standard photographic accessories, or do you need to use film accessories like matte boxes or a rig?

A DSLR is not a custom-designed film camera and is therefore not always practical for shooting video. My assistant was actually quite unhappy during the first few test shots because the various buttons and levers aren't where he expected them to be. There is no adjustable viewfinder, so it is difficult to shoot from above or below without performing gymnastics. The 7D's monitor isn't tiltable, so I definitely need to use a rig to keep the camera position and the use of accessories flexible. A flexible external monitor is indispensable for shooting from unusual perspectives. Blonde hair is usually backlit in beauty shots and often produces stray light in the camera's light path, so we have to use a compendium or barn doors as well. The compendium we are using here doubles as a filter holder. Video cameras usually have built-in gray filters for reducing the working aperture in brightly lit situations.

I often need to use additional ND filters with the EOS 7D if I'm shooting outdoors in direct sunlight. There are also countless other color and effect filters that I like to use to produce particular moods and looks.

Can any photographer now become a filmmaker at the push of a button?

Shooting photos and video are closely related skills, but are nevertheless like two dissimilar siblings. The light, the viewpoint and

The white ring around the focus knob makes it easier for the focus puller to mark the start and end positions for each shot.

The Cameraman

Kumaran Herold was born in Sri Lanka in 1973 and grew up there and in Germany. He trained as a camera operator at the Baden-Württemberg Film Academy. He worked on various industrial and image film productions before graduating in 2004, and has since been a freelance camera operator, mainly for advertizing and documentary films (www.thanikai.de).

the mood of the moment are the most important factors in a photo, whereas a film always tells a story over time using a sequence of shots and technical devices such as camera pans or the movements of the actors and actresses. The spoken word, ambient sound and music are also important factors in the overall effect produced by a film. The individual shots in a film also have to be edited to make dramatic sense. A film camera operator is always part photographer, but a photographer has a lot more to learn to become a filmmaker.

What are the practical shortcomings of DSLRs compared with traditional film cameras?

Most standard DSLR lenses have built-in autofocus functionality, which is of no use whatsoever in a film context. Moving pictures depend on focus being accurately adjusted to follow elements within the frame that are relevant to the story being told. The focusing scales of most DSLR lenses are very short compared to those found in 35mm film camera lenses. It is much easier to shift focus accurately from 1.8 meters to 1.9 meters to follow a person's movement using a film camera lens.

Compression codecs are another drawback. The high compression rates they use make it very difficult to adjust colors or image brightness during editing without producing excessive image noise, so it is essential to get the lighting exactly right at the shooting stage. Once the director and I have agreed how a clip should look, I can use the EOS 7D to immediately reproduce that look in the camera. If the director wants to leave some room for adjusting color or contrast during post-production, I would suggest that we use a different camera.

How would you classify DSLRs within the range of traditional video cameras? Are they a real alternative to shoulder-mounted video cameras with 1/2" or 1/3" sensors?

These types of video cameras are typical documentary cameras with individually adjustable external microphone sockets. One of the EOS 7D's biggest weaknesses is its sound level, which is very difficult to adjust manually. I found it difficult to go back to 1/2" and 1/3" video cameras once I had tried shooting with a DSLR, even though you need to use shoulder mounts and a certain degree of improvisation to get good handheld shots.

What are some of the most common mistakes people make when shooting video using a DSLR?

It is tempting to simply increase the ISO value when shooting in low-light situations. The 7D has an ISO scale that goes all the way up to 6400, which makes it easier to shoot in low light but produces footage with very obvious noise artifacts. At ISO values above 400, the 7D produces images with unacceptable noise. You can produce a pleasing "movie-like" look using fixed focal length lenses and wide apertures of around f1.4 or f2. Zoom lenses are usually too dark to produce acceptable footage.

What shouldn't we expect from a DLSR?

The EOS 7D is small and light, which makes people think that using it to shoot video should be quick and easy. In fact, the opposite is true: you need just as much time as you do for a 35mm shoot, especially for focus, which has to measured and set very precisely. I try to maximize the camera's strengths – for example, its small size makes it ideal for shooting inside cars or in other cramped situations. (pen) c't

The close-ups for this clip were shot using a rig and a precisely lit studio background, and edited into the location footage later. The bolt-on 7-inch HD monitor is clearly visible in the foreground.

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Martin Biebel

HD Video Camera Test

Three DSLRs and three Mirrorless Cameras

Many newer digital cameras have a built-in video mode, and the opportunity to use interchangeable lenses to shoot movies opens up a whole range of new possibilities for moving picture enthusiasts everywhere. We took a look beyond the HD hype and tested three video-capable DSLRs and three of their mirrorless cousins in depth. This report tells you what these cameras are really capable of, and where they are still not quite as good as we'd like.

A quality HD camcorder costs about US$1,000 and forces its owner to use a single built-in lens. The only way to enhance the capabilities of this type of lens is to mount a wide-angle adapter. Most camcorders are highly automated and use tiny image sensors combined with small monitors or low-resolution displays. DSLRs, on the other hand, have large image sensors that offer high sensitivity and movie-like depth of field. Interchangeable-lens cameras allow the user to adjust the configuration of the camera itself, as well as adjusting focus and exposure manually. Does this make camcorders a thing of the past?

In order to answer this question, we tested three DSLRs and three EVIL (**E**lectronic **V**iewfinder **I**nterchangeable **L**ens) cameras with HD video functionality. The DSLRs include Canon's EOS 5D Mark II, which was largely responsible for starting the HD video DSLR ball rolling and is still one of the favorites among DSLR video enthusiasts all over the world.

The 5D's smaller, cheaper brother, the Rebel T2i (also known as the EOS 550D in some markets) is the latest addition to the Canon range and is being marketed specifically with video in the foreground of its many capabilities. The Nikon D90 actually introduced DSLR video functionality before the Canon 5D, and the new Nikon D5000's video functionality offers stiff competition to the Rebel.

Today, video DLSRs are under increasing fire from the mirrorless, EVIL competition. These cameras are extremely compact and often have no viewfinder at all, relying on high-resolution three-inch displays for composition and image viewing.

The Panasonic Lumix DMC-GF1 represents the Micro Four Thirds camp, named after the unusual sensor format these cameras use. Sony has managed to squeeze the APS-C format sensor from its A550 DSLR into the tiny NEX-5 model. The Samsung NX10 also uses an APS-C sensor and is the only mirrorless camera in our test with a built-in, electronic viewfinder.

Lenses and Resolution

The relationship between sensor format and depth of field (see also the A Question of Sensor Formats section overleaf) means that if Panasonic wants its Micro Four Thirds camera to produce images that are just as pleasing as

Test Methods and Results

We used all the cameras in our test to shoot standardized zooms, pans and dolly shots, made in daylight (1000 lux), artificial light (150 lux) and low light (30 lux). We analyzed the test sequences using a direct HDMI link to a 40-inch Sony Bravia monitor.

We have included some of the test sequences on this issue's free DVD. These include a pan sequence that was designed to test definition, color and low light noise characteristics, and a second sequence that demonstrates the capabilities of the cameras' automatic and semi-automatic focusing systems. The Nikon D5000 wasn't capable of focusing automatically in low light, so we have included a second clip that demonstrates the image quality the camera produces when focused manually. The noise produced by the focus and image stabilizer motors built into all of our test cameras is clearly audible in these clips.

The second part of the test deals with exposure metering. We filmed test charts under laboratory conditions and analyzed the results. We used standardized color patches to analyze color intensity, color accuracy and noise characteristics, and line charts to check resolution.

We compared the results with those produced by camcorders, deliberately ignoring any stills functionality for the purposes of this test. As far as handling is concerned, we concentrated on functionality, with ergonomics playing only a secondary role.

those produced by an APS-C camera, it has to manufacture reasonably-priced, wide-aperture lenses to match the camera body. This should be relatively simple, as lenses for smaller sensor formats are smaller and lighter, and therefore cheaper to produce than equivalent lenses for use with larger sensors.

Panasonic cooperates closely with Leica for its lenses, but hasn't yet managed to produce any recognizable advantages over the APS-C competition. The kit lenses sold with all three mirrorless test cameras are equally unspectacular: they all only cover moderate ranges of focal length (from medium wide to short telephoto) and have variable maximum apertures ranging from f3.5 to f5.6.

This is why we used brighter "pancake" lenses to test the EVIL cameras. These have much larger maximum apertures than their zoom counterparts and are small enough to make the cameras handle like compacts. The Samsung NX10's performance benefits greatly from the 30mm f/2.0 lens. The low light test was specifically designed to allow the EVIL cameras to show their mettle compared with their DSLR cousins – one additional f-stop is, after all, equivalent to doubling the amount of light that reaches the sensor. This makes maximum aperture at least as important as focal length when it comes to choosing a camera for use in low light situations.

The Sony only uses the central nine megapixels of its sensor to capture video, giving it an additional 1.8x crop factor and an effective sensor size that is directly equivalent to the Micro Four Thirds format. Using full-frame lenses with APS-C cameras magnifies the subject. For more information on lenses, see the Accessories review on page 50.

Compression Codecs and Real Resolution

Shooting digital video means capturing 25 two-megapixel frames per second as well as to sound. To make it possible for cameras to handle such large amounts of data, manufacturers use various compression algorithms to remove redundant elements from the stream of digital information produced by the image sensor. If a compression algorithm removes too much information, artifacts appear in the captured footage in the form of jerky movement or poor image definition.

Canon uses its own MPEG-4 video codec, which is largely lossless but produces 40 MBit/s data streams that require a lot of processing power.

The three DSLRs in our test:

The full-frame Canon EOS 5D Mark II, pictured with the Canon Rebel T2i and Nikon D5000 APS-C models

A Question of Sensor Formats

It is not the absolute number of pixels, but rather the physical size of the image sensor that is the crucial factor driving the integration of video functionality in digital stills cameras. The camcorder industry has recently realized that the 100-year-old 35mm movie format, adapted for use in stills cameras by Leica, is still a state-of-the-art shooting format.

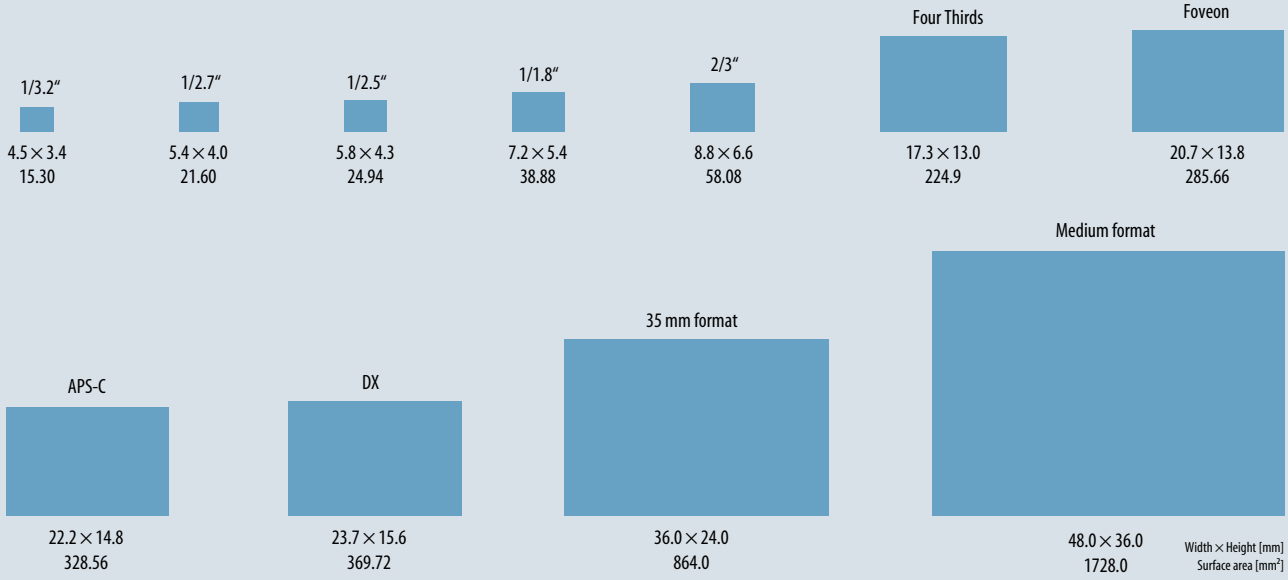
Today's digital technology has helped the 35mm format to return to its moving picture roots. Since the first 35mm movies were made using hand-cranked cameras, generations of moviegoers have got used to a look that portrays their favorite film stars in front of more or less blurred scenery. Every analog SLR photographer knows that a portrait looks best if the subject is framed against an out-of-focus background. These effects are the result of the ability to manipulate depth of field in a shot.

Modern video-makers, with their small, high-resolution camcorders, cannot use depth of field as a creative tool. Tiny image sensors that are often just three or four millimeters wide have been used to reduce the overall dimensions of video cameras to the minimum. The smaller an image sensor, the shorter the focal length lens you need to capture a subject but, unfortunately, decreasing focal length by half also quadruples depth of field. This phenomenon is counteracted somewhat by the reduced size of the individual pixels and the way the camera is constructed, but the effects it produces are still difficult to ignore. Having every last detail portrayed in sharp focus used to be seen as a boon but nowadays, it seems that many film-makers no longer find the "video look" acceptable or desirable.

The video world found its way back to normality through the introduction of the APS-C format image sensors found in cameras like the Canon Rebel T2i, the Nikon D5000 and the Samsung NX10 tested here, which give the footage they capture a movie-like look.. The exact sensor size varies slightly from camera to camera. The Canon's sensor measures 22.3 mm × 14.9 mm, giving it a 2:3 format, and it is no coincidence that the APS-C format was developed as an analog stills equivalent to Academy format movie stock. The original "35mm" film size refers to the entire width of a movie film strip, while still images shot on 35mm film are oriented sideways between the perforations, resulting in a much larger 24 x 36 mm frame size. This is the same "full-frame" format that is used in the Canon EOS 5D's sensor.

In 2003, Olympus and Kodak, the pioneers of digital sensor technology, began using a brand new, 4:3 photo sensor format measuring 17.3 × 13 mm. A little smaller than APS-C, this format was intended for video use and was designed for projection on 4:3 television screens. This was a fine idea, but fell foul of public taste, which dictated that the 16:9 widescreen cinema format is better for watching television.

Today's Micro Four Thirds format cameras use the same size of sensor. This format's extremely shallow 21mm lens flange makes it possible to construct ultra-compact APS-C format camera bodies that can nevertheless be used with bright, wide-aperture lenses. The Micro Four Thirds specification also includes two sensor pins intended exclusively for video use. The Panasonic GF1 is the most compact camera available in this class.



The difference in size between full-frame and APS-C sensors is obvious, and the camcorder sensors illustrated to the left of the top row seem tiny in comparison. Even smaller 1/4" and 1/6" video sensors are still common in smartphones and some consumer camcorders.

Sony also records using MPEG-4, but compresses it to the AVCHD standard, producing 17 MBit/s data streams. Panasonic's AVCHD Lite recording format also works at 17 MBit/s, but produces smaller, less compressed 720p HD images that capture less detail. The Samsung compresses its MPEG-4 video data strongly to 9 MBit/s, a rate that is bound to compromise image quality.

Nikon uses the clunkier Motion JPEG (or M-JPEG) recording standard and compresses its data streams to 12 MBit/s, a rate which also risks loss of image quality.

The length of a clip a camcorder can capture is limited only by memory capacity, whereas stills-based cameras can usually only record up to 30 minutes of video at a time. This is due to customs stipulations in some countries, where cameras that can record for longer are defined as video cameras and are placed in a higher tariff band. Some DSLRS also have problems with sensor overheating if they are used for too long without a break. The Nikon D5000 can only shoot for five minutes at a time, while the Canon cameras have a limit of 12 minutes.

Viewfinders and Monitors

When you are shooting in Live View mode, a DSLR's mirror is raised, making it impossible to use the optical viewfinder to check focus. The Panasonic and Sony cameras in our test have no viewfinder at all, while the Samsung has a built-in high-resolution mini-monitor for eye-level use. We found this electronic viewfinder no better than the camera's traditional three-inch monitor for checking detail sharpness, although it does help to counteract the effects of distracting stray light in brightly lit situations.

The displays built into the EVIL cameras in our test are some of the best on today's market, and all have around 300,000 RGB dots. The Panasonic has a power saving OLED with a large viewing angle that sets it apart from the others and allows it to shoot for two hours in video mode on one battery charge. This is longer than all the other cameras in our test (see also the table on page 49). The Nikon's monitor is smaller than the others, with just 74,000 dots, and often displays misleading color casts.

None of the monitors in our test have resolution that is high enough to satisfactorily check focus for the entire frame, so they all have a built-in magnifier function that you can activate in manual focusing mode before you start to shoot. None of the test cameras allow you to zoom the monitor image during shooting.

The EVIL cameras in our test:

The Panasonic Micro-Four-Thirds-based Lumix GF1 shown with the Samsung NX10 and Sony NEX-5 APS-C models

Vari-angle monitors like the ones used by Sony and Nikon (shown here), which can be rotated to prevent unwanted reflections, are perfect for shooting video footage

Handling

Camcorders are usually equipped with functional autofocus systems, although manual focus has been high on many camcorder users' wish lists for quite a while. Video DSLR users have the opposite problem, and often find themselves wishing their cameras had quick, reliable autofocus. Unfortunately, such systems do not yet exist.

The contrast-based autofocus systems built into most digital stills cameras are too slow and are not capable of seamless object tracking. Only the GF1 and the NEX-5 are capable of smooth focus tracking during video shoots, albeit with some focus delay.

None of the cameras in our test managed to focus accurately in low light situations, and the Nikon D5000 was especially susceptible to focusing problems. Check out the sample videos on this issue's free DVD for examples of each camera's performance. All the cameras we tested refocus if you press the shutter button halfway while you are shooting. This is completely impractical, and produces loud motor noises while the lens adjusts itself through its entire focus range on the lookout for high-contrast objects or the perfect focal point. This can take seconds, and is guaranteed to spoil any video shot.

You can set your aperture manually if the lens you are using has a separate aperture ring – otherwise, you can only select apertures electronically using one of the camera's dials. The Sony NEX-5 doesn't even offer this option in video mode. All the other test models allow you at least to select an aperture before you start shooting, while the two Canons and the Samsung also allow aperture adjustment during a shot.

The NX10 has stepped aperture settings, while the Panasonic allows you to preview the depth of field your chosen aperture setting will produce. This is not to be confused with AE Shift functionality, which simply shifts the effective aperture value to gain a little image brightness at the cost of increased noise. This type of functionality has nothing to do with true exposure compensation or adjustment.

It is therefore more practical to use AE Lock to lock exposure before you start to shoot. Usefully, both Canon cameras allow you to unlock and reset a locked exposure value while you are shooting.

No Motorized Zoom

Video DSLRs don't have the zoom rocker switch that allows camcorder users to perform smooth zooms. Creative film-makers often prefer to zoom manually anyway, but documentary film-makers often have to react to fast-changing scenes, making a power-assisted zoom a real advantage.

If you adjust the zoom ring on your lens manually while shooting video, you will be amazed how jumpy the movement looks in the finished shot. Sony's NEX lenses are easier to zoom smoothly than those manufactured by Samsung or Panasonic. Canon and Nikon offer a larger range of lenses, but you will have to choose carefully to find the ones that are best suited to video use.

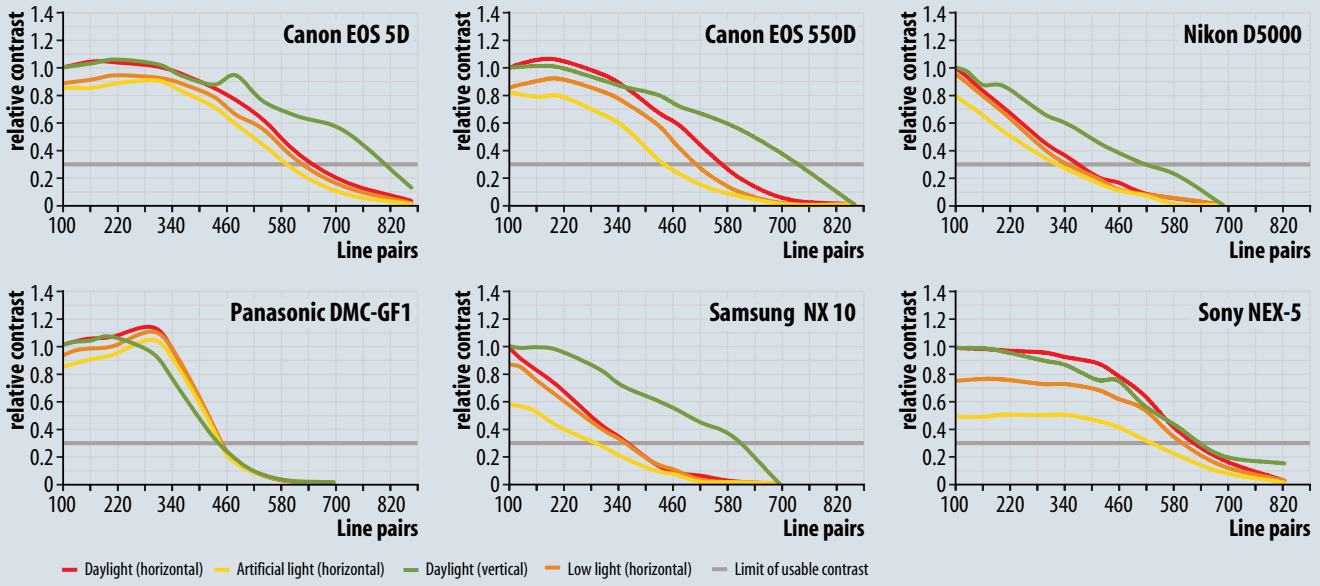
To summarize: stills cameras have a long way to go to catch up with the ease of handling offered by purpose-built camcorders. Photo cameras are also not designed for prolonged use at eye level and can only produce smooth, shake-free footage using longer lenses if you use image stabilization to keep your shot steady. The problem with image stabilizers is that, if they are set to continuous mode, they produce constant motor noise that gets picked up by the camera's microphone. The problem was more obvious in our Nikon, Samsung and Canon test cameras, and less significant in the Sony and

Test Results

	Color variance [D] (ΔE) lower is better	**Color variance [A]** (ΔE) lower is better	**Color variance [L]** (ΔE) lower is better	**Noise [D]** (%) lower is better	**Noise [A]** (%) lower is better	**Noise [L]** (%) lower is better	**Relative contrast D/A** (%) higher is better
Canon EOS 5D	7.11	13.43	11.50	6.50	6.72	4.19	86.00
Canon EOS 550D	8.93	16.60	23.09	5.43	6.15	5.46	75.00
Nikon D5000	8.00	18.04	10.54	7.02	8.47	9.36	60.00
Panasonic DMC-GF 1	11.34	17.10	17.45	5.53	4.55	7.23	91.00
Samsung NX 10	9.82	16.46	16.67	14.22	15.31	18.00	57.00
Sony NEX-5	9.15	9.04	16.26	9.65	8.86	6.43	73.00

Key: D = Daylight A = Artificial light L = Low light

Resolution



We measured the real, usable resolution (i.e., detail resolution) of each camera by analyzing their ability to reproduce fine textures. The graphs show how many pairs of vertical line pairs per frame width each camera can reproduce when used to film black and white test bars.

Full HD camcorders shooting at 1920p horizontal resolution encounter a limit of 960 line pairs due to the effects of the Nyquist frequency. The red curves show the horizontal resolution in daylight (1000 lux), while the yellow curves show horizontal resolution in low light (30 lux). The green curves show vertical resolution, which we have also listed in units of line pairs per frame height to make it easier to compare the vertical and horizontal values.

The Nikon D5000 has a short but linear spectrum, which shows that the signal is not artificially enhanced by the camera, but doesn't provide particularly good resolution. Increasing image sharpness could help to improve things. The Samsung NX10 has similar characteristics with weak contrast in low light, but with HD-grade vertical resolution. The Panasonic GF1's 720p signal drops off dramatically after an overly high contrast peak at 300 LP/frame width, but still produces almost HD-quality footage.

The Sony NEX-5 produces convincing resolution, with good contrast that drops off gently above 400 line pairs. Low light resolution is also more than acceptable in comparison with camcorder performance. The Canon Rebel T2i's horizontal performance is not as good as the Sony's, but compensates to a degree with higher vertical resolution. The EOS 5D Mark II performs much better overall, with only one small kink in the vertical resolution curve. The 5D's low light curve is easily the best we tested.

Panasonic models, probably due to these manufacturers' experience in building camcorders.

The menu systems are of secondary importance compared to the basic handling weaknesses of the test cameras. The Sony menu system is the most sophisticated, while the Samsung system is clearest, and includes a precise percentage value to indicate remaining battery power.

Unlike most camcorders, none of our test cameras allow you to change the battery without first removing the camera from the tripod. The DSLR models have memory card slots on the side of the camera body that can be accessed without difficulty. Our handling test results are based more on whether the camera settings can be adjusted at all during

Relative contrast D/L (%) higher is better	**Horizontal resolution (absolute)** higher is better	**Vertical resolution (absolute)** higher is better	**Horizontal resolution (relative, in %)** higher is better	**Vertical resolution (relative, in %)** higher is better	**Color resolution (absolute)** higher is better	**Color resolution (relative, in %)** higher is better
80.00	632.95	791.68	68.50	79.40	177.52	43.80
60.00	554.88	714.66	57.80	68.20	164.33	41.30
49.00	345.48	479.85	37.50	52.80	148.71	48.80
85.00	444.48	430.67	58.80	0.55	117.46	34.40
38.00	339.77	588.15	35.10	64.20	161.14	53.80
48.00	610.41	623.72	67.90	66.20	163.00	43.80

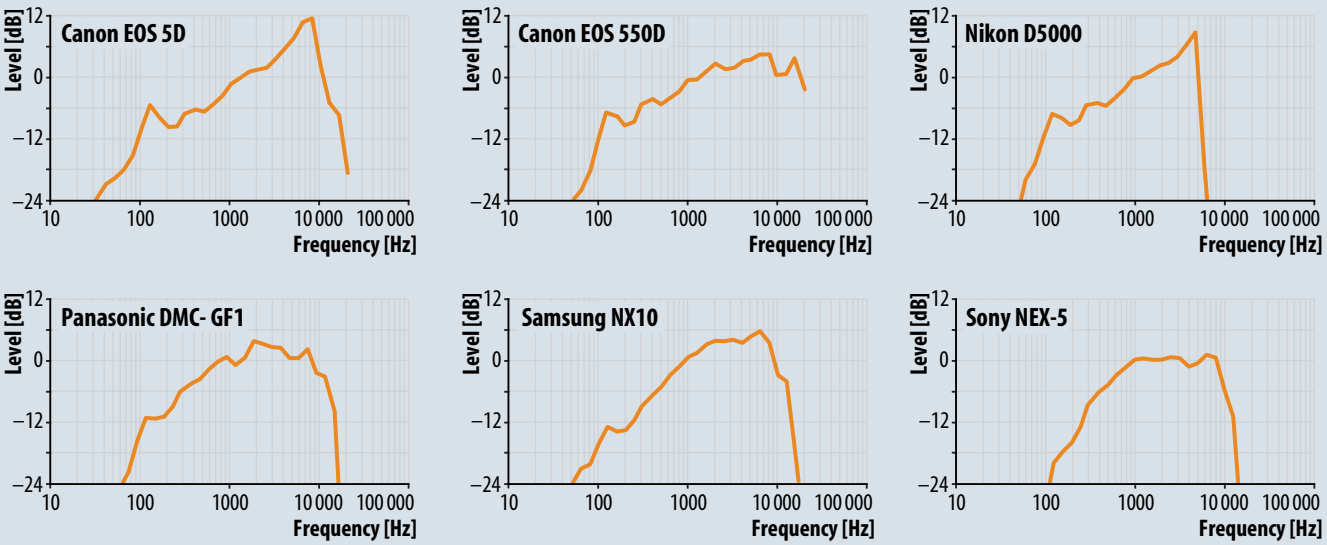
Built-in Microphone Sound Quality

We used a 31-tone signal made up of harmonic thirds to test the sound quality of the cameras' built-in microphones. Our test signal covered the entire spectrum of frequencies between 20 Hz (deep bass tones) and 20 kHz (the highest frequencies audible to humans). Our 0 dB reference tone had a frequency of 1000 Hz. Ideally, camcorders will not record any tones above the 0 dB level. Camera microphones don't need to be particularly sensitive in the bass range, as this only emphasizes distracting background noise produced by wind and other incidental sounds.

The Nikon's sensitivity range is similar to that of a telephone line, and the curve drops off at relatively low frequencies. The Samsungs NX10 shows weakness in the bass range due to excess filtering – low frequencies are only recorded satisfactorily above 500 Hz.

The Panasonic GF1 also dampens bass tones too much in an attempt to reduce camera noise, but performs well in the middle range. The EOS 5D Mark II's curve is steep, indicating a strong, but not necessarily natural, sound.

The Sony NEX-5 records bass only hesitantly, like the Samsung, and the curve drops off relatively early at around 10 kHz. The Canon Rebel T2i recorded the best sound in our test, and also managed to produce satisfactory high frequencies.



filming, rather than on any basic ergonomic considerations. Canon handling is the best of the bunch, followed closely by Samsung. The Sony and the Panasonic both have many useful automatic features, while the Nikon is the most difficult to use.

Sound Quality

None of our test cameras produced satisfactory sound, and they all picked up unwanted motor noise from the camera's autofocus and image stabilizing systems, as well as during zooms. These types of sounds are all transmitted and amplified by the camera body. The Panasonic dealt with unwanted noise better than the others. The Sony has a built-in stereo microphone that produces genuine three-dimensional sound, but also picks up too much camera noise in the process.

Most of our test candidates produced background noise and significant fluctuations in sound levels due to their automatic level control systems. The only exception is the Canon EOS 5DD, which has been given usable manual sound level adjustment in the course of a recent firmware update. All of the test models have stereo microphone jacks, allowing you to use accessory microphones to produce better sound. You can also use separate sound recorders (see the Accessories section on page 50). The Panasonic and the Samsung both have a built-in wind reduction filter that helps to improve the quality of outdoor sound.

Other Connectors

All of our test cameras have an HDMI socket for HD video playback and an AV OUT socket for connection to a conventional television. You can also use the AV socket to record analog sound or connect headphones using an adapter.

Only the Canon cameras offer Live View for monitoring during shooting, although the 5D's reduced-quality output makes judging image quality slightly difficult.

The proprietary multi-function sockets located behind the Sony and Panasonic hot shoes are an annoyance and can only be used with the manufacturers' own accessories. We would prefer to see standardized stereo microphone sockets that allow users to choose which accessory to use.

Playback and Editing

Video signals can be transmitted to a monitor for editing or presentation via an HDMI cable. The introductory section on page 32 describes various types of video or combined video/stills output.

Viewing direct output from the Nikon D5000 and the Samsung NX10 is a real pain: the clips appear with significant time delay and often in the wrong format. Fast forward and rewind are difficult to operate and playback stops automatically after every clip.

The Sony allows you to view multiple clips in sequence (albeit with a slight delay between shots) and has a usable slide show feature. The Panasonic firmware includes prerecorded sound effects that can be included as a soundtrack with your video output. Both Canon models offer relatively simple, comprehensive navigation between clips.

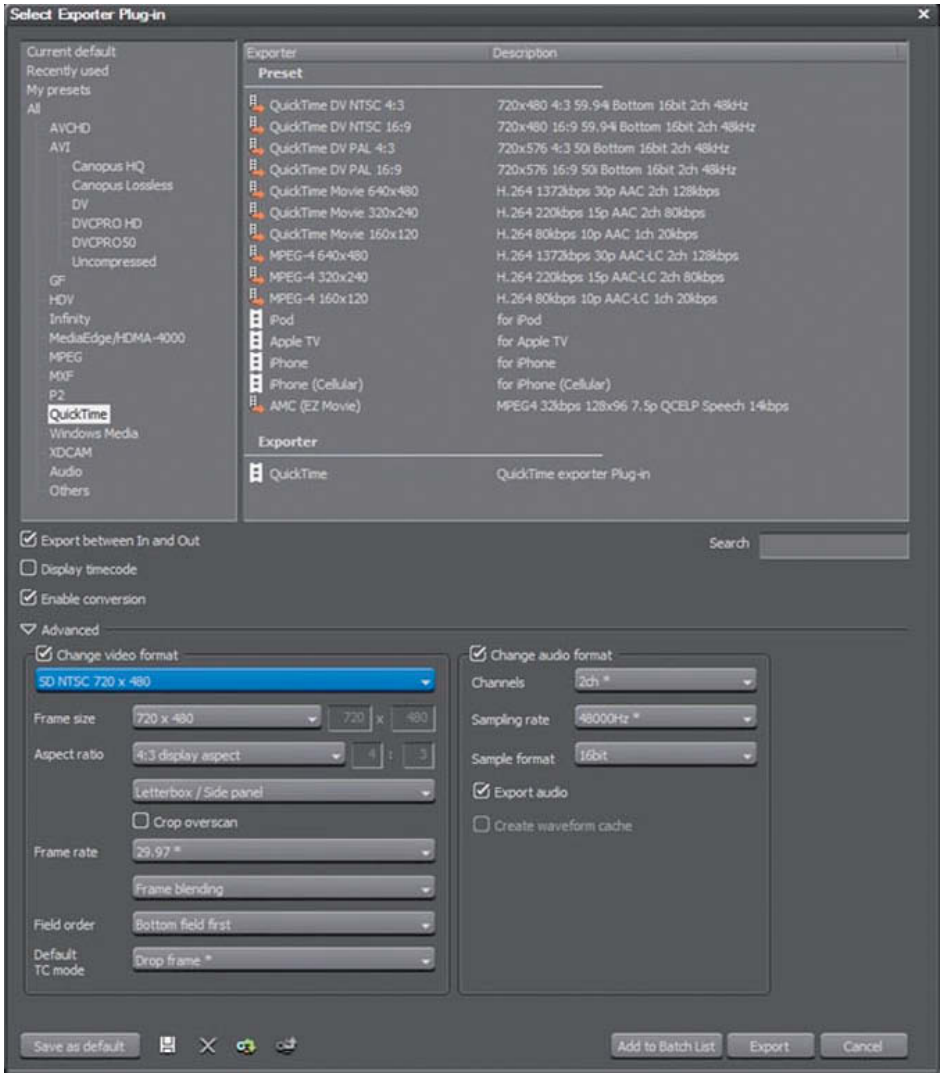
Both Canon cameras are designed with subsequent editing in mind, and the Rebel – like the Panasonic – even has some rudimentary built-in editing functions. *Apple Final Cut Pro* opens and processes Canon MOV files without any glitches, and the consumer-level *iMovie* program included with most Mac computers also handles Canon video files without any problems. *Adobe Premiere CS4/CS5* and *Photoshop Elements 8* can also handle Canon video natively. Other software manufacturers are working on Canon support.

QuickTime 7 (and higher) is a useful standard video player. All camera manufacturers include their own players on their software CDs, although these rarely include any really useful editing functionality. The Panasonic *PHOTOfunSTUDIO* package is better than the proprietary software included with the other test cameras.

All programs that support AVCHD can load and process Panasonic and Sony files. AVCHD playback can be jerky if you are using an older computer, and editing is virtually impossible on notebook computers or desktops with less than four processor cores.

Samsung's 720p, 30fps MPEG-4 files are easy to edit using *Adobe Premiere CS4, Sony Vegas 9.0* or *Final Cut Pro*. These clips were also easy to load and view in the widely-used, freeware *VLC Media Player* and Microsoft's *Windows Media Player 11*.

The Motion JPEG files produced by the Nikon are supported by most media software, including older programs.



If you use an older editing program or if your current program has compatibility problems, you will have to convert your files to a different format. This screenshot shows the Green Valley EDIUS export interface with its choice of export codecs. Conversion can take time, but allows you to edit smoothly once it is done.

Image Quality

Our analysis of the image quality produced by our test cameras yielded mixed results, with only the two Canons and the Sony recording true HD quality. The Panasonic, Samsung and Nikon cameras only managed to produce standard horizontal resolution. The Samsung NX10 produced the most noise, whether shooting indoors or outdoors in bright sunlight.

The Panasonic and the Nikon both left a lot to be desired in low light situations and aren't much better than purpose-built camcorders, in spite of their much larger sensors, although the Panasonic Program Shift feature does allow you to artificially brighten your image a little. Both Canons and the Sony are capable of shooting good low light footage although, it has to be said, the EOS 5D really is in a class of its own – it produces brighter, less noisy footage than any camcorder we have used.

The quality of the available lenses plays a significant role in the overall image quality, as demonstrated by the images in the introductory section on page 32. The depth of field available to the Panasonic and Sony cameras is very similar, but Samsung and Nikon both have more to offer in this respect. Compression artifacts left some darker parts of the Panasonic's images looking rather soft, although this is not a significant drawback if you are working with out-of-focus backgrounds anyway.

Panasonic and Samsung showed erratic white balance behavior and even produced some distinctly magenta colored faces. All of our test cameras produced good overall color balance in bright daylight and indoors. Only the Canon Rebel suffered from some limitations when recording red tones in indoor situations.

The Canon Rebel T2i is the only test model with a true 50fps shooting mode. All the others displayed jerky progressive scan performance during pans, although the slower shutter speed used by the Sony, the Panasonic and the EOS 5D counteracted this effect to a certain degree, especially in less brightly lit situations. The sharpness of the Rebel T2i's images also diminishes in

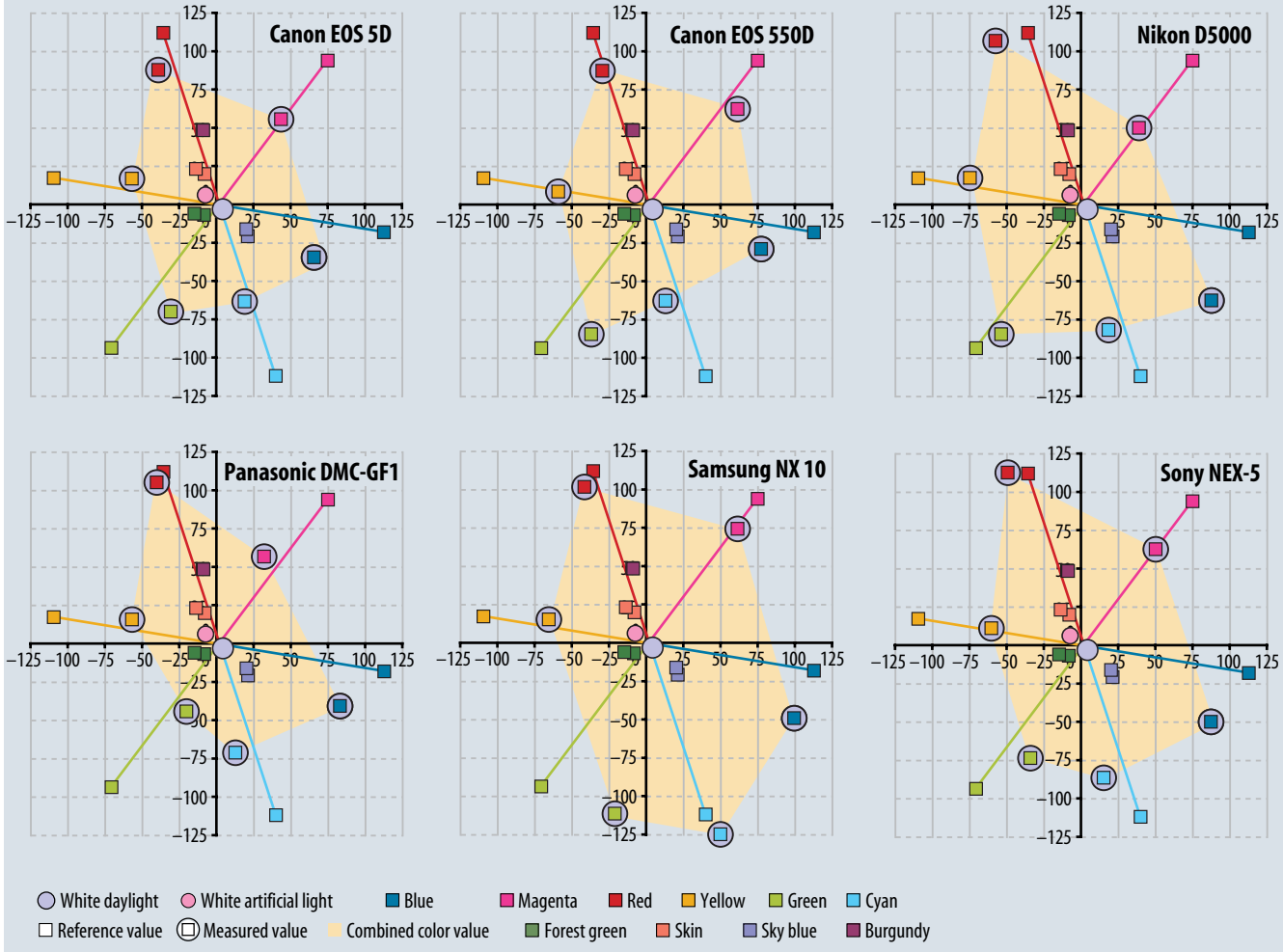
Color Accuracy

These graphs show how accurately the test cameras reproduced six primary colors and a range of natural colors. The closer the points are to their corresponding lines, the more accurate the test colors were.

The Panasonic GF1 has perfect white balance in daylight, but tends to accentuate reds in artificial light. The condensed look of the entire left-hand side of the Panasonic's graph indicates too little color saturation.

The Sony NEX-5 produced the strongest colors and the most precise white balance in our test, both outdoors and in artificial light. On the other hand, the Sony's discrepancies for blue and sky blue were among the largest we tested. The Samsung produces extremely bright colors that look good on television screens, and the saturated colors (especially cyan) are very accurate. Its bright colors can, however, cause highlight blooming when viewed on a television screen.

The Nikon produced unremarkable results with some slightly shaky red tones. The Rebel T2i uses a color space that is optimized for video use, resulting in accurate blue and green tones. The EOS 5D produces similar results to the Rebel, but with less overall saturation.



720p/50fps mode due to the progressive scan technique it uses.

The Samsung and the Panasonic both display the dreaded "rolling shutter" effect that produces horizontal image distortion during fast pans. The Panasonic and the Nikon both produced wavy, colored interference in artificially lit shots, although the Panasonic does have a menu setting for suppressing this type of effect.

Conclusions

Surprisingly, we discovered in the course of our tests that the more blurry the background, the sharper the other elements in an image appear. Unlike when you are using a camcorder, these cameras allow you to produce a variety of looks for your images, opening up a whole new world of creative possibilities. We also discovered that shooting video with these cameras is a completely different experience from shooting with an automatically controlled camcorder, and requires you to spend time and effort setting up each shot.

Our major criticisms of the test cameras all relate to handling. In our opinion, the most important thing for the manufacturers to concentrate on is developing practical focusing mechanisms and zoom rings that are easier to adjust smoothly.

Camera Test Overview

Model	EOS 5D	Rebe T2i / EOS 550D	D5000	DMC-GF 1	NX 10	NEX-5
Manufacturer	Canon	Canon	Nikon	Panasonic	Samsung	Sony
Video codec	AVC/H.264	MPEG-4, AVC/H.264	MJPG	AVCHD, MJPG	MPEG-4, AVC/H.264	AVCHD, MJPG
Video storage medium	CompactFlash	SD-HC/XC	SD-HC	SD-HC/XC	SD-HC	SD-HC/XC, Mem. Stick PRO Duo
Video Specifications						
Image sensor (Total pixels, size)	21.1m, 36 mm × 24 mm	18m, 22.3 mm × 14.9 mm	12.3m, 23.6 mm × 15.8 mm	13.06m, 18 mm × 13.5 mm	14.6m, 23.4 mm × 15.6 mm	14m, 23.4 mm × 15.6 mm
HD Resolution	1080	1080 / 720	720	720	720	1080
Progressive scan / Interlaced	✓ / –	✓ / ✓[2]	✓ / –	✓ / –	✓ / –	– / ✓[1]
Frames per seond (fps)	24 / 25 / 30	24 / 25 / 50 / 30 / 60	30	25	30	25 / 50
Max. clip length	12 minutes	12 minutes	5 minutes	30 minutes	25 minutes	30 minutes
Manual aperture / focus / WB	✓ / ✓ / ✓	✓ / ✓ / ✓	– / ✓ / ✓	– / ✓ / –	✓ / ✓ / ✓	– / ✓ / ✓
Manual shutter speeds	1/30 – 1/4000 sec.	1/25 – 1/4000 sec.	–	–	–	–
Autofocus	✓ (press shutter rel. halfway)	✓ (press shutter rel. halfway)	✓ (press shutter rel. halfway)	✓	✓ (press shutter rel. halfway)	✓
Depth of field setting	–	–	–	✓	–	–
Manual sound level setting	✓	–	–	–	–	–
Wind reduction filter	–	–	–	✓	✓	–
AE Lock	✓	✓	✓	✓	✓	–
AE Lock adjustabel during shooting	✓	✓	–	–	–	–
Face recognition	✓	✓	–	–	–	–
Viewfinder active	–	–	–	–	✓ (color LCD)	–
Monitor size / resolution (in pixels)	3 / 306 660	3 / 335 000	2.7 / 78 000	3 / 460 000	3 / 300 000	3 / 307 000
Tiltable monitor	–	–	✓	–	–	✓
Thumbnail view	✓	✓	✓	✓	✓	✓
In-camera editing	✓	✓	–	✓	–	–
Live View	✓[3]	✓	✓	–	–	✓
Seamless ouptut / with photos	✓ / –	✓ / –	– / –	✓ / ✓	– / –	✓ / ✓
Photo Specifications						
Max. resolution (in pixels)	5616 × 3744	5184 × 3456	4288 × 2848	4000 × 3000	4592 × 3056	4592 × 3056
Built-in flash	–	✓	✓	✓	✓	✓
Shooting formats	JPG/RAW/RAW+JPEG	JPG/RAW/RAW+JPEG	JPG/RAW/RAW+JPEG	JPG	JPG/RAW/RAW+JPEG	JPG/RAW/RAW+JPEG
Connections						
Computer interface	USB	USB	USB	USB	–	USB
HDMI out	✓	✓	✓	✓	✓	✓
Composite Video in / out	– / ✓	– / –	– / ✓	– / ✓	– / ✓	– / ✓
Microphone / Headphone socket	✓ / –	✓ / –	– / –	✓ (proprietary) / –	✓ / –	✓ (proprietary) / –
What's in the Box						
Mains adapter / Charger	– / ✓	– / ✓	– / ✓	– / ✓	– / ✓	– / ✓
Battery life (in constant use)	110 minutes	120 minutes	115 minutes	120 minutes	160 minutes	118 minutes
Remote control	✓[7]	✓[7]	–	–	–	–
Software	ZoomBrowser EX/EOS Utiliy	Zoombrowser EX/EOS Utiliy	Nikon Transfer, ViewNX, WT-4, QuickTime, Silkypix	HD Writer	Samsung Master, QuickTime	Picture Motion Browser
Weight (body only)	28.6 oz. (810 g)	18.7 oz. (530 g) [incl. Battery]	19.8 oz. (560 g)	10.05 oz. (285 g)	17.6 oz. (499 g)	8.1 oz. (229 g)
Dimensions (B × H × T – body only)	6.0" × 4.5" × 3.0" (152.0 × 113.5 × 75.0 mm)	5.1" × 3.8" × 3.0" (128.8 × 97.5 × 75.3 mm)	5" × 4.1" × 3.1" (127 × 104 × 80 mm)	4.69" × 2.80" × 1.43" (119 × 71 × 36.3 mm)	4.84" × 3.43" × 1.57" (123 × 87 × 39.8 mm)	4.36" × 2.31" × 1.5" (110.8 × 58.8 × 38.2 mm)
Video Test Results						
Image quality	⊕⊕	⊕⊕	○	⊕	○	⊕
Light sensitivity	⊕⊕	⊕	⊖	⊖	⊖	○
Sound	⊖	⊖	⊖⊖	○	⊖	○
Viewfinder / Monitor	⊕	⊕	○	⊕	⊕⊕	⊕⊕
Handling	⊕	⊕	⊖	○	○	○
Feature set	⊕	⊕	⊖	○	○	⊖
List price	US$ 2,500	US$ 900	US$ 750	US$ 680[5]	US$ 550[6]	US$ 650[4]

[1]Progressive scan recording – interlaced output [2]720/50p and 1080/25p [3]Reduced format during shooting [4]with AF-E 16mm f/2.8 Pancake lens [5]with 14-45mm lens [6]with NX 18-55mm lens [7]Remote control via PC and USB

⊕⊕ Excellent ⊕ Good ○ Satisfactory ⊖ Unsatisfactory ⊖⊖ Poor ✓ Available – Not available

The extraneous noises produced by kit lenses make it imperative to record sound separately, which involves extra effort. These cameras' autofocus and exposure systems are designed for use in a stills environment and often produce inappropriate results when used to shoot video. A basic camera setup will probably be sufficient for your first clips without zooms or dolly shots, and simple shots won't generally suffer too much from poor sound quality. Should you need to, both Canons allow you to adjust exposure during a shot.

If you are prepared to invest in more sophisticated equipment, you will be rewarded with respectable results. There are many very impressive film sequences shot using DSLRs to be found on the Internet. The two Canon cameras produced the best overall results in our test, although the EOS 5D, with its excellent image quality and super-sensitive image sensor (as well as its price!) is definitely in a league of its own. The 5D produces video of a quality that few camcorders can equal. The Rebel T2i is a great tool for skilled amateur video-makers, and includes a great set of high-end video features. Among the EVIL cameras we tested, the Sony NEX-5 was the clear leader in image quality and sensor performance. (pen) c't

Martin Biebel, Hans Ernst

Video Accessories

for DSLR and EVIL cameras

Whether you are a professional camera operator or an occasional videographer, if you use your DSLR regularly to shoot video, you are sure to need some accessories to make the job easier. From choosing the right lens to selecting a follow focus setup, this article describes some of the essential and nice-to-have equipment on offer.

Depending on the amount of time and effort you want to spend, you can shoot video using a minimal setup or a complete rig that includes follow focus gear and a bolt-on monitor. Of course, you can also shoot video using just a camera and a lens, but you are sure to find that a bare minimum kit doesn't produce the quality of results you might have been hoping for.

Without a tripod, you won't be able to shoot shake-free video or make smooth pans. Many scenes require additional lighting, and a fair amount of extra effort and gear is needed if you want to use lenses designed for stills cameras for video shoots that include zooms or focus pulls. Most camera microphones are not capable of capturing clean, high-quality dialog or ambient sound.

The following sections explain what to look out for when you are choosing accessories We distinguish between high-end gear and accessories for use with mid-range mirrorless cameras, and there is a separate section devoted to high-quality sound recording devices.

Lenses

There are not as many lenses available for mirrorless cameras as there are for DSLRs. There are just three lenses to choose from for the Sony and Samsung cameras reviewed in our test, and the manufacturers have not yet fulfilled their promise to introduce more lenses. Nikon and Canon DSLRs can fall back on a wide selection of bright, wide-aperture lenses that has developed over a period of many years. These lenses are, however, much more expensive than the standard kit zooms that are included with most DSLRs. We recommend that you use a bright wide-angle zoom, like the Canon 24-70mm f/2.8L USM as your standard lens, but that you also experiment with ultra-wide-angle lenses with focal lengths of 18 mm and below. These offer a completely new view of the world that was previously unobtainable using video cameras. We also recommend that you use a 100mm (or similar) fixed focal length lens for telephoto shots. The Sigma 105mm f/2.8 macro lens is particularly effective in this range. Avoiding camera shake is a real challenge with longer telephoto lenses. Whichever lens you choose, remember that the focal length is the equivalent 35mm focal length and needs to be multiplied by the crop factor appropriate to the size of your camera's image sensor. For example, a 50mm standard lens becomes an 80mm short telephoto when used with an APS-C format camera. Olympus and Panasonic lenses use the same control signals and lens bayonet and can usually be used with both brands of camera.

The best standard lens for Canon-based film-makers: the EF 24-70mm L-series lens has a constant maximum aperture of f2.8

Lens Adapters

Adapters like those manufactured by Novoflex broaden the range of lenses Samsung and Olympus users can use, and are available for the – mostly manual – lenses made by a number of manufacturers. Panasonic also sells its own adapter for use with

The Panasonic DMW MA2M adapter allows you to use Leica M-series lenses with Lumix G-series Micro Four Thirds digital cameras. The original Panasonic version costs about US$200 and third-party alternatives are available for about US$100.

the Leica M-series lenses, which have an excellent reputation among film-makers and command high resale prices in spite of being decades old. But be warned: some Leica lenses that were designed for use with 35mm lens flanges extend backward at certain focus settings, which can damage the image sensor and/or mirror in some cameras. Sony recently announced the introduction of an adapter that makes it possible to use Alpha-series lenses with the new NEX cameras, including full autofocus control. Other suppliers, like www.enjoyyourcamera.com, sell a range of adapters for Canon EF lenses, although most of these can then only be used at maximum aperture. Micro Four Thirds adapters with aperture rings are available for Nikon and Pentax lenses. Many adapters can only be used at close focus distances. Always check the exact capabilities of an adapter before making a purchase.

Tripods

A tripod is the basis for all video shoots and needs to meet a multitude of requirements. Photographers who shoot video only occasionally will probably just buy a video head for their existing photo tripod, and a monopod is sufficient for most documentary uses. A tilt capability for positioning the camera in portrait format is not necessary for film purposes. Serious film-makers, who think in scenes, will look for a custom-built video tripod. These are often equipped with a standard-sized bowl for use with a ball-based video head, which allows the operator to quickly align the entire camera/head setup with the horizon using a single movement of the grip built into the tripod head. This is much more effective than adjusting the legs of a photo tripod individually. A fluid-damped tripod head with adjustable resistance is the best option for smooth pans. A tripod is often one of the most expensive parts of a video setup. If you want to include tracking shots in your work, you will need to have access to a dolly and rails, a crane, or special gear for attaching your camera to an airplane or helicopter.

Sun Shades

You will need to eliminate stray light if you want your footage to display sufficient contrast. The sun shades included with most DSLR lenses are great if you want to keep your setup small and inconspicuous and some, like those included with Canon's L-series lenses, are coated with a soft protective material on the inside.

Professional film-makers usually use a more complex, much more expensive matte box with adjustable "barn door" shades and multiple filter mounting slots. Filters are an important part of any professional's creative gear. Speckle filters can be used to liven up dead shadows, while gray and blue graduated filters help reduce contrast and simulate bright skies.

Shoulder Mounts

A shoulder mount helps you to carry your setup once your rig gets too large for normal, handheld use. Unfortunately, the center of gravity of most shoulder mounts is located in front of the user's body and is centered on

A tripod head with adjustable fluid damping ensures smooth camera movements at constant speeds and in all directions. The ball base built into the head allows you to precisely align the camera/head combo with the horizon.

The LUX-LED4AA, manufactured by Bebob Engineering (around US$250) runs on four AA batteries and uses a spiral of LEDs to produce 250 lux of homogenous light at a distance of about three feet. The barn doors shown in the illustration are optional.

the mount's hand grips. Most manufacturers have obviously not yet realized that their products need to support the use of various sizes of interchangeable lens. Systems that utilize the user's chest to support the camera usually offer better support.

Follow Focus

If you want to be able to reproduce a scene later, you need to be able to precisely reproduce the focus points you use. This is where a "follow focus" setup is particularly useful. A follow focus consists of a toothed belt attached to the focus ring on the lens and a geared knob for turning the ring according to pre-measured and marked focus points. A follow focus usually requires its own operator and, if it is motorized, can also be operated via radio control or remote cable. A follow focus is mounted on the same rails as a matte box and enables extremely precise and smooth focusing.

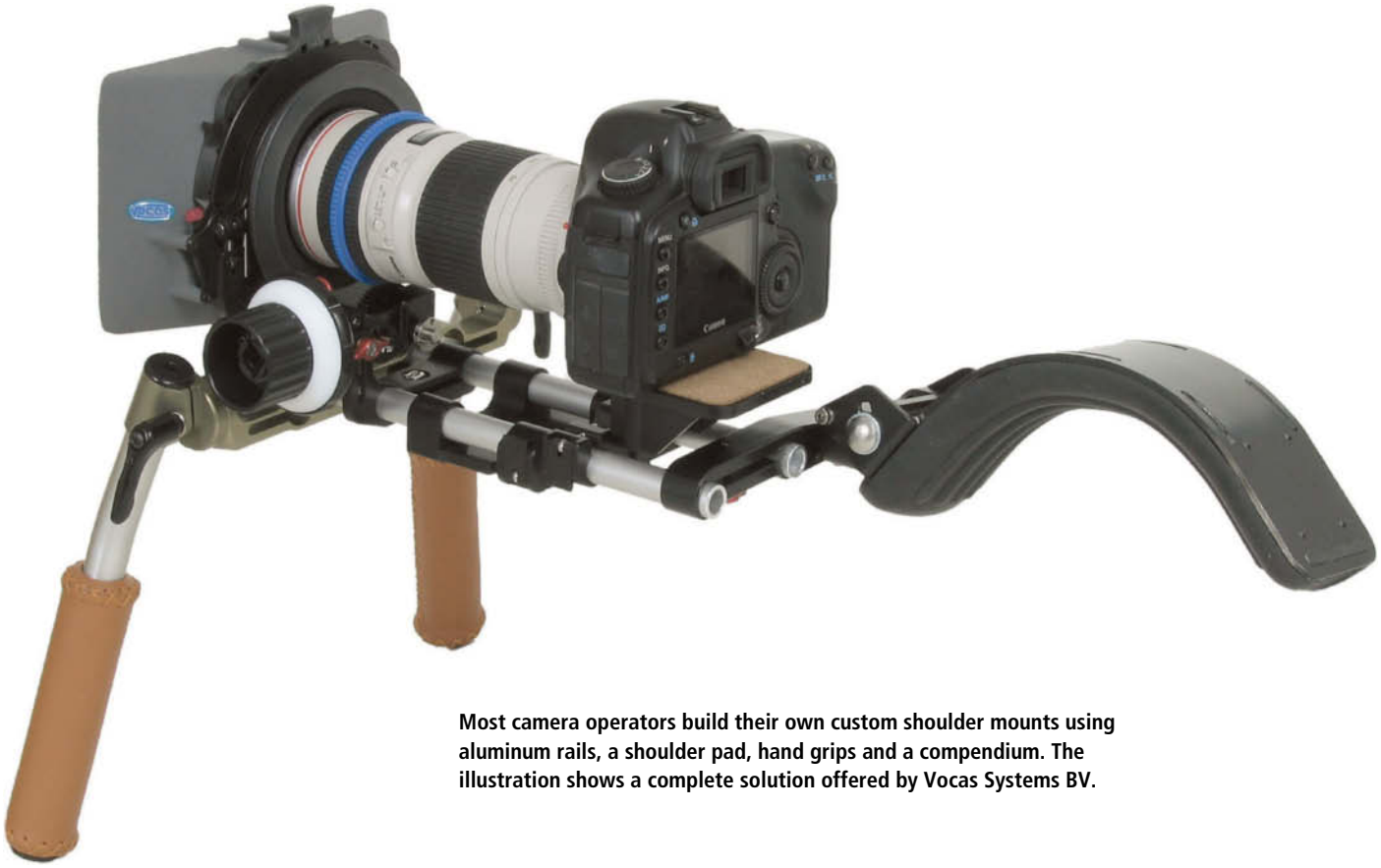
The focus puller uses a felt pen to mark the focus points for the upcoming shot

Lighting

Most DSLRs are light-sensitive enough to require only minimal additional lighting for video shoots, and a hot shoe-mounted video light is usually sufficient to keep image noise down to an acceptable level. Low-power LED-based lights have recently become very popular, and high-end models can be dimmed to suit the situation and produce balanced, evenly-projected light. Unlike most camcorder lights, LED video lights have a separate power source and their own chargers.

Microphones

It is virtually impossible to operate an interchangeable-lens camera noiselessly, making it essential to decouple sound recording from the camera's built-in microphone. This is easiest to achieve using a separate directional microphone made by a high-end microphone manufacturer, such as Sennheiser, Beyerdynamic or Shure. Videographers generally try to capture only the sources of sound that are visible within the frame and to eliminate all others. Only a very few DSLRs have separate microphone sockets. These are usually located behind the hot shoe and have channels for saving sound information and for providing power directly from the camera's battery. This type of solution is often inadequate for professional use because the hot shoe is required for mounting a flash unit or an optical viewfinder.



Most camera operators build their own custom shoulder mounts using aluminum rails, a shoulder pad, hand grips and a compendium. The illustration shows a complete solution offered by Vocas Systems BV.

Most DSLR manufacturers sell own-brand accessory microphones, but independent microphone manufacturers have yet to offer models designed for use with specific cameras.

Monitor Magnifiers

A magnifier for the camera's monitor is a practical way to bridge the distance between your eye and the monitor when you are shooting shoulder-mounted and also helps prevent shoulder cramps and eye strain. The Hoodman Corporation's HoodLoupe 3.0, one of the less expensive solutions available, is attached to the camera using a rubber band. The Zacuto Z-Finder costs around US$375 and offers state-of-the art 3x magnification, an adjustable eyepiece, a robust body and finely-tuned diopter adjustment. The Z-Finder is the best currently available option for shooting handheld.

Checking Footage On Set

Professional film-makers prefer to leave nothing to chance, so a powerful notebook computer is an integral part of every modern video shoot. The camera operator's assistant transfers video files from full memory cards to the notebook's hard disk and is also responsible for checking that the major scenes have been properly recorded. Mistakes that go unnoticed during a shoot are virtually impossible to rectify later – "Video Photoshop" simply doesn't exist! Most DSLRs include playback software, so an on-set notebook doesn't necessarily have to include an editing program. Highly compressed codecs like AVCHD are better edited using a powerful, multi-core computer anyway.

A matte box is used to hold filters and to prevent stray lateral light from reaching the lens. This matte box is mounted on aluminum rails.

Memory Cards

The first major rule of recording digital video is "swap out your memory card more often". With today's high-capacity cards, streaming rates of 17 MBit/second and more (for AVCHD-compressed footage) are not a problem, but using a single memory card poses risks. If a lone memory card gets lost, the potential setback for the project is much greater than if just one of a number of cards gets lost or damaged.

The Nikon M-JPEG and Canon H.264 recording formats stream as much as 40 MBit/second to the memory card, so it is essential to have a stock of cards at hand. Cards with transfer rates of 30 MB/second and more are now the norm, and are available at reasonable prices from high-end manufacturers like Sandisk. Avoid no-name products – they often don't fulfill their nominal specifications, which can lead to recording errors.

Remote Control

Canon offers a USB-based remote control system for the EOS 5D Mark II (see also the article on remote triggers on page 94). The *EOS Utility* program included with the camera has a built-in video mode that allows you to view the current shot live on a computer monitor and transfer the footage directly to a hard disk (albeit in non-HD quality) if required. It also supports remote recording and camera settings.

Sony's accessory microphone for its NEX cameras reduces camera noise and improves the directionality of recorded sound

The Zacuto Z-Finder is held in place by a robust metal frame. Additional rubber bands prevent it from getting accidentally dislodged.

Mobile Audio Recording Devices

Great footage but terrible sound? Our camera test shows that only a few video-capable DSLRs record adequate quality sound. Pocket-sized sound recorders developed for the music industry provide a solution. These pint-sized miracles record high-quality stereo sound on internal Flash memory or removable memory cards.

Sound recorders capture stereo sound using built-in or external microphones connected either directly or via radio and usually have line input sockets as well. They offer manual pitch control and usually have a built-in peak limiter. Some even have built-in wind filters for outdoor use. Sound recorders can be used as independent external microphones without attaching them to the camera at all, and battery operation means that you can place the recorder as near as you like to your sound source, providing clear, targeted recording.

Cheaper models don't allow for precise synchronization between the camera and separately recorded soundtracks. Digital recording is inherently more stable and reliable than tape recording, although it is virtually impossible to keep even digital cameras and sound recorders synchronized for periods of 30 minutes or more. This isn't usually a problem for film-makers, who tell their story and synchronize sound one scene at a time.

At the cheaper end of the scale, we recommend the Yamaha Pocketrak C24 for use with DSLRs. It weighs just 2 oz, can be fixed directly to a camera rig or hot shoe if necessary, and produces much better sound than its size might lead you to think. A good alternative at the same price level is the H1 manufactured by market leader Zoom.

Pocket recorders capture sound directly using built-in Flash memory or removable memory cards. They usually also have an auto-level option for making spontaneous recordings. All of the devices listed can record in high-quality PCM/Wave mode or compressed MP3 format. Some also offer the less common WMA recording format. You can control microphone sensitivity to close-up or wide-area recording situations, and we recommend that you activate the peak limiter if you are recording loud noises or live music. You can check your recording levels using the built-in display, where peak LEDs warn you of potential over-modulation. We recommend that you use headphones to monitor the sound during recording. Make sure that your preferred recorder can sample sound at 48 kHz, as this is the frequency used by most common video formats. Many newer recording devices can even sample 24-bit sound at 96 kHz, although this level of sound quality exceeds the requirements of most video applications.

By far the best recorder currently available at a sub-US$300 price level is the Sony PCM-M10. The Sony's microphones offer excellent recording quality and the device is reported to record less of its own internal noises than its competitors. Unfortunately, it doesn't have built-in XLR sockets, unlike the Zoom H4n, which can also be used as an audio interface for a computer. One of the really attractive features of all these devices is the incredibly small amount of power they require, leaving you free to concentrate on recording and the amount of free memory capacity you have left. (pen) c't

Audio Recorder Overview

Manufacturer	Model	XLR socket	Price (approx. In US$)
ESI	Rekord M	–	120
Marantz	PMD661	✓	599
Olympus	LS-11	–	299
Roland/Edirol	R-09 HR	–	265
Sony	PCM-M10	–	299
Tascam	DR-100	✓	300
Tascam	DR-07	–	115
Yamaha	Pocketrak C24	–	200
Zoom	H1	–	100
Zoom	H2	–	140
Zoom	H4n	✓	300

✓ built-in – n/a

The Yamaha Pocketrak C24 weighs just 2 oz. and is small enough to be attached directly to a camera rig or hot shoe

The Zoom H4n offers XLR connectors in a great-value package. XLR connectivity is only usually available in top-end Tascam or Marantz recorders.

Bettina K. Lechner

Retouching Images
with GIMP

As well as dealing with spots and specks caused by random dust on the image sensor, which are easy to remove, we sometimes need to "erase" larger unwanted objects, such as cars, street signs or people from our images. Power pylons and power lines are two of the things that people most often want to eliminate from their photos. With a little patience and some practice, you too will be able to use GIMP to retouch these and other imperfections in your pictures.

To retouch an image, you "paint over" the blemish and the pixels surrounding it. It therefore makes sense to check whether this is actually possible before going into the details of how to remove the object in question. Are there sufficient source pixels surrounding the object? If not, are there pixels with the right qualities elsewhere in the image?

Let's train our cloning eye with the following example:

Example 1: In this image of Apulian trulli, there is sufficient blue sky surrounding the power mast and the power lines for copying and cloning:

Here, all we need to do is copy blue sky pixels to cover the power mast and power lines, taking care not to paint over the roof of the smaller trullo on the left.

Example 2: It is much more difficult – if not impossible – to retouch the tree branch in the foreground of this shot of the Amalfi coast. In principle, you would be right to say that nothing is impossible, but in some cases, you nevertheless need to assess whether the potential improvement in an image is worth the effort involved in adjusting it. Here, it would take an enormous amount of time and effort to remove the individual twigs covering the houses. I had a second shot without the tree branch which I could have used to copy the house façades into my favorite shot, but this, too, would involve a lot of time and effort adjusting perspective, exposure and tonal range in order to get the merged image looking authentic.

Example 3: Cloning is perhaps not the best choice of tool at all for improving this image of a sculpture in Atlanta. Here, it is probably more effective to select and crop the subject and then paste it onto a suitable background, such as a sky or a color gradient.

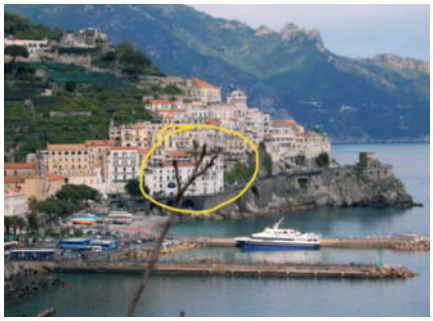


Photo: Reinhard Helmer

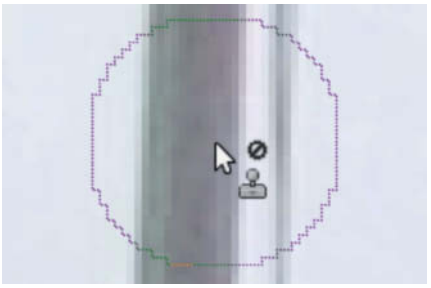
Preparing to Clone

Retouching is generally performed using a brush tool, the tip diameter, opacity and strength of which can be selected in the window that is displayed below the currently active tool in the GIMP interface. The settings you select will depend on the nature of your image and the areas you wish to clone. Don't use a brush tip that is too hard, as this can cause obvious edge artifacts in your results.

Adjust the brush size to suit the resolution of your image and the nature of the cloned pixels.

Open the *strommasten-muss-weg.jpg* file from this issue's free DVD and select a brush size that completely covers the mast.

It's a good idea to create a new, transparent layer for the details you are working on when you are cloning. This way you don't have to adjust your original image data at all, and you can readjust your cloned elements – or even delete them and start again – if your adjustments don't go according to plan. You can create a new layer using Ctrl+Shift+N in the Layers dock. Call your new layer Clone Layer, select the Transparency Layer Fill Type and click OK.



We will be adding our cloned pixels to this layer in the course of the following steps. To let the program know that you want to clone pixels into your new Clone Layer from the image layer below, activate the *Sample merged* tool option.

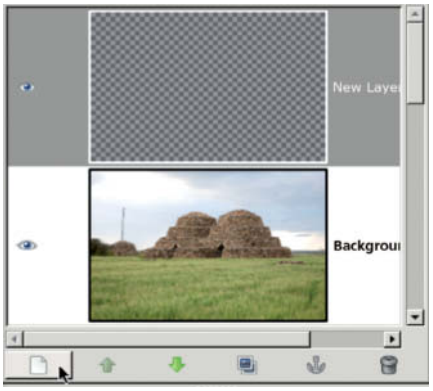
Select the *Aligned* option in the Alignment drop-down list to ensure that the offset between the source and the cloned pixels remains constant.

GIMP Retouching Tools

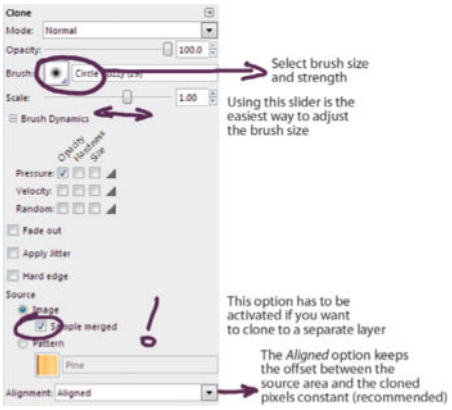
The Clone Tool
This is the most important image adjustment tool, used for copying and pasting pixels.

The Healing Tool
This functions much like the Clone tool, but also takes the textures and exposure in the surrounding pixels into account. It is ideal for correcting minor skin blemishes, dust particles or imperfections in colored surfaces.

The Perspective Clone Tool
Also similar in its functionality to the Clone tool, the Perspective Clone tool also allows for perspective effects in cloned image areas and uses user-defined vanishing lines to adjust images accordingly.



The most important tool settings are:



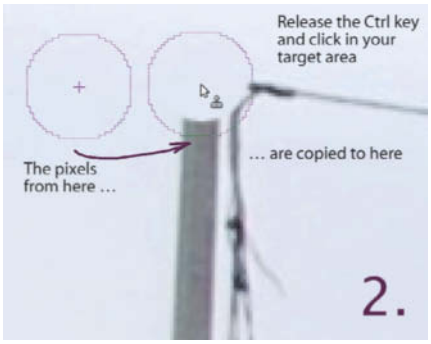
Let's Go!

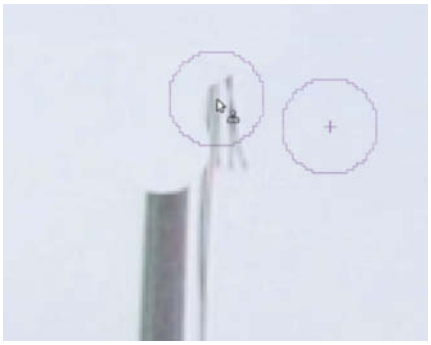
We will now use the power mast in our image to learn the basics of cloning. Make sure you have selected your new Clone Layer in the layer dock and zoom into the area you want to clone by repeatedly pressing the "+" key.

Activate the Clone tool. Copy the source pixels using a Ctrl+click near the power mast.

Now release the Ctrl key and place your cursor over the power mast. You will now be able to see two circles. The one with the crosshairs in the center indicates your source area and the empty circle shows where you are about to paste the source pixels. Click to "paint over" the power mast.

Now, if you move your mouse downward, the Aligned option ensures that the source area moves correspondingly. Now click along the power mast to blot it out completely.





Always use source pixels from as close as possible to the area you want to retouch – here, from both sides of the mast.

If you make a mistake, use Ctrl+Z to undo your previous step.

So far, so good.

Cloning Edge Detail

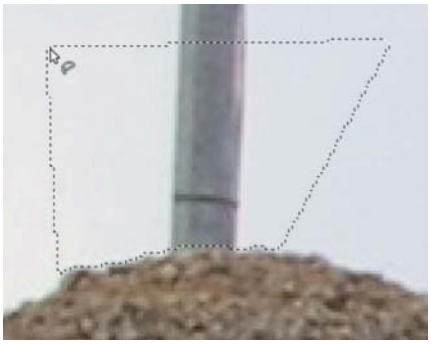
But what can you do if you need to retouch an area that isn't as easy to paint over as the power mast or the power lines in our example? Let's use the area where the power mast meets the roof of the trullo to practice.

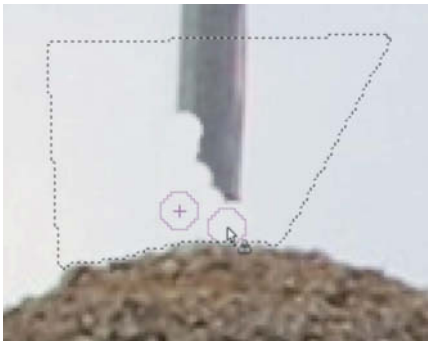
In this case, it is all too easy to paint over some of the roof tiles. We can work around this risk by creating a selection that functions as a boundary when we are pasting our cloned pixels. This makes it impossible to paint outside the frame – something we all did in our painting books when we were children.

We used the Free Select tool to make our selection. You can make your selection either by painting with the mouse button pressed – which can make the selection slightly shaky –

or by clicking a series of individual corners to form a polygon. Once you have selected your corners, the tool automatically joins them up. We used the polygon approach and activated the Feather edges option (with a radius setting of between 3.0 and 5.0) to soften the edges of the selected area. The setting you use will also depend on the resolution of your image.

Click on the image at a "safe" distance from the roof, release the mouse button and





click again to produce the first edge of your selection, and continue carefully along the roof of the trullo, clicking and releasing, until you have finished bounding the roof. Once you have clicked your way back to your starting point to close the polygon, you can clone away within your selection using source pixels from anywhere within the image – the only area limited by the selection is the area into which you can paste. Once you are done, you can deselect your selection using Select > None, or Ctrl+A.

Cloning using Asymmetrical Source Pixels

Cloning sky is pretty easy, and one cloud more or less doesn't usually make a significant difference to the finished image. However, if we want our results to look realistic, we need to be a little more careful if we are cloning asymmetrical objects, such as tufts of grass.

If you look closely at our sample image, you will see the remains of a well in the foreground. We will now use the surrounding grass to retouch these remains out of the image. Check out the grass and consider which parts you think will provide the most inconspicuous cover. The dark green "line" is fairly distinctive and can be used as a reference point. The numbers sketched into the cropped detail here indicate one possible sequence for copying and pasting.

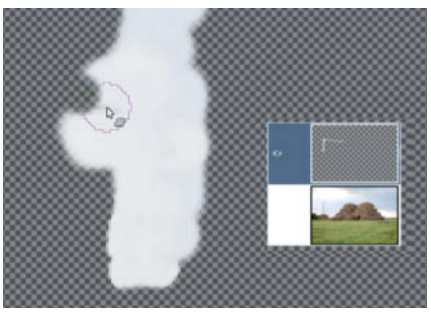
Always work smoothly from left to right or right to left and don't use source pixels that

are located too far from the object you are retouching. If you paste source pixels from too near the camera into an image area that is further away, the perspective won't look quite right. If you can't find suitable source pixels close to the subject, use the Perspective Clone tool (see below).

Try to clone horizontally or following lines within the area you want to retouch. Work inward from the outside edges of the frame using source pixels from left and the right of the subject. Poor retouching is often recognizable due to unnatural-looking repeated patterns within natural objects. You can always re work specific areas using source pixels from further away if you find that parts of your retouched image still look unnatural.

Correcting Errors

If you make a mistake while cloning, you can undo your last step immediately using Edit > Undo (or Ctrl+Z). You can also undo multiple steps using the Undo History dialog located in the dock (indicated by the tab with the double yellow arrow). Simply click on the state of your image that you wish to return to.

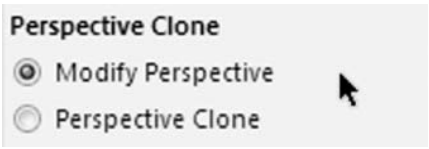


You can also undo your cloning steps by erasing pixels on your Clone layer (see *Preparing to Clone* above). Temporarily hide the background layer(s) to show just your cloned areas and activate the Eraser tool to erase your chosen cloned pixels.

Perspective Cloning

If you want to clone parts of your image foreground and paste them into an area that is "further back" in your image (or vice versa), you will need to alter the perspective in your source material. Fortunately, the GIMP Perspective Clone tool can do this automatically using the following steps.

First, create a new transparent layer to add your cloned pixels to and activate the *Sample merged* and *Modify Perspective* tool options. The image window now displays handles at the corners of your image, which you can drag until the resulting vanishing lines represent your desired perspective. The area you want to clone doesn't have to be enclosed by the vanishing lines, as these only serve to delineate the perspective effect.



Now select the Perspective Clone tool option and work as you would using the standard Clone tool. You will see when you paste your selected source pixels into "distant" areas of your image that they are automatically adjusted to fit your designated perspective.

Retouching by Copying

Brush-based clone tools are not always the best choice if you want to clone large source areas or clone without being restricted by the brush parameters. In such cases, you can simply select and copy larger portions of your source image, paste them into your new image and soften any hard edges later.

In this example, we want to get rid of the ugly hatch on the left of the image. The standard clone brush would produce a series of round edges, so it is much quicker and easier to copy a section of the façade above the hatch and paste it into separate layers as often as necessary.

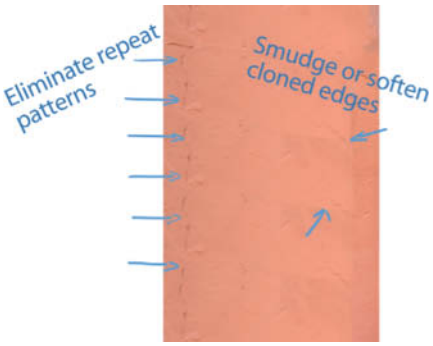
You can try this technique yourself using the sample *klonen-durch-kopie.jpg* file on this issue's free DVD.

Activate the Free Select tool and a radius setting of between 3.0 and 10.0 (depending on the resolution of your image), then make your selection by clicking the corners of the area you want to copy and close the polygon you have created by clicking on the first corner again, or by double-clicking.

Copy and paste your selection using Ctrl+C and Ctrl+V, and then use Shift+Ctrl+N in the Layers dialog to anchor the floating selection. You have now extracted a portion of the façade which you can move to cover the hatch using the Move tool.

You can duplicate the layer containing your new piece of wall by clicking on the third button from the right at the bottom of the Layers dialog. Move the new duplicate layer to cover more of the hatch and repeat the last two steps until the hatch is completely covered.

To fine-tune your retouched image, merge all of the layers to a single layer by right-clicking and selecting the New from Visible command in the context menu that pops up.



Finally, soften any remaining edges using the Smudge tool and re-clone any patterns that are too obviously repeated. You can also use the Healing tool to erase any remaining irregularities.

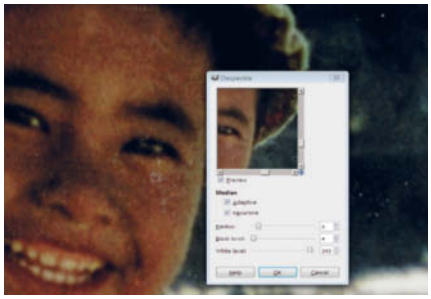
Check your results at different zoom levels and don't be afraid to try a different clone technique if you are not completely satisfied with the effects you have achieved.

Eliminating Dust Particles

You can get rid of individual blemishes quickly and effectively using the Clone and Healing tools described above, but what can you do if your image is covered with dust spots or scratches? This problem often confronts people who are working on scans of slides or other, older image material. The simplest way to counteract these types of imperfections is to reduce the size of your image using the Image > Scale Image command.

If this doesn't suit your intentions, try using either the Despeckle or the NL Filter. Both of these tools not only eliminate hundreds of irritating dust specks at the click of a mouse, but also go a long way toward eliminating the noise artifacts that often occur when photos are taken in low light or using high ISO sensitivity settings. Generally speaking, both filters function by smoothing the brightest or darkest pixels in an image, which can have an adverse effect on overall sharpness. If the specks you are trying to eliminate only occur in specific parts of your image, select the affected area and use the Despeckle filter to make your adjustment. The NL filter can only be applied to a whole layer, but not to a selection. Whichever filter you decide to apply, duplicate your background layer first and apply effects to the copy. This way you avoid the risk of irreversibly altering your original image data.

The Despeckle filter is located in the Filters > Enhance menu.



If you activate the *Adaptive option, GIMP* automatically calculates the ideal filter settings based on the image's histogram and moving the sliders in the filter's dialog has no effect. If you activate the *Preview* option, you can see the filter's effects in real time in the Despeckle dialog window – simply move the preview cursor to the image detail you want to check. Activating the *Recursive* option makes the filter's effect stronger, but can also make the results less sharp.

If *Adaptive* mode doesn't provide you with satisfactory results, you can always deactivate it and make your settings manually. The *Radius* setting determines the overall strength of the effect, but remember, the higher the Radius value, the less sharp the resulting image will be. The Radius setting ranges between 1, which is equivalent to a 3 × 3 pixel area, and 20, which affects a 41 × 41 pixel area.

The *Black Level* and *White Level* sliders determine above or below which points on the 0 to 256 scale of 8-bit tonal values white or black pixels are removed from your image. For example, if you set the White Level to 230, all tonal values between 231 and 256 – together with any bright blemishes – are deleted from the resulting image. Adjusting Black and White Level values affects image sharpness less than adjusting Radius values, and its overall effect is milder.

The Swiss Army Knife

The *GIMP* NL Filter is widely known on the Internet and in image processing circle as the Swiss Army knife among today's image correction tools, and combines sharpening, despeckle and smoothing functionality in a single interface. This makes the NL filter more complex to use, but also more gentle in its effect than the Despeckle filter – it generally smoothes more subtly and thus affects overall image sharpness less.

The NL filter cannot be applied to selections and is also deactivated if the active layer contains an alpha channel. Alpha channels contain information regarding a layer's transparency. A layer's name is displayed in normal type if an alpha channel is present or bold type if not. To delete an alpha channel, use the *Remove Alpha Channel* command in the layer context menu.

The NL filter is a complex tool, and a detailed description would go beyond the scope of this article. Here, we will here stick to describing its Despeckle mode. Activating the *Alpha trimmed mean* option and moving the *Alpha* and *Radius* sliders to the right increases the filter's effect.

If you want to know why: the Alpha trimmed mean option replaces a pixel's color values with the average value of the pixel itself plus the six pixels surrounding it in hexagonal form. The values of these seven pixels are determined by the Alpha value you select, while the effect's strength is governed by the Radius setting. The Alpha and Radius slider values range between 0 and 1, and setting both to 0.8 is a good starting point. Once you have set your values, apply the filter by clicking OK. Re-applying the filter (Ctrl+F) strengthens the effect.

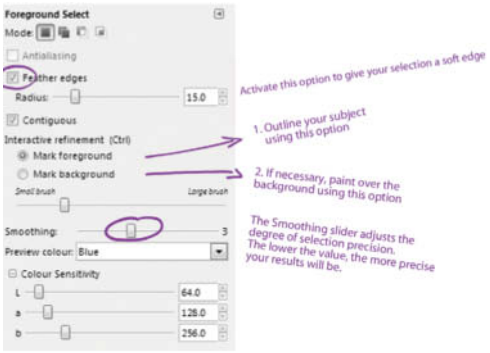
There are some sample images for you to experiment with in the *Sample Images and Videos* section on this issue's free DVD.

(ae/rez) c't

Bettina K. Lechner

Selecting Objects

at the Click of a Mouse

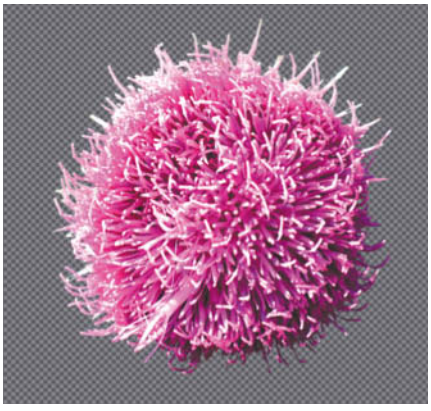


If you want to place an object on a different or more neutral background, you will first have to isolate it from the rest of the image – a process known as "selection". Selection is often one of the most complex tasks in the whole image processing workflow, especially for randomly shaped objects. This article shows you how to use the GIMP Foreground Select tool, which automates and simplifies complicated selections.

The basic steps involved in selecting an object are as follows:

1. An object first has to be outlined as precisely as possible, using Paths, the Free Select tool or the Foreground Select tool in conjunction with a layer mask.
2. Once you have successfully outlined your object, copy it using Ctrl+C.
3. Paste the copied object into its new location – for example, into a new layer – using Ctrl+V. In GIMP, this keystroke produces a floating selection, which has to be anchored to a new layer using Shift+Ctrl+N.

As a result of these steps, the selected object is pasted onto a transparent background, which is indicated by a checkerboard pattern in the new layer. The object can then be copied and pasted at will into other images and layers.



SIOX – Simple Interactive Object Extraction

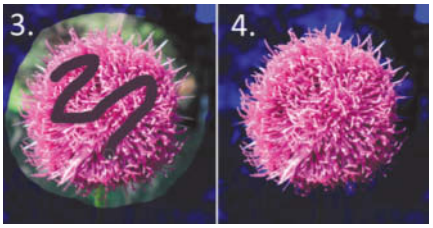
The GIMP Foreground Select tool is capable of selecting objects semi-automatically. This tool is based on the SIOX plug-in and has been included in GIMP since the 2.4 release of the program. The SIOX plug-in was developed at the informatics department at the Free University of Berlin (see also www.siox.org), and can "guess" the precise outline of an object using a rough, hand-drawn outline as a reference. It can also detect objects of similar size and color to the outlined object and select them all at the same time using the *Multiple Object Extraction* option.

Let's take a look at how to use this wonderful tool in practice. Using conventional tools to select the thistle flower in our example would involve a great deal of painstaking work, as it is extremely difficult to outline the individual blossoms sticking out from the main flower. The GIMP approach to the task is as follows: first, we outline the flower roughly using the Foreground Select tool and a Radius value of about 15. The exact value will depend on the resolution of your image, but 15 gives us a sufficiently soft edge for the selection in our 4,000 × 3,000 pixel example.

Handling the GIMP Foreground Select tool is a slightly unusual experience in that the tool takes on different forms and functions while you are using it. The first step involves outlining your chosen object roughly while pressing the mouse button. Once you have completed the outline (1) and released the mouse button, the background will be displayed with a blue tint (2).

For the next step, the tool acts as a brush. Select a relatively broad brush in the tool options and paint liberally over the foreground object to give SIOX the best possible set of reference colors for your chosen object (3). Once you stop painting by releasing the mouse button, GIMP display the results of the foreground extraction and displays the entire background in blue. All non-blue areas have been selected (4).

If there are any blue tinted "holes" in the selection that are larger than you would like,

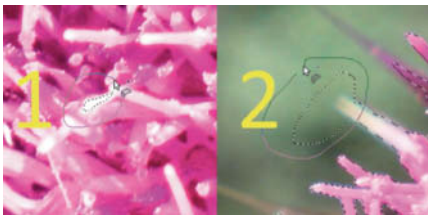


you can repeat your brush action using a smaller brush. If there are only a few unobtrusive "holes", simply ignore them for now, as any attempt to remove them can cause the plug-in to resample the whole of the rest of the selection. It is quicker and easier to repair them once we have finalized our main selection.

If large portions of background have been wrongly recognized as belonging to the foreground subject, select the *Mark background* tool option and correct them using the eraser tool that appears. Here too, you can cover the affected areas liberally, although a small splash is often sufficient to get rid of unwanted foreground elements.

The Foreground Select tool resamples the selection after every brush stroke. Progress is indicated in the status bar. Once you are satisfied with your selection, press the Enter key to finalize it. You will now see the running

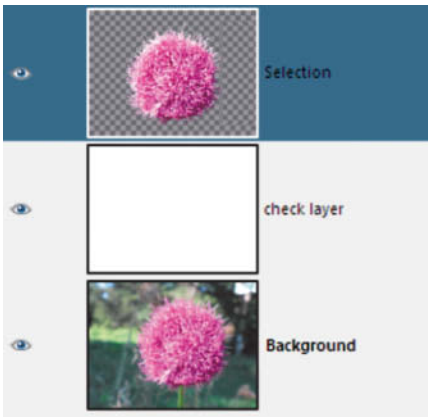
black and yellow selection border surrounding your selection. If your selection includes closed sub-selections, you can integrate them into the main selection by surrounding them with the Free Select tool while pressing the Shift key (see illustration 1 below). If your selection includes elements that protrude too far into the background, you can also drag these into the main selection using the same Free Select/Shift maneuver (see illustration 2 below).



You should now have a clean, precise selection. Press Ctrl+C and Ctrl+V to extract it from the background and Shift+Strg+N to anchor it to a new layer. You can test the quality of your selection by inserting a solid colored "check layer" below the main image layer. To do this, select a suitable foreground color in the Toolbox color picker and use it to create a new layer (Layer > New Layer). If the edge of your selection is too sharp, you can soften it by returning to the Foreground Select step in the History

dialog (the double yellow arrow in the *Layers, Channels, Paths* dock) and then reducing the Radius of the feathered edge to a value between 1 and 10 in the tool options. Confirm the new, softer selection and repeat the copy, paste and anchor steps described above. The Foreground Select tool produces spectacular results that never fail to impress me.

You can now turn your selection into a finished illustration like the one shown above!!! Currently, we have the extracted thistle flower on one layer, followed by a white or colored check layer with the original image below that. The layer stack looks something like this:



You can use either a new layer (Shift+Ctrl+N) or the check layer to create a black gradient located behind the backlit thistle. Press the D key to revert the foreground/background colors to black/white and activate the Blend Tool. Check the *foreground to background* checkbox and select the *Shaped (angular)* Shape option. You can now draw your gradient into your chosen. To produce the white frame, create a new, transparent layer and select it using Ctrl+A. Then use the Select > Shrink command to shrink the frame by about 30 pixels (or a different value that matches the resolution of your image). Press the X key to switch the foreground color to white and navigate to the Edit > Stroke Selection command. Here, select a *Line width* of 1 pixel and press Stroke to confirm. As a final flourish, I inserted the

thistle's Latin name – which, you have to admit, sounds more glamorous than "Great Globe Thistle". I then used the Filters > Enhance > Unsharp Mask filter to sharpen the thistle a little.

The original image is included on this issue's free DVD in the *Sample Images and Videos section*.

Selecting People

So far, so good, but how does Foreground Select cope with human subjects? We used this photo to test its capabilities.

Photo: Jean-Christoph MELETON – Fotolia.com

We started by roughly outlining the subject (below left) and marked the foreground as explained above (below right).

The result isn't perfect, but it will do as a starting point for a bit of fine-tuning. You can use a layer mask or the Eraser Tool to remove unwanted background details.

Selecting Multiple Objects

As already mentioned, Foreground Select can select several objects simultaneously.

To do this, activate the tool and outline the entire image. Then select the Mark background option. For this example, I also set the L*a*b* lightness setting to a very high value

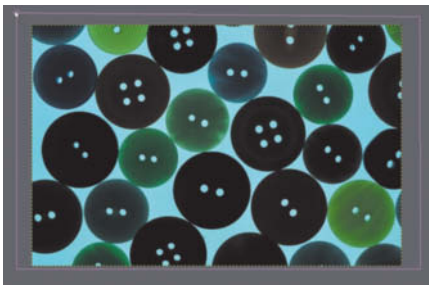
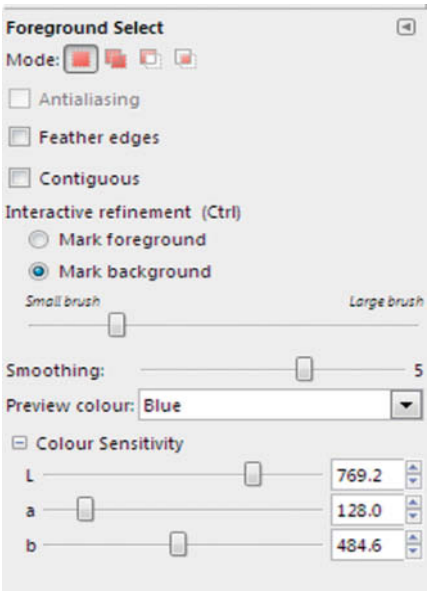
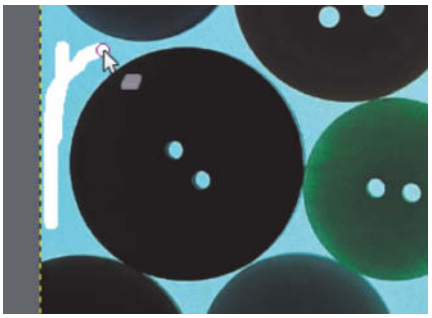


Photo: www.bigfoto.com



to compensate for the very bright background (see the box *Tips & Tricks with Foreground Select* on page 64).

Marking part of the background now produces the usual preview in the image window. Keep experimenting with the feather



value or the L*a*b* settings until you are satisfied with your results, then press Enter. The sample photo used here can be downloaded at www.bigfoto.com.

The Three Basic Selection Steps

Photo: Barbara Wilding

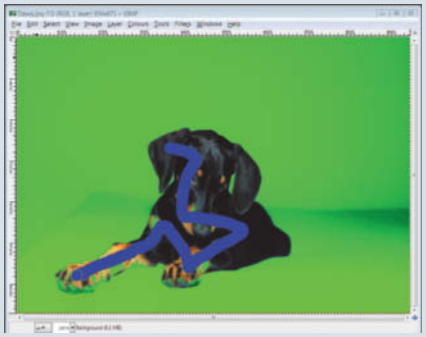
1. Outline the subject

2. Mark the subject with a few bold brushstrokes

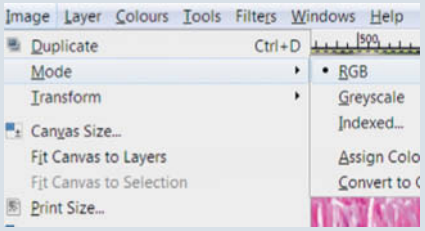
3. Press Enter

Tips & Tricks with Foreground Select

Subjects: Foreground Select is very good at recognizing and selecting objects that were clearly photographed as the main subject of a picture, or which simply stand in obvious contrast to the background.

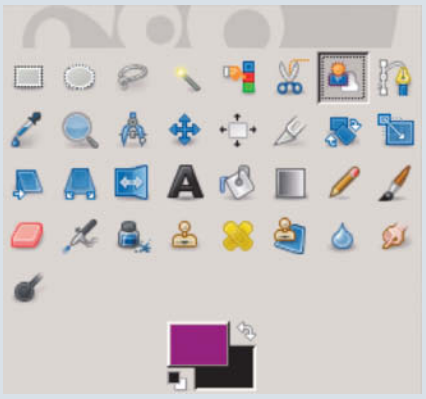


Marking your selection: Foreground Select is based on a segmentation algorithm that requires the user to mark the right colors if it to function successfully. If you are marking a portrait, try to include as many different skin tones and as much hair and clothing as you can. When marking animals, make sure you mark the body as well as the head.

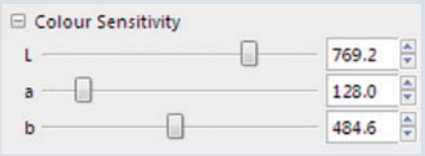


Mode: Save your image in RGB mode. If your image is indexed, convert it using the Image > Mode > RGB command.

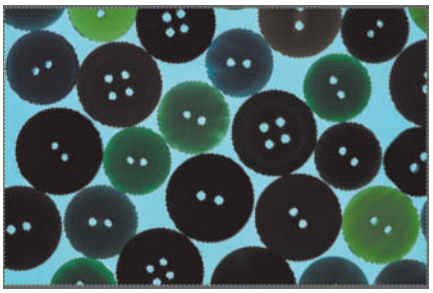
Don't be too precise: Try to err on the vague side rather than being too precise when drawing your initial outline, and paint over your subject using bold brushstrokes. You can deal with any "holes" in your selection later.

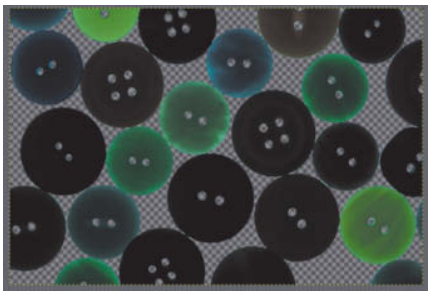


Default tool colors: The plug-in uses the currently active foreground and background colors in the Toolbox for marking the foreground and background. The plug-in uses the currently active GIMP preview color as its semi-transparent background masking color.



L*a*b*: The tool options include sliders for making adjustments using the L*a*b* color model. These are labeled L for Lightness, a for the red/green tones and b for the blue/yellow tones. If your subject contains too much of one particular tone, move the appropriate slider to the right. This will help the tool to select the correct parts of the image.





I would like to thank Dr. Gerald Friedland at the International Computer Science Institute, Berkeley, USA, who is the main developer of the SIOX plug-in, for his support. More information is available at http://en.wikipedia.org/wiki/Simple_Interactive_Object_Extraction. Dr. Friedland recently took part in a Google Summer of Code project and mentored a student who implemented the new soft segmentation module, which promises to be capable of selecting objects as fine as human hair in the near future. The new module is earmarked for inclusion in the 2.8 version of GIMP.

Foreground Select is a fantastic tool that produces great results for clearly outlined subjects. Use it – it's worth it! (ae/rez) c't

Bettina K. Lechner

How to Brighten up Your Bad Weather Snaps

You had a great trip with unforgettable moments, but the weather didn't play along? This workshop explains how to turn your bad weather snaps into wonderful memories. To give ourselves the greatest possible processing flexibility, we use layer masks to make these kinds of image adjustments.

The sky always plays a significant role in the overall "weather mood" of an image. In this example, we want to replace the dark clouds with clear blue sky and adjust the colors of the mountains to fit the new, tweaked weather situation.

Photo: Mountain by Berndt Sevcik, sky by Bettina Lechner

The two image files we used are also in the *Sample Images and Videos* section on this issue's free DVD.

Ideally, you will have a picture of an appropriate sky at hand before you start, but if you don't, we explain below how to use GIMP to produce artificial sky. Open the bad weather image and then open your sky image as a new layer using the File > Open as Layers command. The sky image is now on top of the main image in the layer stack and covers it completely. The first step involves removing enough of the sky image to make the mountains behind it visible.

You may be tempted to simply erase the parts you don't need. The problem with this approach is that it irreversibly deletes the erased parts, making it impossible to undo the change if you make a mistake. We prefer to use a non-destructive layer mask method

to make our adjustments so that we can simply mask the parts of the sky that we don't want to see in our final image.

Before actually creating a layer mask, we will save ourselves some effort by turning the boundary between the mountains and the sky into a selection that we can apply to the mask. This means that we don't have to trace the profile of each mountain into the layer mask manually. This particular technique doesn't always work smoothly for all types of images, but is usually reliable for images that show a reasonable degree of contrast.

Creating a Layer Mask Selection

First of all, hide the sky layer by clicking on the eye icon next to the layer in the Layers dialog. Now switch to the image layer and activate the Fuzzy Select Tool. This tool automatically selects colored pixels of a similar color – exactly what we need to select our bad weather sky.

Activate the *Feather Edges* option and select a value between about 3.0 and 10.0. The exact value will depend on the resolution of your image. Set the Threshold (color sensitivity) value to about 22. Now click on the sky. If everything works out, the resulting selection will follow the line between the mountains and the sky. It doesn't matter if there are "holes" in the selection. If your first attempt doesn't produce the desired result, try again while clicking elsewhere in the sky, or by clicking on multiple locations while holding down the Shift key. You can also adjust the size and position of the selected area by increasing or decreasing the Threshold value and clicking on the image once again. Once your selection is good enough, you can create your layer mask

for the good weather sky. Show the sky layer (by clicking the eye icon) and select the Add Layer Mask command in the Layers dialog context menu. Confirm the Selection option. You should now be able to see the good weather image filling the spaces outlined by your selection.

Masking the Bad Weather Sky with a Layer Mask

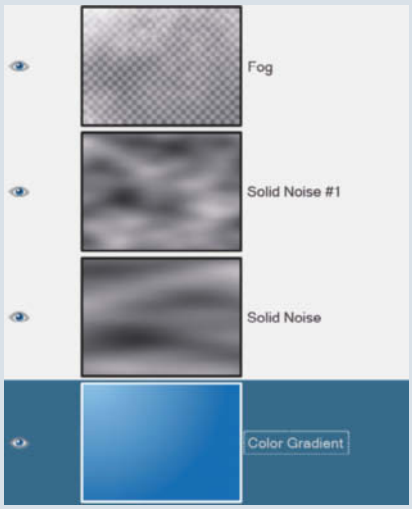
Everything that is colored black in a layer mask completely obscures the corresponding portions of the layer it is linked with, while white colored areas allow the corresponding image areas to show through. In our example, we can "see through" the mountains and the glacier to the sky layer. Accordingly, gray values in a mask are semi-transparent and are often used to apply soft transition effects from dark to light or from one color to another.

Digital Sky

Here's how to make your own sky using GIMP. First create a new layer, then click on the foreground color icon in the Toolbox and select a dark blue with red 60, green 107 and blue 174 values. Confirm this color using the *OK* button and create a lighter background blue with red 170, green 201 and blue 232 values. Now activate the Blend Tool, select the *Radial* Shape option and draw a gradient that covers the whole layer. Take care to check your bad weather image and to locate the lighter blue of your gradient nearer the source of light in the image.

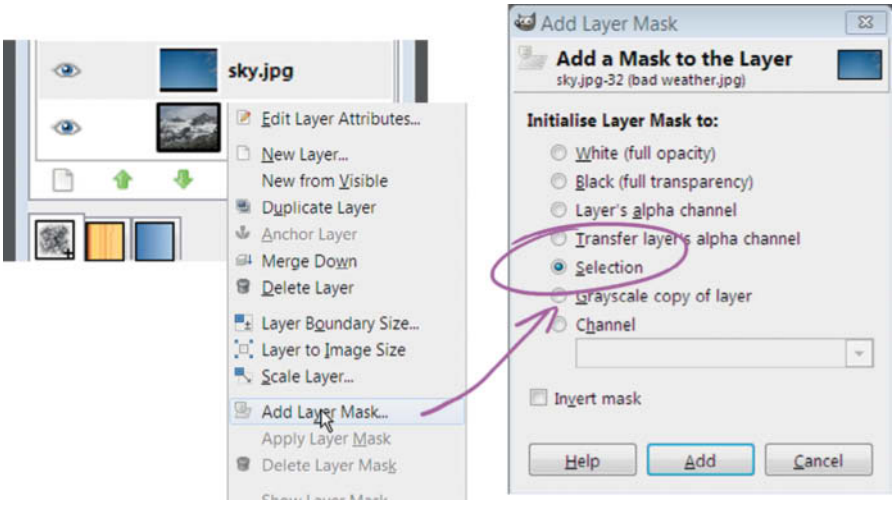
We can now create a few clouds to make our sky look more interesting. Create a new transparent layer and select the Filter > Render > Clouds > Solid Noise command. Set the Detail option to 1 and the *X/Y sizes* to relatively low values (for example, 1.8 and 3). Now click OK and repeat these steps for a second layer using slightly different values to create more varied and realistic-looking clouds. Set the Mode for both sky layers to *Grain merge* and Opacity to about 22. You can also use the Render command to create a mist-like effect (using a desaturated *Plasma* effect).

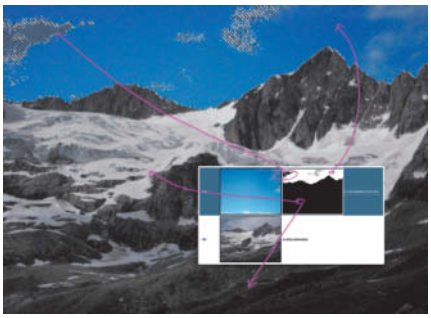
You can now experiment with the opacity and layer modes of your new layers until you find a mix of effects that suits your image. GIMP can also be used to create realistic-looking "classic" cirrocumulus clouds. To do this, activate the Eraser in the Toolbox and select the *Galaxy, Big* brush type. Reduce opacity, set Scale to 10 and click once or twice on your rendered sky layer. You can now merge all of your sky layers to a single layer by showing them (click the eye icon) and selecting the Merge Visible Layers command in the Layers dialog context menu. As all of the new layers are the same size, you will need to select the *Expand as necessary* option in the Merge dialog. And that's it – instant clouds!



And a quick tip: if you have managed to select the mountains instead of the sky, select the Invert mask option before you click OK. If you find that your fuzzy selection hasn't worked out as you would have liked, remove it using Shift+Ctrl+A and select the White (full opacity) option when creating your layer mask. You will then see only sky once you confirm the layer creation action. The next section tells you how to delete the parts of the new image you don't need.

We have already produced a pretty good result which we are now going to fine-tune. Remove your selection using Shift+Ctrl+A and select the Brush tool in the Toolbox. We will now use the brush to "free up" the sky. If necessary, press the D key to switch the foreground and background colors back to black and white, and then press X to switch the foreground to white. Select a soft-edged brush size that suits the resolution of your image and click on the layer mask in the Layers dialog. The layer mask will then be displayed with a white frame to indicate that it has been selected and the image window will display a green frame (instead of its normal black/yellow dotted frame) to indicate that you are painting into the layer mask and not into the original image.

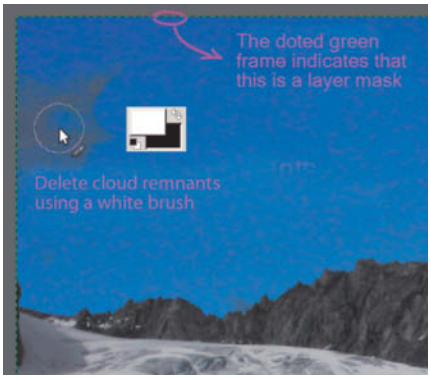




Now, using the white foreground, paint over the sky to eliminate the remains of the bad weather sky. If your selection includes parts of the image that lie outside the sky area – which can happen if the colors are similar enough – you will need to paint over the parts of the mask that are unintentionally

Tips & Tricks 1

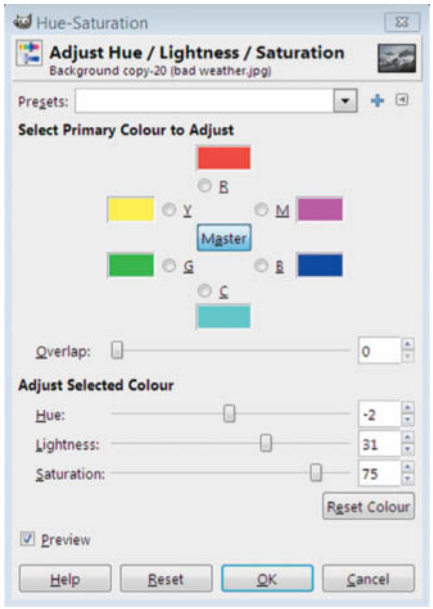
Duplicate the background and position the copy – with a low opacity value – above the sky layer you are working on. This helps to identify the parts of the layer mask that still need to be painted white.



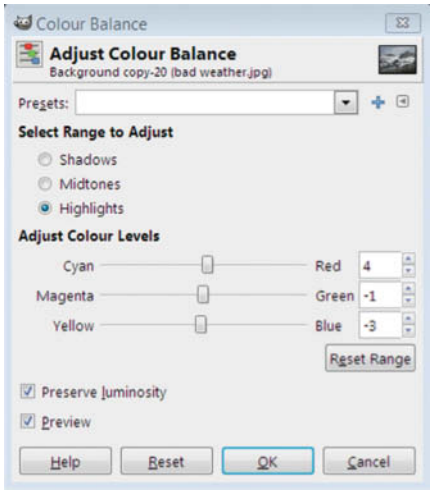
white using a black brush. To do this, switch your foreground color to black (by pressing the X key) and paint over the details you no longer want to appear in your mask.

Adjusting Colors

Once you have successfully created your new sky, you can fine-tune the colors in the rest of the image to match the brightness of the sun that was not present in the original. Select the mountain layer in the Layers dialog and navigate to the Colours > Hue-Saturation dialog. Select Y (for yellow) and move the *Lightness* and *Saturation* sliders to the right. This intensifies the yellows in your image. Do the same for the reds, click OK and then navigate to the Colours > Colour Balance dialog.



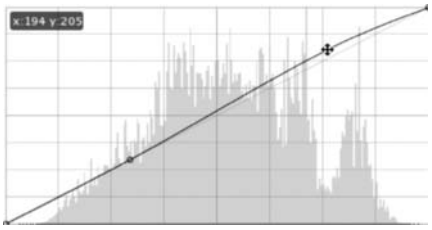
Here, you can intensify the complementary cyan, magenta and yellow tones for the shadows, highlights or midtones in your image. A Shadows adjustment is appropriate for the dark cliffs in our example, while a Midtones adjustment helps to brighten the meadow in the foreground. Try to increase the warm yellows, reds and magentas in the midtones and highlights, but remember to use these adjustments sparingly if you want to keep your results looking realistic. Confirm your color adjustments by clicking OK and navigate to the Colours > Curves dialog, where you can brighten the image highlights globally by moving the top right-hand end of the curve slightly upward.



Tips & Tricks 2

Take pictures of skies everywhere you go – they often come in handy when you are merging images or making photomontages later on.

Save your skies in a separate folder and try to collect as many different moods as you can.



So you see, bad weather is no longer a reason to keep your camera in its bag, especially if you are faced with one-of-a-kind views like this one in the Ziller Valley in Austria. (ae/rez)

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Bettina K. Lechner

Tuning Your Photos with GIMP

If you are already a GIMP user, then this article is for you. It's the first of an occasional "Get the most from your photos" series. This installment explains how to produce impressive infrared color shifts, cross-processing effects, photomontages, reduced depth of field and professional-looking postcard layouts.

Two Easy Steps to Infrared Effects

Infrared techniques block the transmission of the parts of the visible spectrum that we normally see and make frequencies beyond both ends of the range visible. Infrared processes produce magical-looking black-and-white images and fanciful color shifts with a multitude of tones.

Infrared images are usually produced using special cameras or infrared filters, but can also be simulated using GIMP. The best photos to use for your first IR images are well-lit landscapes, winter shots or urban scenes. The effect is different for every photo – this is what makes using it so exciting! The more you use it, the more likely you are to go out and purchase an infrared filter for your camera.

Step 1

▶ Open your image, duplicate the background layer using Shift+Ctrl+D and rename it *Channel Mixer* by double-clicking its name in the Layers dock.

▶ Leave the new layer active and open the Channel Mixer dialog in the Colours > Components menu. Take care – the effectiveness of the entire process is determined by the settings you make here, although the optimum values vary widely from image to image. Whatever you do, activate the *Monochrome* and *Preserve luminosity* options. The following values worked well with our sample image:

Red: 118
Green: 200
Blue: 102

The most challenging part of this step is to find the right mix for the red and blue channels, to preserve detail without making the result too grainy. Keep an eye on the image preview and use the Magnify button to check detail close up. Pay special attention to uniform shapes like the sky, where image noise is most obvious.

Increasing the Red and Blue values reduces noise and, if the result still lacks detail, you can further reduce the Blue value to prevent your image from looking too dull. There are no catch-all settings that we can recommend, but a good starting point for your experiments is:

Red: 40-200
Green: approx. 200
Blue: 100-150

Once you have entered your chosen values, click OK to close the dialog.

Please note: you can only see the results of your settings once you have clicked OK. If you don't like what you see, use Ctrl+Z to undo the previous step and reopen the Channel Mixer to enter different values.

Step 2

▶ Duplicate the background layer again using Shift+Ctrl+D and name the resulting layer *Invert*.

▶ Activate the Invert layer and select the Colours > Value Invert command. This inverts

The GIMP infrared effect is easy to use and produces impressive results

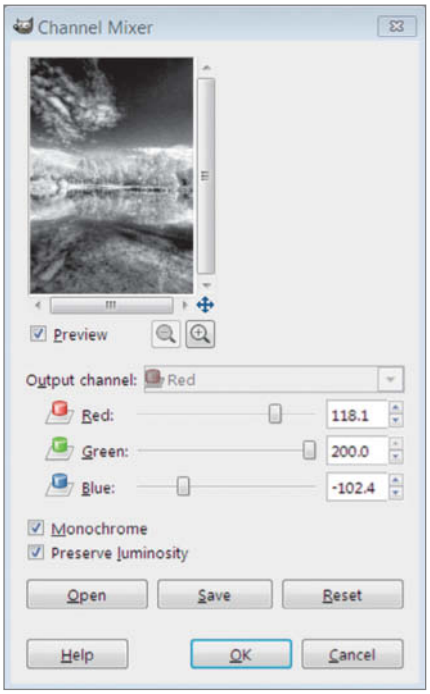
only the luminosity values in your image. Set the Layer Mode to *Soft Light* and reduce Opacity (perhaps to between 40% and 70%) until you like the result. And that's it! If you are still not happy with your results, try these fine-tuning steps:

Reducing Image Noise

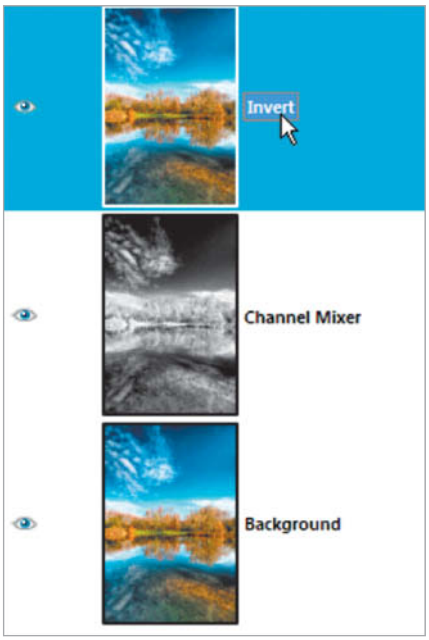
Duplicate the Channel Mixer layer, place the new layer between the Channel Mixer and Invert layers and reduce its sharpness using Filters > Blur > Gaussian Blur (for example, using a Radius value of 9). Reduce opacity to about 10%. This reduces the noise produced by the Channel Mixer and softens the overall effect.

Color Variations

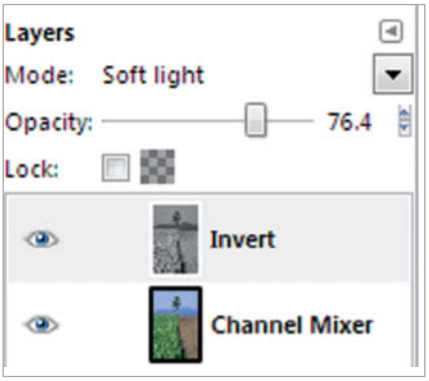
Instead of using the Value Invert command described above, use the Invert command from the same menu. This inverts all color and saturation values as well the luminosity values, providing your image with a new spectrum of colors.



Step 1: **The settings you make in the Channel Mixer are the key to successful infrared effects**



Step 2: **The Layer stack before the luminosity values are inverted to their complementary values …**



… and after applying the IR effect in *Soft light* Layer Mode.

Cross-processing is Back!

Cross-processing is enjoying a revival. The style had its heyday in the 1980s, when extreme contrast, over-the-top highlights and deep shadows were combined with bizarre colors to produce a new, contemporary look.

Did you read that right? A 1980s style and contemporary digital photography mentioned in the same sentence? Actually, cross-processing has its origins in analog darkrooms, where adventurous types deliberately used the "wrong" chemicals to develop their films, using color negative developer to develop slides, for example. The randomness of the process means that there is no definitive cross-processing look, but the idea has always been to produce something that looks unusual.

Any well-lit image makes suitable source material for digital cross-processing, but retro-style images with unusual views (of antiques shops, for example) are ideal. Just about any portrait shot is also a good starting point.

Photo: Mirma – Fotolia.com

Gaudy, unrealistic colors and over-the-top contrast are typical features of cross-processed images

Step 1

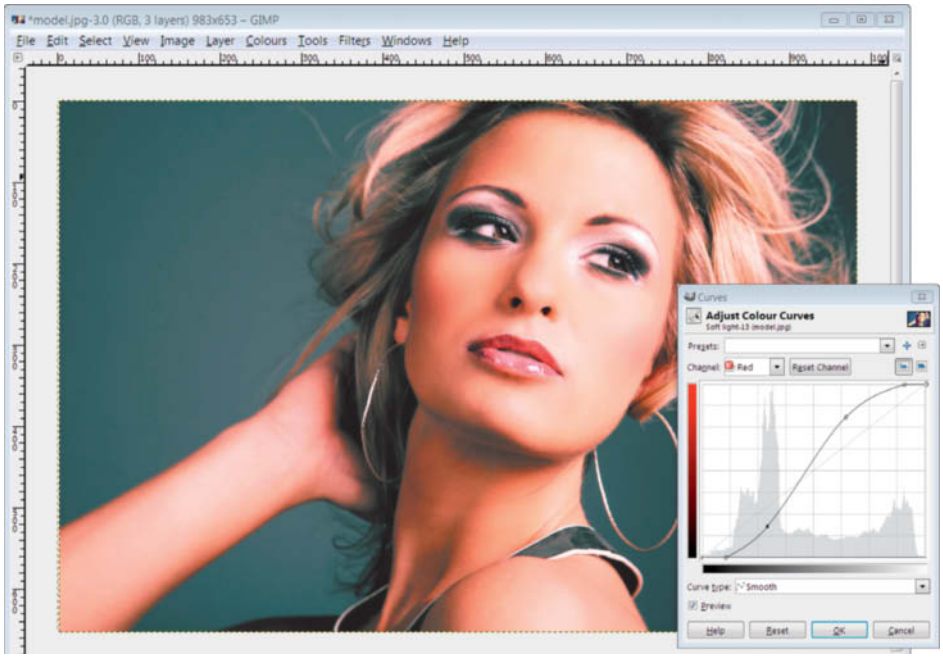
▶ Open your image and, once again, duplicate the background layer using Shift+Ctrl+D.

▶ Navigate to the Colours > Curves dialog to change the hue of the individual color channels. It is important to keep an eye on the effects your adjustments have using the image preview. The look of your results on your own monitor at home is much more important than concentrating on using the same settings that we do. Switch from *Value* to *Red* in the Channel drop-down menu and shift the upper anchor sharply to the left and the lower anchor sharply to the right. This eliminates the brightest highlights and the darkest shadows from the red channel. You can then adjust the curve to form a moderate S shape to increase contrast. Don't worry if your initial results look a little over the top.

▶ Switch to the Blue channel in the same dialog and shift the top right anchor down by one square, then shift the lower left anchor up by the same amount. This shifts light blue tones toward red and strengthens the shadows. You can now shift the middle of the curve down a little to form a light curve.

▶ Switch to the Green channel. At this point you should be starting to get an idea of the new look your image is taking on. Here too, you can form an S curve and, if necessary, shift the highlights a little to the left until the leftmost tonal values start to increase. This intensifies the greens in your image.

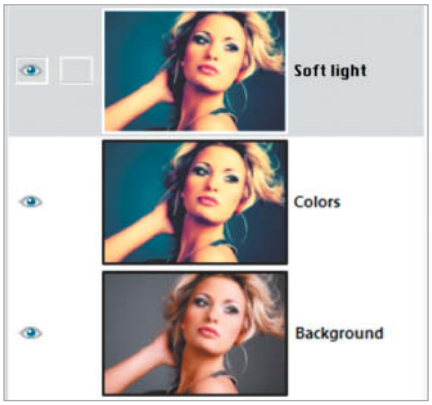
Confirm your changes and click OK to close the dialog.



Step 1: Altering the curves for the individual color channels – in this case, the red channel

Step 2

Switch the Color layer's Layer Mode to *Colour* and duplicate your cross-processed layer using Shift+Ctrl+D. Switch the new layer's Layer Mode to *Soft light*.



The layer stack after step 2 has been performed

Step 3

Open the Curves dialog for the uppermost layer and create a moderate S curve with the Channel option set to *Value*. This increases contrast for all color channels simultaneously.

Optional: strengthen the colors

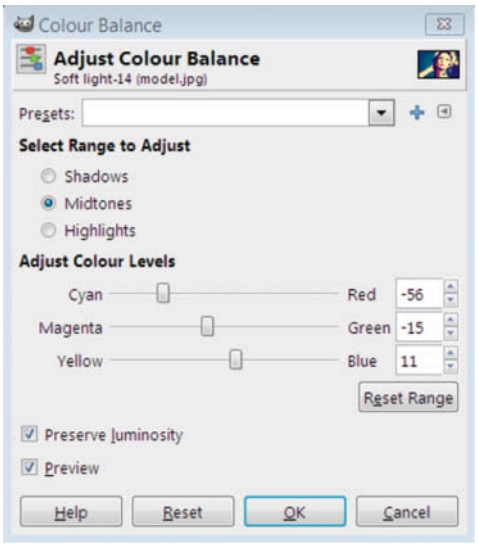
To strengthen individual colors, use the Colours > Colour Balance dialog. Leave the Range setting set to Midtones and shift the first slider toward Cyan, the second toward Magenta and the bottom slider a little toward Blue. As already mentioned, these are sample values that won't necessarily be applicable for your own image.

Another way to add an artificial color cast to an image is to create a new layer at the top of the stack, using Shift+Ctrl+N, and fill it with a strong color like magenta (HTML notation: dc18d5).

A useful trick when filling a layer is to define your color first and then simply drag the foreground color icon from the toolbox to the image window. You can then adjust the Opacity setting for the filled layer in the Layers dock until you achieve the right degree of transparency for your image. A value of 10.5% worked well in our example.

Frame Your Image to Look Like a Slide

You can give your retro-look image a final flourish by framing it to look like an analog slide. To do this in GIMP: right-click the top layer in the stack and select the New from Visible command. GIMP then creates a new composite layer using all the current layers in the dock. Remove the alpha channel by right-clicking the new layer and selecting the Remove Alpha Channel command. Now all you have to do is select Filters > Decor > Slide and enter some text. We used "1980s". Leave the rest of the settings at their default values and click OK. The built-in GIMP script does the rest.



You can use the Colour Balance dialog to fine-tune individual colors

Photos: 1-3: Marion Salinger, 4: flickr.com/photos/simon_shek

A photomontage and the source images we used to construct it

Making Photomontages

A photomontage is like a picture book that has been compressed onto a single page to tell a story without words. The first challenge lies in selecting source images that fit together to produce an agreeable finished picture.

Let's start with a few basic "rules" for making a successful photomontage:

– Collect all of the images that are relevant to your subject in a single folder
– Select a background image that has sufficient empty space or unimportant details that you can cover with your other, more important details
– Select a single main image and a collection of smaller details that help to tell your story
– Make sure all of your images have colors that suit each other. It's easiest to make a

successful photomontage using images taken as a series or on a single shoot.

– If the colors in your images don't harmonize, you can adjust individual colors later once you have finished the merging process. Desaturating a finished montage also helps to harmonize mismatched colors.

To keep this article concise, we will show you how to make a photomontage using simple layer masking techniques and just four source images. Use these guidelines as an inspiration for making your own, more complex photomontages.

Step 1

▶ Open the image you want to use as your background (here: montage1.jpg) and then use the File > Open as Layers command (or Ctrl+Alt+O) to open your second file as a new layer.

▶ Click on the upper layer in the Layers dock and select the Add Layer Mask command from the context menu (reached via a right-click).

▶ In the dialog that follows, select the *White (full opacity)* option. We will now use the layer mask to cover the parts of the layer that we don't wish to be visible in our final, merged image. The necessary steps are as follows:

▶ Press the D key to set the foreground color to black and the background color to white. Painting into the layer mask with a black brush masks pixels in the upper layer and allows the background to show through, while painting white into the mask has the opposite effect, and "uncovers" already masked pixels. You can now experiment as much as you like, as this method is non-destructive, which means that you can undo any of your brushstrokes at any time should you mistakenly "erase" the wrong part of your image. The Brush, Pencil and Airbrush tools are great for this type of work, too. The Blend tool is a boon for photomontages, so we will start by using it to create a smooth transition between our two source images. We will use the Brush tool later to fine-tune some details.

▶ Press the L key to activate the Blend tool. The default settings create a linear gradient and use the current foreground and background colors – in this case, black and white.

▶ Click on the layer mask in the Layer dock. The image preview will now be outlined in green to indicate that you are working on the mask and not the original image.

▶ Place your cursor where you want the gradient to start – in this case, slightly to the right of the jeep

▶ Click in the image and drag a short horizontal line from right to left. This masks the entire right-hand side of the active layer and creates a smooth transition between the two visible half-images. If you are not happy with your results, simply reposition your cursor and drag a new gradient using different lengths, angles and gradient shapes.

Step 2

▶ Open the next file (here, montage3.jpg) as usual using File > Open as Layers or Ctrl+Alt+O.

▶ Repeat step 1 to create a layer mask for the new image. We used a black-to-white blend gradient to reveal the clear water from the lower layer in place of the muddy river in the image on the new layer. Starting at the river bank, we dragged the gradient to the lower edge of the bridge.

▶ We then used a relatively broad, soft-edged brush to reveal the jeep. Once again, if you reveal too much of the lower layer, press the X key to switch the foreground color to white and paint over the excess pixels.

Step 3

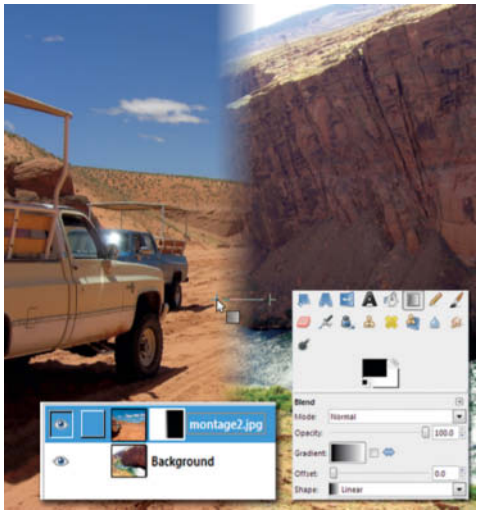
▶ Load the final image (here: montage4.jpg) and use the Move tool (press the M key to activate) to place it in the lower right corner of the preview frame. The road sign is pasted onto a homogenous white background, which makes selecting and cropping it using a layer mask easier. Activate the Fuzzy Select tool (press the U key to activate), check the *Feather edges* option and set its Radius value to about 10.0. You can now click on the white frame around the road sign.

▶ Now create a new layer mask for the montage4.jpg layer (using Add Layer Mask in the layer's context menu), activate the Selection and Invert mask options. This switches the white portions of the frame surrounding the sign to black, making them invisible in our photomontage. Confirm your selections by clicking Add and delete the temporarily saved selection using Shift+Ctrl+A.

Step 4

Nearly done! The last step involves inserting a colored layer reminiscent of the dusty red landscape in a Western movie.

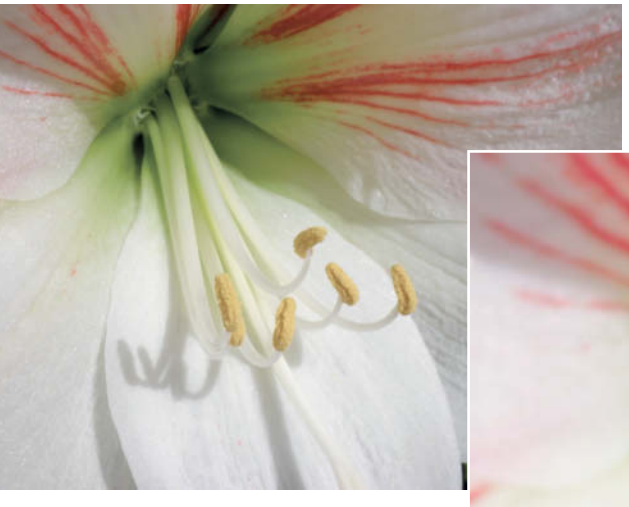
▶ Create a new layer using Shift+Ctrl+N and click on the foreground color in the toolbox to open the color picker. Enter appropriate color values (we used Red: 118, Green: 103, Blue: 103) and click OK to select the new color. You can now drag the foreground color to the image preview window. Switch Layer Mode to Saturation and set opacity to about 50. There you have it – a finished photomontage.



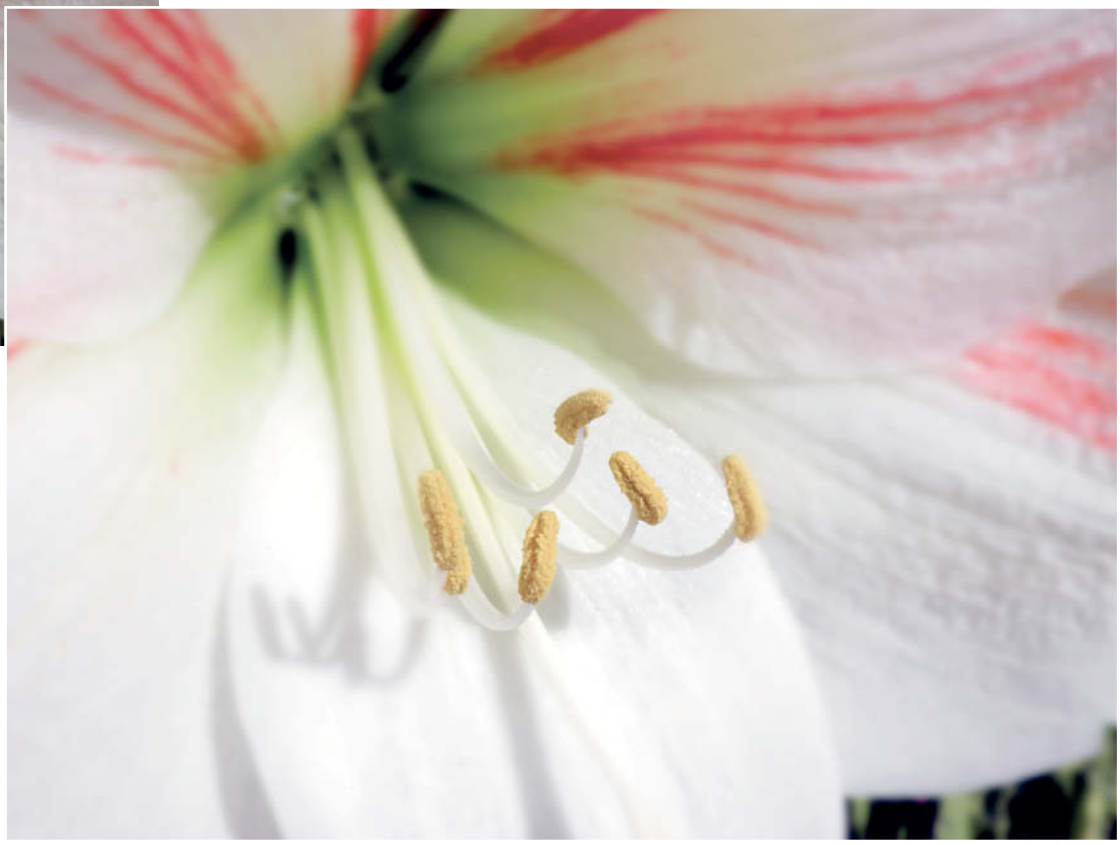
Using the blend tool to create smooth transitions between the image elements on the various layers

Using the Brush tool to reveal the masked jeep

Selecting and cropping the road sign using a layer mask



The original image, showing the entire subject in sharp focus



Reducing depth of field automatically attracts the viewer's attention to the parts of the image that are still in focus

Reducing Depth of Field

Adjusting focus is an effective way to steer a viewer's attention toward the most important element in an image.

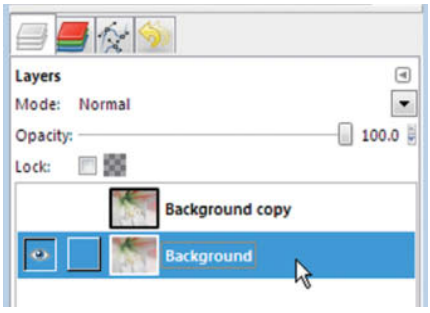
Most compact digital cameras have relatively short focal length lenses and, consequently, a relatively deep field of focus that portrays subjects in sharp focus from the close foreground to the furthest background. This makes deliberate, creative use of depth of field virtually impossible if you are using a compact camera. This article shows you how to use GIMP to reduce apparent depth of field after shooting.

Step 1

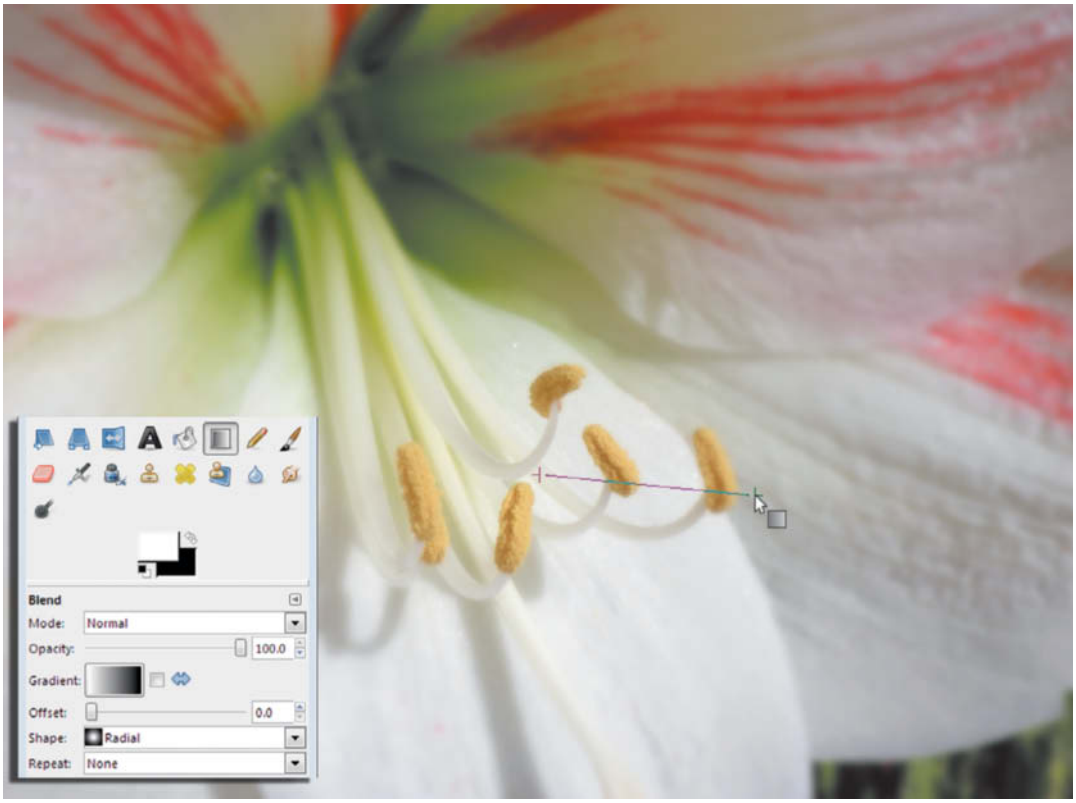
▶ Open your source image

▶ Duplicate the background layer using Shift+Ctrl+D and temporarily hide the copied layer by clicking on the eye icon in the Layers dock. Reactivate the background layer.

▶ The background layer is where we create the defocused part of our final image. Select Filters > Blur > Gaussian Blur and enter a high Radius value. We used a value of 40 for our 4000 × 3000-pixel sample image. Select the IIR Blur Method option for faster processing and click OK to apply the blur effect. If the effect is not strong enough, you can re-apply the filter by pressing Ctrl+F. Shift+Ctrl+F reopens the filter dialog if you want to change your selected values manually.



Step 1: As always, we work on a copy of the background layer. At this stage, the copied layer is hidden.



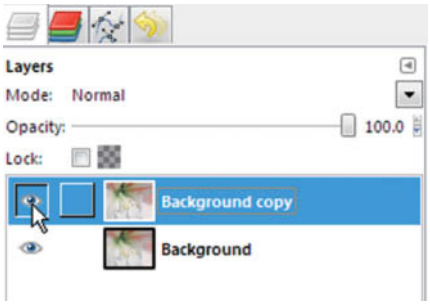
Use a blend gradient in a layer mask to determine which parts of the finished image are kept out of focus

Step 2

▶ Show the upper layer by clicking on the eye icon in the Layers dock. The preview image will once again be in focus.

▶ The next step involves masking the unwanted sharp areas using a layer mask that allows the blur we have created on the copy layer to show through. Layer masks are explained in detail in the *Photomontage* section above, so we will only include an outline of the necessary steps here.

▶ Create a white layer mask for the upper layer and press the D key to switch the foreground color to black and the background color to white. Then press the X key to switch these settings (i.e., to make the foreground color white). Now Press the L key to activate the Blend tool and set the Shape option to *Radial*.



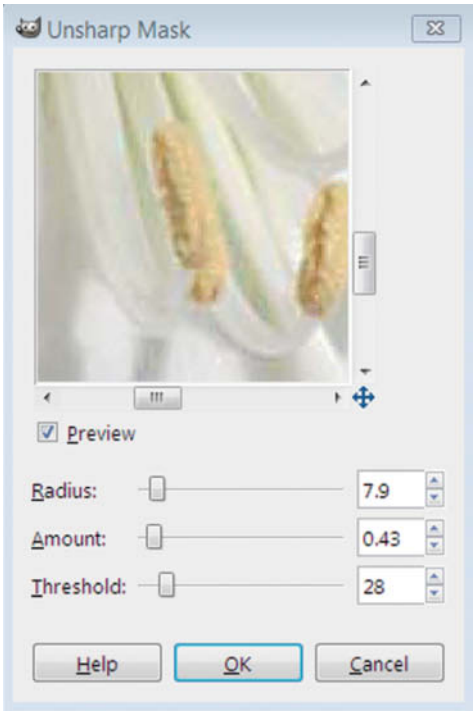
The layers stack at the start of step 2

▶ Now place your cursor where you would like the center of your in-focus area to be and drag it to where you want your blur to start. The line that the tool displays is a radius of the circle formed by the gradient. Once you release the mouse button, you will see the effect your gradient has in the image preview. The layer mask enables you to adjust the blur effect and the run of the gradient as often as you like without actually affecting a single pixel in the original image.

▶ You can further enhance the sharpness of the in-focus area by applying a couple of careful dabs with a large, soft white brush (activated by pressing P) to the area where the gradient is active.

Step 3

▶ To complete the process, we used the Unsharp Mask filter to sharpen the entire edited image. To do this, select the 100% view in the status bar, as this is the only setting at which you can adequately judge overall image sharpness. Instead of the layer mask, select the image itself in the Layers dock and navigate to Filters > Enhance > Unsharp Mask. The values you enter here will depend on the sharpness of your edited image. We didn't need to sharpen our sample image too much, so relatively low Radius and Amount values of 7.9 and 0.43 did the trick. The greater the Threshold value, the more blurred the results will be, and we selected a medium value of 28. Click OK to apply your selected values. Reducing background sharpness is a particularly effective way to accentuate faces in portrait photos.



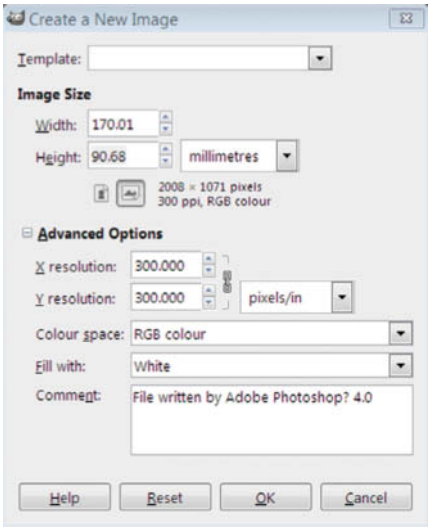
Step 3: Sharpening the finished image using the Unsharp Mask filter

Creating Professional-looking Postcard Layouts

Have you ever looked closely at the postcards that people send you? The quality of the images often leaves a lot to be desired, but a frame and some appropriate text can easily turn a sub-standard photo into a great-looking greeting.

Step 1
Select File > New (Ctrl+N) and make the following settings:
▶ Set the units to millimeters
▶ Set Width to 170 mm and Height to 120 mm – these are common postcard measurements. The slight discrepancies between the values you enter and the values displayed by the program are due to rounding errors during the internal conversion from pixels to millimeters, and can simply be ignored.
▶ Click the Advanced Options button and set *X resolution* to 300 pixels/in – the Y resolution value will automatically change to match. Leave the color space set to RGB and select white as your Fill color. Use Ctrl+S to save your settings as a template.

Step 2
This is where we prepare the image for use in our postcard template.
▶ Select File > Open (Ctrl+O) to load your image in a new window. Make any adjustments to color, contrast etc. before proceeding.
▶ Adjust the size of your image to fit the postcard layout using Image > Scale Image. Set X resolution to 300 pixel/in. Now switch the Image Size setting to millimeters and select a width of 136 mm. Pressing the Enter key automatically sets the height to match. Confirm these settings by clicking the Scale button.
▶ The image is still a little too high. Use the crop tool to draw a large frame over the en-



Step 1: Selecting width, height and resolution settings

tire width of the image. Here too, you need to set units to millimeters and a height value of about 80.

▶ Move the crop frame to the correct position using your mouse and press Enter to confirm your settings.

▶ Selecting the Filters > Decor > Add Border command does just what it says. Set the X and Y border widths (in pixels) and select a color. A border adds emphasis to the image in the finished postcard. We used a 7-pixel border with the HTML color notation 4e4e4e and a delta value of 20. The higher the delta value, the more luminous the border's color will be.

▶ Confirming your border settings by clicking OK creates a new Border layer, so you will need to use the Image > Flatten Image command to combine the two layers into one.

Step 3

This step combines the prepared image with the layout template we made earlier.

▶ Navigate to your template file in the Windows menu and select your image file in the drop-down menu at the very top of the Layers dock.

▶ Now drag the image icon from the Layers dock to the empty template in the image preview window.

Step 4

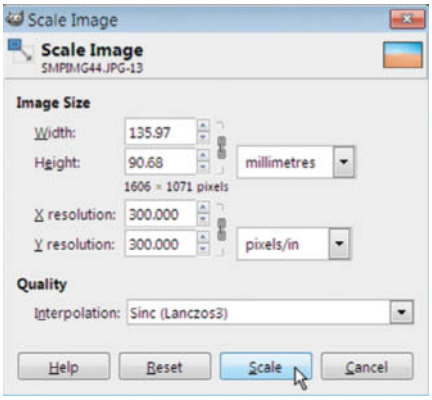
▶ As soon as you release the mouse button, your cropped, framed image will be positioned precisely in the center of the template. Switch back to the layout layer in the Layers dock and use the move tool (M key) to shift the image toward the upper edge of the frame. It is quicker and more precise to use the keyboard instead of the mouse. Pressing the arrow keys moves the image one pixel at a time, or 25 pixels every time if you hold the Shift key down.

▶ Activate the Text tool (T key) and select a typeface and type size (in millimeters). Leave the *Hinting* and *Antialiasing* options checked. Hinting makes text look smoother by adding pixels to the rough edges of individual letters. For our caption, we used the same 4e4e4e color (78, 78, 78 in RGB notation) that we used for the frame around the image. Select center justification (the third button) and extend the character pitch to spread the letters out. We used a value of 57.

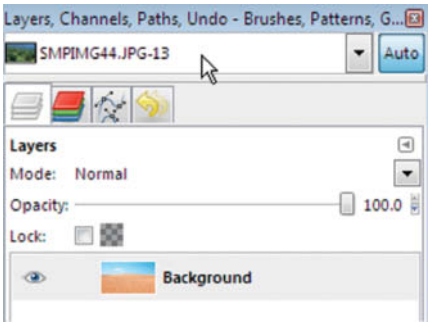
▶ Click on the text frame, drag it to cover the entire area below the image to ensure that it is truly centered and type your desired text into the editor that automatically opens when you adjust the frame. You can then fine-tune the position of the text frame using your mouse.

▶ Finally, add a drop shadow to your caption. Leave the text layer activated and navigate to Filters > Light and Shadow > Drop Shadow. We used X and Y offset values of 5, a blur radius of 15 and an opacity value of 64. Black is the best color to use for a shadow. Click OK and your postcard is finished.

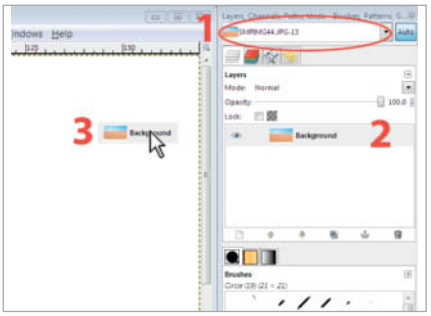
You can use the technique described here with any image you like to make birthday cards, Christmas cards, greeting cards or whatever else takes your fancy. The range of variations for text size and shape is endless. One final tip: remember to use the thickest paper your printer can handle when printing home-made cards. (keh)



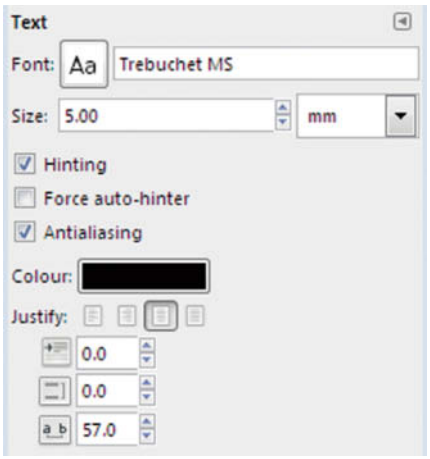
Step 2: Scaling and cropping the image to fit the layout



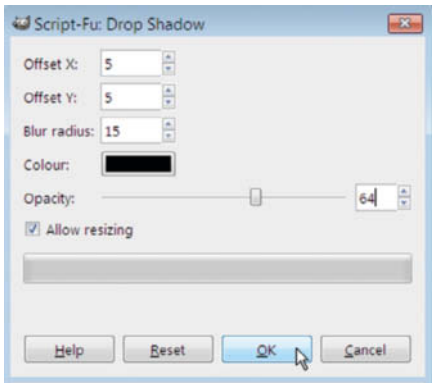
Step 3: Getting ready to drag the prepared image …



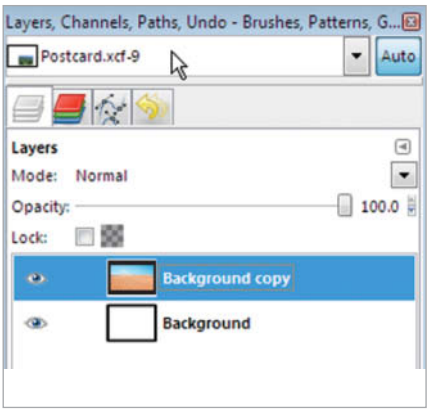
Step 3: … into the empty postcard layout



The text settings we selected in step 4



The final touch: a drop shadow for the caption



The layer stack after step 3


FUJIFILM

Sascha Steinhoff

How to Reduce Image Noise

Whether you use a cheap compact or an expensive full-frame DSLR, your unfiltered image data will always contain a certain amount of image noise. There are many ways to combat this phenomenon, but most noise filters have side-effects of their own. Reducing noise digitally always involves a loss of image quality, so it is better to reduce noise while you are shooting if you can.

Image noise was never a problem for analog photographers, and the only thing that produced electronic noise in those days was the television. The nearest analog equivalent to image noise is grain, which is usually used, or even deliberately enhanced, as part of the creative process. Although grain is basically an imperfection in the analog process, no-one ever thought of trying to reduce it or filter it out. The opposite is true of digital image noise, which is widely regarded as unaesthetic. Most currently available digital cameras have built-in, adjustable noise reduction filters and there is a whole armada of tools available for reducing noise during image processing. The disadvantage shared by most of these tools is that they involve additional work that costs time and effort. Once you have switched on a built-in noise filter, you can leave it switched on and forget about it.

Night shots, with their long exposure times and high ISO values, are especially susceptible to image noise. Applying a noise filter produces a smoother, more pleasing overall look.

Noise reduction filters tackle the symptoms rather than the cause of noise (for more information, see the following sections). Noise usually appears in one of three forms. The first, called **luminance noise**, occurs exclusively in the brightness channel rather than in the color channels of an image's data. The degree to which luminance noise interferes with the photo workflow depends on the type of output you intend to produce. Luminance noise is much more obvious on a monitor than it is in a print and reducing it also reduces overall image sharpness.

The second type of image noise, called **color** or **chroma noise**, occurs in the color channels of an image and is a more significant problem, because it directly affects the quality of print and monitor output. In order to keep the loss of detail to a minimum, it is advisable to reduce noise for each color channel separately.

Contents

The third major type of image noise is **hot pixel noise**, which is caused by much the same circumstances as color noise.

In-camera Noise Reduction

The noise reduction filters built into most cameras affect both color and luminance channels and can usually only be switched on or off (see also page 88), although some cameras do offer different strength settings. As far as we know, there is no camera firm-

ware that includes the range of settings and precise level of user-definition offered by purpose-built noise reduction filters like *Neat Image*, *Noise Ninja* and *Nik Dfine*. The dark frame data used to combat image noise during long exposures is usually activated automatically by the camera and cannot be switched on or off manually.

If you prefer to filter image noise manually, it will involve extra time and effort during image processing. Many of the options available in noise filtering tools, such as masking, are time-consuming and complex to apply, so you will have to decide whether the extra effort involved justifies the potential increase in image quality that manual filtering produces.

Other Alternatives to Noise Filters

Just as with unsharp-masking, the appropriate degree of noise filtering depends on our chosen output medium. Images that appear clear and sharp on the camera monitor can actually prove to be noisy and unsharp when viewed at 100% magnification on a computer monitor. Luminance noise is not necessarily a problem for print output, so make sure you really need to reduce noise before applying a filter. Strong filter effects reduce image detail as well as noise, and can produce flat, fake-looking images. This type of effect can actually improve images of cars or other products, but can produce waxy, artificial-looking skin if overused in portraits. The best way to deal with image noise is to avoid producing it in the first place – the following pages explain how.

One of the side-effects of noise filters is flat-looking skin texture that tends to make real people look like shop window dummies

Care is required when applying noise filters to portraits, as they often produce a non-authentic look

Images: www.scanguru.info

What Causes Noise?

The basic principle of digital photography is simple: light falls on an image sensor and is saved as visual information. However, the technical limitations of the process mean that the results are often less than ideal.

Noise, caused by unwanted interference mixing with the signals that we wish to receive or transmit, can affect music or moving images just as it affects digital photos. All the types of noise that affect digital images are referred to collectively as image noise.

Both CCD and CMOS image sensors convert incident light into electrical signals in a process known as the **photoelectric effect**. While generally reliable, this effect produces anomalies under certain circumstances. Sometimes the sensor simply cannot interpret the incoming light correctly or records light where none exists. In such cases, the pixels in the resulting image have the wrong colors, i.e., the image contains noise.

Dark Noise

Image noise occurs in various forms, including the ambient (or "dark") noise common to all image sensors. You can make dark noise visible if you take a picture in complete darkness. Theoretically, the complete lack of incident light should produce an image consisting entirely of black pixels, but this is not the case. Your image will be largely black, but will also contain random, colored pixels. Dark noise is not usually a problem under normal shooting conditions and, if sufficient light reaches the image sensor, the useful signals outweigh the interference anyway.

Dark noise is responsible for most of the noise produced by image sensors. It is caused by the "dark current" of electrical signals that result from the effects of warmth on the image sensor, which are then falsely interpreted as light. Dark current can be reduced by reducing the temperature of the image sensor. It is physically possible to use external means to do this, but the process involved is technically very complex. No current compact or DSLR camera has built-in sensor cooling, and such systems are generally the preserve of special astronomical and scientific cameras. Image sensors in off-the-shelf cameras simply adapt to the surrounding air temperature, although camera features such as Live View also produce additional sensor heat. Long exposures subject the sensor to longer periods of electrical activity and therefore also produce heat. Simply put: the warmer the sensor, the more noise the resulting image will contain, which is why image noise is sometimes also known as "thermal noise".

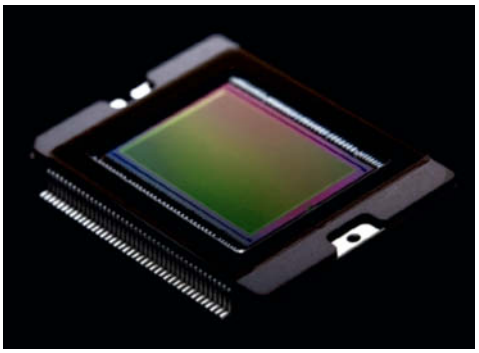


Image: Canon

The process of converting incident light rays into electrical signals isn't perfect, and a certain amount of interference noise is unavoidable. This picture shows the image sensor from a Canon EOS 7D.

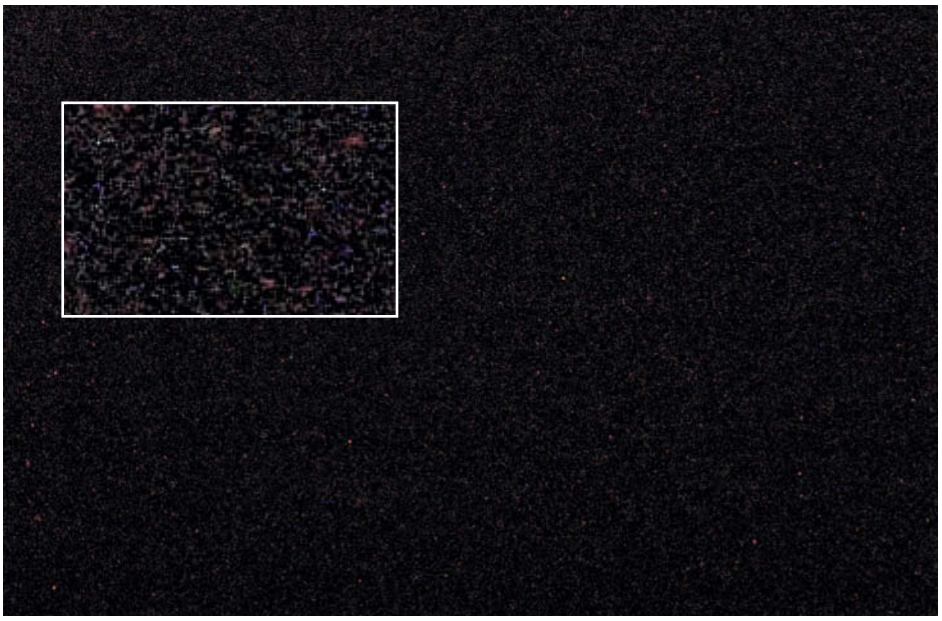


Image: www.scanguru.info

This is not a picture of a distant galaxy, but rather a digital image taken in complete darkness using a long shutter speed at ISO 1600. The colored pixels are dark noise, which we have accentuated for clarity's sake by digitally increasing the dynamic range of the image.

Other Sources of Noise

Normal, incident light can cause "photon noise" if it hits the image sensor in an erratic pattern and causes individual pixels to record erroneous information. The circuits that are used to amplify the signals captured by the image sensor can also produce noise and amplify any interference that is present anyway. This type of interference is known as **readout noise** and is amplified in direct relation to the strength of the amplification applied to the original signal. The electrical signals generated by an image sensor are amplified only slightly at low ISO sensitivities, but amplification increases with increasing ISO speeds, making images taken at ISO 200 less noisy than those taken at ISO 1600 using the same camera.

Lastly, there is the noise caused by **hot pixels**, which are usually very bright and of a noticeably different color from the surrounding pixels. Hot pixels are reminiscent of the broken pixels sometimes found in LCD monitors but only occur when an image sensor becomes warm. The effects dissipate once the sensor cools down. Individual image sensor pixels can break, but are then either dark (dead pixels) or bright white (stuck pixels).

The noise patterns produced by an image sensor depend on the physical arrangement of its electronic circuits. This image is a full-frame reproduction of the noise pattern produced by the Nikon D70s used in our tests. The readout amplification circuits are located at the top left corner of the sensor

Image: www.scanguru.info

Image: www.scanguru.info

This photo was taken in 30-degree heat at ISO 1600 as part of a burst sequence. All of these factors increase sensor temperature and can cause hot pixels to occur. The hot pixel shown here disappeared once the camera had cooled down.

Image Noise and Sensor Size

"The larger an image sensor, the less noise it will produce" – a widely-believed rule of thumb – is not entirely true. It is pixel density, not the absolute sensor size, that makes the difference.

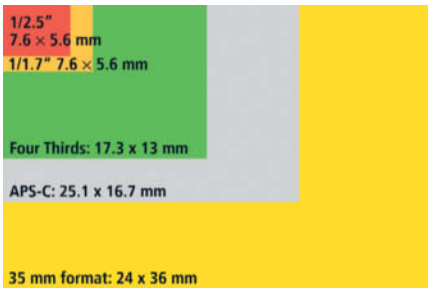


Illustration: www.scanguru.info

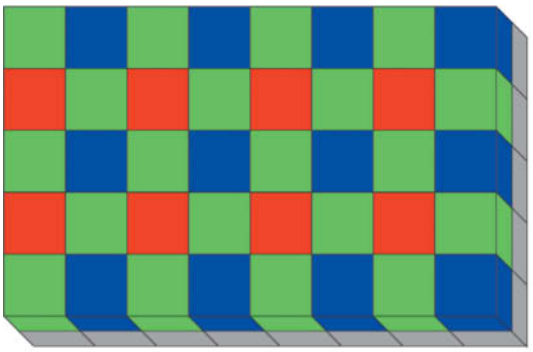
The 35mm format was the dominant format in analog compact and SLR cameras. In the digital market, the high costs of producing larger image sensors have led to a wide variety of formats competing for acceptance.

A camera's image sensor is the major culprit when it comes to producing digital image noise, so you should choose carefully when purchasing a camera. If you are looking to buy a camera with interchangeable lenses, you will usually end up using just one size of sensor. Most current DSLRs use either Four Thirds, APS-C or larger, full-frame (i.e., 24 × 36 mm) sensors.

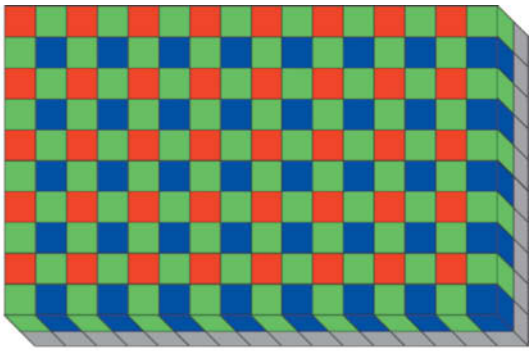
Larger sensors are more costly to manufacture, making small sensors the key to affordable DSLRs. The size of an image sensor also determines which lenses can be used – an important factor when you consider that even a modest set of lenses usually costs many times more than a camera body alone. For example, if you decide to invest in a Nikon D90 with its APS-C sensor, you will not be able to use the same lenses if you later decide to upgrade to a full-frame D700. The D90's DX lenses simply cannot cover enough of the larger image sensor to produce satisfactory images.

It is said that large image sensors produce less noise, and some photographers avoid using particular camera systems for this reason. The real reasons for sensor noise characteristics lie in the way the camera manufacturer uses an image sensor and its circuitry. The Four Thirds system uses the smallest sensors currently available on the DSLR market.

Pixel size and pixel density are more important than absolute sensor size when it comes to determining the noise characteristics of an image sensor. The number of mega-



5 × 8 = 40 pixels



10 × 16 = 160 pixels covering the same area

If you increase resolution for a constant sensor area, the pixel density increases. The less space a single pixel covers, the more likely it is to produce noise.

Comparison of Pixel Densities

Manufacturer	Camera Model	Camera Type	Sensor Size	Sensor Height [mm]	# of Pixels (vertical)	Sensor Width [mm]	# of Pixels (horizontal)	Pixel Density [Pixels/mm]	Sensor Area [cm²]	Theoretical Pixel Width [µm]	Sensor Area Proportional to 35mm Frame [%]	Megapixels (absolute)
Samsung	Pixon 12 M8910	Mobile	1/2.5	4.30	3000	5.76	4000	694.44	0.25	1.43	3.86	12.00
Canon	G10[1]	Compact	1/1.7	5.60	3312	7.60	4416	581.05	0.43	1.69	4.93	14.63
Canon	G11	Compact	1/1.7	5.60	2736	7.60	3648	480.00	0.43	2.05	4.93	9.98
Panasonic	DMC-L10	DSLR	Four Thirds	13.00	2736	17.30	3648	210.87	2.25	4.75	26.03	9.98
Olympus	E-30[2]	DSLR	Four Thirds	13.00	3024	17.30	4032	233.06	2.25	4.30	26.03	12.19
Sigma	DP2s[3]	Compact	Foveon X3	13.80	1768	20.70	2652	128.12	2.86	7.81	33.06	4.69
Canon	EOS 550D	DSLR	APS-C	14.90	3456	22.30	5184	232.47	3.32	4.31	38.46	17.92
Nikon	D70s	DSLR	APS-C	15.60	2000	23.70	3008	126.92	3.70	7.80	42.79	6.02
Nikon	D90	DSLR	APS-C	15.80	2848	23.60	4288	181.69	3.73	5.55	43.16	12.21
Canon	EOS 5D Mark II	DSLR	35mm[4]	24.00	3744	36.00	5616	156.00	8.64	6.41	100.00	21.03
Nikon	D700	DSLR	35mm[4]	24.00	2832	36.00	4256	118.22	8.64	8.47	100.00	12.05
Leica	S2	DSLR	Leica-S	30.00	5000	45.00	7500	166.67	13.50	6.00	156.25	37.50
Hasselblad	CFV-39	Medium format	Medium format	36.70	5412	49.00	7212	147.18	17.98	6.78	208.14	39.03
Leaf	AFi 10	Medium format	Medium format	36.00	6000	56.00	9288	165.86	20.16	6.00	233.33	55.73
Anagramm	David2[3]	Large format	Large format	72.00	16000	118.00	26000	220.34	84.96	4.50	983.33	416.00
Anagramm	Salvadore[3]	Large format	Large format	72.00	8000	118.00	13000	110.17	84.96	9.00	983.33	104.00

[1] The follow-up G11 model has reduced reoslution but the same sensor size.
[2] These are scan backs that are used for scanning static objects
[3] An unusually large sensor for this type of camera
[4] For reference

pixels or the physical measurements of a sensor are not particularly meaningful on their own, but the relationship between the two is crucial to sensor performance. For example, the Nikon D90's sensor packs 4,288 pixels into its 23.6mm width, giving it a horizontal pixel density of 4,288/23.6 = 181.69 pixels/mm. Each pixel is therefore 0.0055 mm (or 5.5 m) wide. Generally, the higher a sensor's pixel density, the more likely it is to produce noise. However, it is important to compare sensors of a similar age, as signal attenuation technology is also improving rapidly.

The table lists models of all classes, from mobile phone to high-end, large-format cameras. The results are extremely interesting and prove that technically, the Olympus E-30, with its Four Thirds sensor, is no more prone to producing noise than the Canon EOS 550D with its APS-C sensor. The Canon has greater resolution but offers no noise-related advantages. The Anagramm Salvadore scan back has the lowest pixel density of all our candidates, due to the manufacturer's decision to keep resolution relatively low in relation to sensor size. In the full-frame DSLR category, the Nikon D700 has lower pixel density than its Canon EOS 5D Mark II rival, which has a pixel density closer to that of some APS-C cameras due to its high (20-megapixel) resolution. Older APS-C cameras, such as the Nikon D70s, have lower pixel density than newer, full-frame cameras like the EOS 5D. Many compact cameras have the highest pixel density of all, due to manufacturers' use of the smallest possible – and therefore cheapest – high-resolution image sensors.

Canon squeezed 15 megapixels onto the 1/1.7" sensor in its Powershot G10 model. The follow-up G11 model has a third fewer pixels on a sensor of the same basic size.

Images: Canon

The Canon Powershot G10, with almost 600 pixels/mm, is particularly susceptible to image noise. Canon has given its successor, the G11, a sensor of the same size with a third less resolution, and the results it produces prove that this was a wise decision. Small sensors do not produce low-quality images per se, but are nevertheless not suitable for producing poster-sized prints. All types of cameras produce less noisy images if sensor resolution is chosen to suit sensor size. The Canon G11 is evidence of a trend reversal that we hope more camera manufacturers will soon be following.

Image: Canon

Image: Olympus

APS-C vs. Four Thirds: Canon continues to follow the trend of increasing resolution in its consumer DSLRs. The Rebel T2i/EOS 550D's high resolution means that it has the same pixel density as the Olympus E-30 Four Thirds camera. In this case, the higher pixel density cancels out the nominal advantage of a greater number of pixels.

In-camera Noise Reduction

RAW image files are widely believed to contain "pure" image data, but even high-end cameras rarely save images without subjecting them to some built-in processing.

The in-camera noise reduction systems built into early DSLRs didn't have a particularly good reputation. The algorithms used were not highly developed and camera hardware was still quite rudimentary. Serious photographers tended to shoot RAW images and reduce noise later using the superior performance offered by computer-based processing. Even now, photographers who shoot JPEG images still have to accept a degree of automatic, in-camera noise reduction as part of the simpler JPEG workflow.

Nowadays, most cameras have higher-performance hardware and improved noise reduction algorithms built in, but these factors alone still don't entirely explain the astonishing performance of the latest Canon or Nikon DSLRs, which both use a combination of various types of noise reduction.

On-chip Noise Reduction

The recent move from CCD to CMOS image sensors, typified by the difference between Nikon's D70s and D90 models, has one disadvantage, namely: CMOS sensors are noisier than CCDs. Camera manufacturers are now busy trying to stamp out noise at the sensor level and Canon has already published an extensive white paper on the subject (see the link at [1] below).

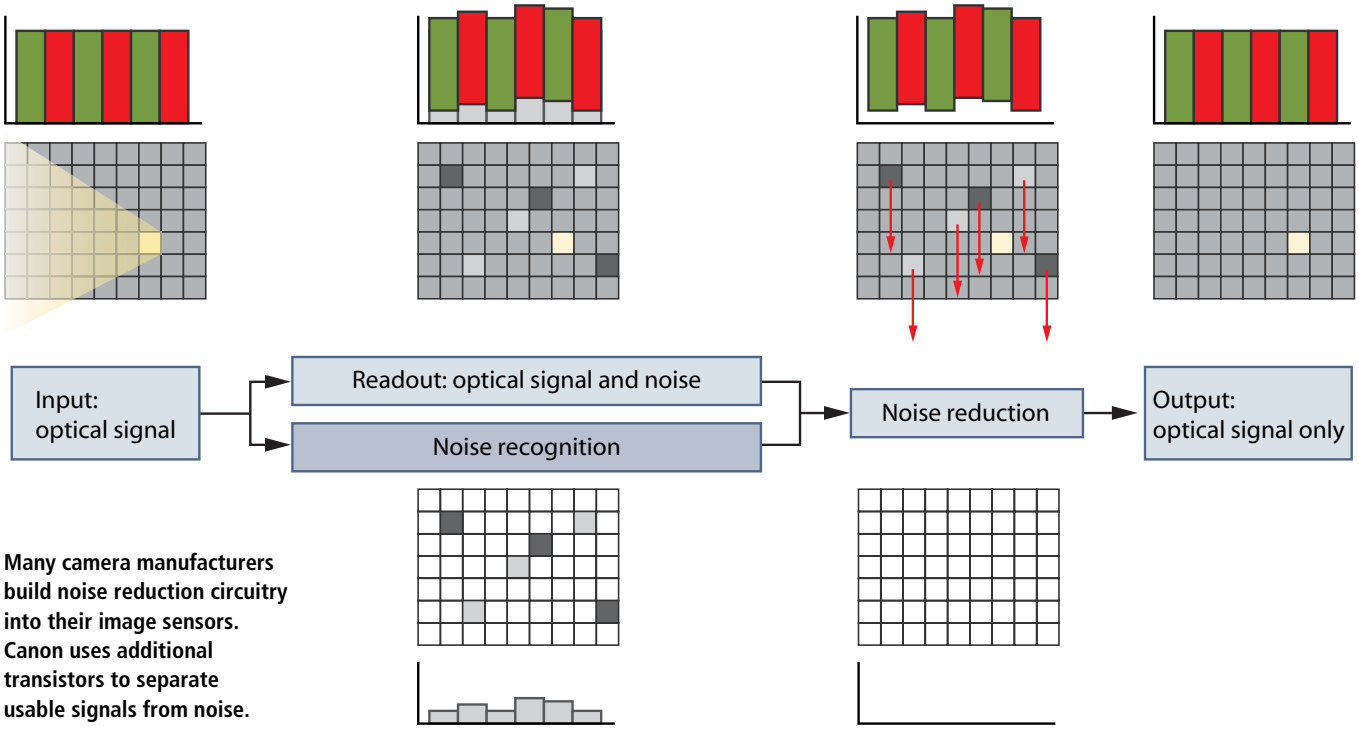
The Canon method uses an additional transistor for each pixel to help separate interference from the usable signal, which means that output from the sensor has already been filtered for noise. This process cannot be switched off by the user. While Canon manufactures its own image sensors, other manufacturers purchase their sensor chips from third-party suppliers like Kodak or Sony, who also build their own proprietary noise filtering technology into their products.

Long Exposure Noise

Dark frame noise reduction is the most common type of on-board noise reduction and is often used during long exposures as these are, by nature, more prone to noise. This technique causes the camera to automatically generate a second, separate image, called a dark frame, after the actual exposure. The dark frame is produced using the same ISO and exposure settings as the image itself, but without the effects of incident light on the sensor. This doubles the time required to make a long exposure. Once the dark frame is stored in the camera's buffer memory, the firmware subtracts the dark frame's pixel values from the image data, thus effectively reducing noise in the finished image. Like other noise filtering procedures, dark frame noise reduction can lead to a loss of image detail. Some cameras allow you to switch off the dark frame mechanism – the Nikon D70s doesn't allow for separate configuration, while the D90 has a menu item for switching the dark frame off during timed exposures. You can, of course, simply switch off your camera after the first exposure but before the dark frame is recorded. The camera will then only save the data that is already present in the data buffer. French astrophotographer Christian Buil discovered this method and named it "Mode 3". In any case, our D70s doesn't generate a dark frame for exposures that are longer than 30 seconds.

Generate your own Dark Frame

If you don't have complete faith in your camera's systems, you can also generate your



Many camera manufacturers build noise reduction circuitry into their image sensors. Canon uses additional transistors to separate usable signals from noise.

Illustration: Canon

The Right to Generate Noise

Dear Reader,

Digital image noise is a terrible thing and should be eliminated by every means possible!

This mantra can be heard on an almost daily basis from various camera manufacturers, and is repeated blindly by the media and many consumers. While the number of megapixels alone defines the quality of consumer-level cameras, a camera's noise characteristics are the make or break selling point for enthusiasts and professionals. The less noise a camera produces, the more high-end fans it will have. The continuing image noise debate is a blessing for camera manufacturers and keeps the market for improved technology alive in times when ever more megapixels no longer loosen consumers' grip on their wallets.

Nikon's "improved noise reduction" argument persuaded large numbers of users to upgrade from the D70s to the D200. But why did the D200's largely identical sensor produce so much less noise than its predecessor? The answer lay in its improved noise filter circuitry. Whether this represented a dramatic improvement for the D200's proud owners is a matter of conjecture, as we assume that they mostly shot in RAW anyway. This particular discussion finally ended two years later with the introduction of the D300. And guess what had been improved in the D300? I'll give you a clue: it begins with "n" ...

Personally, I am not a big fan of noise reduction per se, and complete elimination of noise produces the super-smooth, artificial-looking images that many critics of digital imaging decry. Waxy looking portraits and product photos that look far better than the products themselves are often the result of over-enthusiastic noise reduction. I like to have the option of switching noise filtering off, but in today's market, I can want as much as I like – even a "purist" camera like the Leica M9 forces its owners to filter long exposures for noise. Not that I question the competence of the Leica engineers, but RAW means raw, and that's how I like my image data served up. Pre-filtered is like pre-chewed and I don't like the taste of either! Whether or not to maltreat my image data later using software remains my own decision. Maybe in future I will simply ignore noise filters altogether and declare image noise to be a cult phenomenon – that way at least I'll have time to get out and take some photos.

All the best from Bangkok
Sascha Steinhoff

own dark frame and manually subtract it from your image data. Dark frame techniques can produce clear improvements in image quality, especially when combined with stacking techniques that superimpose multiple images taken using varying exposure values (see the link at [2] below).

This involves producing a sequence of images and a corresponding sequence of dark frames while keeping the camera in exactly the same position. Generally, the more images you stack, the more complex the merging process will be, but the quality of your results will improve accordingly.

Astrophotographers often use stacking techniques to improve their results (see the link at [3] below). Although painstaking, stacking is better at reducing readout noise than even a cooled image sensor.

High ISO Values

Low noise at high ISO values is a killer feature in any digital camera and, as a result of improvements in sensor technology and firmware-based noise filters, today's cameras produce less noise at ISO 6400 than their predecessors did at ISO 1600. Reduced-noise images often look cleaner, but sacrifice sharpness and authenticity. Sony, Canon and Olympus only allow you to switch their noise filters on or off, while Nikon's latest cameras offer various noise filter options. When asked, Nikon also confirmed that some automatic noise filtering takes place at certain ISO settings. Note that sensor-level filtering takes place independently of any menu-driven settings.

RAW Processing

In-camera noise reduction doesn't only affect JPEG image data; it is often sampled into RAW data too. The processes used to apply in-camera noise reduction vary from manufacturer to manufacturer and from model to model. For example, Nikon doesn't allow its users to switch off sensor-level noise reduction and claims that the feature simply produces better images. The dark frame is irreversibly integrated into the RAW image file (Nikon's RAW format is called NEF). If activated, the same is true of Nikon's High ISO noise filter, and once a NEF file has been de-noised, it stays that way. Basic noise filtering is active for every image file anyway, but you can still use a RAW editor to perform your own fine-tuned noise filtering in addition to any filters applied automatically.

Limited Choice

The idea that RAW image data represents the "pure" form of the light hitting your image sensor is becoming less and less appropriate as technology advances and camera manufacturers build increasingly sophisticated automatic noise filters into their products. These usually produce better results than non-filtered systems, but we would still like to see them as an option rather than a hard-wired necessity. Currently, camera manufacturers tend to decide what is good for consumers without giving them any choice in the matter. A quick look at some of the more popular Internet forums reveals that this trend is not necessarily a hit with consumers.

Useful Links

[1] Canon CMOS Whitepaper: www.usa.canon.com/uploadedimages/FCK/Image/White%20Papers/Canon_CMOS_WP.pdf
[2] Astrophotography, Nikon vs. Canon: www.astropix.com/HTML/I_ASTROP/NIK_CAN.HTM

Useful Tips for Reducing Image Noise

Even if it's impossible to eliminate image noise completely, there are still various ways for digital photographers to influence the noise characteristics of their images during shooting.

If you feel you need to use an in-camera or software-based noise filter it is probably too late, as this usually means your image is already noisy. There are, however, various ways to avoid producing noise artifacts in the first place – prevention is not only the most elegant way to avoid image noise, but also produces the best results.

First, protect your camera from excessive warmth. Most digital cameras are designed to function properly in a temperature range of 0–40 degrees Celsius (32–104 degrees Fahrenheit), and it is generally true that the cooler the image sensor is, the less noise the resulting images will contain. Even if you cannot directly influence the ambient temperature, you can protect your camera from excess heat. The interior of a car can quickly heat up to over 50 degrees Celsius (122 degrees Fahrenheit) in summer, so do not leave your camera in the glove compartment of your car in warm weather. Always take it with you if you can.

The longer an image sensor is in use, the warmer it becomes, so using shorter shutter speeds helps to avoid producing too much sensor heat. The same is also true if you are shooting in burst mode, although bursts have to be long and the additional shooting conditions fairly adverse before they really make a difference to the noise levels in your images.

Live View allows you to view a scene directly as it will appear in the photo, either via the camera's monitor or its electronic viewfinder (if it has one). Most current compact cameras do not have viewfinders and the latest EVIL (Electronic Viewfinder Interchangeable Lens) cameras have purely electronic viewfinders. The disadvantage of this type of design is that the image sensor is active the whole time an image is being vie-

Subsequent image brightening amplifies noise artifacts, so it is always better to expose your original image for longer rather than relying on adjustments you make later

Image: www.scanguru.info

Aperture Steps

Common f-stops	Arithmetic equivalent
f0.5	0.5
f0.7	0.71
f1	1
f1.4	1.14
f2	2
f2.8	2.83
f4	4
f5.6	5.66
f8	8
f11	11.31
f16	16
f22	22.63
f32	32

Image: Olympus

wed, which produces unnecessary sensor heat. Thirty minutes of Live View usage are usually enough to seriously deplete a camera's battery and to produce additional, unwanted image noise. Always switch off Live View during long sessions to save battery power and avoid producing additional heat-related noise.

Camera Specifications

Pixel density is an important factor in the chain of events that cause image noise. Once you have decided which camera you wish to purchase, you cannot alter the pixel density of the built-in image sensor. High resolution combined with small sensors automatically produces more noise than large-sized, low-resolution sensors. The relationships between sensor size, sensor resolution and image noise are described in detail on page 136!!!. Once you have chosen a camera, you can still influence noise levels by shooting at lower ISO speeds. The lowest speeds offered by your camera (usually ISO 100 or 200) will produce the lowest noise levels, but require more available light to make exposures. Bright, wide-aperture lenses are heavier and more expensive than other lenses, but allow more light to reach the sensor in low-light situations. Generally, image detail suffers at wider apertures, so a standard 50mm f/1.8 lens will produce its best image quality at a medium aperture of f8 or f11.

Four Thirds cameras offer no gains in image detail through stopping down. The 2x crop factor doubles the format's depth of field in comparison with traditional 35mm cameras. The amount of light that reaches the sensor is doubled (or halved) with each f-stop, and the mathematical difference between f-stops can be calculated by multiplying the previous value by the square root of 2. If you replace an f/2.8 lens with an f/1.4 model, you gain two f-stops – in other words, four times as much light reaches the sensor).

Live View is a really useful feature, especially when combined with a tiltable monitor. However, having it on all the time will increase the amount of noise in your images.

Choosing the Right Exposure Values

You can also influence image noise levels by adjusting your exposure values. Many digital cameras, typified by the Nikon D70s, tend to slightly underexpose, producing fewer highlights than an image can usefully bear. If you adjust the dynamic range of an underexposed image to brighten its highlights, you also automatically strengthen any noise artifacts present in the image data. Experience has shown that it is better to adjust exposure slightly upward than to attempt to adjust underexposed shadows and highlights later. Making sure the image histogram is exposed slightly "to the right" is often a better option and makes subsequent brightening unnecessary.

Image: Nikon

The range of focal lengths covered by the 18-55mm f/3.5-5.6 and 17-55mm f/2.8 Nikkor lenses are almost identical, although the brighter lens – at US$1,350 – costs nearly six times as much as the cheaper model. The more expensive lens has much wider apertures at longer focal lengths, but offers no real advantage at the shorter end of the scale.

Camera Modding – Build in a Sensor Heat Sink

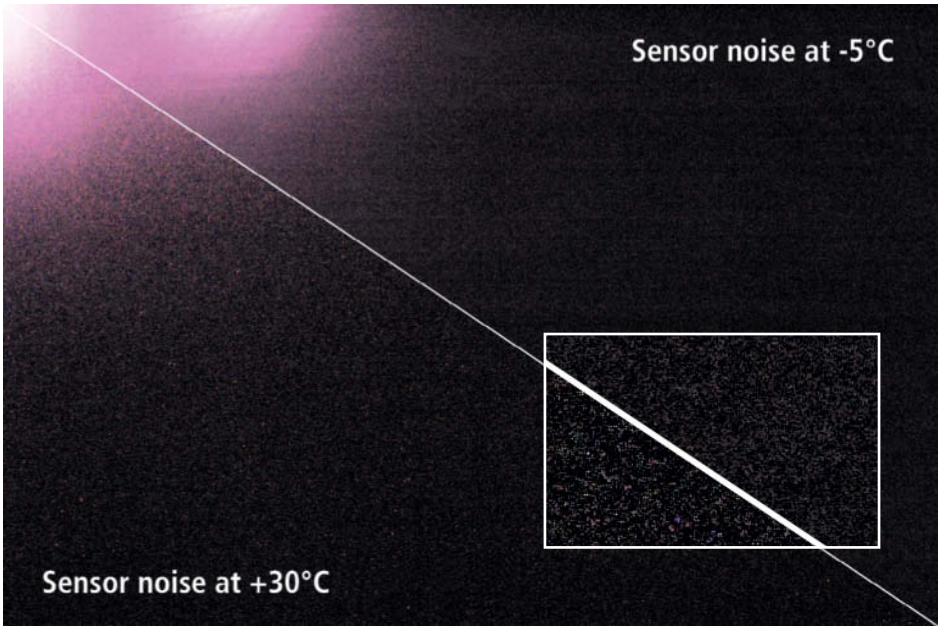
If you cannot reduce image noise enough using the conventional methods described above, you can, as a last resort, build a heat sink into your camera. This type of accessory is, as yet, the preserve of specialist applications such as astrophotography.

Astrophotographers lead a tough life. Not only do they have to stay awake all night, but they also have to get their cameras to do all sorts of things they weren't designed for. Hours-long exposure times and a subject that is basically black (i.e., the night sky) are a perfect recipe for producing a lot of image noise. And image noise is exactly what we don't need when we are trying to portray distant galaxies, due to the simple fact that erroneous pixels look a lot like stars. For the same reason, software-based noise reduction is a risk for astrophotos because it is all too easy to unintentionally filter out individual stars along with image noise.

The only sure-fire way to reduce image noise in astrophotos is to build an active cooling element into your camera. Some cameras – the Hasselblad H3DII, for example – use passive cooling to dissipate heat from the sensor via the camera body. The disadvantage of passive cooling is that it only reduces excess heat. It is, in fact, much more effective to actively reduce the sensor temperature to below that of its surroundings.

Less Heat, Less Noise

None of the major camera manufacturers include actively cooled image sensors in their range of products. Active cooling is still the preserve of scientific applications, although Canon did briefly manufacture and sell the special astrophotographic EOS 20Da, with a modified low-pass filter and early Live View focusing aids. The 20Da's sensor nevertheless remained uncooled. In spite of the industry's apparent disinterest, there is a flourishing worldwide community of astrophotographers who build and operate their own sensor cooling systems. Operating temperatures of as little as –20°C have been widely reported, although these do require a great deal of additional energy if they are to be consistently effective.



Our test scenario: a five-minute long exposure made at ISO 1600 in complete darkness using a Nikon D70s. At +30°C, the image displays strong noise and a large number of bright red hot pixels. Noise and hot pixel incidence are visibly reduced at –5°C. We used an identical tonal shift to make both effects visible in print.

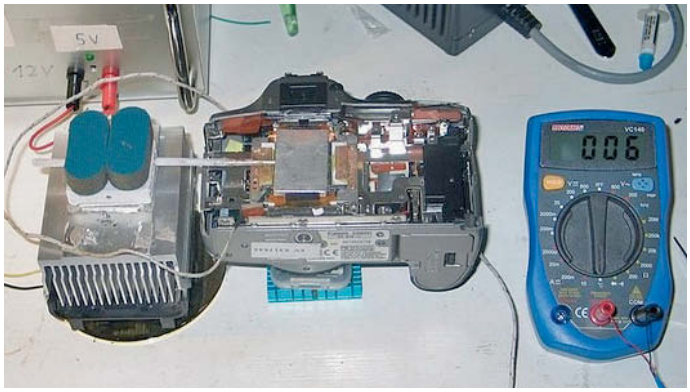
Deep-freeze DSLR

It is easy to try out the effects of sensor cooling for yourself. Simply wrap your camera in a towel and put it in the freezer for an hour or two. This is the method we used to produce our test photos. However, the cooled camera quickly reaches room temperature once you start shooting, making this particular technique unsuitable for longer sessions. You also need to take care that your camera doesn't warm up too quickly, causing water to condense inside the camera's body. The greater the difference in temperature between the camera and its surroundings, the higher the humidity will be, and the more likely it is that water will condense in or near the camera. The freezer effect also occurs if you shoot outdoors in winter, but both situations are outside the manufacturer's recommended usage scenario. Nikon and Canon both recommend operating temperatures of 0–40 degrees centigrade, which effectively equates to a recommendation not to shoot outdoors in winter!

Home-made vs. Factory-built

There are several factory-built sensor cooling solutions available. One example is Central DS in South Korea (www.centralds.net), who build and sell actively cooled versions of the Canon EOS 400D and EOS 50D models. Sensor cooling can be achieved either by cooling the entire camera, which is simpler to achieve, or by cooling just the sensor, which involves taking the camera apart. The simplest of all cooling methods is to use a portable beer cooler with a hole cut in it for the camera's lens but since this approach severely restricts camera handling, targeted sensor cooling is a more practical and elegant solution.

Modification techniques vary, but the basic principle involves dismantling the camera so that the back of the sensor is exposed. It is theoretically possible to mount a cooler directly on the sensor, but that would severely hinder use of the viewfinder and the camera's other controls. Most practical solutions involve the use of a metal bridge or heat pipe to transfer heat away from the sensor. You can attach such a "cold finger" to the



Images: www.astroklaus.de

The website at http://ghonis2.ho8.com/rebelpeltier.html includes detailed descriptions of the advantages and potential pitfalls of modifying a Canon EOS DSLR with a Peltier device

back of your sensor using thermally conductive paste, allowing you to position the heat sink or cooler beside or below the camera body. This type of solution usually also involves modifying the camera back to accommodate whichever type of heat bridge you are using.

Peltier Devices

Peltier devices are the most popular image sensor cooling solution and are constructed using a special type of thermocouple that produces heat at one end and absorbs it at the other when an electrical current is passed through it. Peltier devices are compact and highly effective, but unfortunately not very efficient. Because they use a lot of power they have not been able to establish themselves in the computer CPU cooling market. A Peltier device requires a power outlet to function properly, which seriously reduces mobility for Peltier-cooled cameras. You can make a Peltier device more efficient by attaching a conventional heat sink and a powered fan, just like in a computer. Once you have set up your cooing system, all that remains is to switch on the electrical current and to cool your image sensor to the desired temperature.

Any cooling system is potentially useful in a photographic context. For example, the website at www.ledametrix.com/co2 demonstrates a camera cooling system based on liquid CO2. Solutions based on liquid nitrogen are also feasible.

Conclusions

In spite of the obvious improvements in noise levels it can produce, practical and technical limitations make active sensor cooling unsuitable for widespread use. Active cooling has been an integral part of specialized applications such as scientific or astrophotography for years, but is simply not of enough use to be of interest to the photographic public at large.

We would like to see camera manufacturers put more effort into developing practical passive cooling systems for their image sensors, but they currently seem more interested in selling cameras with Live View functionality and electronic viewfinders, both of which contribute to increased sensor heat. (anm) c't

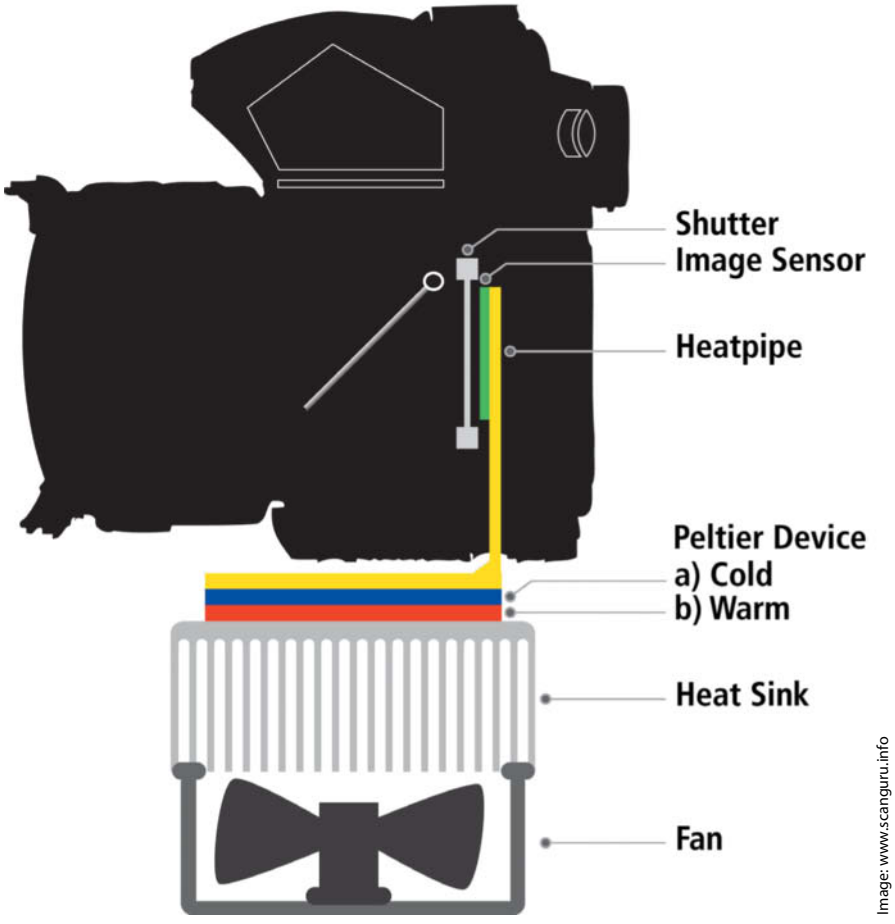


Image: www.scanguru.info

Active sensor cooling requires a high degree of electronic know-how. This illustration demonstrates the principles of such a system.

Ralph Altmann

Remote Triggers for Digital Cameras

You don't have to be a wildlife photographer to know that the best position for the camera is not necessarily the best position for the photographer. Remote control can improve the situation. This article explains the technical possibilities not only for releasing the shutter from a safe distance, but also for completely controlling digital cameras remotely, either by wire or wirelessly.

When using digital cameras, effort and success are sometimes only moments apart – the image appears on the display a split second after taking the picture, and it only takes a little longer to print the pictures or transfer them from the memory card to a computer. However, sometimes this isn't really convenient or fast enough. For studio photographers it isn't enough to have the result on the display. They often want it right on the computer's monitor without having to take the memory card out of the camera and plug it into the computer. Sport and nature photographers need to be able to be physically detached from the camera at times, for various reasons. The ideal position for the camera may be too uncomfortable or too dangerous. In some cases the presence of the photographer would make it impossible to take the picture, for example with shy animals. Still, all of the camera's functions should remain controllable and, if possible, the image should be transmitted. This is no longer a problem as many SLRs have a live preview.

Almost all cameras have a data interface, which is usually a miniature USB socket. However, a USB cable merely makes it possible to transmit images to a computer, so that you don't have to remove the memory card. Camera manufacturers only allow for higher communication capability in their digital SLRs, and even then, sometimes only in top-of-the-line models. The CHDK program (Canon Hack Development Kit), which can be used to retrofit several of Canon's compact cameras with a USB remote control, shows that this is only a question of firmware and therefore, of the manufacturers' will.

Behind the casing of these the small SD memory cards you will find full-fledged wireless electronics. The transmission only goes in one direction, from the camera to the computer.

A few compact cameras have the ability to transmit images to a computer over wireless LAN (mostly designated as Wi-Fi) at the outset. Other cameras can use a special SD memory card with an integrated Wi-Fi chip, although this requires that the camera has an SD memory slot. These cards are available under the Eye-Fi label and cost between US$50 and US$150 depending on the version. It is more of a marketing strategy than a matter of necessity that Eye-Fi offers so many different versions. Only the most expensive Pro versions can transmit RAW files and allow ad hoc connections. However, memory cards have a rather limited range; in cameras with a metal body, it may be just a few feet. It is not possible to control the camera remotely using this kind of memory card.

USB Remote Control

All that is required to trigger the camera is a signal in its direction. In comparison, a full-fledged remote control needs the communication to run in both directions. This is necessary so that at least the current camera settings can be displayed on the computer. The camera has to provide this information at the USB interface. It should also provide the Live View display at the same time. Therefore, the computer as a controlling device needs to have the right software. Most manufacturers offer both software and remote control, but only for their high-end cameras. Sometimes the remote control software is not included in the package and has to be

The wireless USB transmission is the only wireless item on the computer side of the setup. The adapter has to be connected to the camera and a power supply.

bought separately. For Nikon's Camera Control Pro 2 you need to spend around US$180. For Canon DSLRs the software EOS Utility, which comes with the camera, takes care of the remote control.

The connection between camera and computer is achieved quickly and without any installation via USB cable. The cable can be up to 16 feet long. Larger distances can be reached using USB repeaters that provide an additional 16 feet of signal strength each. The maximum number of amplifiers permitted in series is five, according to USB specifications. Together with the first passive cable, this equals a length of 96 feet. Plugging more together might work, but success is not guaranteed. Using special USB Ethernet adapters and a network cable, you can reach distances of up to 197 feet and more. If the network and adapters are designed for Gigabit Ethernet (as with the Silex SX-3000GB) such a connection can easily compete with USB 2.0 in terms of speed.

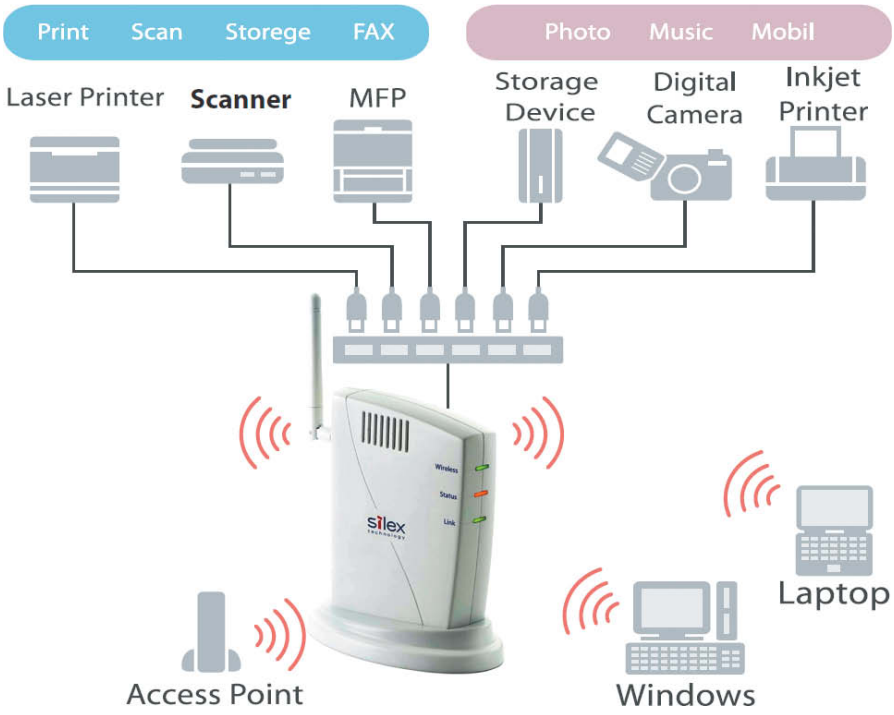


Illustration: silex technology, Inc.

The USB wireless LAN adapter can integrate up to 15 USB devices into a wireless home network. This picture shows the Silex SX-2000WG.

USB Wireless

Wireless USB was launched in 2005 with the intention to replace the USB cable connection. It was predicted that the wireless standard would have a big future. However, wireless kits are still rather scarce. We tested Hama's "Basic" Wireless USB Starter Kit. The Hama model is difficult to find in the US, but Belkin make similar models which are available for around US$60 at retail stores. The kit comprises two USB sticks with swivel-mounted plugs and a small port docking station, including an AC adapter. The USB peripheral device is attached to the docking station, as it probably won't have its own power supply. Therefore, this solution isn't entirely wireless, since the starter kit needs a socket nearby. With a little skill, you can make your own power supply with four mignon (AA) rechargeable batteries, which can be integrated with the camera USB stick in a small housing. Instructions are available at: http://ip-networx.de/index.php?option=com_content&task=view&id=39. Or see here: http://faq.d-r-f.de/wiki/Bild:Kl_wusb1.jpg for a lithium ion battery alternative. According to the author, the battery charge can last for the transmission of almost 1000 pictures, while the camera battery is used up much more quickly.

The disadvantage of wireless USB is its short range of about 30 feet. The highest transmission speed of 480 Mbit/sec can only be reached within a 10-foot range. In the case of larger distances, the transmission rate drops to 110 Mbit/sec. In our experiments, the Hama wireless kit had a range of only 15 feet. The Live View transmission rate dropped to almost half the cable transmission speed and the image was quite jerky.

Not even 110 Mbit/sec can be achieved in practice. We actually reached similar transmission rates with the wireless LAN 11.g – at least this was the case when we tested it at

This is what the "wireless" configuration using the Belkin "Home Base" USB WLAN adapter looks like in practice. Here, too, an outlet is required to supply power to the adapter.

distances greater than 10 feet. So why not use the wireless LAN in the first place? The wireless network can be used over greater distances, is available almost everywhere and, most of all, it is technically mature. A special USB wireless LAN adapter is necessary on the client side (camera), to transmit the USB signals transparently over the wireless network. The software on the host side (computer with wireless LAN or connection to a wireless LAN router) ensures that this connection appears as if it were a USB interface to other programs. There is a wider range of wireless LAN adapters than wireless USB adapters available on the market, but none of them are designed for mobile use, as they have a relatively large housing that contains a lot of air and several USB ports. In comparison, Belkin's "Home Base" (for around US$70) is a nicely designed flat box with four USB ports to which 15 more USB devices can be attached via additional hubs, and already supports the new wireless networking standard, 11n. Moreover, configuration, including the security settings, is surprisingly simple. Simply attach the device to the router with the LAN cable, select the network and you're done. Selecting the WPS button, if the router has one, is even faster.

When a camera is attached to the Home Base it appears as a removable media device or multimedia device in Explorer or the Finder, depending on which USB setting (mass storage or MTP/PTP protocol) you have selected. The remote programs work with this constellation in the same way as with a USB cable connection, except that the transmission speed is slower. As long as the host computer is connected to the Internet you can upload pictures to Picasa or Flickr. Silex's USB Device Server SX-2000WG is rather more expensive at around US$150 retail.

You can connect up to 15 devices to the network using a hub to just one USB port. However, the Silex USB device does not yet support the fast 11n wireless standard.

Nikon's separate wireless adapter WT-4, the camera-specific adapter WT-2 (for the D2x, middle) and WT-3 (for the D200, right)

It was possible to install rechargeable batteries as a replacement for the power supply in both of the USB wireless LAN adapters we tested. The Silex SX-2000WG offers the best specifications, with its 5V supply (Belkin Home Base:12V). However, USB wireless LAN adapters use more than twice as much power as Hama's wireless USB adapter.

Wi-Fi: Fire without Wire

To our knowledge, only Nikon and Canon offer wireless remote control for some of their top-of-the-line DSLRs. The technology is either integrated in an adapter, which is screwed into the camera, or is a small device with an antenna that is then connected via a USB cable. There is enough room in the device for additional rechargeable batteries to power the wireless network electronics. We took a closer look at two such devices.

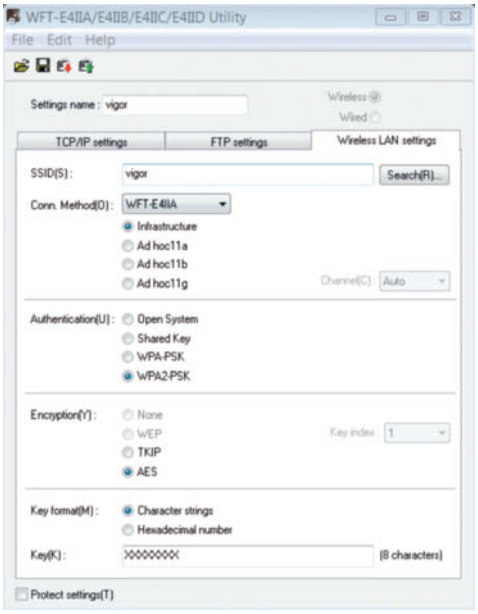
The back of Canon's 5D Mark II including the attached wireless adapter and the connecting options

Nikon WT-4

Nikon's external wireless adapter WT-4 is attached to the camera via a short USB cable and can therefore be used for several Nikon cameras. The included software allows you to browse the saved images and transfer them wirelessly to the computer or FTP server. In order to use the remote control, you will have to purchase and install the program Nikon Camera Control Pro. The communication with the camera has to be installed using the "WT-4 Setup Utility", which is part of the kit. Make sure you manually download the latest update from the Nikon website, as in our test the "Nikon Message Server" didn't recognize that updates were available or rather, didn't install them correctly and, as a result, failed to communicate with the D700.

The WT-4 can be attached to a belt with a device bag (special accessories). Power is supplied by a rechargeable lithium ion battery, EN-EL3e, the same type of battery used by several of the supported camera types. The WT-4 can also get its power supply from a separate power supply unit. It is not possible to supply power to the WT-4 via the camera. The package does not include rechargeable batteries, a charger or an AC adapter, so these have to be purchased separately.

The WT-4 transfers data using the protocols IEEE 802.11a, b or g, which allows for maximum outdoor transmission distances of up 150 yards and data transfer rates of up to 3 Mbytes/sec. Up to 5 cameras can be set up in a wireless network (each camera with its own WT-4). There is



The add-on program WFT Utility allows you to configure the network settings for the WFT-E4 II on the computer and transfer them via USB cable or memory card to the Canon camera

also an Ethernet connection (10Base-T and 100Base-TX) available, which allow you to directly implement the cameras in wired networks. It does not have another USB port for connecting GPS devices.

The WT-4 seems to work similarly to the USB wireless LAN adapters. One might therefore assume that it would work with other Nikon cameras and maybe also with those of other manufacturers. However, the WT4 setup utility on the host computer does not allow this. It does not even recognize those Nikon cameras that can be controlled remotely via a USB cable. According to Nikon, the WT-4 can only work with the following cameras: the D300 series, the D3, D3x and D700. Nikon also offers two camera-specific wireless adapters for the D2x and D200, the WT-2 and WT-3. Both can be screwed tightly to the bottom of the camera body.

Canon WFT-E4 II

All Canon wireless file transmitters (WFTs) are camera-specific. There is no adapter available that fits all Canon cameras but, at the end of last year, Canon extended the range or adapters for the DSLR cameras 1D Mark IV and the 5D Mark II. The WFT-E4 II fits to the latter camera and can be screw mounted to the bottom of the camera body. Note that the adapter requires its own rechargeable battery (type LP-E6 Lithium-ion battery pack, the same as in the camera body) and has a display for status information. This device transmits data using the protocols IEEE 802.11a, b or g. If you prefer, the data can also be encrypted. An Ethernet port allows integration in conventional wired networks (10Base-T and 100Base-TX). A Bluetooth or GPS device or an external hard drive can be attached to an additional USB port. If you have access to an FTP server, you can transfer the images automatically to a pre-selected file. It is possible to filter the different media types. This is a great feature for working in a studio. Photographers like to work with RAW files, due to their higher quality. However, because they are very large, they take a long time to transmit. The solution is RAW+JPEG. Select this combination and within this setting the smallest JPEG size, which in a 5D Mark II is still over 5 megapixels. Even large DTP monitors can barely reproduce half of that resolution. If the preview image doesn't need to be of the highest JPEG quality, then you can reduce the files sizes to just over 1MB, which increases the transmission speed. Transmission then takes less than one second. When the correct filter is used, only the JPEG file is transmitted, while the 25 MB file remains on the memory card, so you have a large format image on the display moments after exposure. Unfortunately this media type switch doesn't exist in combination with the camera's remote control modes.

The 5D/WFT combination offers two of these remote control modes, which, just as with FTP transmission, can be found among the connection methods in the wireless set up. The "EOS Utility" requires the corresponding software as the host application and is delivered with every EOS camera. Beforehand, the wireless LAN connection between the camera and the computer must be established using a pairing driver. This is usually started automatically. The remote control operates entirely without special host software in "WFT Server" mode. An ad hoc wireless LAN connection to the controlling device is all that is required. A web browser, if possible with JavaScript support, must be running on this device. A smartphone or iPod Touch would do the trick. This is the best solution we found for mobile remote control photography in difficult terrain, where even a netbook is a hindrance. More details on this later on.

The fourth connecting mode, the "Camera Linking" function, enables photographers to link up to 10 "slave" cameras wirelessly to one "master" camera. The cameras can be placed up to 300 feet away. Every camera can be configured as a master or a slave camera. However, due to network run times, it is not possible to have all 11 cameras shooting simultaneously. This applies to all remote control functions. If the release delay is in the range of a tenth of a second with a USB cable, it can amount to a second under bad wireless LAN conditions.

DSLR Camera Remote saves all images on the host computer. The Live View and preview pictures are transferred to the iPod Touch.

Smartphone Remote Photography

None of the remote control solutions presented so far have been really convenient to use. A full-fledged Windows or Apple desktop or notebook computer with a USB port or wireless LAN is required for the remote control software and the driver. Wouldn't it be great to be able to leave all the equipment at home and use your cell phone or iPod to operate the camera?

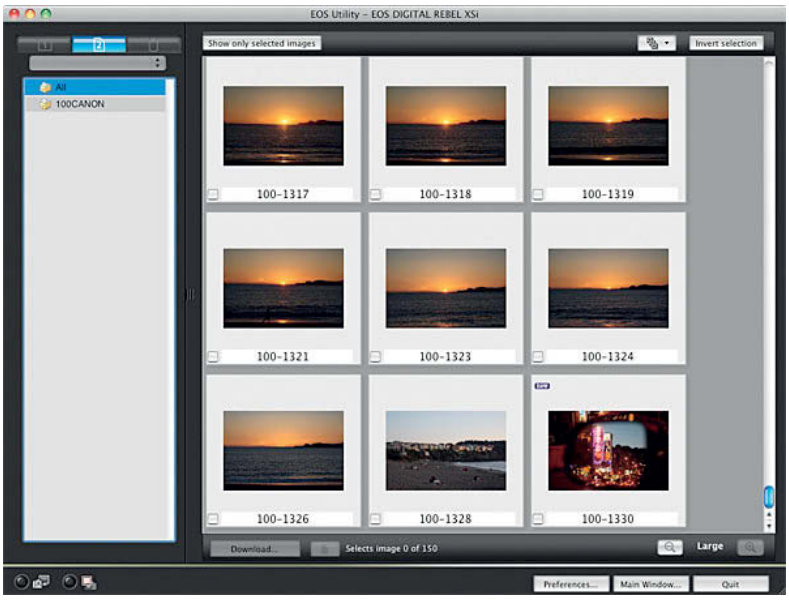
One company took a step in the right direction; onOne software, known for professional Photoshop plug-ins, programmed the iPhone application "DSLR Camera Remote".

This app also runs on the iPod Touch and probably also on the iPad. All these devices can communicate over wireless LAN and, therefore, can contact Nikon and Canon wireless transmitters. However, the connection alone is not enough. The smartphone application has to understand and speak the camera's "language", just like any other application that also has direct access to the camera settings. In general, larger manufacturers support the programming of third party applications with software development kits (SDKs). The SDKs issued by Canon and Nikon only run on Windows and Mac OS and not on the iPhone's operating system. Therefore, onOne Software explains that their remote app requires an additional computer that can be connected with the camera via FireWire or USB and should have a host application (DSLR Camera Remote Server) running on it. The host application serves as a "translator" for the camera's commands. The iPhone app communicates with the server program and not directly with the camera or a wireless adapter. In fact, the adapter isn't required at all.

The advantage of not having an adapter is also the main advantage of onOne solution, despite it being complicated. A suitable notebook costs a fraction of the price of a wireless transmitter from Nikon or Canon. At least the notebook can be used for more than one purpose. Furthermore, the onOne app allows for the wireless operation of those Nikon or Canon cameras for which there are no propriety wireless transmitters. Updates appear occasionally for new camera types. So far, onOne does not seem to have any plans for the app to support cameras from other manufacturers.

DSLR Camera Remote costs about US$20 and has to be downloaded by Apple's iTunes App Store. For about US$2, you can get a "Lite Version", which only allows you to fire the shutter and review your images on the iPhone.

What onOne has not yet succeeded in doing, Canon managed to implement in several of its new WFT adapters via software in December 2009. The WFT can now be remotely connected using the WFT Server mode. Therefore, images can be viewed over a web browser, similar to web cameras. The remote control software runs entirely on the server, which is "in" the WFT adapter, while the remote control takes place via a web browser from a remote computer, PDA or smartphone. It is a clever approach, as only the user interface and the live image have to be transmitted to the device and that in the worldwide standard HTML or JavaScript code. Not a single line of proprietary software is necessary. No program needs to be installed and there is no app that needs an Apple certification. Devices such as iPhone and iPod Touch – which don't allow the installation of non-authorized software – can be just as easily used for controlling the Canon 5D or 7D as any wireless LAN capable smartphone. After installing an ad hoc connection, you can access the camera's IP address with the integrated Safari browser. In order for the connection to succeed you have to select connection mode "WFT Server". The camera window then opens and, once you have pressed the "Viewer" button, it allows you to browse and download individual images or all the images stored on your memory card.



The WFT Server image viewer. Access to the program's interface is password-protected.

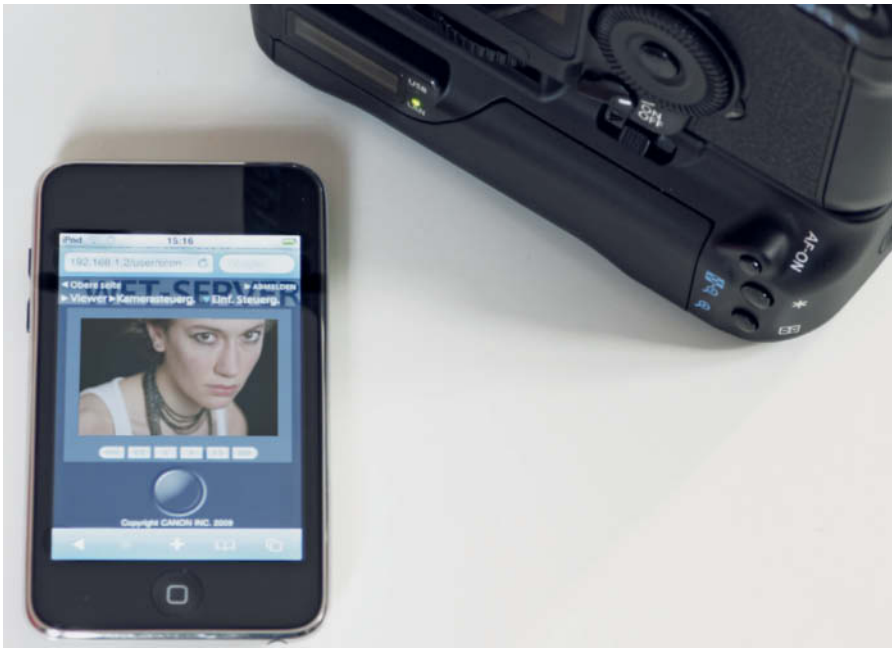
Canon Remote Control

The Canon WFT Server remote control functions are found behind the buttons on the aforementioned camera side. We will now use these functions to make a thorough comparison of camera remote control software (see also the chart at the end of the article).

The WFT Server allows the selection between simple remote control (live preview, manual focusing, shutter release) and total remote control of the camera using browsers with JavaScript support. Total remote control comprises the selection of image quality, exposure parameters and white balance. However, the shooting mode and focus areas cannot be selected and have to be adjusted ahead of time on the camera. Even a contrast autofocus is not available. In the Live View mode, there are three buttons for rough, medium and fine manual focal adjustments. There is no zoom function or 100 percent preview image, which would be very useful for this kind of focusing, and which even the onOne app offers. If you switch off the live preview you can select between AF and MF in the browser window. This means that the camera is triggered without further focus control, even if it is set to AF. The camera focuses the lens itself only when the browser based AF setting is on, which means the camera's fast AF setting is on with the mirror down. The only way to determine where the focal point should be is to use the camera. Also, there is no display in the browser window. After taking the picture, as long as the Live View mode is turned off, the image appears in the browser window. There is no Zoom function, overexposure indicator or even a histogram for subsequent image control.

Remote control per EOS Utility is significantly more convenient. There is a contrast autofocus in live mode (even with face recognition) and a movable focus area. A histogram (brightness or RGB channels) can be inserted on request. You have to switch to "Exposure Simulation" in the live preview settings beforehand. Double-clicking the Live View image opens a 100 percent section in another window, which can be opened to almost the size of the screen. Even a 200 percent enlargement is possible. Alternatively, double-clicking can sharpen the image by using contrast-detect autofocus on the clicked pixel.

Nevertheless, we thought there were a few features missing: the remote control window does not allow you to switch the picture mode of the 5D; after shooting, the control check on the monitor is limited to a preview window without a zoom function, clipping warning, etc. A practical feature is the option of taking a test photo, which is not stored but can be stored later. If you specify



An iPod Touch controls the Canon 5D Mark II using the Safari browser and a wireless LAN. The main hard and software is in the Wireless Transmitter WFT-E4 II, which is attached to the camera's body.

the path to Canon's RAW converter and editing software "Digital Photo Professional" (which is included in the package) in the preferences, the loaded image is immediately opened for editing. Alternatively, another image editing program can be selected. This feature can be limited to certain file formats such as RAW files.

The third remote control program, which is exclusively for Canon cameras, comes from Breeze Systems (www.breezesys.com) a manufacturer of digital camera software. "DSLR Remote Pro" supports almost two dozen Canon DSLRs and can be tested for 15 days free of charge. Retail price is US$129. Breeze Systems also offers a remote control for Canon Powershot cameras under the name PSRemote. Both programs have multi-camera versions allowing you to control up to 16 cameras. The record is the simultaneous control of 120 Canon D30 cameras for a 360-degree view of a car. You can have a look at the spectacular set-up for the photo shoot on the Breeze website.

The remote control window of Canon's WFT Server showing the full set of camera controls.

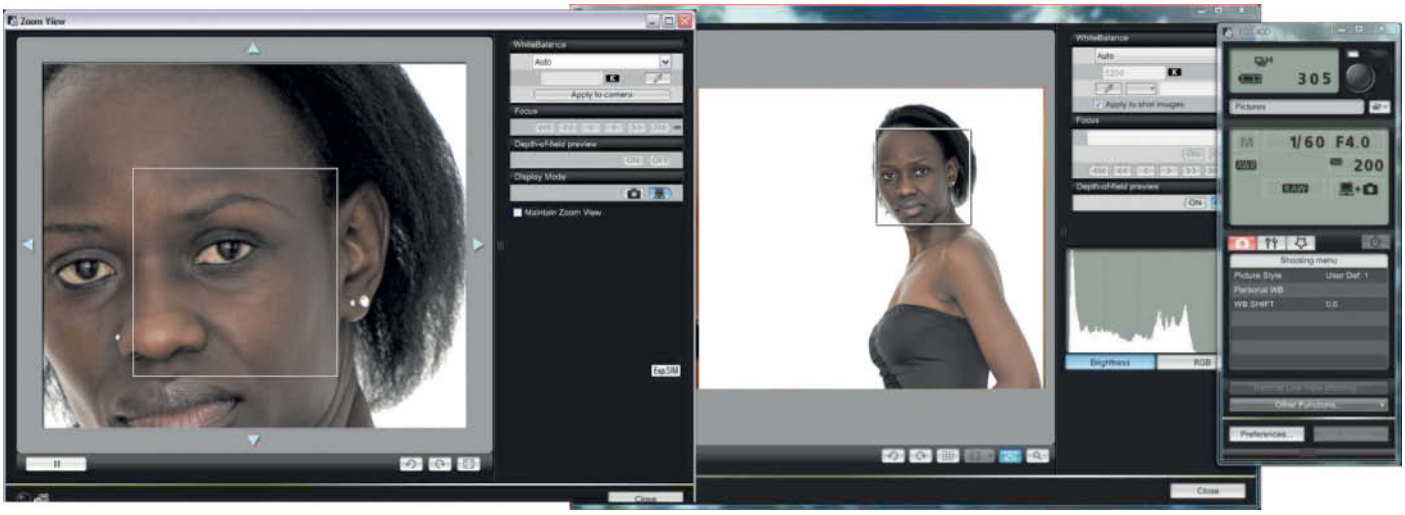
Although DSLR Remote Pro's design is not so appealing, it offers a few more features than the original Canon software. Keyboard control of the settings is taken for granted. Using "onion skinning", the last picture or a saved background image appears transparent in the Live View window. This is very useful for stop motion animation, in which animated films are composed of many single photographs. For stitching panorama pictures together, you can move the background image to any edge of the screen. "Photobooth" automatically takes a sequence of photos and prints them out, which is ideal for parties and corporate events.

The program only lets you save your images on the memory card. Since transmission of the files has been omitted, the camera is quickly ready for operation again as it doesn't have to react to the computer's attempts to take pictures during the transfer, and the Live View image continues while shooting. However, even when saving only on the memory card, the minimum time between images when shooting from the PC is still more than two seconds. According to Breeze, this option leads to instability in some cameras. Although Breeze did not include the 5D in the list, the program regularly crashed after taking the first photograph when this option was selected.

The functions of the remote control software should, of course, use all the possibilities the cameras have to offer, but they can also go beyond these possibilities. The Time-Lapse feature is the only function that does so. Almost all programs allow automatic shooting of a pre-selectable number of shots at specified intervals. A lead time can usually be set as well.

We found almost no advanced control functions. The auto bracketing menu offers an implausible set of options of up to 15 shots at maximum increments of three or even four EV. However, in practice most of the combinations did not work. Only five pictures were possible with the Canon 5D at a maximum increment of 2 EV which at least is two more than the camera offers on its own. Here, EOS Utility is limited to three shots.

The focus stacking function shows what is possible, in principle, when putting the Breeze software together with AutoHotKey, an open-source utility for controlling Windows programs. The script is free and can be found in the Breeze installation directory. It controls the remote program so that the camera shoots a series of photos with a slightly shifted focus. The images can be assembled to create one image with a greater depth of



EOS Utility features spread over several windows. The Zoom View window (100 percent actual pixel size or 200 percent enlargement) is on the left, the Live View full screen mode with optional histogram is in the middle and the capture menu with the release button is on the right.

field using further program such as CombineZM (http://hadleyweb.pwp.blueyonder.co.uk/CZM/News.htm). This is how macro photographs are created with a depth of field that would not be possible with a normal camera. The scripts do not offer a user-friendly interface and the number of photos and the focal increments have to be changed manually in the script with a text editor. With a little more effort a graphical user interface could be created using AutoHotKey. Of course it would be even better if the manufacturers had already integrated these quite simple photo series functions in the software.

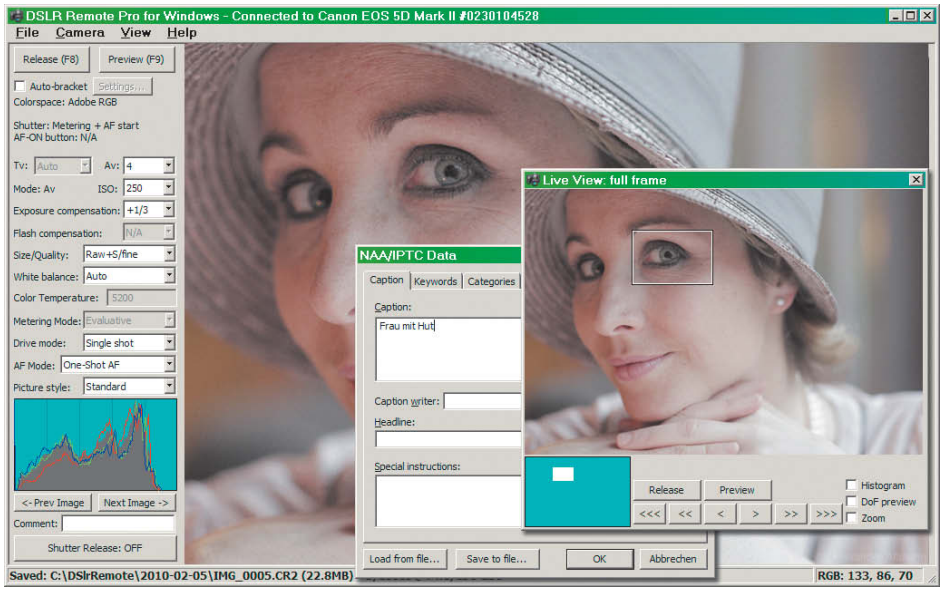
Nikon's Remote Controls

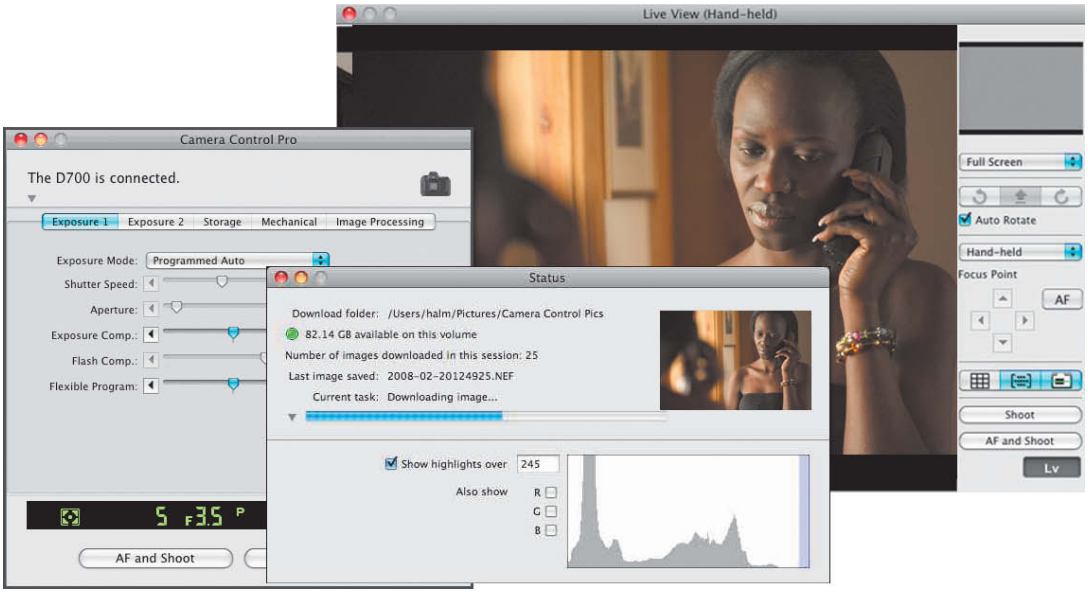
Nikon's own remote control program, Camera Control Pro (CCP), must be purchased. It was not created for transferring the images from the memory card to the computer; the freeware program Nikon Transfer is meant for this purpose. The settings are spread over five tabs in CCP's main window and more can be found in the menus. This is not very clear and it doesn't really save space on the screen. On the one hand, it is good that the complete dialog can be collapsed so that only the most important exposure settings remain visible. On the other hand, it is not ideal that you can't change the dialog immediately in the bar. Once in the settings menu, you have access to all individual functions of the D700. This could be called luxurious as these are rarely changed. However it is rather unacceptable that there is no keyboard function, at least for the trigger button. This is rather unsatisfactory for an expensive professional program.

In Live View, you can zoom in at 200 percent. However, the window size is limited to 640 × 426 pixels. The image is only displayed in miniature, but with a histogram and a clipping warning in a status window. It can also be displayed full screen in the Viewer by selecting Fit to screen.

The Handheld and Tripod options in the Live View window influence the way the autofocus functions. In Tripod mode, you are executing a contrast-detect autofocus when you click on the AF button. Subsequent manual correction is possible. The focusing in Handheld mode takes place using the much faster camera AF, as the mirror is down during the process. However, manual focus correction is not available. The mouse can move the displayed focus area only in tripod mode. Four navigation buttons serve this function in the handheld mode. However, you are not moving the focus area, but selecting one of the up to 49 focus areas of the D700, which can then be displayed by clicking a button. We thought it distracting that the contrast-detect AF put the mirror down before and after the shutter release, even in Live View

Breeze Systems DSLR Remote Pro offers several special features, including the embedding of IPTC data immediately after the shot. The data can be downloaded from a file.



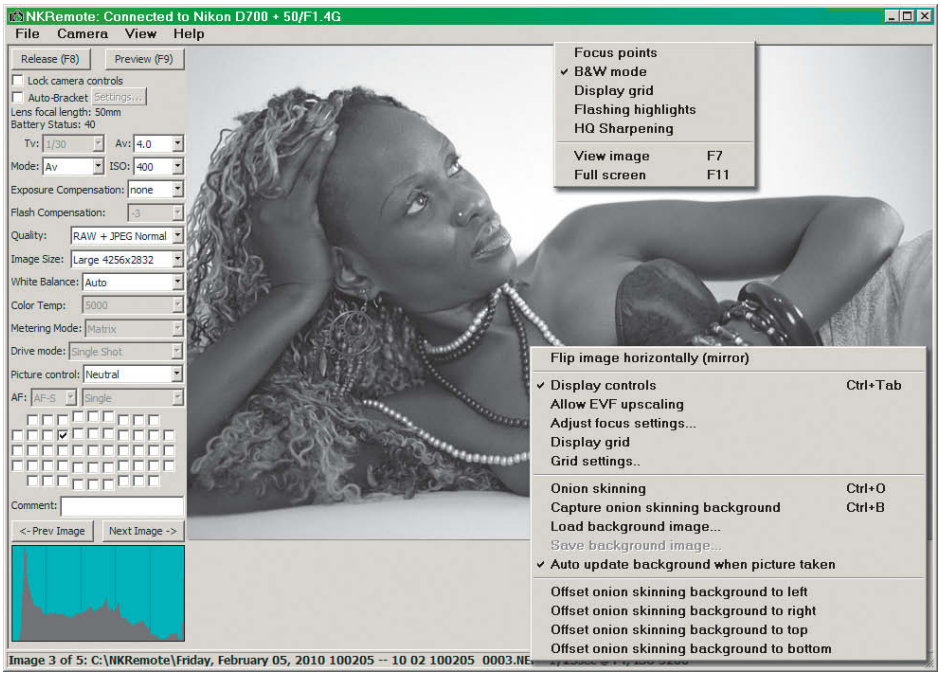


Nikon's Camera Control Pro settings window (left) and the Live View window (behind). The status window in the middle serves to review the image after it has been taken. There is no separate zoom preview of the Live View image but the selection can be enlarged up to 200 percent.

mode. This is a characteristic of the camera itself, rather than of the remote software. The D700 and other Nikon DSLRs master a (slow) contrast-detect autofocus with the mirror up, but not exposure measurement. In order to measure, the mirror is put down briefly, which increases the release the delay. In contrast, the Canon 5D does not move the mirror at all in Live View mode.

Breeze Systems also offers remote control software for Nikon DSLRs. NKRemote is similarly structured to DSLR Remote Pro, but doesn't offer all features. The images are always saved on the computer without having a choice. Just as with the Canon version, onion skinning, Photobooth and color management features are available for Nikon. The Live View image is just as small in Nikon's CCP program, but can be scaled to the size of the screen just as in Breeze's Canon remote program, although with considerable loss of quality.

A free alternative to these programs can be found on the DVD included with this issue.



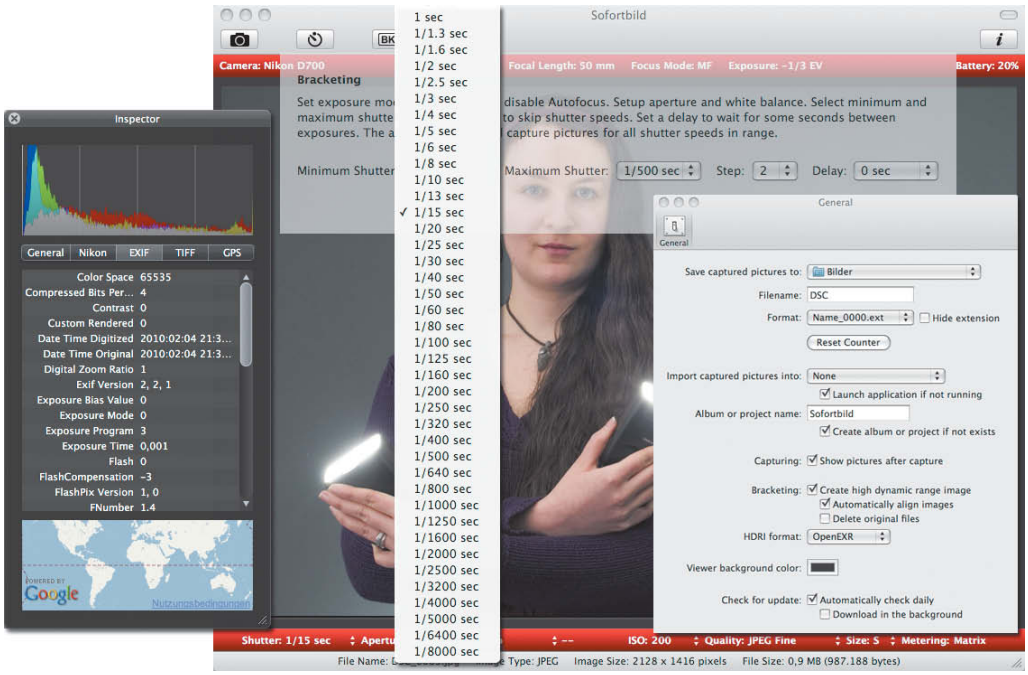
NKRemote's control panel and main window, in this case in B&W mode. The context menu at the bottom left shows the viewing options (not depicted here) for the Live View window.

The iPhone App

In terms of scope of functions, onOne can't keep up with the above-mentioned remote control programs. Nevertheless, it can easily compete with Canon's WFT Server. Instead of using an expensive specific wireless adapter, the app solution only needs a computer with a Mac or Windows operating system with onOne Remote Server (open source) installed. The app itself can be downloaded from Apple's App Store for US$19.99.

When held upright, the iPod/iPhone depicts exposure settings, white balance and file format in the main window. These can be modified in the app. If you tilt the device horizontally, the display switches to wide format. Only the Fire and menu buttons remain visible. The

You will find it under the name Sofortbild (www.sofortbildapp.com). It was program by Stefan Hafeneger, a student of computer science in Germany. The program and support are in English. Sofortbild only runs on Mac and supports only a few Nikon cameras. It does not transmit the Live View image, but does cover the most important shooting modes and offers some special features. The exposure modes are the most comprehensive we have found so far. The program can perform bracketing and there is an option to merge the pictures automatically to create an HDR image. The Inspector window displays a histogram and the EXIF files of the recorded image. If they contain GPS data you can identify where the picture was taken. Doing the opposite - entering the GPS data manually - would make more sense but is not yet possible. Nor is the editing of EXIF files.



The *Sofortbild* tethered shooting freeware allows you to make bracketing sequences throughout the entire shutter speed range. Unusually, the *Step* value refers to the increments in the shutter speed list, making three *Steps* equivalent to one full f-stop. The program's settings dialog includes an option for automatically merging bracketing sequences into HDR images.

menu contains an "Intervalometer" for time-lapse photography, exposure bracketing and photo series. For exposure bracketing you need to set the camera to manual, which indicates that this function is controlled by the program. This way, even with the Canon 5 Mark D II, which limits you to three pictures, you can take up to 11 pictures using exposure bracketing over a range of 10 EV – theoretically. In practice, it was only seven EV, because the program does not strictly observe the preselected "Full Stop" (1 EV) increment.

Also, switching into the Live View mode can be selected in the settings menu. If the Live View is disabled or is not supported by a camera, the preview window will then show the last image taken. You can browse the last images taken by stroking your finger over the iPhone's display. A double-click on the image displays it 100 percent. Intermediate values cannot be displayed and there is no zoom function in Live View mode. Instead, when you tap on the display of the iPhone, the contrast-detect autofocus or a corresponding setting (such as Canon's Quick Mode or Nikon's Hand Held) starts up the camera autofocus with fold-down mirror. The obvious assumption is that the image section will be focused on where you tapped your finger, but this isn't the case. Actually, the autofocus uses the previously selected camera AF focus area. This, however, is not indicated anywhere and moreover; it can't be changed from the iPhone. It seems that the program always focuses on the center of the image when using the contrast-detect autofocus.

Apart from these undocumented weaknesses, the program runs reliably. It takes up to a second for the image to appear in Live View. If Live View is off it takes a quarter of a second, which is comparable to the other wireless remote controls, as is the Live View frame rate of a maximum of 10 pictures per second, which slowed considerably at distances of just a few yards. Canon's WFT Server in combination with the iPod is even slower.

Conclusions

Although most digital cameras have a USB port that allows the transfer of data from the memory card to the computer, immediate transmission and display of a picture that has just been taken is by no means a given. Live image transmission and remote control of exposure times, focusing and triggering are all state-of-the-art. Manufacturers only install these gadgets in their high-end cameras. In addition, you need a USB cable and the remote control software. In the case of Canon, this is part of the package, but with Nikon it has to be additionally purchased. You can bridge up to 15 feet with a USB cable and up to 100 feet with intermediary repeaters. A USB LAN adapter goes even further. The active USB connection depletes the battery relatively quickly.

If you want to do without a connecting cable, then the amount of effort rises considerably. As yet, there is no universal mobile (hence battery-driven) wireless adapter that can be plugged into the camera's USB port. The camera USB port cannot power the adapter on its own, because it does not have a voltage of 5V, and because this would strain the camera's rechargeable battery even more. If power supply is a problem, you may have to tinker a bit. However, USB

A self-portrait of onOne Software's *DSLR Camera Remote Pro* app, here shown running on an iPod Touch.

Wireless Transmission Rates and Operating Distances

Wireless Local Area Network (WLAN) transmits at 2.4 GHz or 5GHz. Originally, it was intended as a wireless addition to office networks (LANs) for mobile computers but it has since been applied in other fields as well. The technology is specified in many standards of the Institute of Electrical and Electronics Engineers (IEEE). These build on each other and are largely compatible. The IEEE 802.11 (2.4 GHz with a data rate up to 2 Mbit/sec gross) is the ancestor of today's wireless networks. It was found only in office LANs before the year 2000 and has no relevance today. The WLAN boom began in 1999 with the release of 802.11b standard (2.4 GHz and max 11 Mbits/sec). Now this standard is also obsolete. The boom picked up speed when the faster version 802.11g (2.4 GHz up to 54 Mbit/sec) became available, but this standard is now deemed obsolete and the v802.11a for the 5 GHz wireless band barely even took hold.

Currently, wireless devices operate in accordance with the 802.11n standard, which works on either 2.4 GHz or 5 GHz. Since 802.11n supports up to 80 different transmission modes (one to four antennas and transmitter/receiver modules parallel, radio channel width of 20 or 40 MHz, various encodings), gross data rates of 6 to 600 Mbits/sec are sufficient. Devices with two antennas and transmitter/receiver modules are common today, transmitting up to 300 Mbit/sec. Typically, these devices can manage up to 80 Mbit/sec on application level and have a range of 65 feet net inside buildings, depending on the frequency used, the installation, the number and consistency of the walls, and the competing radio systems. A number of different radio systems, including analog video bridges, Bluetooth, ZigBee and surveillance cameras are competing, especially in the 2.4 GHz bandwidth. These and further wireless LANs may reduce your data rate to less than 20 Mbits/sec. In practice, the increase in range in comparison to the older wireless LAN standards does not turn out to be as high as manufacturers claim.

Wireless USB (WUSB) is based on the ultra wide band (UWB) radio standard and uses the frequency range from 3.1 to 10.6 GHz. It is supposed to reach a gross data rate of up to 480 Mbit/sec, similar to the USB 2.0 wired transmission standard. This maximum speed only applies to a range of 10 feet and an unimpaired view between the antennas. Beyond 30 feet the transmission rate drops to zero. You are better off using a cable. It is cheaper and doesn't require electricity.

Moreover, Intel and Texas Instruments, two important chip manufacturers, discontinued their UWB project in 2008. UWB devices are rare and quite expensive. There are now alternatives that transmit the USB protocol transparently over wireless LAN. They achieve the same effect, are less susceptible to interference and have a greater range. WUSB is noticeably faster at close range only, which is not relevant for the remote control of a camera.

Bluetooth is more likely to be a better cable replacement. It has been successful for a long time in the communication between cellphones, notebooks and headsets. Version 3.0, released in December 2009, may bring an end to the slow data rate (net 1-2 Mbit/sec) and short range. Also, Bluetooth was energy efficient right from the start. A quicker connection and greater range (110 yards) is the main focus of version 3.0, which can, if necessary, use a parallel wireless LAN to achieve data rates of up to 24 Mbits/sec.

Meanwhile, Sony has developed its own close range radio technology to market-readiness. At the moment, TransferJet has a range of 1.2 inches, but is claimed to have a gross transfer rate of 560 Mbit/sec. At application level, the transmission rate still should be around 375 Mbits/sec. With this technology you could transmit a 14-megabyte image file in a second. The technology is meant for the transmission of images and videos between a camera and a computer or television. Simply touching one of the devices is enough to initiate the connection. Since several big camera manufacturers are involved in the TransferJet consortium it may be assumed that it will spread quickly. Just as with the Eye-Fi wireless LAN SD cards, it should be possible to retrofit older cameras with TransferJet memory card combinations. The new TransferJet memory card should fit into the memory card slot. Sony has already announced a memory stick with integrated TransferJet technology.

wireless LAN adapters can transmit up to 300 feet outdoors and still get acceptable data transfer rates. Wireless USB (WUSB) only performs reliably over a distance of a few feet and, in practice, doesn't reach higher transfer rates.

Cameras with integrated wireless LAN electronics are still the exception. You can retrofit your camera using wireless LAN SD Cards (Eye-Fi) if it has an SD slot, but the these card have only a short range and don't include remote camera control functionality. There are several wireless transmitters available for professional Canon and Nikon DSLRs. They can be attached directly to the camera and usually only fit to one type. Even Nikon's separate WT-4 transmitter only fits on a few Nikon cameras. Including the additional battery pack, you can expect to pay up to US$800. This doesn't include a computer for saving your images. All this is only worthwhile in a studio environment, where cables might be in the way and pictures need to be previewed quickly on the monitor.

If the camera is to be remote controlled then onOne's iPhone app is a good value alternative to the manufacturers own wireless transmitters. The software and all the hardware (i.e. iPod Touch and notebook) together cost only a fraction of the other options. However, this solution is a little delicate for using out in the wild. Although Canon's WTF adapters are rather pricey, they are robust and can be controlled by an iPod or smartphone when set in the WFT Server mode.

Altogether, wireless solutions and remote control software are by no means yet fully developed – presumably; the demand is too low for manufacturers to make a greater effort. Low frame rates when operating in Live View and significant delays when shooting make it difficult to make snapshots from a distance. Unfortunately, camera manufacturers have not used remote control software to extend their cameras' capabilities (HDR bracketing exposure, focus stacking, etc.) We only found these features in remote control software from other manufacturers. (ae/rez)

Remote Control Software

	EOS Utility	WFT Server	DSLR Camera Remote	Camera Control Pro 2	NKRemote	Sofortbild	DSLR Camera Remote Pro
Manufacturer	Canon	Canon	Breeze Systems	Nikon	Breeze Systems	Stefan Hafeneger	onOne Software
Website	www.canon.com	www.canon.com	www.breezesys.com	www.nikon.com	www.breezesys.com	www.sofortbildapp.com	www.ononesoftware.com
Minimum system requirement	Win XP, Mac OS 10.4	all	Mac OS X 10.4, Windows 2000 (also 64 Bit)[2]	Windows from XP SP3 (also 64 Bit)	Windows XP (32 Bit) Windows 7 (32 and 64 Bit)	Mac OS × 10.5	Mac OS 10.5, Windows XP SP2
Languages	English, International	English, International	English	English, International	English	English	English
Test with camera	5D Mark II	5D Mark II	5D Mark II	D700	D700	D700	5D Mark II, D700
required hardware	–	WFT-Transmitter	–	–	–	–	PC
Controled by	PC	PC, Smartphone	PC	PC	PC	PC (Mac)	iPod Touch or iPhone
Preview							
LiveView / Live View window size	✓ /any	✓ / 480 × 320 / (260 × 173)[1]	✓ / 1024 × 680	✓ / 640 × 426	✓ / 640 × 426	–	✓ / 404 × 262 / 314 × 205
Live View Zoom	100/200 % (separate window)	100 %	25–200 %	25–100 %	–	–	
LV frame rate USB cable	10	n. s.	12–15	12–15	12–15	–	–
Wireless (WLAN 11g, max.)	3–4	3–5	ca. 5	12–15	12–15	–	10
Preview window	✓	✓	✓	✓	✓	✓	if no EV
Histogram / RGB / Highlights	✓ /✓ / –	– / – / –	✓ /✓ /✓	✓ /✓ /✓	✓ /✓ /✓	✓ /✓ / –	–
Depth-of-field preview	✓	–	✓	–	–	–	–
Exposure and focus							
Keyboard trigger release	–	–	✓	–	✓	✓	–
Release delay without/with EV, sec.	0.2 / 0.4	0.5 / 1.0[1]	0.2 / 0.5	0.3 / 0.9	0.2 / 0.7	0.3 / –	0.2 / 0.6
Camera AF	✓	✓	✓	✓ (Handheld mode)	✓	✓	✓ (Handheld Mode)
AF Focus Area display /select	✓ /✓	– / –	✓ /✓	✓ /✓	✓ /✓	– / –	– / –
Contrast-detect AF	✓	–	✓	✓ (Tripod mode)	✓	–	✓ (Tripod Mode)
Manual focus	✓	✓	✓	✓	✓	–	–
Settings							
Shooting mode	– (only on camera)	– (only on camera)	– (only on camera)	A, T, P, M	A, T, P, M	– (only on camera)	– (only on camera)
Exposure / Flash correction	✓ /✓	✓ /–	±3EV/v	± 5 EV / –3 . . . +1 EV	±5 EV / –3	– / –	– / –
Program Shift	–	–	–	±15 steps	–	–	–
ISO / ISO limits	✓ / –	✓ /–	✓ / –	✓ /✓	✓ / –	✓ / –	✓ / –
White Balance / fine tuning	✓ /✓	✓ /✓	✓ / Kelvin	✓ /✓	✓ / Kelvin	✓ / –	✓ / –
File format / quality	✓ /✓	✓ /✓	✓ /✓	✓ /✓	✓ /✓	✓ /✓	✓ /✓
Color space	–	–	✓	✓	✓	–	–
Features							
Bracketing / max increments in EV	3/2	–	3–5 / 2[3]	2–9 / 1.0	3–15 / 3	>50 / 3	3–11 / 1/3 oder 1
Interval exposure	✓	–	✓	✓	✓	✓	✓
Automatic release	over time lapse	–	✓	–	–	✓, 1 – 9 shots	with intervalometer
Display							
Grid	✓	–	✓	✓	✓	–	–
Battery capacity	✓	✓	–	✓	–	✓	(warning at 20 %)
Remaining exposures	✓	✓	–	✓	–	–	–
Storage space PC	–	–	–	✓	–	–	✓
File saving							
Location	only PC or card+PC	only on card (manual download possible)	only card, only PC, card+PC	only PC (D3S: PC or PC+card)	only PC	only PC	only PC
Auto filename / with date / time		–	✓ /✓ /✓ (also for filenames)	✓ /✓ /✓	✓ /✓ /✓ (also for filenames)	✓ / – / –	–
IPTC / EXIF editing	–	–	IPTC (also import/export from file)	Copyright, comments	–	EXIF (display only)	–
Special features (beyond camera features	no flash control	–	Onion skinning, Script for Focus stacking, Photobooth etc.	–	Onion skinning, script for focus stacking, Photobooth etc.	HDR merge, GPS	–
Supported Canon EOS cameras (selection – partially dependent on OS version)	all current and several older EOS DSLRs	5D Mark II (with WFT-E4 II) 7D (with WFT-E5), 1 D Mark III/IV (mit WFT-E2 II)	1D series, 5D Mark II, 5D, 7D, 50D, 40D, 30D, 20D, 10D and others	–	–	–	1D series, 20D, 30D, 40D, 50D, 5D, 5D Mark II and others
Supported Nikon cameras (selection)	–	–	–	D2 and D3 series, D700, D300S, D300, D200, D100, D40, D40x, D50, D60, D70x,	D3 series, D300S, D300, D700, D90, D5000, D200, D80	D3 series, D300S, D700, D90, D80, D5000	D3, D3x, D40, D40x, D60, D80, D90, D200, D300, D300s, D700, D5000
Price (approximate)	free	free	US$129	US$180	US$129	free	US$19.99

[1] on iPod Touch [2] seperate software versions for Mac und Windows [3] higher setting possible, but didn't work in test with 5D

✓ available – not available n. s. not specified

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Ralph Altmann

Image Composition

Some people only realize what great places they have visited when they look at their vacation snaps afterwards. I am not recommending that you look at the world exclusively through a camera lens, but I do urge you to use your camera to help you get into situations you might not otherwise encounter and, of course, to record them. In the course of this tutorial I will be addressing not only some general aspects of photography, but also the inner workings of digital cameras themselves.

Like me, you too are probably scared by the flocks of tourists who disgorge from buses, cameras at the ready, at well-known landmarks all over the world; and it is tempting to paraphrase the German comedian Karl Valentin, who once said, "Everything has already been photographed, just not yet by everyone". But the desire to record experiences for yourself and to share them with others is a legitimate one, and is as old as travel itself. In earlier times, travelers could only make sketches or keep a diary, so a photo-diary is a much more convenient way to go about the same thing, especially if combined with maps and modern GPS technology.

The camera as an aid to seeing …

If you should find yourself taking part in a group trip, turn around! Don't point your camera in the same direction as everyone else – point it the other way. Aren't the astonished expressions on the faces of a group of tourists looking at St. Peter's in Venice a better subject for a photo than the cathedral itself? There are a thousand perfect postcards of subjects like this anyway. Look for the little things that symbolize or even contradict the character of your surroundings. A photo of a Balinese student explaining the whys and wherefores of a temple for a tip is surely a more personal memory than a photo of the temple itself.

A camera can be used to manipulate a view, but it can also teach you to see. Ideally, the "photographic view" captures not only the formal qualities of a scene, but also some background information – a good photo helps the viewer to look beyond the surface events. A camera can help occasional photographers to take a closer look at their surroundings too, and the search for new subjects often takes you to places and gets you into situations you wouldn't otherwise have found. You don't need to go on a photo safari or an expensive private tour. You might find that the local fishermen land their night's catch at dawn a couple of hundred yards from your hotel while their wives light fires to cook breakfast, but by the time "normal" hotel life has got into swing (and the sun is too high in the sky anyway), the beach is once again empty as if nothing had happened.

… and as an entrance ticket

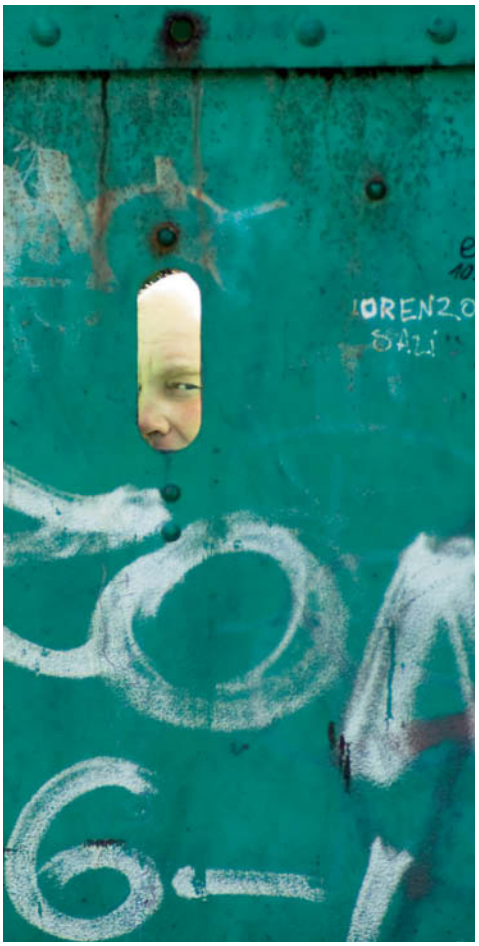
With the help of your camera, you can end up in places you would otherwise not have been; and a large, professional-looking camera can even help to open official doors without the help of a press pass. It is definitely difficult to gain the trust of a stranger you wish to photograph. People who allow themselves to be photographed are giving something away, and someone who allows himself to be photographed many times a day is either very generous, or it is simply part of his business. This makes photos of staged ethnic dances hackneyed in a double sense: you have already paid for the show with the price of your ticket, and the photos you take have no intrinsic value.

On the other hand, the desire to take a photo is a sign of interest in the events taking place, and most people (with the exception of those whose beliefs forbid them to be photographed) interpret a photographer's interest as such. The openness towards photographers in some Islamic countries is astonishing and provides a stark contrast to the warnings issued by some guidebooks. You

Here, the photographer should have lowered his viewpoint, or at least opened the aperture to blur the background a little. The verdict here is: great subject, bad photo!

A successful photo often tells a complex story

A photographer's attention is a gift that children often repay with a smile



What is that photographer looking at?

do, of course, need to use some intuition when photographing strangers. Try not to be too pushy, and make sure you get permission either with a gesture or using eye contact before you shoot. Remember to observe the local customs and, even if it seems strange to you, you will sometimes have to gain a man's permission before photographing his wife or children. Taking a photo of the head of the family first is never a bad idea.

People generally don't mind if you publish these types of photos at home, and trying to get someone to sign a model release form for a casual portrait would probably just cause confusion. Photos of public places that unavoidably include passers-by are classed as documentary or reportage material anyway. The value that is nowadays attributed to personal images in the western world is a result of the commercialization of everything visible and the legitimate fear of an increasing loss of privacy.

These are phenomena that photographers can do little to influence – with the exception, of course, of the paparazzi or the creators of Benetton advertisements. It is also legitimate for the subject of a photo to want to participate in any profit the photo produces, although publication in an exhibition, a book, or on a website can't usually be classed as a commercial venture. Commercial use definitely starts when a photo is used for advertizing purposes, and you should be aware that publishing portraits on the internet is still something of a legal gray area.

"Perfect" Photos

What makes a great Photo? Is there a recipe? If you look at photos from the last few decades and paintings from bygone centuries, you will come across certain recurring compositional rules that appear to be almost genetically linked with our human sense of perception – regardless of personal individuality or our degree of resistance to fashion. Over the course of history, human beings have learned to subconsciously recognize certain shapes and patterns, some of which immediately interest us or ring alarm bells irrespective of how clearly they are perceived. Human face recognition is especially highly developed, and the ability to recognize people or interpret their intentions was (and sometimes still is) crucial to our ability to survive. The human brain sometimes even "sees" faces in inanimate objects – for example, in the surface of the Moon.

The forms that are generally accepted as "good" image composition are based on simple rules (see Gestalt Theory below). The way objects, lines, and colors are arranged cause an image to appear "open" or "closed", "calm" or "tense", and applying a strong soft focus effect often helps to reveal an object's true form. Horizontal and vertical lines communicate calm (especially if they are positioned in the center of an image), while diagonal lines generally create an impression of tension. Triangular compositions that combine vertical and diagonal lines in a closed form are especially popular. A triangle can be placed on its point or on its baseline, and can thus be used to produce appropriately secure or insecure feelings in the viewer. Repeated patterns create rhythms that interest us and simultaneously make us aware of breaks in rhythm. It is important to include rhythmic breaks in an image, as the human brain tends to interpret simple repeat patterns as boring.

Slanted or diagonal lines and textures give an image structure, but can also spoil the overall mood. Placing the horizon in the middle of an image is simply bad technique, and it is always better to place people away from the center of the frame. There are, of course, always exceptions that prove the rule, and frame-filling portraits will always cover the center of an image. All the same, it is generally better to avoid using too much symmetry. Some cameras have a built-in "rule of thirds"

grid that you can superimpose on the monitor to help you with your composition. The "golden ratio" divides a line so that the length of the shorter part has the same ratio to the longer part as the longer part to the length of the entire line (approximately 38:62). Artists and architects have been using this rule for thousands of years to help them produce harmonious-looking results.

An eyecatcher is an important element of any image, and immediately gains a viewer's attention, regardless of what it actually is. Faces (and especially eyes) are good eyecatchers, but a patch of bright color can be just as effective. If the eyecatcher isn't the actual subject of your photo, make sure it doesn't distract the viewer's attention. Multiple eyecatchers are confusing and should be avoided. If you can't change your position or framing, you can always use a wider aperture to help emphasize your subject by blurring the background. You can achieve similar effects using image processing software, but it is much easier to use an appropriate aperture while you are shooting. There are stories of photographers who have had trees chopped down in order to achieve the effect they were looking for, but I prefer to use the Photoshop cloning tool!

Combining various compositional elements can make a good image, and unusual compositions help to make an image really special, although what is "unusual" is not easy to define. Ideas such as deliberate blur or radical crops that were considered revolutionary a few of years ago are standard fare in today's newspapers; and by the time a visual trend has found its way into advertising images, you can be sure that the same trend is already "out" in the art scene.

But formal suspense only serves to create interest and expectation the same way the smell of a steak whets our appetite. A good image will fulfill your expectations, while the isolated special effects that many image processing tools produce only serve to disappoint. An artificial look cannot compensate for missing content the same way that the taste of fast food gets worse the flashier the advertising that sells it to you.

Every Picture Tells a Story

Photos extend the observer's view, filtered by the photographer. They not only tell the story of the events they portray, but also tell us

Basic Photographic Techniques

The fact that you can nowadays process a digital photo in just about any way you like increases the risk of the photographer becoming careless while shooting. The following sections describe how image processing can improve an image and also the circumstances under which it either doesn't help or is simply too much trouble.

Basic composition and **perspective** cannot really be changed once an image has been shot, although you can adjust the overall composition slightly by cropping. Perspective is entirely dependent on the camera position and is not affected by the focal length of the lens. There are two ways to fill the frame with a subject: either get nearer or zoom in. Getting nearer (also known as the "sneaker zoom" technique) changes the perspective in your shot, while zooming with the lens doesn't.

Lighting (whether natural or artificial) is largely responsible for the mood of an image, and existing light can only be brightened or darkened using image processing techniques. This can change the mood slightly but not fundamentally.

Correct **exposure** is much more important in the digital domain than it ever was for analog photos, due to the relatively narrow dynamic range of digital image sensors. While film reacts "gently" to overexposure, producing only slowly darkening blacks, a sensor can no longer function at all once a certain amount of incident light is exceeded. Detail in washed-out highlights simply cannot be retrieved, regardless of which software tricks you use.

Sharpness is dictated by your focus setting, and the aperture is determined (at least in the case of moving subjects) by the shutter speed. Blurred images, especially where camera shake is involved, cannot be corrected later. In contrast, there are a large number of filters and tools available for causing deliberate blur, including extremely convincing photographic blur filters that produce an effect very different to run-of-the-mill soft focus effects. The crux of post-processing blur effects lies in the successful isolation of the objects which are to remain in focus, and emphasizing a subject by blurring the background can involve a lot of hard work on a computer. If your lens is bright enough, it is easier to use a wider aperture while shooting – provided, of course, that your sensor is capable of capturing sufficient depth of field.

Of all the analog accessory filters available only **polarizing**, **neutral density**, and **graduated filters** are of any real use in the digital world. Polarizers reduce reflections and intensify colors optically – effects that are difficult to reproduce digitally. Neutral density filters can be used to artificially extend exposure times, which can help when photographing flowing water, for example. Graduated filters are generally used to manage subjects with too much contrast. This is a situation that can only otherwise be handled by merging multiple, differently exposed images of the same subject (a technique known as High Dynamic Range, or HDR imaging).

Where analog photographers had to change films in order to change the color characteristics of their images, a digital photographer can choose a **film profile** (with soft colors for portraits or "Velvia"-style candy colors for architecture or landscapes) at the push of a button or the click of a mouse. Such effects can also be achieved (with similar quality) during post-processing if you shot your images in RAW format.

Post-processing is very important if you are shooting images for **grayscale** (black-and-white) presentation, as the quality of monochrome images is heavily dependent on the relative brightness of the individual tones within the image. Digital cameras always use the same preprogrammed tonal patterns when shooting in black-and-white mode, but these can be appropriately adjusted for each individual image later.

Triangular composition

Repeat pattern with variation

Symmetry

The rule of thirds grid compared with the golden ratio (illustrated by the red line)

Gestalt Theory

The Gestalt principles describe the circumstances under which human perception separates single objects from their surroundings and when spatially separate objects are perceived as being joined. The most important of these principles in a photographic context are

Figure and Ground: an object that has a distinctive characteristic is more likely to be perceived as the subject than another, less, obvious object.

Symmetry: multiple objects that are arranged symmetrically are perceived as a single object.

Similarity: similar-looking objects are perceived as belonging together.

Proximity: objects that are close together are perceived as belonging together.

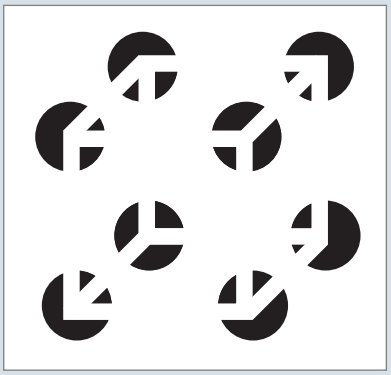
Continuity: objects that appear to extend the shape or position of other objects are perceived as being a part of the other object.

Closure: broken lines are perceived as being part of a complete figure.

Area: the smaller of two overlapping objects will be perceived as the subject while the larger will be perceived as being the background.

Combination: joined elements are perceived as a single object.

Experience: we recognize and prefer shapes that we have often seen in the past.



Optical illusions are often caused by the simultaneous application of multiple principles of perception. Here, the brain fills out the empty spaces and applies the principles of experience and continuity to make us see a cube.

something about the photographer's ideas and interests. We view images in the context of every other image we have ever seen, from those in our childhood books to the very last advert we saw, and the human brain automatically makes connections between all images we have seen, combining familiar forms, similarities, and memories. A good photographer will take this visual experience into account, and will either use it as a springboard for his own ideas, deliberately play with your perceptions, or present his own view as a counterpoint. An image is only a collection of colored pixels until the viewer applies his imagination to it. By the same token, an image that doesn't remind us of anything will probably interest us just as little as one that appears completely familiar. An image should leave room for the viewer's own fantasy.

Really great photos are often very sparsely composed, with nothing to distract the viewer from the subject. A few clear shapes with just a few, well-chosen colors increase the effectiveness of an image. Monochrome images have never really gone out of fashion, in spite of relentless progress in color imaging, and are even currently experiencing something of a renaissance. In times when a flood of information is more of a burden than a luxury, the arts of reduction and omission take on new importance. Having said that, it is much easier to reduce clutter in a studio than it is "out there" in the real world. Even experienced photographers sometimes fail to notice distracting backgrounds or tree branches protruding behind their subject's heads. This is where the monitor on a digital camera comes into its own, as it shows the scene you have just photographed in two dimensions. This often helps you to judge the effects of the surroundings that you might otherwise miss when concentrating on your subject. (ae/rez) c't

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Quality is key

Thomas Saur

Back to the Basics

Nowadays, when we are congratulated on a successful photo, praise is usually immediately followed by the question, "… and which camera did you use?" The role of the camera in the creative process is becoming increasingly important, while the photographer's own skill seems to be taking on a secondary role.

Twenty years ago, even amateur photographers needed to have a good grasp of the relationship between shutter speeds and apertures in order to take acceptable photos. Nowadays, increasingly automatic cameras are breeding a generation of photographers who are often unaware of the degree of influence they can exercise over their results. Many photographers simply trust the camera's systems and view the technically "correct" results as their own interpretation of the situation. But aren't automatically exposed photos just a formularized reproduction of a scene?

From Analog …

A look back at the history of photography shows that many images that we now regard as classics were produced under circumstances that were technically far from ideal. The 20th century's photo pioneers set out into the field carrying enormous plate cameras. The plates themselves were heavy and fragile, and only a small number of exposures could be made per session. The results weren't always predictable, even for the most experienced photographers, and focusing using a ground glass screen protected from stray light by a cloth was far from easy. The only information available to a photographer in advance of releasing the shutter concerned framing and focal plane, and the photographer had to rely on the power of imagination to visualize the results.

Photographers with a good grasp of the photo-chemical development process were able to influence the resulting image more directly. While shooting his famous North American landscapes in the 1940s, Ansel Adams (1902-1984) developed the "zone" system of composition and development in which the grayscale values of the different elements of an image were taken into consideration during exposure and development, and each negative was developed individually according to the nature of the image. This approach allowed Adams to precisely reproduce the tonal range of his subject in spite of being limited by the tonal range of his photo paper. Using his virtuoso talents to visualize his own personal interpretation of his subjects, he produced images that are still unparalleled in their visual power and technical prowess. Adams' iron will helped him to achieve technical near-perfection and to influence many generations of photographers who followed in his footsteps. His books *The Camera*, *The Negative* and *The Print* are still standard reference texts.

The invention of the 35mm camera made photography quicker and more practical, as well making it affordable to a broader public. Prepacked rolls of film could be used to shoot multiple images in a single session and there was suddenly no longer any need to load your film in the dark. These developments also increased the importance of photography as a documentary medium. The smaller film format initially reduced image quality, with grain becoming visible in prints and enlargements made using all but the least sensitive films while large format negatives were only ever enlarged using very small magnification factors, if at all. Medium format analog film was developed as a kind of compromise between the extremes of large and pocket format photography and today still plays a role in the professional photographic segment, although most major camera manufacturers have begun selling medium format digital cameras and camera backs that are sure to become the norm very soon.

The next stage in the development of popular photography was the advent of single-lens reflex cameras, which use a system of moving mirrors to allow the photographer to see the scene as it is being captured through the viewfinder. The development of through-the-lens (TTL) exposure metering followed in the 1960s and, for the first time, allowed fully automatic flash exposures at the press of a shutter button.

Once the photographer had been freed from having to manually meter exposure before every shot, autofocus was the next logi-

A classic film-based black-and-white image

A 4×5 inch large format camera with sheet film holders and a light meter

cal step, and cameras were soon focusing faster and more accurately than humans ever could. Programmed automatic exposure modes designed for photographing portrait, macro, landscape or other specific types of subject gave hobby photographers the opportunity to produce well-rounded images, while image stabilization systems minimized camera shake without us having to resort to using a tripod. But the most significant technological change, which influenced the everyday behavior of amateur and professional photographers alike, was the introduction of digital cameras.

… to Digital Cameras

In recent years, digital image sensors have completely changed the camera market and the habits of generations of photographers. The first digital cameras to hit the market were extremely expensive and produced results reminiscent of video stills. Any film-based pocket camera – no matter how cheap – produced better quality images.

But technology progresses quickly and, similar to the development cycle in the computer industry, every new generation of cameras brought considerable improvements at increasingly affordable prices. Three-megapixel amateur and 6-megapixel professional cameras were the first to deliver acceptable image quality to a broad public. At this stage, image quality was still not directly comparable to that produced by analog equivalents, but the practical advantages of digital photography soon began to outweigh the new medium's shortcomings. Suddenly, images could be viewed immediately after shooting and manipulated virtually at will on a computer, and additional images did not produce any further costs. The savings in film costs alone made it worth buying a digital camera, and the image quality of today's cameras is generally even better than that produced by their analog cousins.

The compact camera market is dominated by cameras with 10- or 12-megapixel sensors and the quality of the lenses they are coupled with is quickly reaching a level at which their full resolution can be used to produce detailed, large-format prints. Image quality has overtaken that produced by most of the 35mm films available. High-end cameras have sensors whose resolution ranges between 15 and 40 megapixels and which offer quality that equals or exceeds that of traditional medium format cameras. But there are still a large number of professional photographers who cannot overcome their skepticism regarding the digital medium, even though soft- and firmware-based noise reduction and dynamic range enhancement tools produce output that is obviously superior to anything that the analog medium can produce. The quality of modern photo printers and print services is constantly improving, and even professional photographers often make their own prints.

Image Quality: Analog vs. Digital

Analog film, with its high storage density and broad color range should – theoretically – be able to produce better results than any current digital imaging process. However, in practice, analog development processes involve too much quality loss to really compete with the digital medium. Modern 35mm negative film is capable of capturing approximately thirteen f-stops of contrast, but analog photo paper can only reproduce contrast in a 5-stop range. Enlarging small negatives also causes further image quality loss due to diffusion produced by the enlarger and the optical errors that are present in every enlarging lens. All of these factors increase exponentially with the magnification factor and make the theoretically superior resolution of the analog process unrealizable in practice. Tests have shown that prints made from conventional, low-speed analog film produce detail that is comparable to that produced by an 8-megapixel DSLR. Specialized document and military film can produce better results, but is not available to the general public.

Compensatory development, multiple exposures, dodging and burning and the use of graded paper are all techniques that can be used to coax greater detail from analog material, but the process nevertheless involves decisions about which details the photographer wishes to preserve and which can be sacrificed in order to produce the desired overall look.

The digital photo workflow is comparatively loss-free and produces much more consistent results. Color, contrast and image brightness can all be manipulated using image processing software, and processed images can be sharpened for additional impact before they are printed. But digital processes involve risks too.

Too Quick and Too Easy

Taking photos has become an almost completely controllable process. Techniques like those used by Ansel Adams, whereby the rhythm used to tilt the developer dish could have a significant effect on the resulting shadow or highlight detail, today seem like alchemy from a bygone era. Today's exposure meters, camera firmware, contrast or brightness settings and output soft- and hardware all work toward the same single aim of producing the best possible distribution of tonal values and faithful detail reproduction for the entire image area. Under- or overexposure are taboo and super-sharp focus is mandatory. In fact, modern cameras follow the same guiding principles as Ansel Adams and attempt to produce balanced images with deep blacks and radiant whites.

But that is where Adams' work really began. He used deliberate shifts in tonality to interpret rather than just photograph his subjects. In contrast, modern technology can only produce "correct" metered results, making it much faster and simpler to produce results that are, by definition, increasingly homogenous. An analog photographer has to be aware of the technical limitations of the medium in order either to avoid them or to use them deliberately as part of the creative process. The costs involved in analog photography also force the photographer to seriously consider each subject and the potential results of every exposure before releasing the shutter. This process makes every analog image the result of a creative process characterized by the photographer's own creative style. Visualizing the desired result in advance of shooting remains the key to producing original photographic images.

Critics of digital photographic processes still maintain that analog photos have more "atmosphere", but this is only true if the results are observed in combination with the processes used to create them. Technical limitations, such as shallow depth of field or the heavy grain and non-linear color reproduction associated with some emulsions, are just some of the factors which cause analog images to appear stylized and "atmospheric". Many classic photos deliberately use the abstraction caused by tonal imbalance or inconsistencies in color reproduction to achieve their effects, especially in the field of black-and-white photography.

So …

In its infancy, the appeal of the digital photographic medium was its ease of use. Nowadays, digital image quality no longer lags behind its analog equivalent. Metering technology and reproduction accuracy are constantly improving and the term "image quality" is beginning to take on a meaning beyond that which can be measured using a test chart. The limiting factor is no longer the camera, but rather the photographer. The simpler it is to produce images, the more arbitrary the results will be.

The modern photographer must learn to see and to decide how to interpret a subject in spite of the virtually boundless technological help that is available at the push of a button or the click of a mouse. There is a lot to be learned from older, "slow" analog techniques. Digital technology is, of itself, neutral and is simply waiting to be used usefully and creatively. With any luck, we will soon get to hear people saying things like, "Great photo! Who took it?" (ae/rez) c't

A deliberate grain effect. This portrait was shot using high-sensitivity 35mm film.

All photos by Thomas Saur

Thomas Saur

Shooting in Black and White

A good black-and-white photo has a magical quality and often helps to reveal aspects of a scene that would normally remain hidden from the viewer. Black-and-white images are much more than just color photos with the color left out – the concentration on grayscale values gives us a new and intriguing view of reality.

In his search for the perfect scene, a photographer who revisited the scenes of some of Ansel Adams' most famous landscape photos was astonished by the banal nature of the scenery he found. Where were the dark, craggy cliffs? Where was the finely-textured vegetation? What had happened to the lush skies with their radiant cloudscapes? He couldn't find any of it. This anecdote proves to me that photos can often give us an enhanced view of reality.

It was, of course, Adams' own view of the scenes and his virtuoso photographic skills that enabled him to portray nature the way he saw it and to produce his famous, almost sculpted-looking images. On his search for subjects, he used a contrast filter that enabled him to view a scene virtually without color, and when making prints, he always used the entire range of tonal values that the black-and-white process offered. He used a spot meter to meter the individual zones within a scene and his own, exclusive zone system to expose and develop each of his images.

Contemporary digital photographers don't generally use antiquated manual techniques to meter their exposures, instead relying heavily on the camera's automatic systems to produce the "right" result. This article explains how knowledge of traditional photographic methods can help modern photographers make the most of the digital photo workflow. The most important factor in the process is correctly adapting traditional techniques for use in a digital environment.

Basic Camera Settings

Make sure you have selected the appropriate camera settings before you release the shutter and always shoot in RAW format if you can – it's definitely worth it! RAW image files nearly always have greater color depth than JPEGs and include much more detailed image data. JPEG image data is automatically processed according to the camera's built-in algorithms and the settings the user makes, and often provides images with improved visual appearance, but which also lack detail. JPEG algorithms often produce visible compression artifacts too. If you shoot RAW images, you can apply selected processing steps individually under controlled circumstances using a computer.

If your camera doesn't support RAW, it is preferable to select neutral contrast and saturation settings and either to set in-camera image sharpening to its lowest level or switch it off entirely before shooting, if you can. That way, you can preserve the greatest possible range of detail and you can also sharpen your image less damagingly later, once you have performed any other necessary adjustments. You can use your camera's built-in black-and-white or sepia settings to preview your composition, but always shoot in RGB mode if you want to give yourself the best possible base image for later conversion to monochrome.

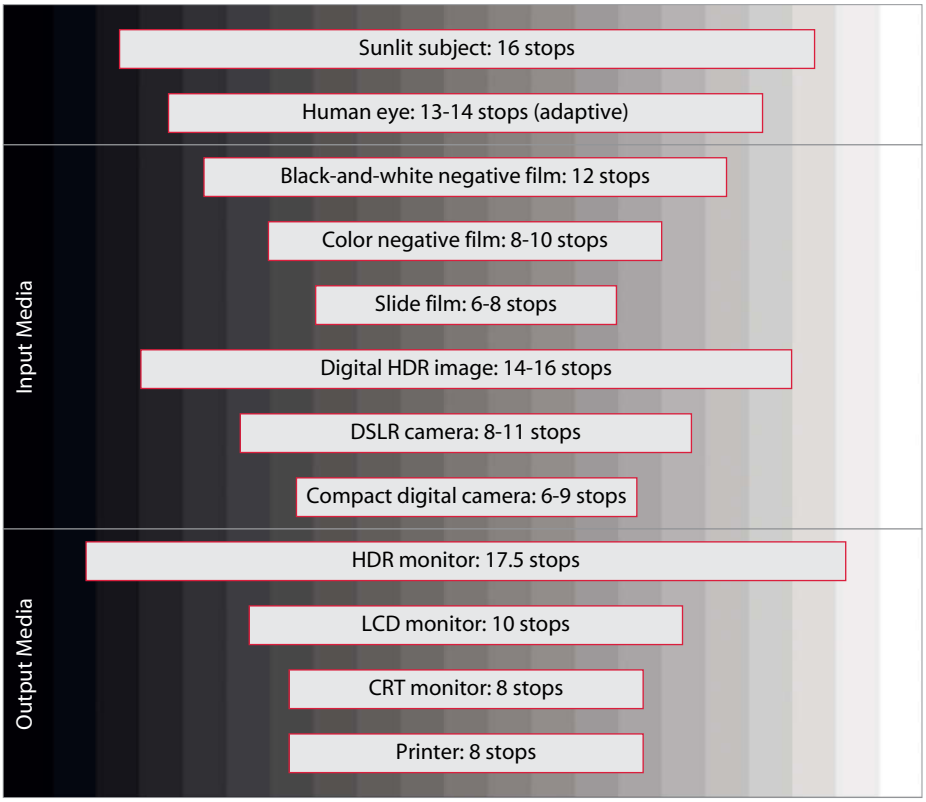
Shooting Tips

1. Select the highest available image quality and lowest possible ISO values when shooting. If possible, always shoot in RAW format. If this is not possible, use neutral color and contrast settings without additional sharpening.

2. Visualize how your image will look in black-and-white. Concentrate on texture, lines and tonal gradients. These will become more obvious later in the black-and-white version of your image. Analyze the individual tones and the dynamic range of your scene and try to consider the technical limitations of your camera and printer while composing your scene. Use the results of your analysis to decide where to place the brightest and darkest tones in your finished image.

3. If in doubt, expose for the highlights! Slight underexposure is better than overexposure.

4. If you are still uncertain of how best to expose your image, shoot a bracketing sequence at half-stop intervals and select your best shot later. You can also merge multiple images using HDR or DRI techniques to produce your desired effect.



The range of contrast that various input and output media can reproduce varies enormously

Exposure

You might think that today's automatic cameras have taken the guesswork out of taking great photos, but an image that looks fine on your camera's monitor can still contain imperfections that aren't immediately visible. Most automatic exposure systems select usable aperture/shutter speed combinations but are not capable of detecting exactly which part of a scene is the photographer's chosen subject. A "normal" scene photographed in bright sunlight can encompass contrast of up to 16 whole f-stops, with each stop equivalent to doubling the amount of light that reaches the camera's image sensor. This means that the contrast in our sample scene measures 2^{16} or 65,536:1. But what remains of all this contrast if the camera you are using can only capture a tonal range of nine f-stops (i.e., contrast of 512:1)? If the range of contrast in a subject exceeds that of the medium used to record it, your image will end up with burned out highlights, detail-free shadows, or both.

Digital image processing techniques can compensate for much of the difference be-

The range of contrast present in an image has to be reduced to a level that a printer can reproduce

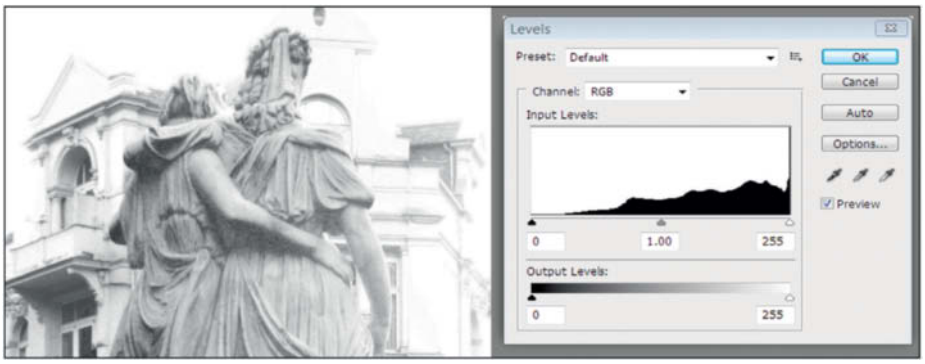
tween input and output contrast levels. This is mainly due to the fact that the dynamic range of most output media is narrower than that of the recording media. An LCD monitor can display a maximum of approximately 10 f-stops, while an inkjet printer cannot reproduce more than six or seven stops of contrast. And although the range of contrast present in the actual subject will always be compressed to the range that your chosen output medium can reproduce, well-made prints can nevertheless include deep black shadows and radiant highlights.

How can this be? While a densitometer will always detect the purely qualitative differences between the highlights and shadows present in a subject or a print, the human eye automatically adapts to compensate for perceived irregularities in dynamic range. We interpret the grayscale values in a print in relation to each other and according to our experience of the interplay between light and shadow.

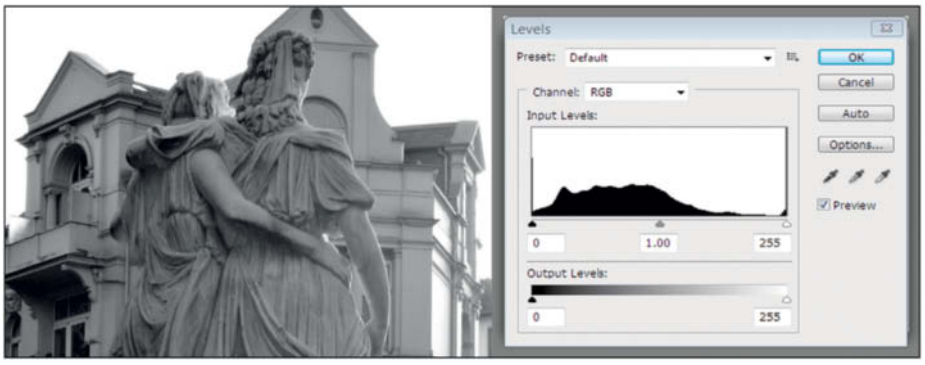
The best monochrome digital images are the ones with the broadest dynamic range, making it necessary for the photographer to actively decide how to expose each frame. Ansel Adams' guiding motto for shooting with black-and-white negative film was "Expose for the shadows and develop for the highlights".

Many analog photographers use the technique of deliberate overexposure and shortened development times to compensate for excess dynamic range in black-and-white subjects. Digital image sensors have different characteristics from negative film and require an approach that concentrates more on preserving highlight detail. Lost shadow detail can often be recovered digitally, while the detail in burned out highlights is usually irretrievably lost.

Transitions from bright areas to highlights in a correctly exposed negative image are usually finely graduated, whereas CMOS and CCD image sensors tend to stop recording abruptly



The histogram curve is clipped toward the right and the image is overexposed. The burned out highlights cannot be recovered.



Slight exposure compensation (between 1 and 2 EV) results in much better highlight detail

beyond a certain level of brightness. Underexposed RAW image files contain more shadow detail than their analog equivalents, so it is important to keep an eye on the highlight values in the camera histogram or monitor image. Most contemporary cameras have a clipped (i.e., overexposed) highlight display feature that makes potentially overexposed image areas blink in the monitor. This gives you the chance to re-expose your photo using different exposure values – if your camera has this feature, use it!

If the histogram curve is clipped toward its right-hand end, this is a clear sign of overexposure. Set an exposure compensation value or underexpose manually by between a half and two stops until the clipped highlights are displayed as well exposed. This can, however, lead to clipping at the other end of the tonal scale with a corresponding loss of shadow detail. Try to find the right compromise between the two extremes and, if you are in any doubt, underexposure is always better than overexposure. If your camera doesn't have an exposure compensation feature, you can press the shutter button halfway while pointing the camera at a brighter part of the frame before reframing to include your intended subject. Be careful if you use this technique, as pressing the shutter button halfway usually locks both the exposure values and the current focus setting. If you cannot capture the entire dynamic range of your subject in a single image, you can take multiple photos and merge them in to a single HDR (High Dynamic Range) image. Especially effective for stationary subjects, this technique involves producing a kind of digital negative that is saved at 32-bit color depth and can cover up to 16 stops of contrast and a wide range of finely graded tonal values. This 32-bit image file then serves as the basis for a technique called tone mapping that transposes the image's extended dynamic range into a form that can be reproduced using conventional monitors or printers. Tone-mapped images make an ideal basis for black-and-white conversions.

Shoot using low ISO values whenever possible. The default ISO 100 setting is best, as higher values tend to reduce a digital camera's exposure headroom. This can lead to a total dynamic range of 6 EV or less in some compact cameras, which will significantly reduce your creative potential. Washed out highlights often betray the digital nature of an image, and if you apply additional sharpening later, your images can end up having an artificial, video-like look.

Compact cameras, with their small sensors and inherently narrow dynamic range, suffer more in this respect than DSLRs, although some camera models produce burned out highlights more readily than others. It is advisable to deliberately underexpose by or of a stop if you are shooting a high-contrast scene with a compact camera. Many cameras now have built-in "highlight priority" functionality that automatically exposes to preserve highlights and highlight detail.

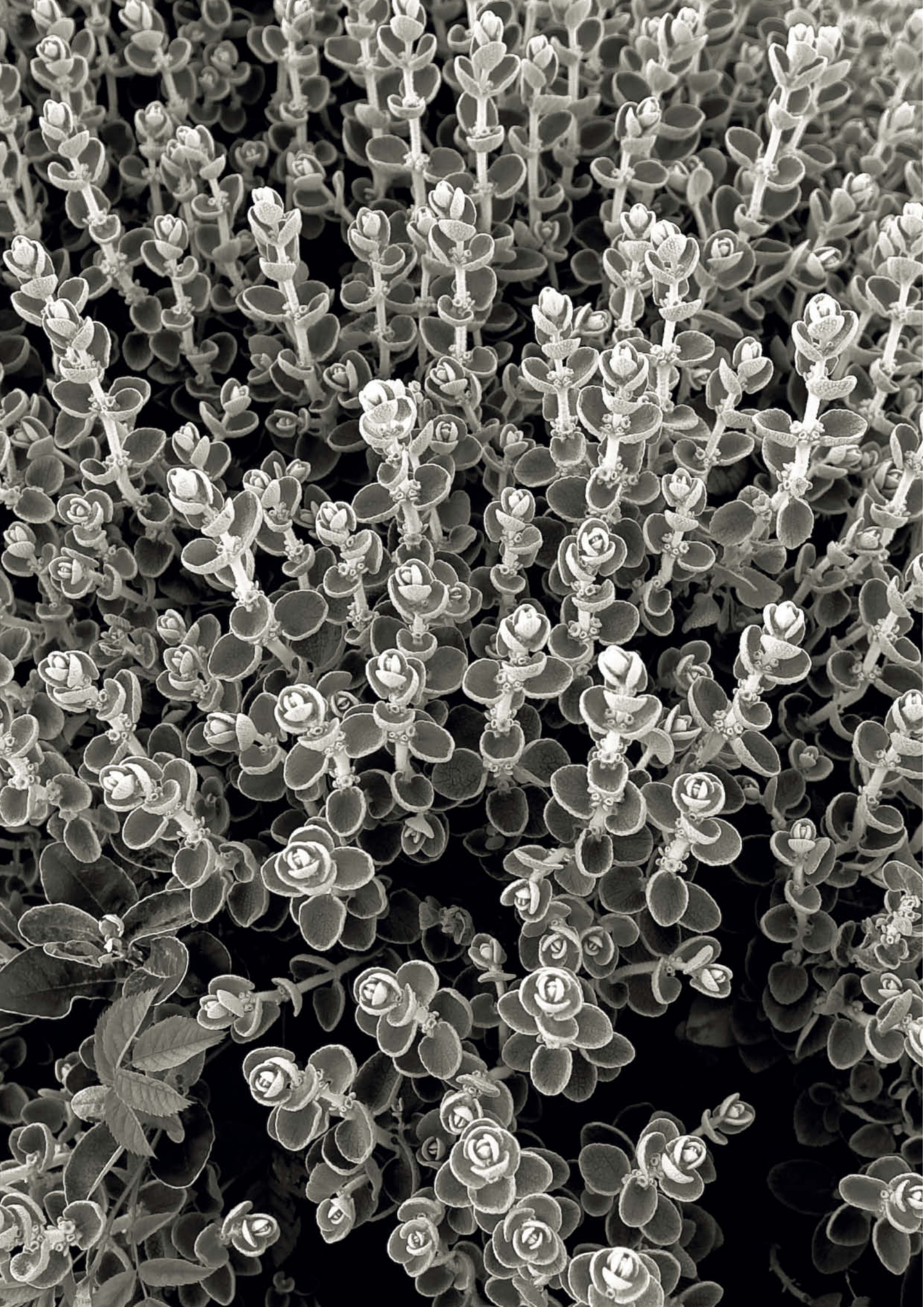
A great example of the abstract effect a black-and-white conversion can have

The Zone System

In his legendary reference book *The Negative*, Ansel Adams details a three-step approach to improving your perceptive and image composition skills:

1. Look for the darkest relevant detail in your scene. Adams states that some objects that appear to be black – such as a black hat or a cat – are not actually black in a photographic sense. He recommends learning to see all dark tones as shades of dark gray in order to select which portions of your image you want to appear truly black in a print.

2. The next step involves concentrating on the brightest parts of your scene. Here, Adams recommends that you always mistrust your first

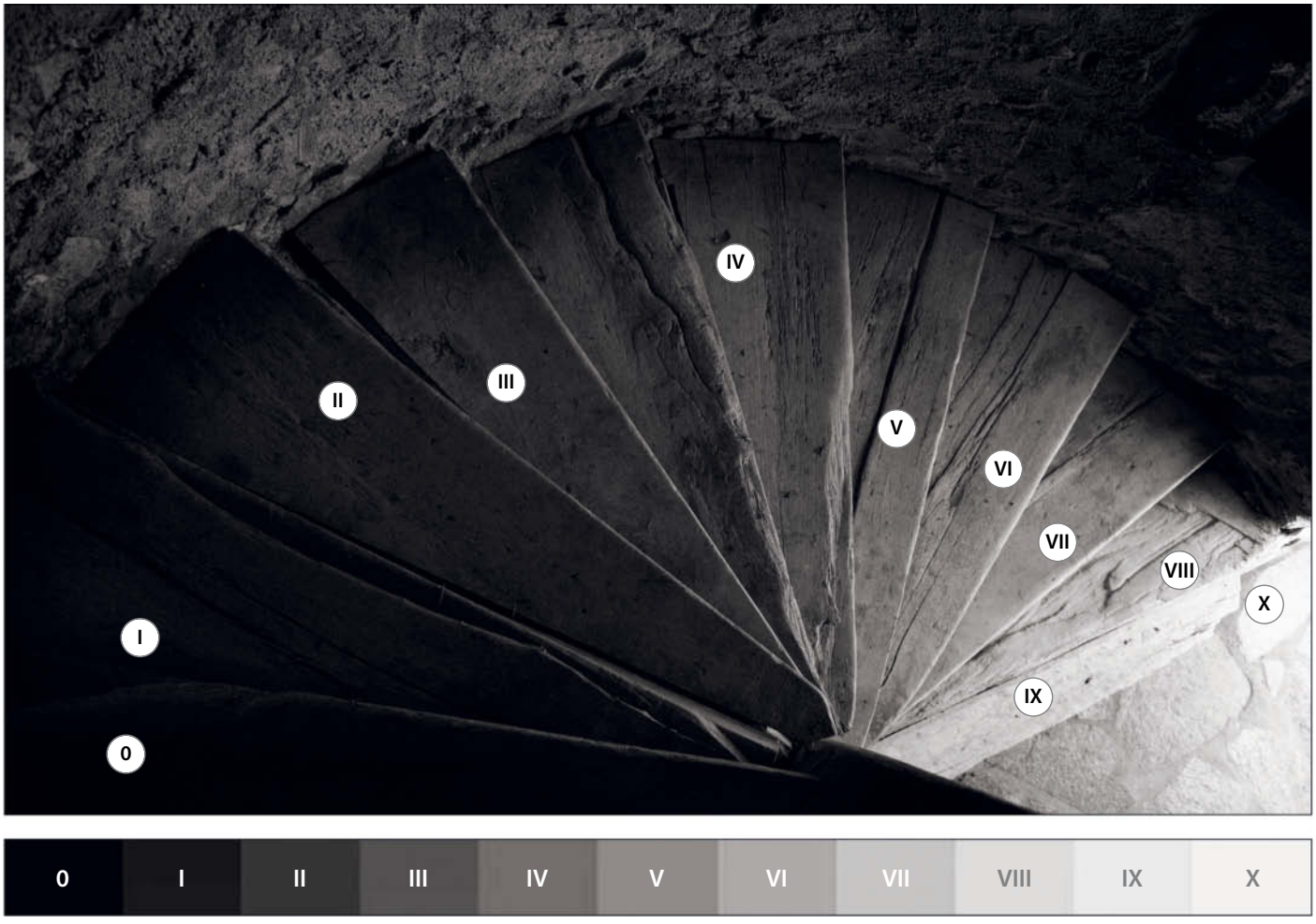


impressions. A white tablecloth might be the lightest colored object within the frame, but reflections from a polished metal spoon, for example, will produce much more intense highlights than the cloth itself at the same exposure level. The reflections from the spoon should, as a result, appear much brighter than the cloth in the finished print. Bright features, like the highlights produced by reflective metal, can even be printed as pure, detail-free white if they only represent minor detail within the frame. This example illustrates Adams' primary idea that the tonal values of individual details have to be assessed within the context of the entire image, and that your choice of the details you accentuate will be based on the results of this assessment.

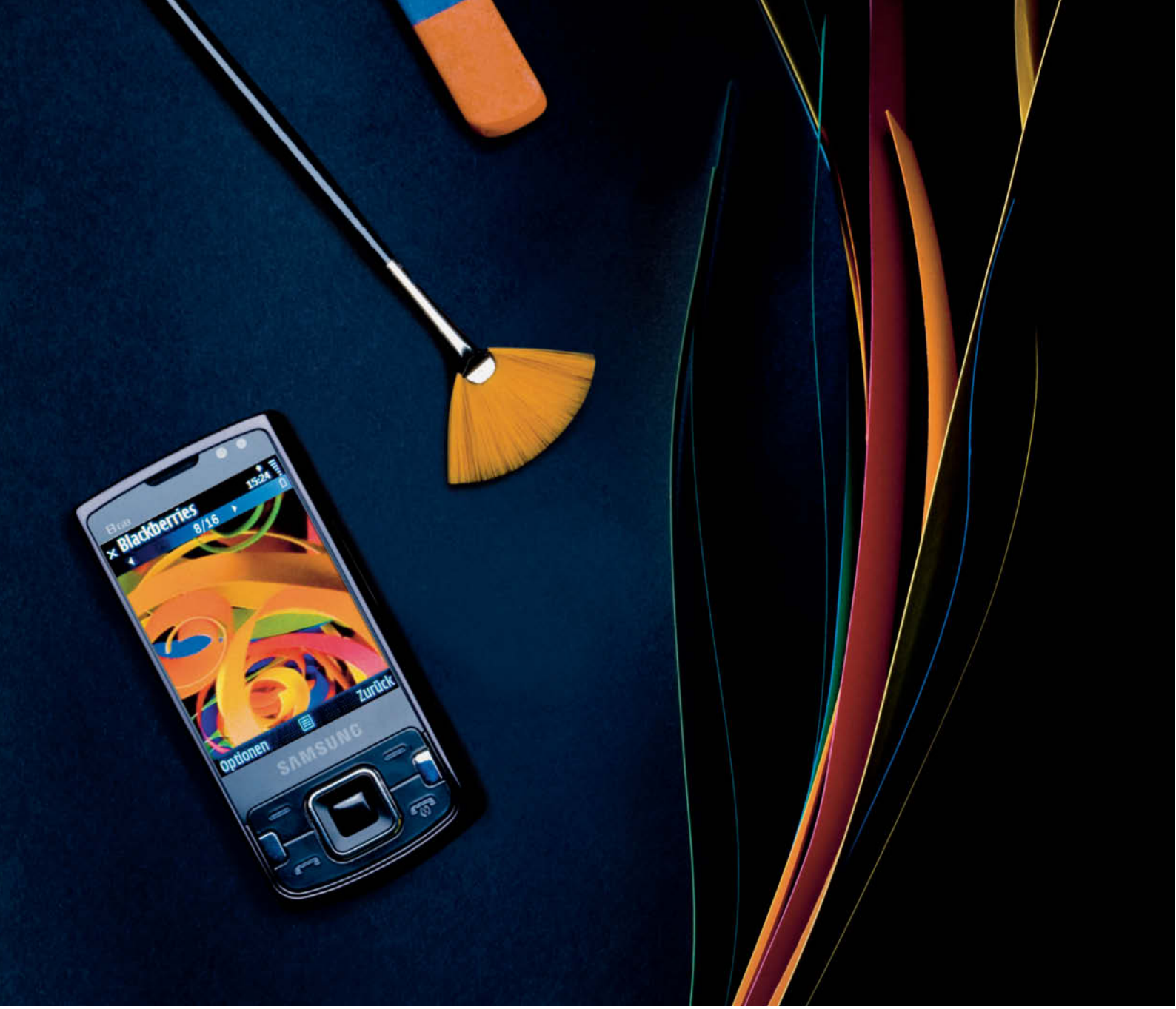
3. The third step involves assessing the midtones that lie between white and bright gray and those between black and dark gray. An important factor at this stage is deciding which gray value represents the middle of the image's overall range. A photographer can learn to recognize and compose using individual tones and semitones, rather like a musician. Adams actually defined a standard range of 11 zones, named using Roman numerals from 0 to X (see the illustration below). His technique involved using a narrow-band spot meter to meter the important details within a scene and allocating them to one of the 11 zones. This allowed him to judge the overall dynamic range of his subject and thus to select the correct combination of aperture and shutter speed, as well as the appropriate developer concentration and development time to produce print contrast that was appropriate to the individual subject.

This technique was originally developed to produce a single, optimized print from a single, large-format negative. While early photographers were unsure how their results would look until after the print had been developed and chemically fixed, digital photographers often only take a quick glance at the camera monitor to see whether a shot has worked out. Whatever you do, don't let this apparent simplicity become a substitute for conscious perception and composition when you are taking photos. While the zone system can't be transposed directly to the digital context, a good grasp of the theories involved can help you to view your subject in more detail and to compose an image that can be effectively converted to grayscale. In the world of endless digital processing options, a preconceived image concept helps you to avoid losing track of your original idea. Human perception doesn't work like a light meter – it tends to see colors and tones differently depending on the nature and brightness of their surroundings. The emotions an image produces depend on how the viewer perceives it, not on the measured values used to create it, so remember to concentrate not just on "correct" exposure, but also on how you want your finished image to appear. A deeper understanding of basic photographic technique can help you to see and photograph the portions of the enormous range of available tones that are important to the emotional impact you want your image to have. A great photographer knows not only how to pack the maximum amount of information into an image, but also which information to leave out in order to produce the best possible results. (ae/rez)

Fine, high-contrast textures are ideal subjects for black-and-white photos



The dynamic range of our subject, divided into 11 Ansel Adams-style zones



Ralph Altmann

Cellphone Photography

with a twist

Cellphone photographs are underexposed and out of focus, full of image noise and JPEG artifacts – suitable, at best, as souvenirs, right? Are you sure? What about using the flaws as a stylistic device instead of covering them up?

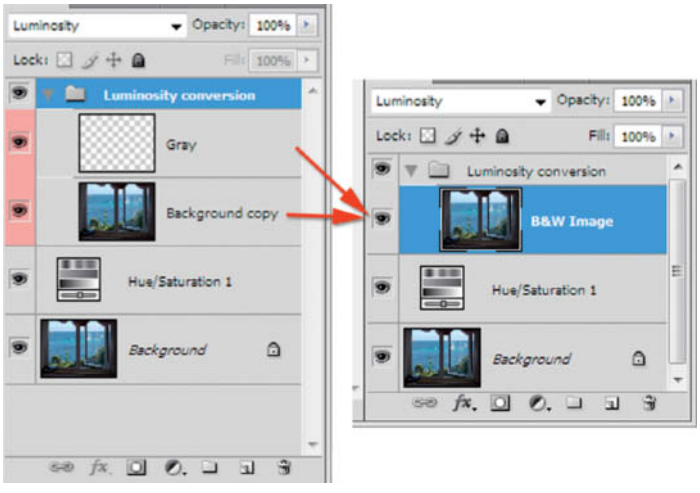
Pro SLR cameras passed the 50 megapixel mark long ago. Even my Motorola, which isn't the youngest anymore, boasts a million pixels. OK, that was already standard 10 years ago, even for SLRs. Technically speaking, the lack of pixels doesn't mean you can't take great pictures with your phone. Rather, the quality is defined by the pinhead-sized lens and the enormous JPEG compression, which boils the 1280 × 960 pixel images down to an average of 300 KB. The settings are limited to white balance and exposure compensation, and the phone immediately forgets any changes you have made to them once you snap it shut. Moreover, the location of the exposure button makes unfocussed pictures almost inevitable.

Strong colors and structures make a blurred cellphone image look more like an abstract painting

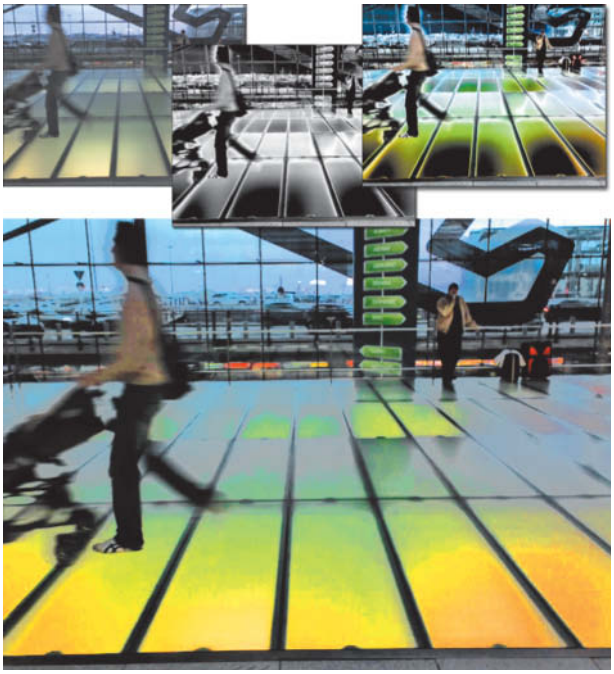
Even so, the camera phone beats any other camera in terms of availability. With other cameras, whether professional or compact models, you have to make that conscious decision to take your camera along, whereas the cellphone is always in your pocket. Eventually, for me, due to the lack of a "real" camera, the day came where I succumbed to the temptation of taking pictures with my phone – even though I thought I knew that nothing good could come from it. At first my suspicions were confirmed: overexposed highlights, underexposed shadows, out-of-focus or shaky images and limp colors characterized the results. My lame attempts to take corrective action only made further inherent qualitative shortcomings like noise and JPEG artifacts more apparent.

The results from my camera phone are likely ill-suited for artwork intended to satisfy ordinary viewing expectations. However, it is not common to use cellphones for landscape and architectural photography or, for that matter, the ubiquitous wedding. Rather, camera phones are more appropriate for snapshots, photographs "in passing", or for capturing situations and moods – basically, for pictures where the images don't have to be in focus or the colors accurate, where crooked horizons and blurred or grainy images aren't considered flaws but rather underline the fleetingness of the moment. I prefer to intensify these flaws, especially the image noise and the JPEG artifacts, until they become visible. This gives the washed out cellphone photograph a graphical texture; a strong emphasis on color does the rest.

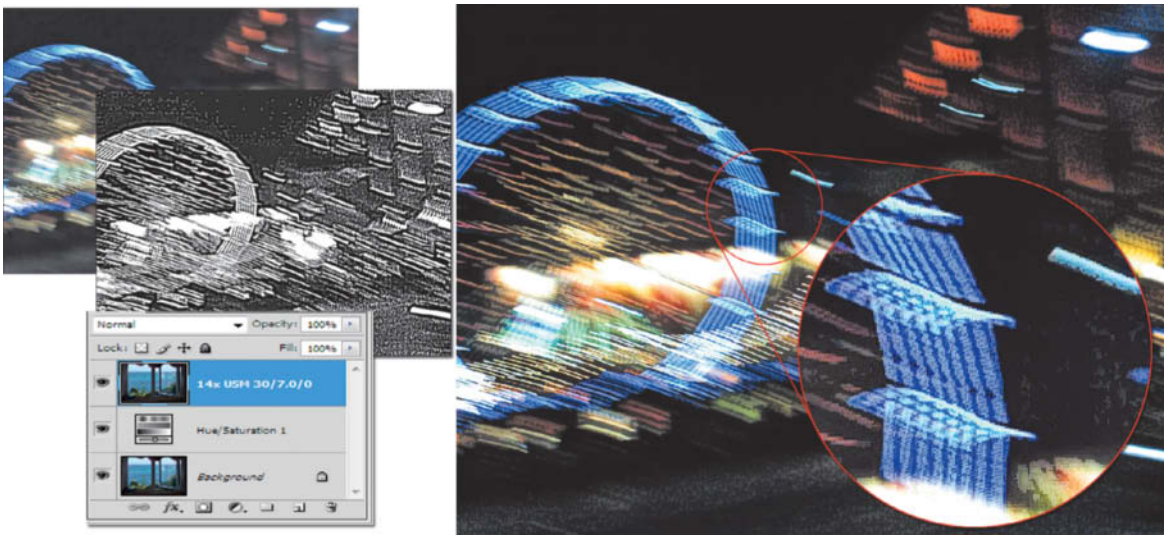
My guiding principle when editing camera phone images is strict separation of brightness and color editing. The L*a*b* color mode is not required. It is sufficient to put a grayscale version of the picture with a suitable blend mode over the layer with the



The grayscale image is created by masking the color image with a pure gray or black layer (using Hue blend mode). We do this in the Layers panel within the "Luminosity conversion" layer group. The entire group is set to Luminosity blend mode. This allows you to manage the color and brightness separately. Color can be regulated using the adjustment layer (second layer from the bottom), brightness by correcting the overlying grayscale image. The top layer in the Layers panel shows a heavy gradation shift after merging the group.



The top row depicts the original cellphone image, the partially solarized grayscale image and the result of the layering by applying the Luminosity blend mode. I used the Soft Light blend mode to create the larger image.



Focus in a fuzzy image: Overlay mode prevents the colored highlights in this blurred photograph from dissolving completely

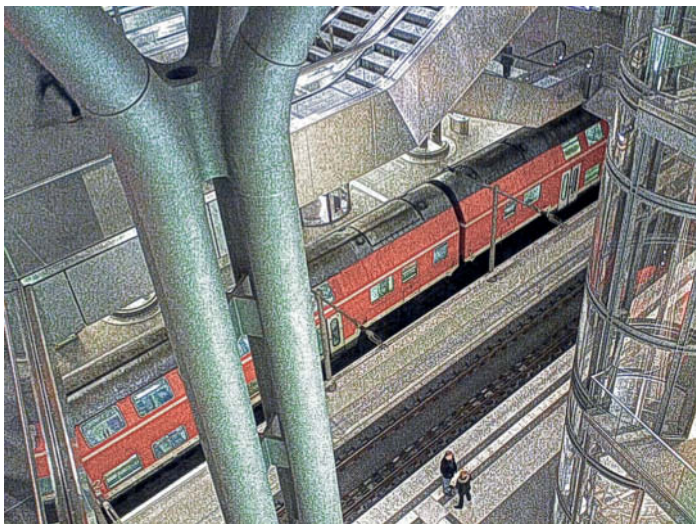
color image. The blend mode on offer is Luminosity or Lighten. The principle is the same even when the gray scale image relies on the luminance of the color image. See the figure at the bottom left on the previous page for how to achieve a "luminance image" like this. Next, I create a Hue/Saturation adjustment layer over the original image and enhance the saturation globally or selectively. The saturation can be regulated further to the right than would otherwise be possible because the grayscale layer greatly reduces the danger of oversaturating an image.

Editing the grayscale layer affects the overall picture only in terms of the brightness of the colors, but not their hue and saturation. Therefore, even significant adjustments to the tone curve alter the image less than if the same modification were applied to the entire image. The image at the bottom right on the previous page was created by partially solarizing the grayscale image (a partial inversion of the tonal values using a gradation curve, for example).

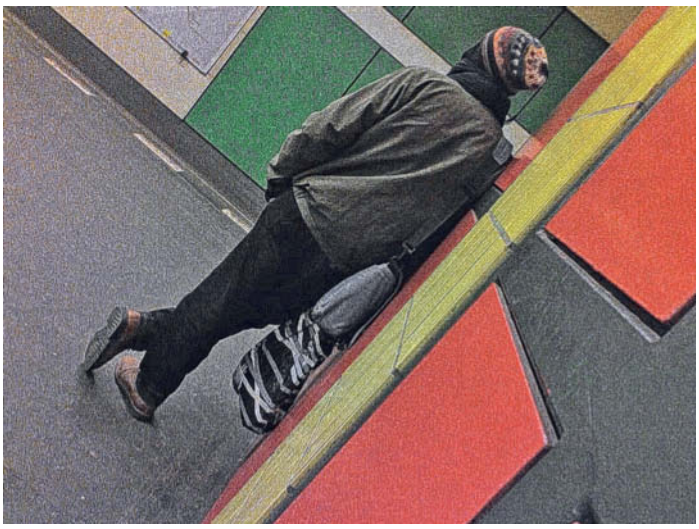
My preferred blend mode for layers, however, is not Luminosity but Soft Light, which produces further amplification of the contrast and colors in the result. You may have to factor this in when preparing the grayscale image. Overlay and Hard Light" give harsher results which, like any result achieved with an overlay layer, can be softened by moving the Opacity slider.

I usually use a variation of the "sharpening using grain" technique to counteract the blur and lack of sharpness in my camera phone pictures. A copy of the original is transformed into a grayscale image and is repeatedly sharpened with the Unsharp Mask filter until only the underlying textures remain in the image. The bigger the sharpening radius, the more the contours will be enhanced. I set this layer to either Luminosity, Overlay, or Soft Light blend mode. In most cases, opacity has to be reduced. The contours, which shimmer through feebly, separate color spaces from one another and ensure that the image appears sharp when magnified. Furthermore, a surface that initially appears to be an almost homogenous, blurry color then gains a texture which in itself also appears to be sharp. This texture results from the image noise and the JPEG artifacts of the camera phone picture. It can even break open under- and overexposed image sections which are almost completely black or white and give them an interesting graphical effect.

Multiple sharpening has the disadvantage of creating very harsh ultra-high-con-



Berlin Central Station



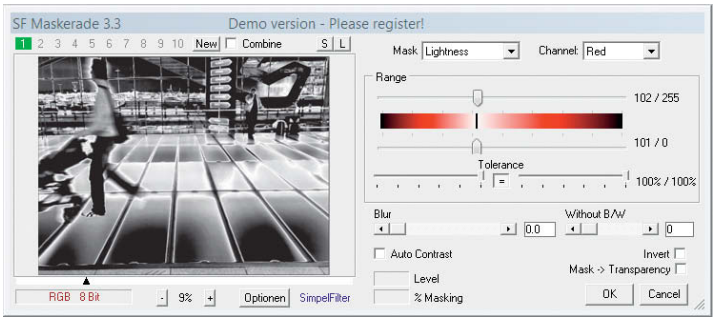
Waiting

trast images that contain nothing but black and white. It is desirable to have an image that still has the contrast gradation of the original, even though it has been extremely enhanced. I create such contrast images with my SF Maskerade plug-in. In addition to the freeware version, the full version of the program (available at www.simplefilter.de/en/) contains two mask modes, called Contours and Contrast. You can also blend several of these masks within the filter. The result is a grayscale image, which I lay over the original with one of the previously mentioned blend modes. The interposed "Hue/Saturation" layer setting provides the color boost.

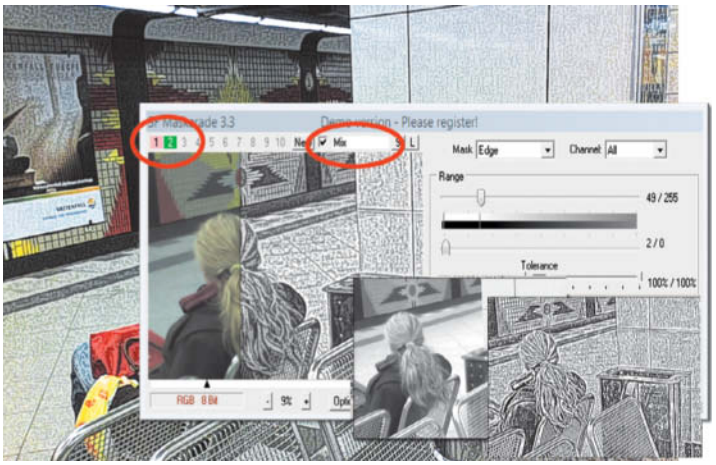
The partially solarized grayscale image (see above) was also created by means of the Maskerade plug-in with the Lightness mode. These reverse gradations can produce better results than the gradation curve tool, and it is also possible to apply the freeware version's filter. I then increase the contrast using the same blend mode, mixing the result beforehand in the filter with the brightness mask. The result is a grayscale image with a visible "grain", the size of which depends on the radius chosen. The contours are also enhanced, and you can choose whether the enhancement will affect only the weak, only the strong, or all types of contours. For our purposes, the other options are irrelevant.

Photographs with totally burnt-out highlights have no JPEG artifacts or image noise at all, so the texture cannot even be made visible, even with maximum contrast enhancement. So it is important that the raw material, the cellphone photograph, is not overexposed. Underexposing the image is less harmful, because although underexposed areas may not contain any useful details, they do contain artifacts that can lighten dark shadows when enhanced. This kind of simulated enhancement of details is always better than not changing anything at all, especially for details where we expect some texture in the image, such as in brickwork and other building materials, textiles, fur, and hair. These kinds of textures can be distracting on smooth skin but there are proven methods of selective image editing and masking that allow you to apply powerful effects to a specific area of an image while excluding others.

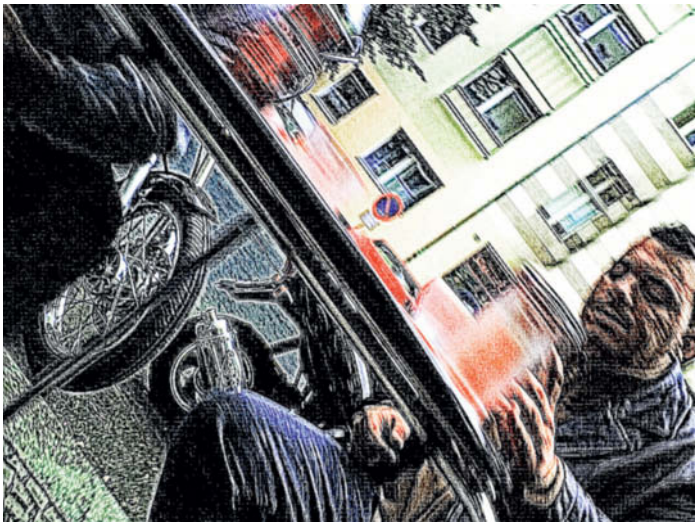
(ae/rez) c't



Partial solarizaton in the Maskerade filter's Brightness mode. In this case, applied to only the red channel of the original image.



The grayscale layer, which I blended in the filter, from a normal but somewhat brightened grayscale image and my high-contrast image, and applied over the original layer. A radius value of 3.0 gives a stronger contour. The two partial images can be seen at the bottom right.



Street café

Cologne Bonn Airport

Rolf Hempel

The Moon

as a large format panorama

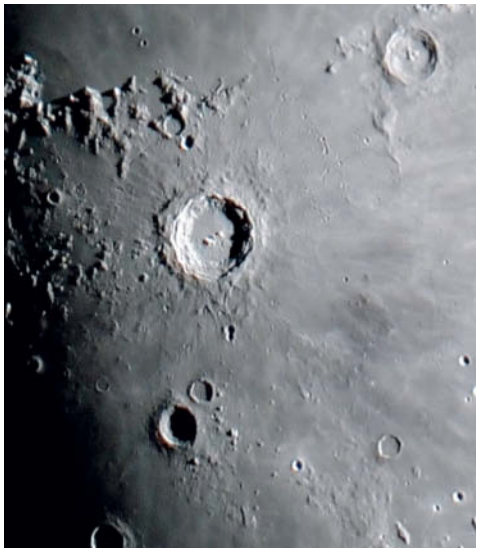
Thirty-eight source images and a lot of image processing were the basic components of this 24-megapixel, high-resolution panorama image of the Moon. The finished image, which is suitable for printing as a poster, is licensed for private use and is included on this issue's free DVD. Here, find out how the image was made.

The source images were shot using a Nikon D80 attached to a 1200mm telescope with a 130mm aperture. I used a Barlow Lens to increase the effective focal length to 3170 mm. This degree of magnification allows even small details to fill the frame, so I shot 64 individual images at ISO 800 and 1/60 second to produce the source material for the nine segments necessary to cover the entire surface. I used a stepper motor to keep the subject centered on the image sensor during shooting. Atmospheric turbulence spoiled some of my shots, leaving me with 38 usable source images, equivalent to about four per segment.

As with terrestrial images, processing took much longer than the actual shoot. I used Giotto 2.1.2 (a free astrophotographic image processing program) to stack the images for each segment and to apply a Gaussian sharpening filter to the results. I then used PanoramaStudio 2.0 Pro to merge the stacked segments into a single image.

I used Photoshop to perform my fine-tuning. In order to avoid loss of detail while processing the extreme difference in brightness between the edge of the Moon and the shadow surrounding it, I merged two versions of the image with different brightnesses using the Photoshop Gradient tool. I also produced a low-noise version of the image using Noiseware Professional 2.6 and merged the edge portions of the resulting image – again, using the Gradient tool – with the overall picture. This step reduced noise where it was most evident and reduced the effects of artifacts in the brightly-lit parts of the image. Finally, I used the Unsharp Mask tool to sharpen the merged image.

The finished image – almost 70 MB in size – is included on this issue's free DVD, along with a detailed description of the individual steps in the processing workflow. To view the image, I recommend using the largest monitor you can get your hands on or having a print made by a high-end print service. The details are fascinating and you are sure to end up inspecting individual craters and bumps with a magnifier. The image is licensed for private use and non-commercial printing and display. (jr) c't



One of the many details in the finished panorama: Copernicus is a prominent and relatively young crater that is 59 miles in diameter. The mountains in the center of the crater reach heights of up to 4,000 feet.

The 68-mile-long, 1,000-foot-high elevation in the centre of this section has a slope of just seven degrees and appears as a dark line just after sunrise, changing to a bright line at sunset.

Photos: Rolf Hempel

Photographed directly from Earth using a DSLR and a telescope. The finished 24-megapixel image is constructed from 38 individual source images.

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