

## 1

### Basic Theory

7

Bitmaps and Vectors	8
Pixels and Resolution	10
RGB and CMYK Color Models	11
Color Management	13

## 2

### The Working Environment

15

The Working Environment	16
Using the Tool Panel	18
Document and Scratch Sizes	20
Ruler Guides and Grids	21
Zooming and Moving Around	22
The Info Panel	23
Panel Techniques	24
Controlling the Workspace	26
Save and Load Custom Settings	27
Printing	28
The History Panel	29

## 3

### Open and Save Files

31

Opening Images in Photoshop	32
Scanning into Photoshop	33
Opening and Placing EPS files	34
Bridge	36
Adobe Camera Raw	39
Graduated Filter Tool	41
Saving Files	42
TIFF Format	43
Photoshop EPS	45
Save As JPEG	46
Creating a New File	47
Photomerge	48

## 4

### Image and Color Basics

49

Rotating an Image	50
Resizing without Resampling	51
Resampling Up	52
Sampling Down	54
Cropping an Image	56
Preserve Details Enlargement	57
Adding a Border	58
Image Modes	59
Foreground & Background Colors	61

Eyedropper and Color Sampler	62
The Color Picker	63
The Color Panel	65
The Swatches Panel	66

## 5

### The Painting Tools

67

The Brush Preset Picker	68
The Brush Panel	70
Custom Brush Settings	72
Brush Tip Shape Settings	74
Brush Presets	75
Mixer Brush Tool	76
The Pencil Tool	78
The Gradient Tool	79
The Paint Bucket Tool	80
Blending Modes	81
Creating Rasterized Shapes	84

## 6

### The Editing Tools

85

Blur, Sharpen and Smudge	86
The Clone Stamp Tool	87
Dodge, Burn and Sponge	88
The Eraser Tool	89
The Magic Eraser	90
The Background Eraser	91
The Healing Brush Tool	92
The Spot Healing Brush Tool	93
The Patch Tool	94
Color Replacement Tool	95
Content-Aware Move Tool	96

## 7

### Selections

97

Marquee Selection Tools	98
Marquee Options	99
Moving Selected Pixels	100
The Lasso Tools	101
The Magic Wand Tool	103
The Quick Selection Tool	104
Refine Edge	105
Feathering Selections	107
Modifying Selections	108
Grow and Similar Commands	109
Pasting Into Selections	110
Filling a Selection	111
Copying and Pasting Selections	113
Focus Area Selection	114
Transforming Selections	116

## 8

## Layers

117

Working with Layers	118
Merge and Flatten Layers	120
Moving Layers Between Images	121
Selecting and Linking Layers	122
Locking Layers	123
Layer Groups	124
Layer Styles	125
Transforming Layers	128
New Layer Commands	129
Smart Objects	130
Linked Smart Objects	132
Warping	133
Auto-Align/Blend Layers	135
The Styles Panel	137
Content Aware Scaling	139
Puppet Warp	141
Perspective Warp	143

## 9

## Working with Type

145

Creating Point Type	146
Creating Paragraph Type	147
Editing and Selecting Type	148
Character Settings	149
Paragraph Settings	151
Masked Type	152
Type and Layer Styles	153
Type Effects	154

## 10

## Paths

155

Converting Selections to Paths	156
Using the Pen Tool	157
Selecting Paths and Points	159
Managing Points	160
Manipulating Points	161
Exporting Paths	162
Smart Guides	163
Creating Shape Layers	164
Fill and Stroke for Shapes	165

## 11

## Channels and Masks

167

Quick Mask Mode	168
The Channels Panel	169
Save and Load Selections	170
Layer Masks	172
Pixel and Vector Masks	174
Mask Properties Panel	176

# 12

## Color Adjustments

177

Brightness/Contrast	178
Auto Tone and Auto Color	179
The Levels Dialog Box	180
The Curves Dialog Box	182
The Histogram Panel	184
The Adjustments Panel	186
Vibrance Adjustment	189
Color Balance	190
Black & White Command	191
Shadow/Highlight Command	192

# 13

## Filters

193

Filter Controls	194
Unsharp Mask and Sharpen Filters	195
Smart Sharpen	197
Blur Filters	198
Path and Spin Blur	200
Noise Filters	202
Automatic Camera Shake Reduction	204
The Liquify Dialog Box	205
Liquify Distortion Tools	206
Filter Gallery	207
Vanishing Point	209
Editing Perspective Planes	211
Smart Filters	212

# 14

## Web and Multimedia

213

Save for Web	214
Saving Optimized Images	216
GIF Optimization Settings	218
JPEG Optimization Settings	219
PNG File Format	220
Color Palettes	221
Dithering	222

# 15

## Animations and Slices

223

Creating a Simple Animation	224
Playing and Managing Frames	226
Optimize and Save Animations	228
Tweening	229
Slicing Images	230
Working with Slices	231
Optimizing and Saving Slices	233

# 1

# Basic Theory

*Understanding the basics of color is important, if you are to get the best out of Photoshop.*

- 8** Bitmaps and Vectors
- 10** Pixels and Resolution
- 11** RGB and CMYK Color Models
- 13** Color Management

# Bitmaps and Vectors

Photoshop is an image-editing application, with a wealth of tools and commands for working on digital images or bitmaps. There are utilities for retouching, color correcting, compositing, and more. There are also over 100 functional and creative filters, which can be applied to entire images, selected areas, or specific layers.

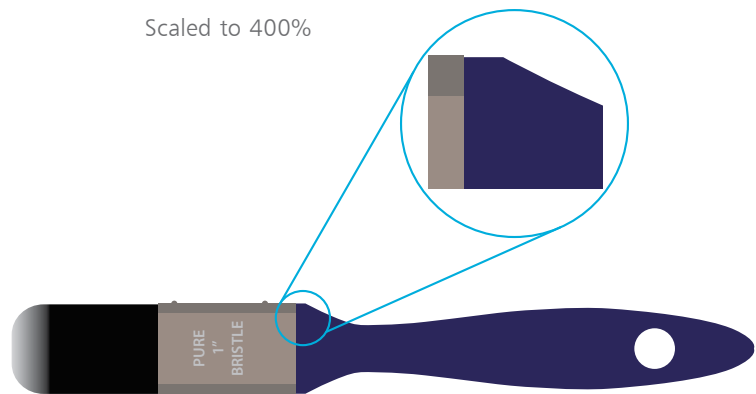
A bitmap image consists of a rectangular grid, or raster, of pixels – very much like a mosaic in concept. When you edit a bitmap, you are editing the color values of individual pixels, or groups of pixels.

Image-editing applications differ fundamentally from vector-based applications, such as Adobe Illustrator. In these applications, you work with objects that can be moved, scaled, transformed, stacked, and deleted, as individual or grouped objects, but each exists as a complete, separate object all the time.

These applications are called vector drawing packages, as each object is defined by a mathematical formula. Because of this, they are resolution-independent – you can scale vector drawings up or down (either in the originating application or in a page layout application, such as QuarkXPress or Adobe InDesign) and they will still print smoothly and crisply.



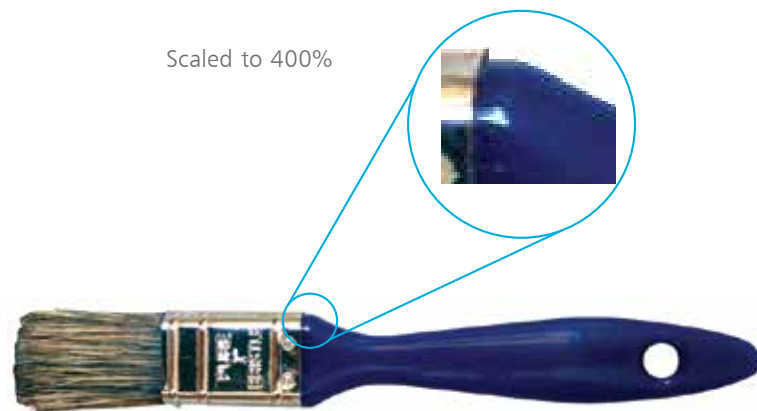
You should always try to scan an image at, or slightly larger than, the size at which you intend to use it. This means you will avoid having to increase the size of the image, reducing its resolution and possibly its quality.



Vector drawing at actual size

...cont'd

In contrast, bitmaps are created at a set resolution – a fixed number of pixels per inch. If you scan an image at a specific resolution, then double its size, you are effectively halving its resolution (unless you add more pixels). You are likely to end up with a blocky, jagged image, as you have increased the size of the individual pixels that make up the bitmap image.



Scaled to 400%

300 ppi bitmap at actual size

### Bitmaps and bit-depth

An important factor when the digital data of an image is captured, typically using a digital camera or by scanning, is its bit-depth. Bit-depth refers to the amount of digital storage space used to record information about the color of a pixel. The more bits you use, the more color information you can store to describe the color of a pixel – but the larger the file size you end up with.

To output realistic images using PostScript technology, an image should be able to represent 256 gray levels. A 24-bit scan is sufficient for recording 256 gray levels for each of the Red, Green and Blue channels (8-bits for each channel), resulting in a possible combination of over 16 million colors.

Ideally, when you work on images in Photoshop, you will do so using a monitor capable of displaying over 16 million colors. This ensures that you can see all the color detail in the image. Although you can work on images using only thousands of colors, for best results, especially where color reproduction is important, you need to work with as many colors as possible.



For digital images, more rather than less color information is usually desirable, as this means the image can represent more shades of color. Finer transitions between colors, and greater density of color, leads to a more realistic image.



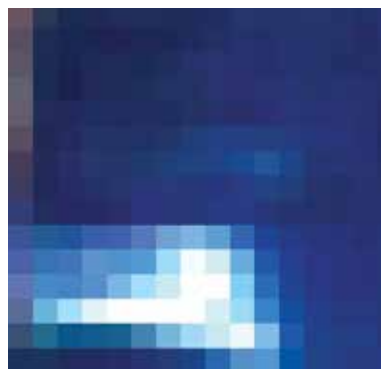
Photoshop can handle images that use 16-or 32-bits per channel, which originate from high-end digital cameras, scanners and microscopes. 16/32-bit per channel images contain a far greater range of colors than 8-bit per channel images. The disadvantage of working with such images is that their file sizes are also dramatically larger. The bit depth per channel of an image appears in the file name tab, or the title bar of the image window if you are working with floating windows:

\_MG\_8120.CR2 @ 12.5% (RGB/16\*) ×

# Pixels and Resolution

## Pixels

A pixel is the smallest element in a bitmap image captured by a digital camera or scanner. Pixel is short for “picture element”. Zoom in on an image in Photoshop, and you will start to see the individual pixels – the fundamental building blocks – that make up the image. When working in Photoshop, you are moving, copying and editing pixels, changing their color, shade, and brightness to achieve a hugely varied set of changes to the image.



## Resolution

A key factor, when working on bitmap images, is resolution. This is measured in pixels per inch (ppi).

Pixels can vary in size. If you have an image with a resolution of 100 ppi, each pixel would be 1/100<sup>th</sup> of an inch square. In an image with a resolution of 300 ppi, each pixel would be 1/300<sup>th</sup> of an inch square – giving a much finer, less blocky, result.

When working on images that will eventually be printed on a printing press, you need to work on high-resolution images. These are images whose resolution is twice the halftone screen frequency (measured in lines per inch – lpi) that will be used for final output – that is when you output to film or directly to plate.

For example, for a final output screen frequency of 150 lpi – a typical screen frequency used for glossy magazines – you need to capture or prepare your image at a resolution of 300 ppi.

Resolutions of double the screen frequency are important for images with fine lines, repeating patterns, or textures. You can achieve acceptable results, especially when printing at screen frequencies greater than 133 lpi, by using resolutions of 1½ times the final screen frequency.

To work with images for positional purposes only, as long as you can get accurate enough on-screen results and laser proofs, you can work with much lower resolutions.



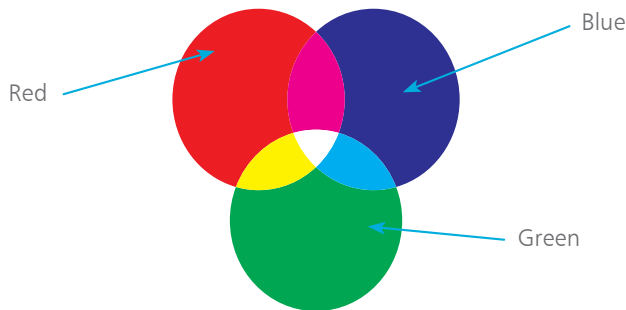
Images intended for multimedia presentations, or the World Wide Web, need only be 72 ppi, which is effectively the screen resolution.



# RGB and CMYK Color Models

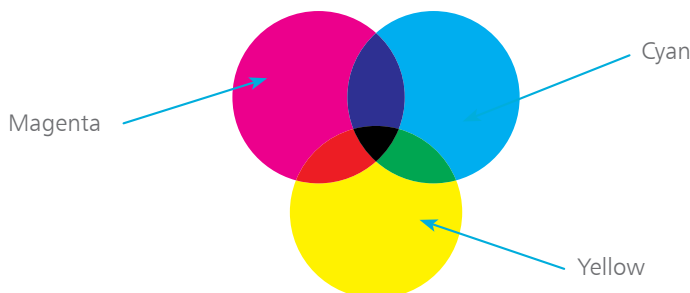
You need to be aware of two color models, as you start working with Adobe Photoshop. These are the RGB (Red, Green, Blue) and CMYK (Cyan, Magenta, Yellow and black) color models.

RGB is important, because it mirrors the way the human eye perceives color. It is the model used by scanners and digital cameras to capture color information in digital format, and it is the way that your computer monitor describes color.



Red, green and blue are referred to as the “additive primaries”. You can add varying proportions of the three colors, to produce millions of different colors – but still a more limited range (or “gamut”) than in nature, due to the limitations of the monitor. If you add 100% of red, green and blue light together, you get white. You produce the “secondary” colors when you add red and blue to get magenta; green and blue to get cyan; red and green to get yellow.

The CMYK color model is referred to as the “subtractive” color model. It is important because this is the color model used by printing presses. If you subtract all cyan, magenta and yellow when printing, you end up with a complete absence of color – white.



Strictly speaking, the ‘K’ in ‘CMYK’ stands for ‘key’. In four-color printing the Cyan, Magenta and Yellow plates need to be carefully and accurately aligned – or ‘keyed’ – to the Black plate.



On the printing press, cyan, magenta, yellow and black combine to simulate a huge variety of colors. Printers add black because, although in theory, if you combine 100% each of cyan, magenta and yellow, you produce black, in reality (because of impurities in the dyes) you only get a muddy brown.

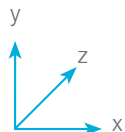


When you convert from RGB to CMYK mode, Photoshop converts out-of-gamut colors (in this case, colors that can be seen on screen, but not printed) into their nearest printable equivalent.



The CIE (Commission Internationale de l'Eclairage) XYZ color model is a model that defines the visible spectrum that can be seen by a "standard" observer.

Colors with the same lightness value fall within an approximately triangular flat plane (the Visible Spectrum area in the diagram opposite). The x axis represents the amount of red in colors, and the y axis indicates the amount of green. The z axis represents the lightness of colors.



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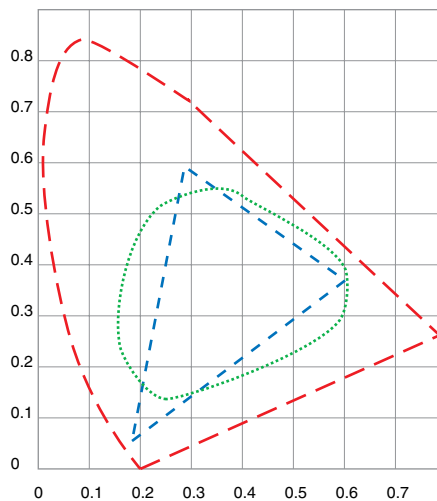
## Color gamuts

Color gamut refers to the range of colors a specific device is capable of producing. There are millions of colors the eye can discern in the visible spectrum. Scanners, monitors, and printing presses cannot reproduce every color in the visible spectrum – the range of colors they are capable of producing is their gamut.

From the desktop publishing point of view, the process of capturing digital color information, viewing and manipulating this on-screen, and then finally printing the image using colored inks, is complicated, because the gamut of a color monitor is different to the gamut of CMYK and PANTONE inks. There are colors (especially vibrant yellows and deep blues) that can be displayed on a monitor, but cannot be printed using traditional CMYK inks.

Typically, you will work in RGB mode if the image is intended for use on the World Wide Web or in a multimedia presentation. You can work in CMYK or RGB mode if the image is intended for print, but you must remember to convert to CMYK mode before saving/exporting in EPS or TIFF file format, in order to use the image in a page layout application. Adobe InDesign can import CMYK or RGB images in native Photoshop (.PSD) file format.

CIE XYZ color model



Visible Spectrum

Monitor

SWOP-CMYK

# Color Management

No two devices that represent color, from digital camera to scanner, monitor to printer, will reproduce color in exactly the same way. The aim of a color management system is to ensure, as far as possible, that the colors you see on your screen are as close as possible to the colors you see in the finished work, whether in print or on screen.

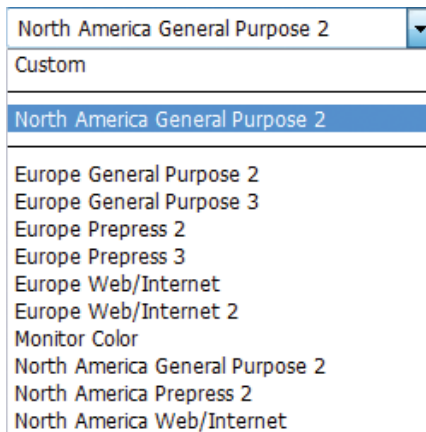
Color management settings are available so that you can choose a color management workflow most suitable for your needs.

Using the Color Settings dialog box, you can define how you manage color in your images as you work in Photoshop.

**1** To specify color management settings for your Photoshop working environment, launch Photoshop, then choose Edit > Color Settings (Ctrl/Command + Shift + K).

**2** Choose the most appropriate setting for your intended final output, from the Settings pop-up list. For example, if you are using Photoshop for images that will be used in multimedia presentations, or on the World Wide Web, choose Web/Internet or Monitor Color options. If you are working with images that will be color separated then printed using CMYK inks, choose Europe or US Prepress defaults, as appropriate.

**3** Only make changes to the default settings when you have gained experience in using Photoshop, and when you have a valid reason for making changes, or if you have consulted with your commercial printer and they have suggested changes to suit your specific output requirements.



If you use Photoshop with other applications in Creative Suite, such as InDesign and Illustrator, it is recommended that you synchronize color settings across the suite, using Adobe Bridge. In Bridge, choose Edit > Creative Suite Color Settings. Select a Color Settings option, then click Apply. (See pages 36-38 for information on Adobe Bridge.)



If you feel that you are not achieving good color in printed output, consult your commercial printer about creating custom settings for color management.



A CMS (Color Management System) is used to translate colors accurately, from one color device to another. It attempts to represent a color consistently, from the color space in which the image was created to the color space used at output, making adjustments so that color displays as consistently as possible across a range of monitors and other devices.



Recalibrate your monitor on a regular basis, as monitor performance can change over time.

...cont'd

- 4 To get a better understanding of how the settings work in the Color Settings dialog box, roll your cursor over the pop-up lists. The Description area at the bottom of the dialog box updates, with information on how the option affects the image.



- 5 Click the More Options button to access advanced color management settings. Only change advanced settings if you have a detailed understanding of color management.

## Monitor Calibration

To make accurate and consistent judgements about the colors you see on your screen, you must calibrate your monitor. Monitor calibration creates a monitor profile that can be used as part of a color-managed workflow.

Hardware-based color calibration utilities are more accurate than the Adobe Gamma utility, previously available in Photoshop. There is a wide range of third-party monitor calibration suppliers – try doing an online search for “monitor calibration”, or look for products such as “i1Basic Pro 2” from X-Rite, “Spyder4™ EXPRESS” from Datacolor, or “huey™PRO” from Pantone.