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Edit in Lab and Proof Colors

Contents

1. Introduction

This tutorial demonstrates two fundamental aspects of image processing in Photoshop:
a) the application of the color space CIELab, which is called Lab in this program.
b) the features Proof Colors and Gamut Warning.

CIELab coordinates [2] will be explained in one of the the last chapters. The other chapters are showing how the colors can be modified without making accurate selections. These methods are based on *Dan Margulis*' book about Photoshop Lab [1]. Similar applications are described in [3].

For chapter 2 to 4 the original RAW photos by Nikon D100 were converted by Nikon Capture, gray balanced and saved as RGB images in AdobeRGB(98)=aRGB with 16 bits per channel. Level corrections were applied in Capture and then additionally in Photoshop CS2, mostly by AutoLevel. The files were saved with 8 bits per channel with layers. Only for this document the basic image was downsampled from 2000x3008 pixels to 600x902 pixels with resolution 144 ppi (pixels per inch). The photos in this PDF are still in aRGB.
The PDF contains this color space as global Output Intent. Figure 1.1 shows how to assign the Output Intent in Acrobat Professional by Tools > Print Production > Convert Colors.

For pixel synchronization and correct colors in Acrobat please use the settings below.
All images are shown pixel synchronized for zoom 200%, because of image resolution 144 ppi and Acrobat resolution 72ppi.

These settings are valid for Acrobat Professional 7.

The free Adobe Reader 9 honours the Output Intent, but Color Management is not explicitly accessible.
Here it is as well necessary to define custom resolution 72ppi.

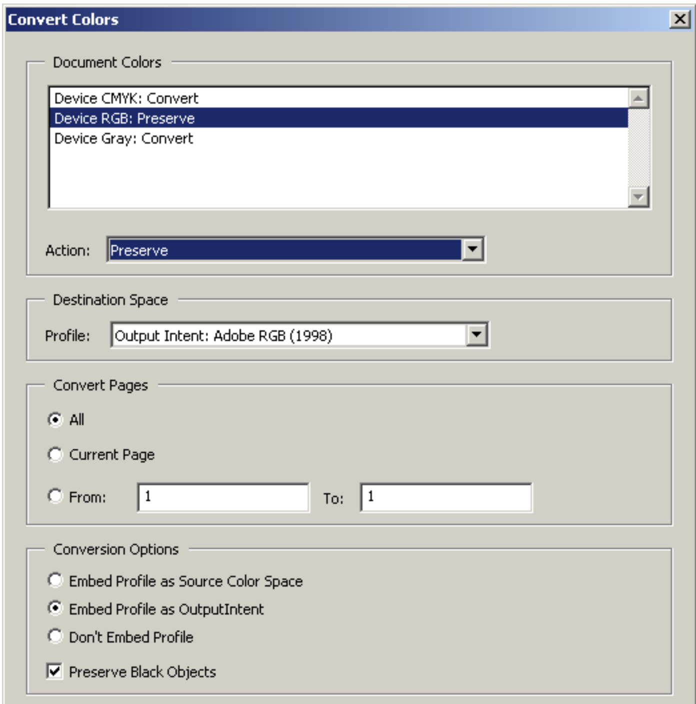

Figure 1.1

Edit > Preferences > Page Display		
Custom Resolution	72 ppi	instead of 96 ppi
Edit > Preferences > Color Management		
RGB	sRGB	standard settings, see below
CMYK	ISO Coated	here not relevant
Grayscale	Dot Gain 20%	here not relevant
Check this box	Output intent	Overrides working spaces
Output intent for this doc	AdobeRGB(98)	here called aRGB
Zoom	200%	optimal for all images

2. Background Neutralization

Figure 2.1 shows the gray balanced and level corrected basic image, downsampled from pixel-width 2000 to 600, then converted into the color space Lab with 8 bits per channel (bpc).

Indicate color numbers by the Info Palette:
Window > Info > Click triangle top right > Palette Options > First Color Readout RGB > Second Color Readout Lab.
For several tools like Move Tool (top right in the Tool Palette), Path Selection (arrow) or Eyedropper the color values at any mouse position are indicated in the Info Palette.
The background values are in these ranges: L=83...98, a=-2...0, b=-3...0.
Target values are L=90 and a=0, b=0.

Then we create an adjustment layer for Curves:
Layer > New Adjustment Layer > Curves > Confirm default name Curves1 > Normal

The new layer is indicated in the Layer Palette:
Window > Layers

We get immediately the Curves diagram. Edit any channel L,a,b one after the other. We are starting with (a), Figure 2.2. The Curve output should be 0 in the range a=-3 to +3. The endpoints are chosen by mouse and then adjusted by numbers. After this definition of a neutral zone, the rest of the Curve is linearized with two additional mousepoints.
The same modification is applied to channel (b), Figure 2.3.
Figure 2.4 shows the luminance normalization by brute force. All values above about L=90 are clipped to L=90. Sharp edged transitions are neither possible nor recommended.

The top layer contains the new neutralized image, which is of course wrong for the colored areas. The bottom layer is the old image (background layer). A mixture of both layers will be created by conditional blending:
Layer > Layer Style > Blending Options > Normal (default)

Figure 2.5:
Blend If > Channel L >
Move the upper handles into the bright region range until bright areas are copied correctly.
Move the lower handles into the light range for an eventual improvement .
There are originally two handles for each slider. For soft transitions each handle can be split:
Alt + Click by Left Mouse + Move
'Blend If' means here:
Copy the top layer only if its pixel lightness (L) is in the indicated range.
Copy the top layer only if the bottom layer pixel lightness (L) is in the indicated range.

Figure 2.6:
Blend If > Channel a >
Move the upper handles to copy only ranges with small absolute values of (a).
Move the lower handles similarly.
Figure 2.7:
Do the same for channel (b)

Figure 2.8 shows the result - the image with neutralized background. Achieved values are L=88...91 and a=0, b=0 in the white background.
The image can be be saved as *.psd or *.tif with layers for further corrections.
The color conversion from Lab to RGB requires flattening of the layers:
Layer > Flatten Image

2. Background Neutralization

Figure 2.1

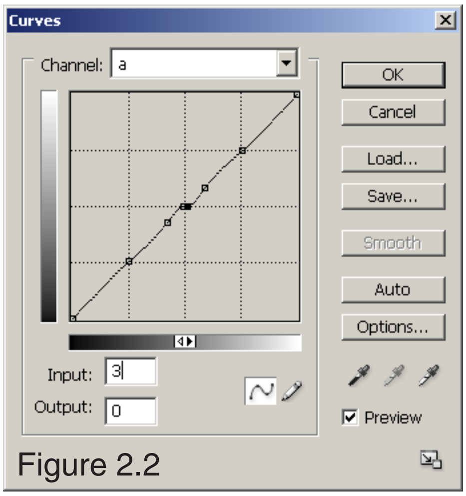

Figure 2.2

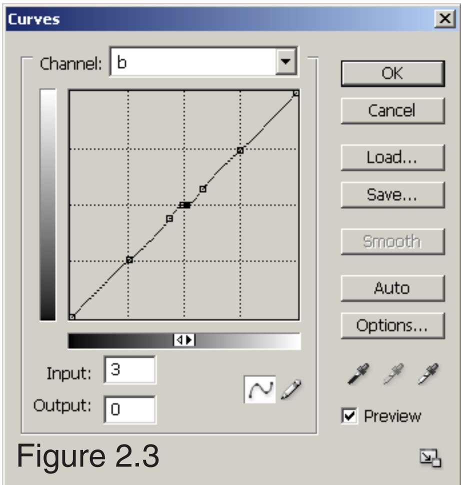

Figure 2.3

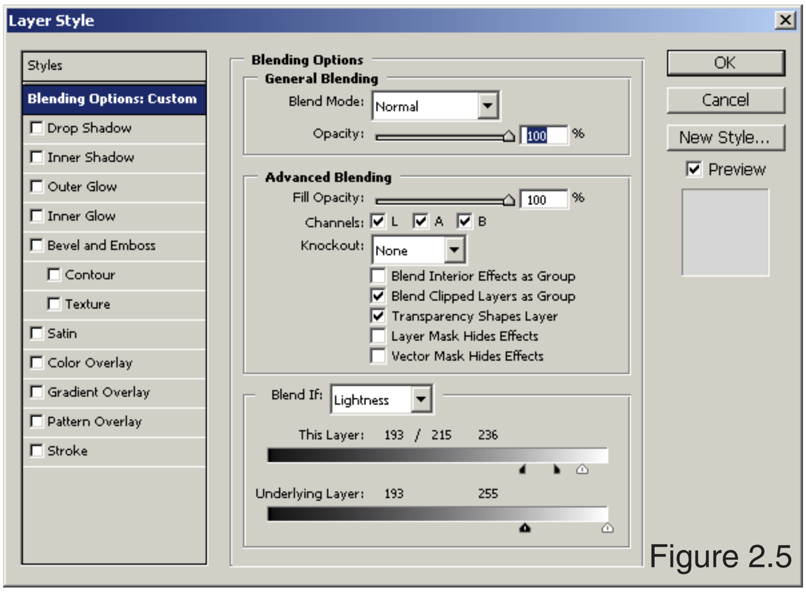

Figure 2.5

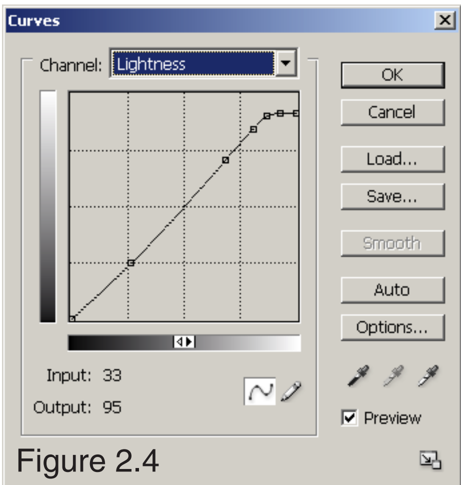

Figure 2.4

2. Background Neutralization

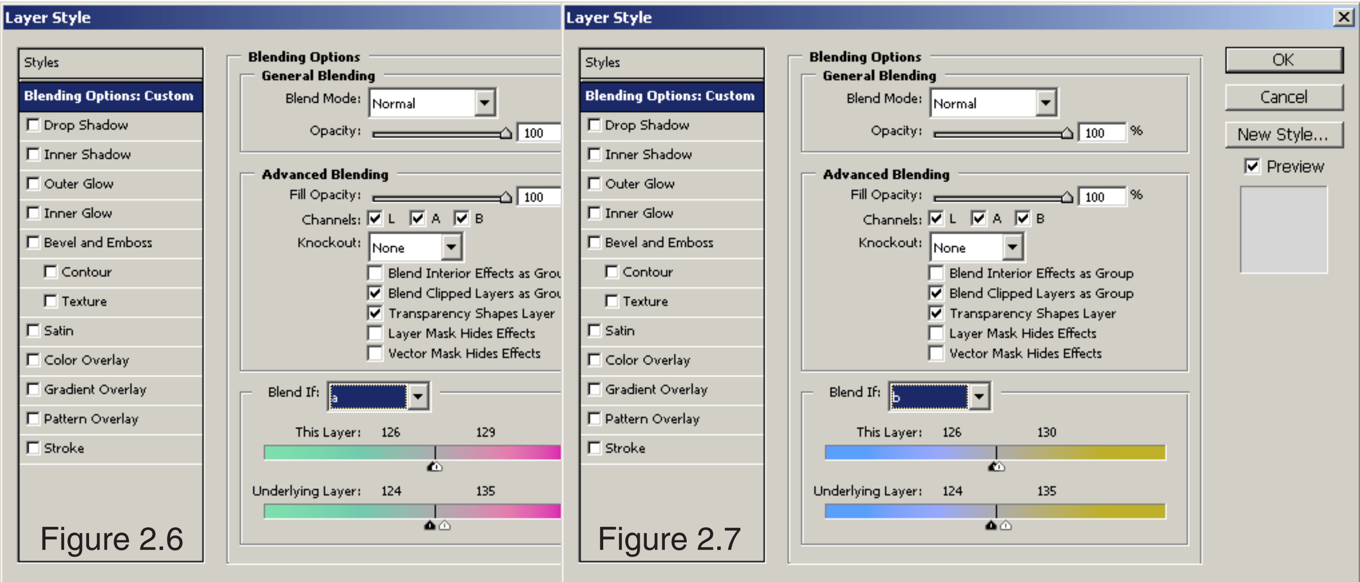

Figure 2.6

Figure 2.7

Figure 2.8

The background is nicely neutralized with almost equal lightness.
Shadows are on purpose still visible.
The colored parts are not affected.

3. Proof Colors, Gamut Warning and Correction in Lab

Proof Colors means: show the appearance in a different color space, without converting explicitly into the new space.
Gamut Warning shows by an alarm color areas which are out-of-gamut in the new space.

The test image is Figure 2.8, using mainly the colorful part.

View / Proof Setup (for RGB):
Choose the new RGB color space.
In Figure 3.1 this is the space as defined by the monitor profile, or shorter, the monitor space.
Actually the monitor was calibrated for white D65 and Gamma=2.2. The monitor primaries are near to the sRGB primaries. Altogether the monitor space could be substituted by sRGB.
The Rendering intent for RGB spaces is always Relative Colorimetric, and Blackpoint Compensation is irrelevant.

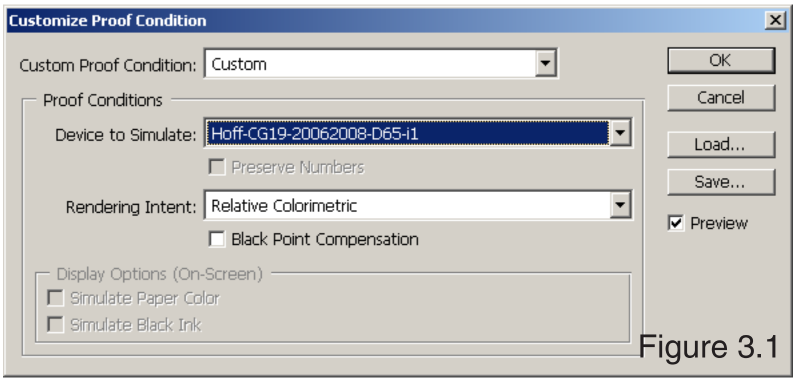

Figure 3.1

View / Proof Colors:
Almost no change for monitor space.
View / Gamut Warning:
Larger areas are out of gamut.

Some color areas of aRGB are out of gamut for sRGB, but the clipping happens already in the standard workflow.

The change can be made visible by reducing the global saturation.
Edit > Color Settings > Desaturate Monitor Colors by 20%.
This mode is not convincing for any practical work. Therefore we uncheck the option 'Desaturate', keeping in mind that the preview is not perfect.

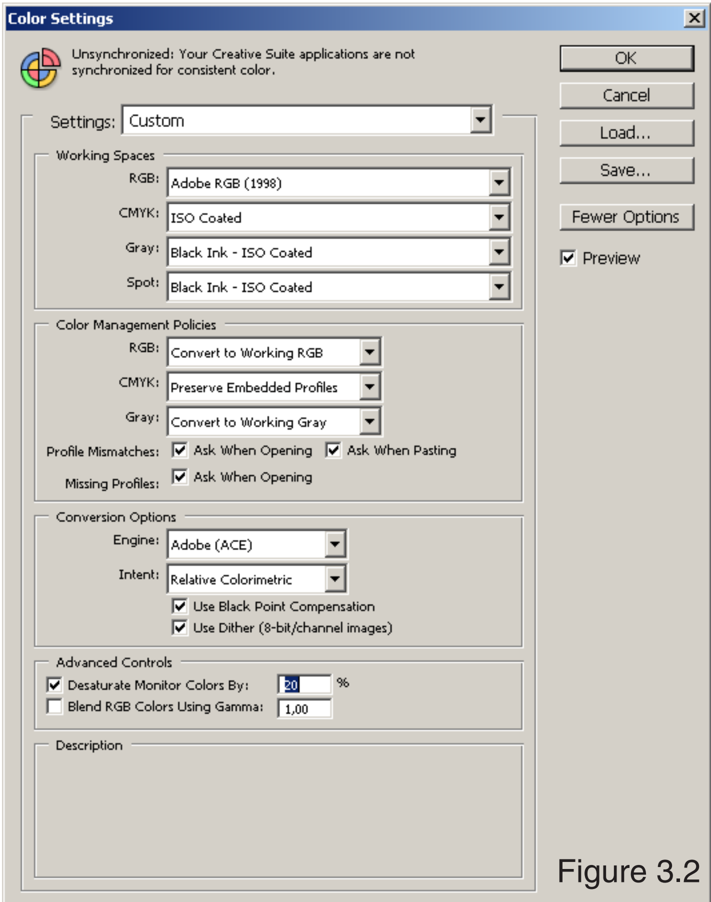

Figure 3.2

View / Proof Setup (for CMYK):
Choose the final CMYK printing space, which is here ISOCoated (or Europe ISOCoated Fogra 27).
Blackpoint Compensation is On: darkest colors in the working space aRGB are mapped to darkest printable colors in the CMYK space.

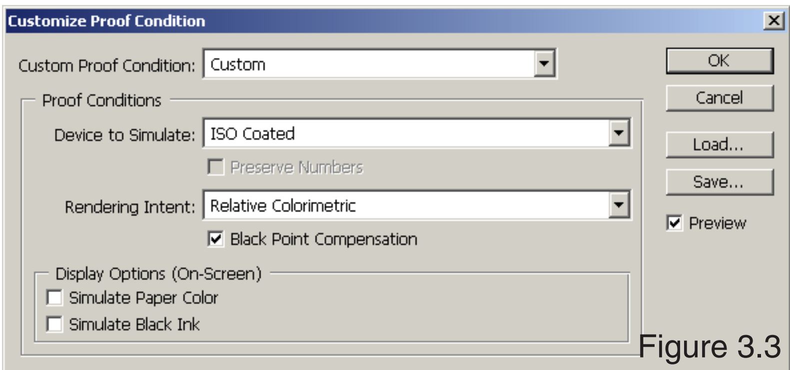

Figure 3.3

3. Proof Colors, Gamut Warning and Correction in Lab

Figure 3.4 is the upper part of Figure 2.8 as a reference.
The proofing space is ISOCoated.

Figure 3.5 shows the result of Proof Colors. Figure 3.6 shows the Gamut Warning.

The Rendering Intent is Relative Colorimetric, which means: all colors in-gamut in CMYK are left where they are. All colors out-of-gamut are mapped to the gamut boundary.

According to this concept, only those areas in Figure 3.5 should be affected which are marked by the alarm color green in Figure 3.6.
Sometimes more areas are affected than indicated by Gamut Warning.
There are two reasons for this discrepancy:
a) the gamut warning is not accurate. In fact it is rather difficult to extract gamut volume boundaries in profiles.
b) the already mentioned clipping of aRGB to the monitor space or sRGB.

The only solution is here: watch the effects carefully and try to avoid changes which are bad even in sRGB.
If the image appearance becomes visibly worse, then the print appearance is mostly affected as well.

Quality is lost for yellow, orange and vivid red. Yellow and orange are always bright. Bright and colorful tones are not printable.
The essential degradation is a loss of levels, which results in a loss of details.

The question is then: how can we preserve visual details ?
Taking a look at the gamut boundaries in chapter 4, though these are valid for sRGB and aRGB, leads to two concepts:
a) reduce lightness in bright areas.
b) reduce saturation in these areas.

Figure 3.4

Figure 3.5

Figure 3.6

3. Proof Colors, Gamut Warning and Correction in Lab

Reducing the lightness and the saturation is almost the same as Rendering Intent Perceptual: all colors are proportionally mapped towards the gray axis (L) until none is out-of-gamut. This can be checked easily if we choose Perceptual instead of Relative Colorimetric. The result is rather disappointing: flat and much less saturated for all colors.
The next trial would be a selective change of the curve in channel (b) for yellow, and, less important in channel (a) for red. Furtheron, the lightness can be reduced in channel (L).
(a) and (b) have to be less steep in the respective parts, and (L) should be lower. The result is again disappointing. One has to think about something else.

As usual we are starting with an Adjustment Layer:
Layer > New Adjustment Layer > Curves > Confirm default name Curves2 > Normal

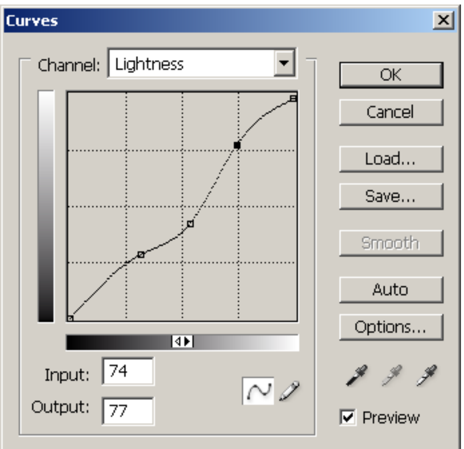

Figure 3.7

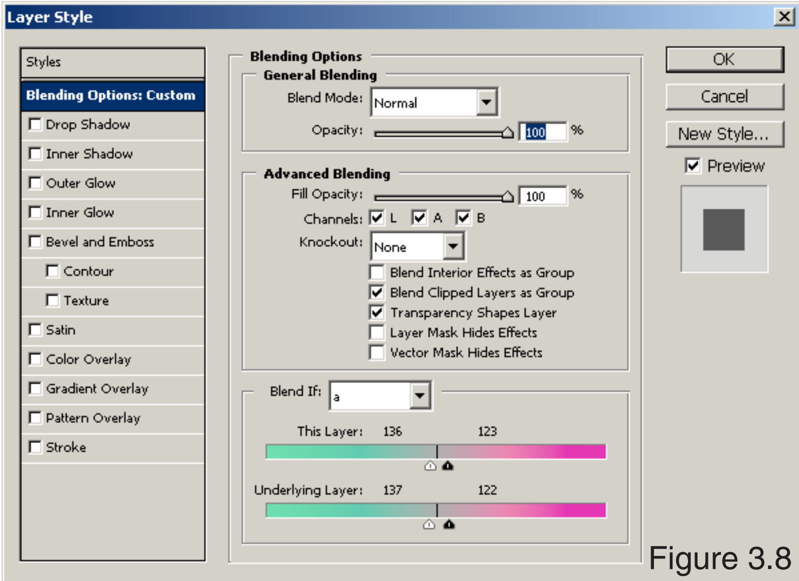

Figure 3.8

The image does not have interesting contrasts in the very light and dark parts. Therefore we can make the Curve (L) rather steep for any lightness as encountered in the color part. This delivers more levels, but it does *not* reduce the area of out-of-gamut colors. It is a visual fake.
The blending happens for (a) and (b) similarly: almost neutral colors are not blended. The triangles are arranged in inverse order: blending left of white and right of black generates a gap for neutral colors. Blending for (L) is unchanged. Figure 3.9 shows the result for Proof ISOCoated.


Figure 3.9

4. Sharpening

The last version is still in Lab with layers, of course saved. In order not to confuse the layer construct, the layers were flattened. A new layer is created by doubling the background layer.
It can be renamed 'USM', which means 'unsharp masking'. This strange word has its origins in the darkroom for classical photography. An image becomes sharper by subtracting masked unsharp (blurred) areas.

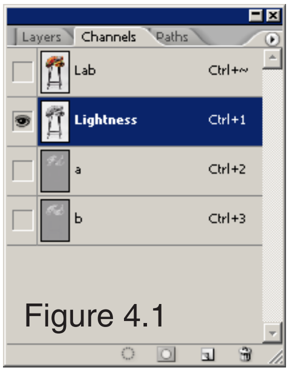

Figure 4.1

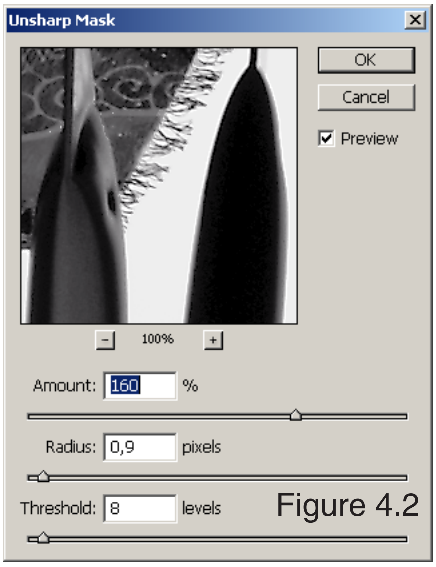

Figure 4.2

In order not to enhance color noise, the sharpening is applied in Lab only to the lightness channel (L):
Figure 4.1

View > Actual pixels
Each file pixel is represented by one graphics card pixel and by one monitor pixel (on LCD or TFT monitors).
This is very important, because the effect of sharpening would be visually spoiled in any other view.

Filter > Sharpen > Unsharp Mask
Figur 4.2
Initialization:
Amount 200% or 300%
Radius 1 pixel
Threshold 0
Adjustment:
Increase or decrease the Radius until the halos at the edges are just perceivable. Reduce the Amount until the edges are a little oversharpened.
Adjust the Threshold until areas are not grainy.


Figure 4.3

Layer > Layer Style > Blend.Options
Mode normal.
Opacity 70% reduces the sharpening effect a little, without going back into the USM menue.

Save, flatten, convert to RGB and save by new name.
Proof Colors for ISO Coated:
Figure 4.3

The images in this doc are downsampled from width 2000 px to 600 px.
Additional sharpening is recommended after downsampling. For clarity this was not done here.

5. Orange Grass


Figure 5.1

Thanks to *Norbert Kustos* for this photo. The original pixel size was 4288x2848. The image was downsampled for 144ppi and pagewidth, with a little cropping at the bottom. The actual size is 1020x600 pixels.
The photo below shows Proof Colors for ISOCoated. Details in the orange leaves of grass are widely lost. It could be proved that this is not mainly an issue of Monitor RGB.


Figure 5.2

5. Orange Grass

Some parts of the orange grass are out-of-gamut: too bright and much saturated. It is not the same situation as for the textile. The grass can be made less bright and less vivid without doing much harm.

As usual, a new adjustment layers for Curves is required. The three channels (L), (a) and (b) are treated similarly. Measure the values in relevant parts of the image and pull down the Curve in this range.

The blending strategy is also not surprising. Choose the relevant range for the upper slider by trial and error. Use a somewhat larger range for the lower slider. Then split at least the upper sliders for smooth transitions.

The comparison with the original image is performed by setting the slider for the opacity occasionally to zero.

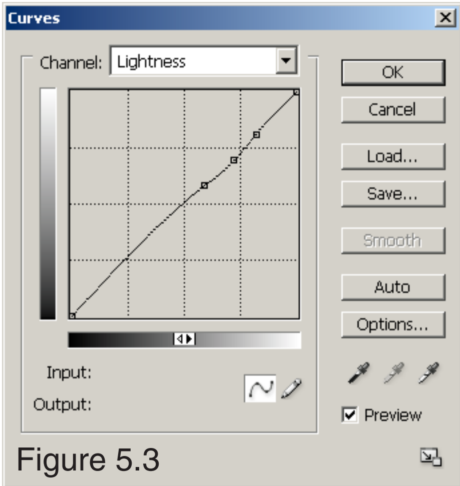

Figure 5.3

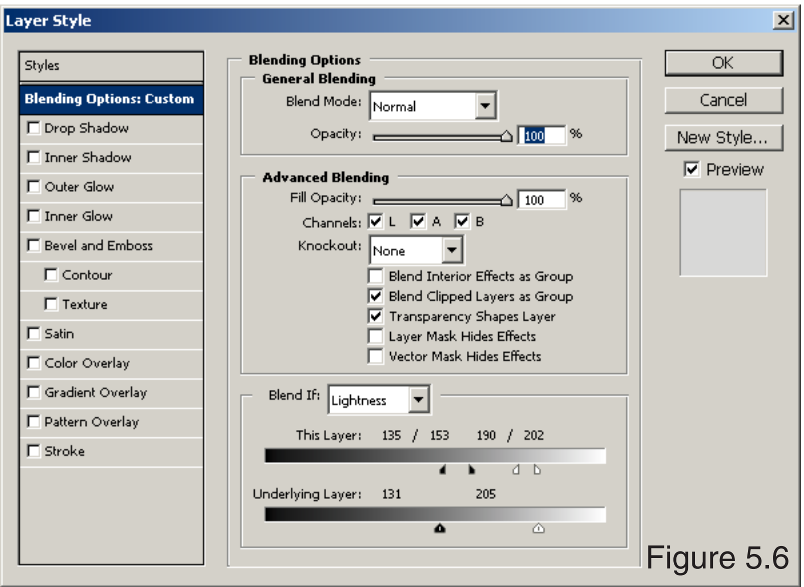

Figure 5.6

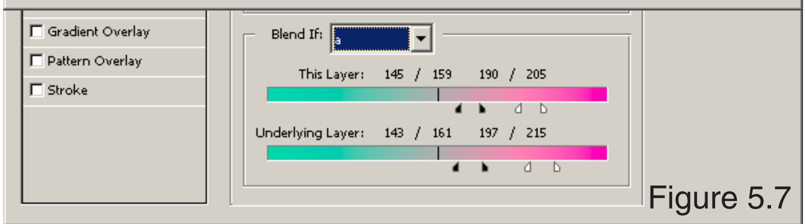

Figure 5.7

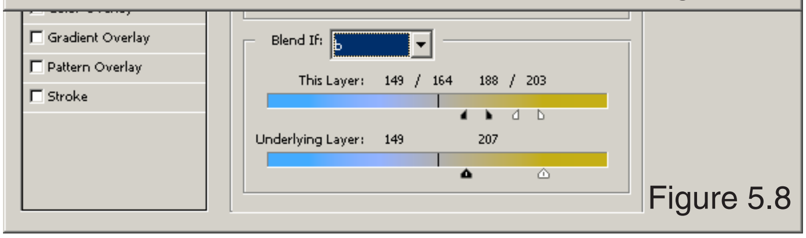

Figure 5.8

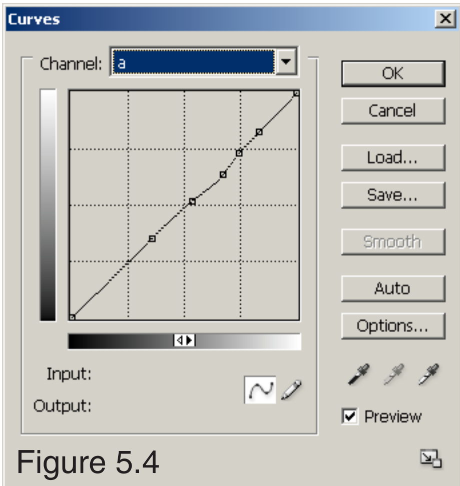

Figure 5.4

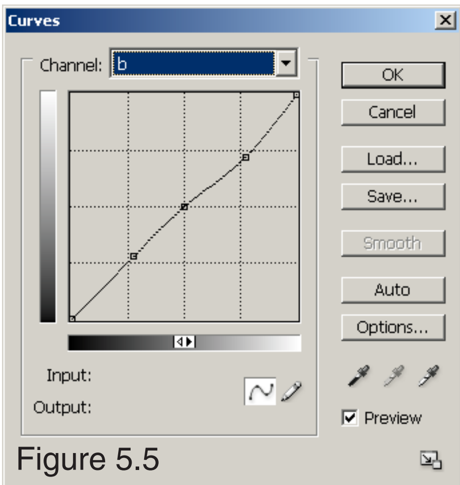

Figure 5.5

5. Orange Grass


Figure 5.9

This is the same Proof for ISOCoated as in Figure 5.2, shown again for a comparison.

The photo below shows Proof Colors for ISOCoated after the Lab manipulations. More details than in Figure 5.9 are retained. Still out-of-gamut are only the two vivid orange parts of the beach-chairs. Best view by zoom 200%.


Figure 5.10

6. Blue Cornflowers

Figure 6.1

Thanks again to *Norbert Kustos* for the photo. The original pixel size was 4288x2848. The image was downsampled for 144ppi and pagewidth, with a little cropping at the bottom. The actual size is 1020x600 pixels.
The photo below shows Proof Colors for ISOCoated. The blue flowers are rather dull. It could be proved that this is not mainly an issue of Monitor RGB.

Figure 6.2

6. Blue Cornflowers

The blue flowers are entirely out-of-gamut: too bright and much saturated. Again it is a new situation. We need vivid colors but much level resolution is not required.

We are starting by a coarse selection for the field, using a flat horizon, not affecting the sky.
As usual, a new adjustment layer for Curves is installed. Channel (L) is made a little brighter for midtones. The change in channel (b) means obviously reduced saturation for blues, but channel (a) may look mysterious. Positive values are mapped to zero in a narrow range. The blue of the flowers is modified towards cyan, which is always better printable.

The blending strategy is not surprising. Channel (L) is not changed. Channel (a) is blended only for the narrow range of the gap, and channel (b) for blues.

Choose the relevant range for the upper slider by trial and error.

Alternatively one may try in mode RGB:
Image > Adjustment > Selective Color > Blue > Rotate hue towards cyan + Reduce saturation.

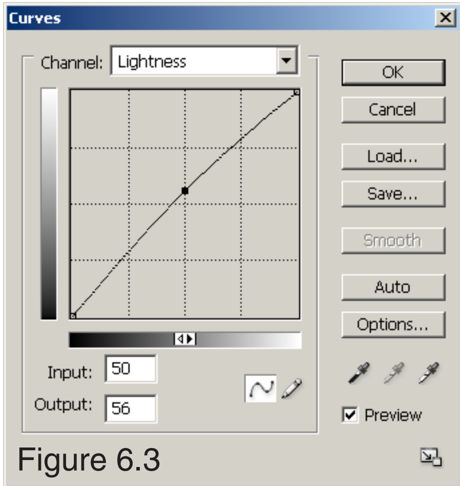

Figure 6.3

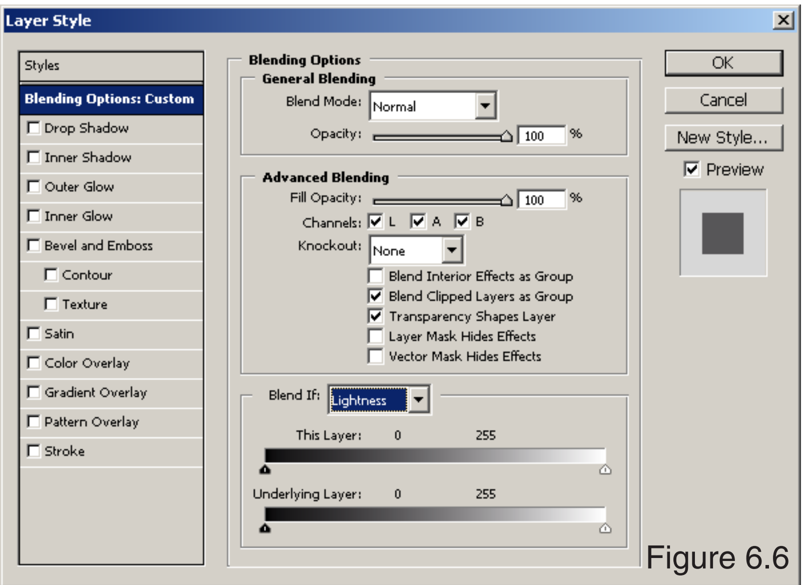

Figure 6.6

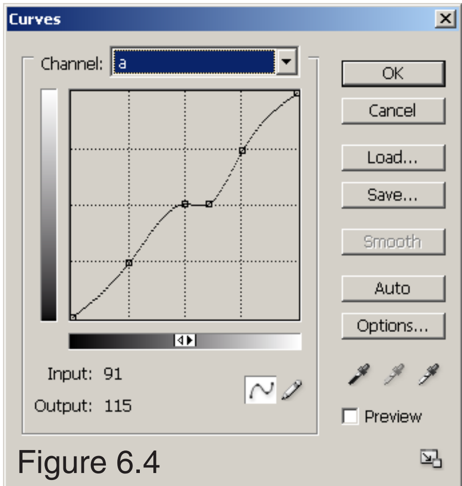

Figure 6.4

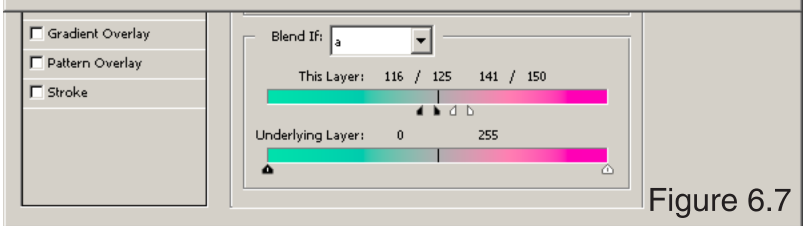

Figure 6.7

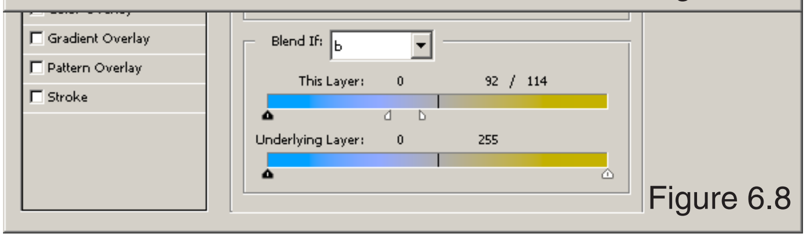

Figure 6.8

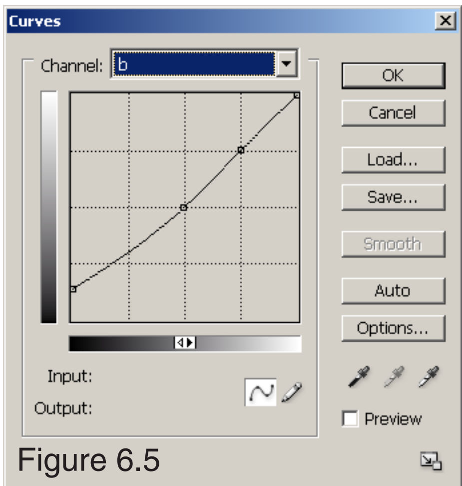

Figure 6.5

6. Blue Cornflowers

Figure 6.9

This is the same Proof for ISOCoated as in Figure 6.2, shown again for a comparison.

The photo below shows Proof Colors for ISO Coated after the Lab manipulations. The blue flowers are more vivid than in Figure 6.9.

Figure 6.10

7. Red Roses

Figure 7.1

Thanks again to *Norbert Kustos* for the photo. The original pixel size was 4288x2848. The image was downsampled for 144ppi and pagewidth, with a little cropping at the bottom. The actual size is 1020x600 pixels.
The photo below shows Proof Colors for ISOCoated after a red boost in channel (a) in Lab. The blue and green colors are not affected. In the roses only small spots are out-of-gamut.

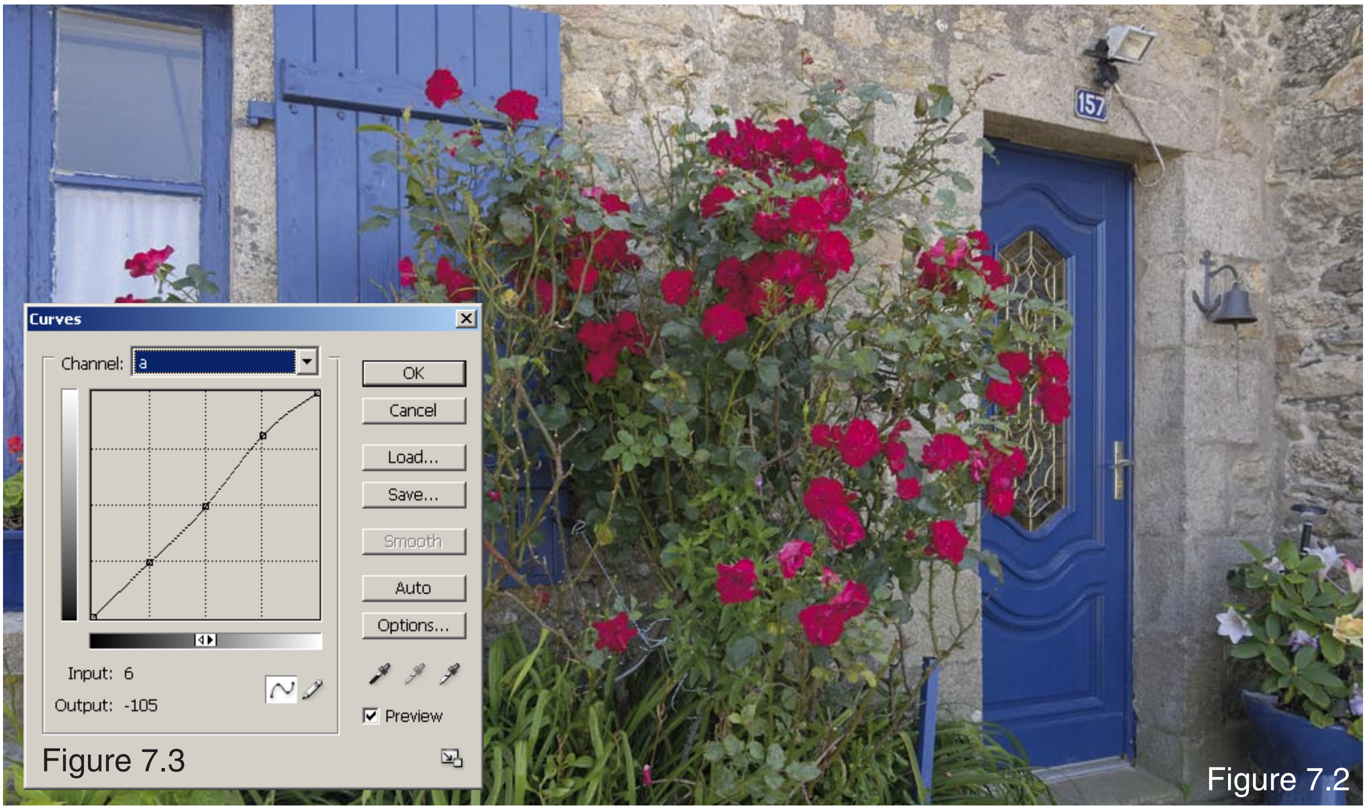

Figure 7.2

Figure 7.3

8. CMYK Conversion

Finally the image has to be converted from RGB to CMYK. Here we are using RGB=aRGB and CMYK=ISOCoated. A more actual profile version is ISOCoated_v2.icc.

We could convert by
Image > Mode > CMYK Color

In order to have a look at the final settings, it is better to use
Edit > Convert to Profile

The source profile AdobeRGB(1998) is confirmed. The destination space ISOCoated is as well our CMYK working space.
Adobe (ACE) is the program for color conversions (the 'engine').

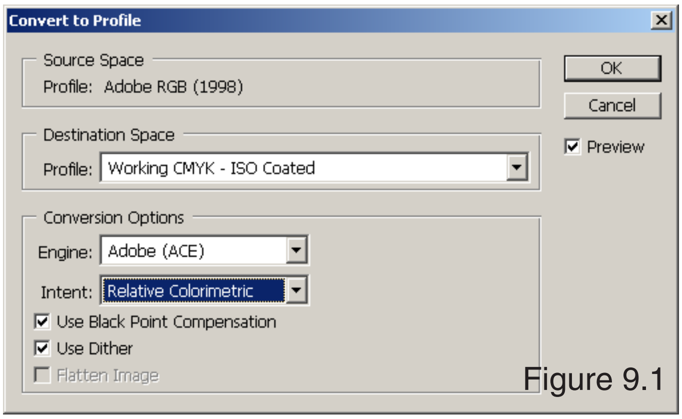

Figure 9.1

By 'Intent' the Rendering Intent can be chosen.

Relative Colorimetric (RelCol):
White in the file R/G/B=255/255/255 is mapped by C/M/Y/K=0/0/0/0) to paper white, whatever color the paper may have. That is the meaning of 'Relative' - relative to paper white.
RelCol does not change in-gamut colors and maps out-of-gamut colors in CIELab towards the gray axis onto the gamut boundary. Different methods how to do this are known, one of them is implemented in the ICC profile, but without explanations.
For larger areas of out-of-gamut colors one has to take care, that loss of levels is avoided. This doc explains some methods.

Perceptual:
If the image contains out-of-gamut colors, then all colors are mapped proportionally towards the gray axis until all colors are in-gamut. This creates generally less colorful images and should be avoided. Perceptual is sometimes called 'Photographic' because some years ago this intent was considered as optimal for photos.

Saturation:
This intent should convert for instance business graphics into colorful prints, disregarding the accuracy. It is now obsolete and mostly the same as Perceptual.

Absolute Colorimetric (AbsCol):
White in the file R/G/B=255/255/255 is mapped on the paper to CIELab D50 white. If the paper is blue-ish because of brighteners, white areas in documents (not only in images) will be covered by a small amount of yellow ink. This is sometimes useful for proof printing, the simulation of offset prints by an inkjet. If this effect is unwanted, RelCol should be used.

Blackpoint Compensation (BPC):
Always On. The darkest black in the file R/G/B=0/0/0 is mapped to the darkest printable black which is for instance at CIELab lightness L=8...10 instead of L=0. Perceptual contains already BPC. Setting this On or Off is irrelevant.

Dithering:
Should be On for this conversion. 8 bits per channel colors which cannot be reproduced directly are simulated by pixel clouds of existing colors.
It has to be Off for the conversion of screenshots into aRGB images (like here), because uniformly colored areas can be be much better compressed than dithered areas.

9. CIELab

The CIELab color space is based on CIE(1931) colorimetry [2]. In Photoshop it is simply called Lab, and the CIELab coordinates L*, a* and b* are called L, a and b.
The graphic below shows eight different views to the Lab representations of the two color spaces sRGB (inner volume) and AdobeRGB(98)=aRGB (outer volume). For details see next page.

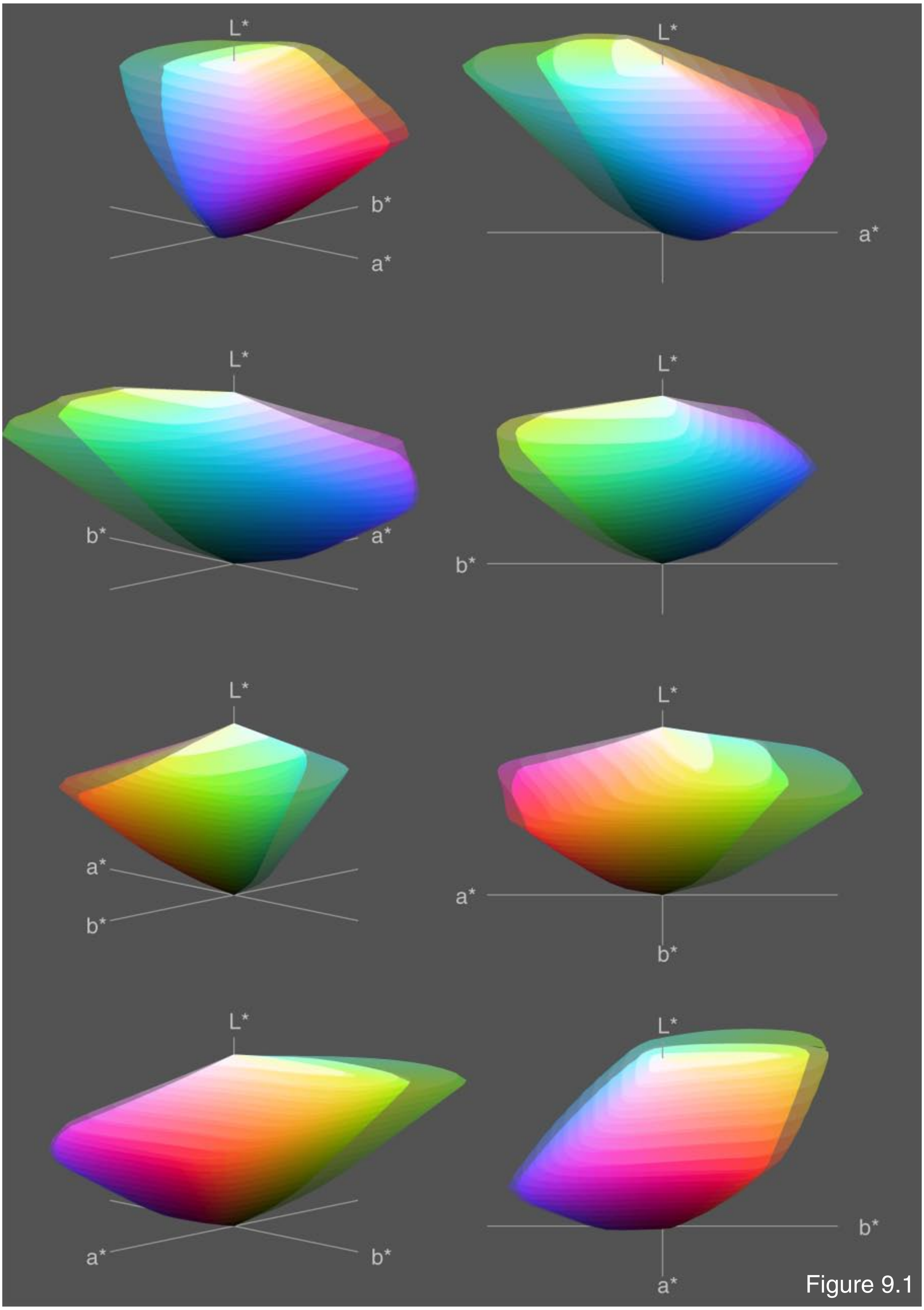

Figure 9.1

9. CIELab

Lab is a very powerful color space for editing, as described by *Dan Margulis* [1]. One doesn't need to know the mathematical details [2].
Black is at L=0, a=0, b=0. White is at L=100, a=0, b=0. Any L=0 ...100 with a=0, b=0 is neutral (D50 gray). The axis (a) points from cyanish green to redish magenta, or (simplified) from green to red. The axis (b) points (simplified) from blue to yellow. Numbers for (a) and (b) are in Photoshop in the range -128 to +127.

The diagram below shows a horizontal slice of the Lab volume for aRGB for L=90. The gray area shows the range -100 to +100 for (a) and (b). The colored area shows the maximal projected area of the whole volume. The black contour contains the valid colors for L=90. Vivid reds would be darker (see previous graphic). Vivid oranges are out-of-gamut, indicated by a dot.

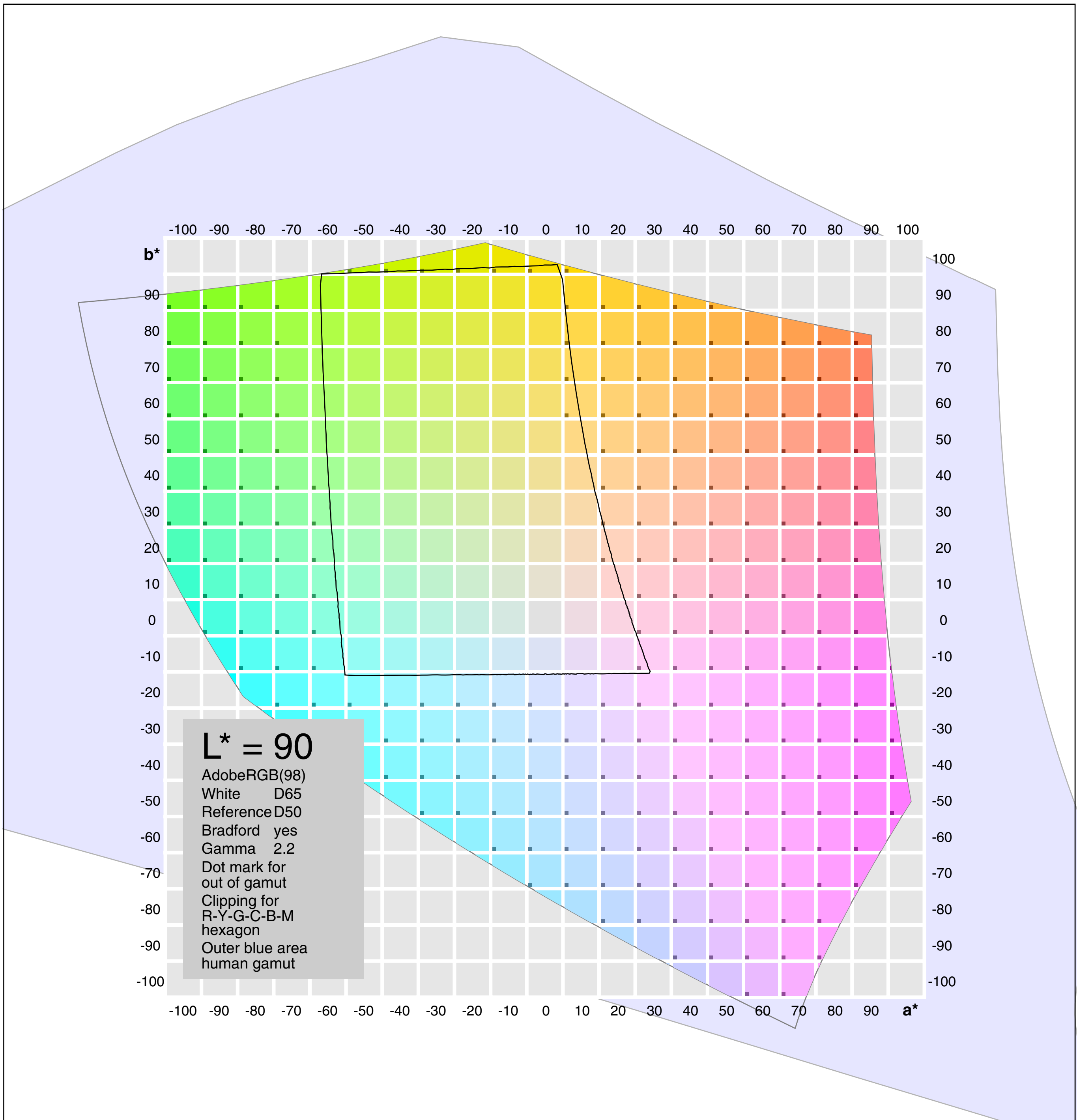

Figure 9.2

9. CIELab

Curves (more accurate: gradation curves) define the relation between the old input (horizontal) and the new output (vertical). They are initialized by a straight line bottom left to top right.
In RGB mode we have either RGB (luminance) or single channels R,G,B. In Lab we have the channels L, a and b.
The origin for the curve (L) is bottom left for black. The origin for the curves (a) and (b) is in the middle: a=b=0 for grays. The axes are going from green to red and from blue to yellow.
In Margulis' book the axes are swapped, as traditionally done for CMYK. This is indicated by the black-white gradient: then white is left and black is right.

Some examples for modified curves (white lines):

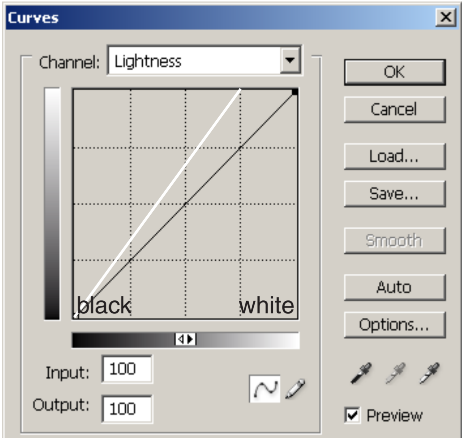

Figure 9.3

Absolutely increasing lightness.

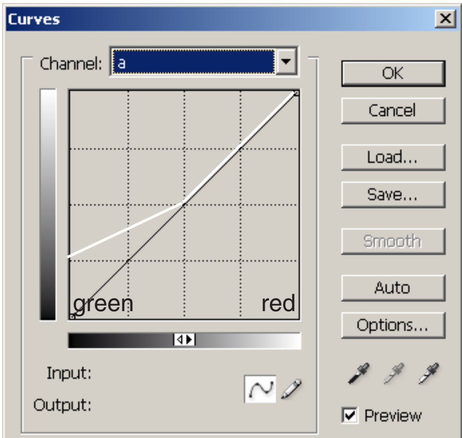

Figure 9.4

Less vivid green. The same red.

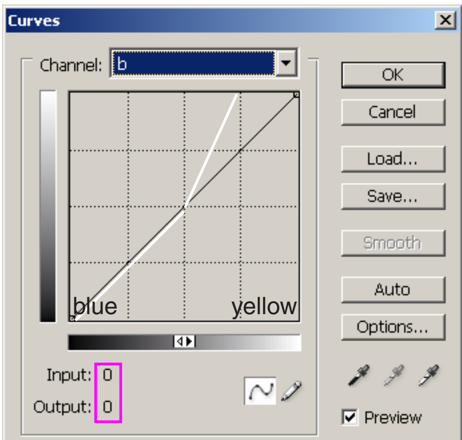

Figure 9.5

More vivid yellow. The same blue.
Assign *numerical* values at critical mouse points: here 0,0.

10. Color Managed Screenshots

Show the image with 100% size without menue frame and without overlapping menues.
Take a screenshot by key PrintScreen.
Open a new RGB document in Photoshop with the assigned monitor profile instead of aRGB.
Edit > Place.
Edit > Convert to profile > AdobeRGB(98).
Crop generously.
Image > Trim.
Save As by new name.

This workflow is necessary for Gamut Warning, because alarm colors cannot be saved directly. The method can be used as well for Proof Colors, but it is easier to convert temporarily, which delivers exactly the same result:
Edit > Convert to profile > ISOCoated.
Edit > Convert to profile > AdobeRGB(98).
Save As by new name.

11. References

[1] Dan Margulis
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The Canyon Conundrum and Other Adventures in the Most Powerful Colorspace
Peachpit Press, 2005

[2] Gernot Hoffmann
CIELab Color Space
http://docs-hoffmann.de/cielab03022003.pdf

[3] Gernot Hoffmann
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http://docs-hoffmann.de/skyblue14072008.pdf

This document

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Major revision at October 10 / 2008.

Gernot Hoffmann
September 09 / 2008 - February 04 / 2013
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