
Profile Mechanic - Scanner 1.0

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Introduction

Profile Mechanic - Scanner is a program for creating custom ICC color profiles for scanners and digital cameras.

Using a custom profile helps ensure accurate color and tonal reproduction when you scan photographic prints or transparencies. Using a custom scanner profile takes the guesswork out of scanning and gives you accurate results every time without having to adjust curves or make color corrections.

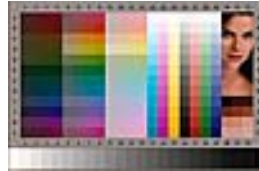
Custom profiles for digital cameras can help you reproduce color accurately, but to make this work you must use the same lighting and camera settings (exposure, saturation, contrast, white balance, color space etc.) when photographing the test target as when photographing the subjects for which you want to use your profile. This makes digital camera profiles most useful for studio work, duping transparencies, copying artwork using a copy stand, table top or catalog photography, or other situations where lighting and exposure are repeatable.

A scanner profile is created by scanning or photographing a test target having a number of color and gray patches each of which has been accurately measured with a spectrophotometer. The RGB values produced by the scanner or digital camera are then combined with reference values for the test target to produce a profile that a color management system can use to convert digital images from your input device to a standard color space.

To make use of the color profiles *Profile Mechanic* generates, you need an image editing program such as Adobe Photoshop or our Picture Window Pro that supports color management.

Test Targets

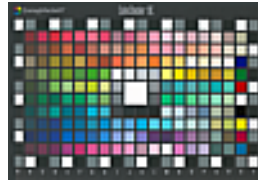
A test target is the key to making a scanner or digital camera profile. *Profile Mechanic* currently supports five types of test targets:



IT8



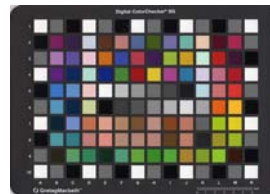
HCT



ColorChecker DC



ColorChecker



ColorChecker SG

Test targets are fragile and should be handled with extreme care and kept clean. Avoid touching the color patches, place your target in its sleeve when not in use, and store it in a cool, dry dust-free location. Do not leave a transparency test target on a light table for any length of time as it may fade. Similarly, do not expose a reflective target to direct sunlight or other bright light for extended periods of time.

IT8

IT8 test targets have been an industry standard for quite a few years, and are manufactured by several sources including the major film suppliers: Kodak, Agfa and Fuji. They contain a large number of gray and color patches, are reasonably priced, and readily available in both print (reflective) and transparency film (transmissive)

versions from a number of suppliers. IT8 targets always come with an associated reference file that contains precise measurements of each color patch—you will need this reference file to create your profile. Sometimes IT8 targets are available for an extra cost that have been individually measured, but normally they are produced in batches and there is one reference file per batch. IT8 targets are a good choice for profiling transparency and flatbed scanners.

Macbeth ColorChecker DC

The ColorChecker DC is a target designed especially for profiling digital cameras. One nice feature of this target is that there are redundant white patches around the edges and in the center that can be used to check for non-uniform lighting.

Macbeth ColorChecker SG

The ColorChecker SG is also designed for profiling digital cameras. The newer ColorChecker SG is a little smaller, has fewer color patches, and is less expensive than the ColorChecker DC which it replaces. Special care has also been taken in the manufacturing process to make sure the color patches do not fade and are uniform from one batch to the next.

Macbeth ColorChecker

The original ColorChecker has been around for many years. While you can make an adequate scanner or camera profile using it, a target with more color patches will produce more accurate results. ColorCheckers are available in a large 9"x12" version for studio use and in a handy miniature version which is useful for field work.

ColorCheckers are made by applying specially prepared permanent pigments to a rigid cardboard backing. For this reason reference files are not required as there is little variation among targets. The rigid backing makes ColorCheckers easier to handle and lets them stand up by themselves. In addition, the pigmented surfaces are less shiny than printed IT8 targets and thus photograph with fewer reflections. For these reasons, ColorCheckers are a good choice for camera profiling. Wolf Faust also makes a letter-size IT8 target printed on matte paper with a rigid backing that is considerably less expensive than either the ColorChecker DC or the SG.

HCT

The HCT from Hutcheson Consulting (www.hutchcolor.com) is the ultimate test target for high end scanners. It has more than twice the number of patches as an IT8 and comes in a variety of formats and media. Like the ColorChecker DC and SG, it has redundant white patches around the edges and in the center to check for uneven lighting.

Color Negative Film

For a variety of reasons, no test targets are available for color negative film and it is not recommended to use color negative film in a color managed environment.

Preparation

Before you can create a scanner or digital camera profile, you need to scan or photograph your test target and save the image as a TIFF file. Preparation is a little different for scanners and digital cameras.

Scanning your Test Target

Before you start, make sure your test target is clean. Carefully use a blower or a soft brush to remove any dust or other debris.

If you are using a flatbed scanner, clean the scanner glass with glass cleaner and a lint-free cloth; if you are using a film scanner, give it a blast of compressed air—this will save time later retouching the image.

Set your scanner software to make no automatic adjustments to the color, contrast or brightness of the image. Also, make sure color management is turned off.

Scan using the maximum bit depth your scanner supports. Some scanners can produce 48-bit color scans (16 bits per channel) while others, even if they internally scan at more than 8 bits per channel can only save 24-bit color images (8 bits per channel). You will get better results profiling with 16 bits per channel than with 8.

Select a scanner resolution that yields at least 1000-pixels across the longer dimension of the part of the image covered by the target. Scanning at significantly higher resolution than this is not recommended.

The profile generated from the scan will only work for subsequent scans made using the same identical bit depth, color, contrast and brightness settings you use to scan the target, so make sure you record this information for future reference.

If you are profiling a transparency scanner, you will get more accurate results if you use a test target made using the same film type you will be scanning - use a Kodak target for Ektachromes or a Fuji target for Velvia/Provia/Astia/Sensia. The differences are subtle, but worth taking into account if you want the most accurate possible results.

If you are profiling a flatbed scanner place a sheet of black paper, cardboard or velvet behind your test target covering the entire scanner bed. This helps reduce brightness variations resulting from flare light reflected from the white underside of the scanner lid.

Once you have captured a good image of your test target, use your image editing software to clean up any dirt or scratches as any nonuniformity in the color patches can result in incorrect readings. If the patches are non-uniform (e.g. grainy or rough in texture), blur the target image to smooth it before using it to create a profile. Failure to do this may cause Profile Mechanic to issue a warning message and may cause slightly inaccurate results.

Finally save the file in TIFF format with a name that includes the type of scanner or camera, any custom settings, and the date. *Profile Mechanic* can read either 24-bit or 48-bit color TIFF files. Where possible, we recommend using 48-bit scans and images as this yields more accurate profiles.

Photographing your Test Target

Before you start, make sure your test target is clean. Carefully use a blower or a soft brush to remove any dust or other debris.

Strictly speaking, the profile you create will only be valid for the exact lighting conditions and camera settings in effect when you photographed the target. A camera profile created with the correct white balance setting for the light illuminating the test target will however be more or less generic for the camera. Getting a good image from a test target is a lot harder with a digital camera than with a scanner. Here are some of the variables you need to control:

Uniform Lighting

The entire target must be evenly lit. Photographing the target under sunlight or an overcast sky is a good way to get uniform lighting. It is very hard to get uniform lighting indoors or with a flash. Try to avoid placing the target near bright objects that may be reflecting light onto the target.

White Balance

The color temperature of the light illuminating the target must be consistent with the white balance setting of your camera. If you use a copy stand with tungsten lights, make sure you use the corresponding white balance setting on your camera. If you shoot outdoors, it makes a big difference if the target is in the sun, in the shade, if it is overcast, or if it is near sunrise or sunset.

Reflections

Avoid reflections from the target. In particular, do not use an on-camera flash as it will produce a hot spot in the center of the image.

Distortion

If the image of the target is too distorted, *Profile Mechanic* may have problems reading some of the color patches. A little care when photographing the target will save a lot of trouble later. If necessary, keep the target flat by taping its corners to a flat surface, but be careful not to get tape near any of the color patches. Line up the camera square with the target, and center the target in the viewfinder. Avoid using wide angle zoom settings as they are prone to barrel distortion. Unless you have a low resolution camera (which will probably not profile very well anyway), don't try to fill the frame with the target as this will produce more distortion than using just the central area. This will also minimize any light falloff in the corners of the frame. Try to get 1000-2000 pixels across the target. Don't save the image as a JPEG - use RAW, TIFF or some other uncompressed file format.

Exposure

The image of the test target needs to have reasonable values for the darkest and lightest patches. The lightest patch should come out slightly darker than pure white and the dark patch a little lighter than pure black. Try bracketing your exposures and select the one that keeps the values for the gray patches centered in the tonal range. Once you get a good exposure, use your image editing software to expand the dynamic range of the image to run all the way from full black to full white. Or you can have Profile Mechanic do this automatically (see Advanced Options, Appendix C).

Sharpening

Turn off in-camera sharpening.

Clean-up

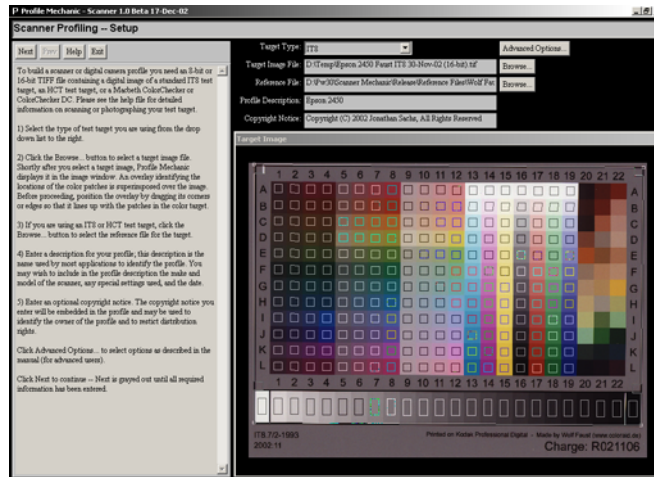
Once you have captured a good image of your test target, use your image editing software to clean up any specks in the image.

Save the TIFF file

Finally save the file in TIFF format with a name that includes the type of scanner or camera, any custom settings, and the date. *Profile Mechanic* can read either 24-bit or 48-bit color TIFF files. If possible, save the file as 48-bit TIFF.

Using Profile Mechanic

Armed with your target image file, you are ready to create a profile, so start up *Profile Mechanic*. It will display the following screen:



While you can resize the main window if you wish, *Profile Mechanic* is designed to run maximized to use the full screen. Instructions are displayed in the panel at the left. The controls in the upper right panel let you select or enter the information necessary to build a profile:

Target Type

The Target Type drop down list lets you select the type of target you are using (*IT8 - Reflective*, *IT8 - Transparency*, *ColorChecker DC*, *ColorChecker SG*, *ColorChecker*, *HCT - Reflective*, or *HCT - Transparency*). If you select one of the ColorCheckers, the *Reference File* control is automatically filled in as the reference files for these targets are built into *Profile Mechanic*.

From the standpoint of creating profiles, there is no fundamental difference between reflective and transparency versions of the IT8 and HCT targets, but this information is copied into the resulting ICC profile header and is used by some programs to determine the profile type.

Advanced Options

When you click the *Advanced Options...* button, *Profile Mechanic* displays its *Advanced Options* dialog box. The available options are described in Appendix C of this manual. In many cases the best results will be obtained with the default settings.

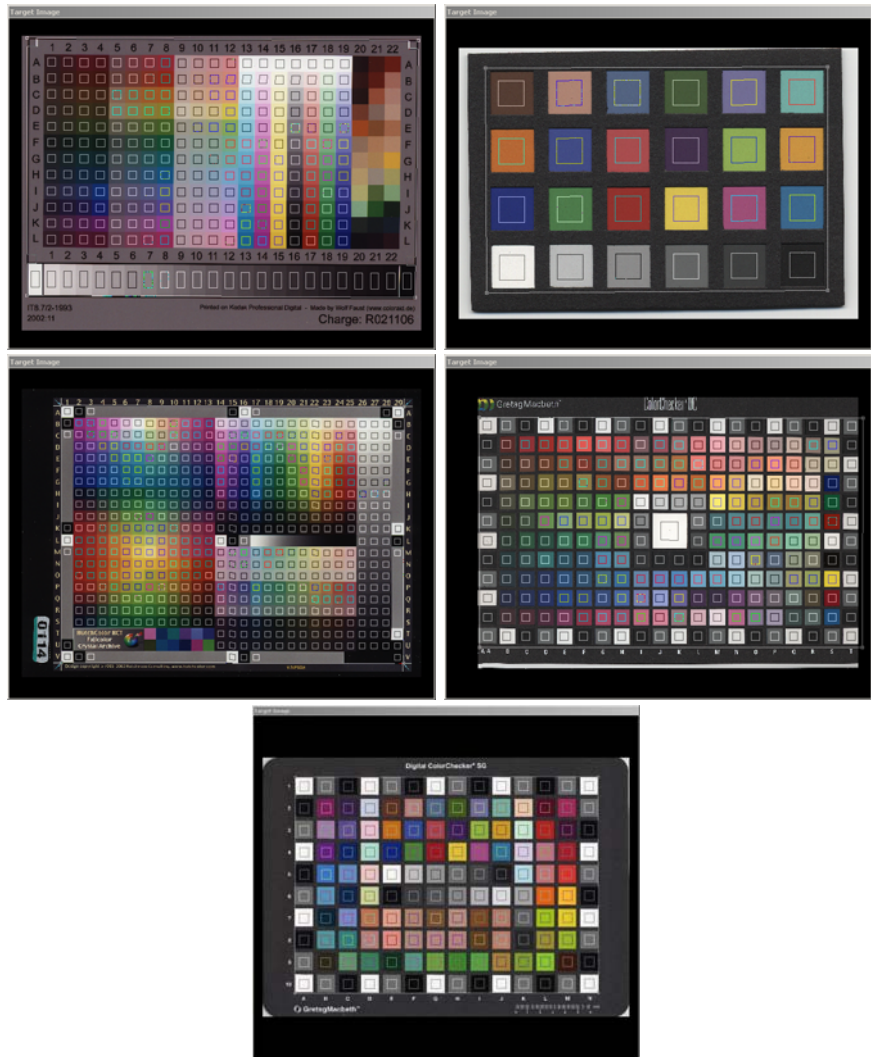
Target Image File

Click the *Choose...* button to select the image of your test target. Shortly afterwards, the image will be displayed in the window below.

Target Image Overlay

Once you select a target image, an overlay is displayed superimposed on the image indicating the locations of the gray and color patches. It is important that you select the correct *Target Type* (see above) so that the overlay matches the target image.

Before proceeding, align the overlay with the patches in the target image. You can adjust the overlay by dragging its corners, edges, or its interior. Examples of proper alignment for each target type are given below:



Reference File

If you are using an *IT8* or *HCT* target, click the *Choose...* button to select the reference file for your target. It is very important that you use the correct reference file for your target. Your target should be labeled with a batch number that identifies the corresponding reference file. *Profile Mechanic* comes with a collection of reference files available at the time the software was released, but if you have a more recent target, its reference file will likely not be included. In this case you should either use the reference file that came with your target or you should be able to download one. The following table lists locations on the internet where you can download reference files:

Kodak	ftp://ftp.kodak.com/gastds/q60data
Wolf Faust	http://www.targets.coloraid.de
HCT	http://www.hutchcolor.com/HCT_data.htm

Custom reference files are not necessary for Macbeth ColorCheckers as they are manufactured to fairly tight tolerances, and we include generic reference files for each type.

Profile Description

The description you enter here will be embedded in the profile you create. Most color management applications identify profiles by their description and not by their filename, so be sure to enter enough information in the description so you can recognize your profile later. At a minimum you should include the make and model number of your scanner or camera. You might also want to include the date and any special conditions under which the target image was created.

While legal within a profile description, using the characters “/”, “\” and “:” is not recommended as they are illegal within a filename. When you eventually go to save your profile or profile log, the default filename that *Profile Mechanic* proposes is derived from the profile description and any of the special characters listed above will be converted to underscores to prevent file system errors.

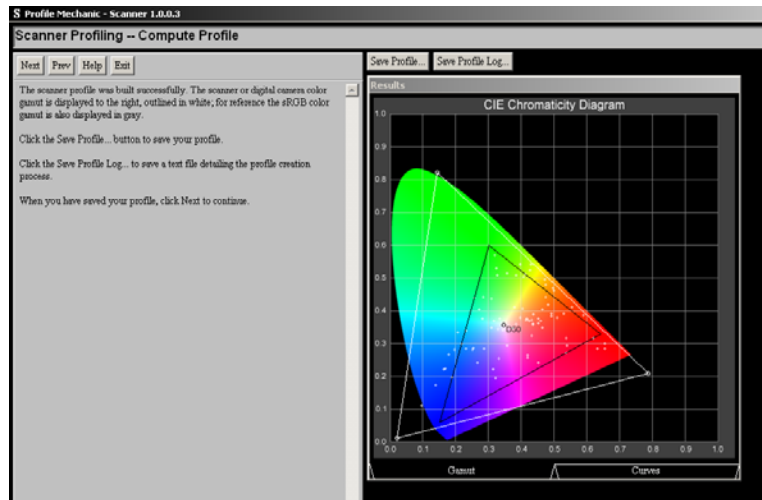
Copyright Notice

A copyright notice is optional. You may choose to include a copyright notice if you need to establish legal ownership of the profile you are creating or to limit its redistribution rights.

When you have entered all the necessary information, click the *Next* button at the top of the instructions panel to compute the profile and continue to the next screen.

Computing the Profile

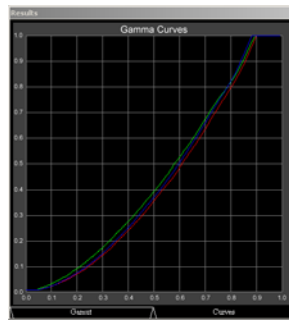
If everything is OK, *Profile Mechanic* computes the profile and displays the results in a screen such as the following:



If errors are detected while computing your profile, *Profile Mechanic* displays an error message and returns to the previous screen. The most common problem is misalignment of the overlay or some other problem that makes one or more of the color or gray patches non-uniform. If this occurs, problem patches will be identified with an X on the overlay when you return.

Once your profile has been computed, *Profile Mechanic* displays a diagram illustrating the approximate color gamut of your scanner or camera as a white triangle. This gamut triangle is not intended to be an accurate representation of the boundaries of the scanner gamut, but it is useful when comparing scanner gamuts. The color gamut, while included in the profile is not used by the color engine when converting images. For reference purposes, the *sRGB* color gamut is displayed as a dark gray triangle. Small circles are also displayed indicating the chromaticity coordinates of each color patch in the target.

Using the tabs at the bottom of the *Results* window, you can also switch the display from the scanner gamut to the gamma curves that linearize the scanned data (see below). It is a good idea to check these curves to make sure they are smooth as irregularities in the curves may indicate problems with the gray patches in the target. If this occurs, you may want to check one of the *Smooth Gamma Curves* radio buttons in the *Advanced Options* dialog box (see Appendix C) and rebuild the profile.



To save your profile, click the *Save Profile...* button and select a pathname for your profile. By default, the profile will be saved in your system profile folder so it can be used by other programs.

To save a detailed report of the profile generation process as a text file, click the *Save Profile Log...* button and select a pathname for your report. For information on profile logs, see Appendix A.

Once you have saved your profile, click *Next* to return to the startup screen from which you can build additional profiles if desired or click *Exit* to terminate *Profile Mechanic*.

Modifying Profiles by Editing the Target Image

Although the idea of profiling is to produce accurately standardized output from a scanner or digital camera, you may wish to deliberately create a profile that systematically alters images in various ways. One way to do this is to use a specialized profile editor, but you can also change the way your profile works simply by editing your target image before creating your profile.

Any changes you make to the target image have the opposite effect on the profile. For example, if you want the profile to produce more saturated images, use an image editor to decrease the saturation of the target image before using it to generate the profile. When applied to a scanned image, a profile created from a desaturated target will boost the saturation of the scanned image. Similarly, altering the brightness or contrast of the target image has the opposite effect on the profile.

Rendering Intents

Scanner profiles created by Profile Mechanic support two rendering intents: *perceptual* and *colorimetric* (encoded within the profile using A2B0 and A2B1 tags). Both sets of lookup tables are embedded in the profile—you select the one you want to use when you use the profile within a color-management-aware application to convert an image from the scanner color space to a working color space.

Normally, rendering intents are used to specify the way images are converted from one color space to another. Perceptual rendering causes the full input color gamut to be compressed in a nonlinear fashion to fit within the output color gamut. Colorimetric rendering preserves colors in the input gamut that are also within the output gamut without compression while forcing out-of-gamut colors into the gamut. The actual method of gamut compression is left to the discretion of the color engine.

For scanner profiles, the input color space is the scanner color space and the output color space is always the profile connection space (PCS) which, by definition is CIE Lab with a D50 white point. Since this color space can accommodate any possible color, gamut compression is never required, so rendering intent does not have its usual meaning. For this reason the choice of scanner rendering intent is not nearly as important as it is for printer profiles since printers cannot reproduce the entire Lab color space and out-of-gamut colors must be brought inside the printer color gamut.

In profiles created by Profile Mechanic, the only difference between the two rendering intents is that perceptual assumes you want pure white and pure black in the input image to become pure white and pure black in the corrected image. When using colorimetric rendering intent, white and black levels are limited to match those of the target as defined in the reference file. Typically, reference values do not go all the way to white or black since film targets are not totally opaque or transparent and reflective targets are not perfectly black or white.

Using perceptual rendering will result in slightly contrastier images that will usually look more pleasing. Using colorimetric rendering is more precise, especially if you want to use your scanner as a densitometer or need absolute accuracy for some other reason. The trade-off is that scanned images converted to a working color space using colorimetric rendering intent will never have pure blacks or whites.

Applying Profiles to Images

To get the benefit of a custom scanner or camera profile, you need to capture images the same way you captured the target image and then assign your custom profile to the resulting image files. Assigning the scanner profile does not change the RGB values in the image—it merely embeds information about the scanner color space in the file for later use.

After associating the scanner profile, it is then strongly recommended that you convert your image files to a standard working color space such as sRGB, Adobe RGB, or whatever space you normally use, before editing or distributing them. This has several benefits:

1. Converting to a standard color space removes any nonlinearities in the scanner color space yielding consistent color, tonality and gamma. These nonlinearities can cause problems when performing image editing operations.
2. Combining multiple images in different color spaces can produce inconsistent results.
3. Converting to a standard color space reduces the image file size.

While it is beyond the scope of this document to explain how to use color management in general or how to use custom scanner/camera profiles with every possible application, here are a few examples to get you started assuming you are already using a color managed workflow:

Photoshop CS

To apply a profile to an existing image file using Photoshop CS, first open it, making sure you do not convert the image to the working color space when you open it. Select *Image/Mode/Assign Profile...* from the main menu—this brings up the *Assign Profile* dialog box. Click on the *Profile* radio button and select the scanner profile from the list of available profiles. If the *Preview* box is checked, the image display will be immediately updated to show the effects of applying the scanner profile. By checking/unchecking *Preview*, you can see what effect the profile is having. If the preview looks good, click *OK*.

Picture Window Pro 3.5

Scanner profiles can be applied automatically to images scanned into Picture Window Pro via its TWAIN interface by selecting the desired scanner profile in the *File/Color Management* dialog box as the *Assumed Scanner Profile*.

To apply a profile to an existing image file, first open it, making sure you do not convert the image to the working color space when you open it. Select *Transformation/Color/Change Color Profile...* from the main menu—this brings up the *Change Color Profile* dialog box. Set *Change to Profile Data Only* and then set *New Color Profile* to the scanner profile. If the preview looks good, click *OK*.

Capture One DSLR 3.5

Within Capture One, color management settings are accessed by selecting *Workflow/Show Color Management Settings* from the main menu.

To create profiles for use with Capture One, it does not matter which camera profile is selected when you convert the target image from RAW to TIFF at long as you do not convert the image to an output color space. To avoid converting to the destination color space, click the Develop tab and set *Color Management Workflow* to *Embed Camera Profile*. This will attach a copy of the current camera profile to the target image file but will not change the image data. Since Profile Mechanic ignores the embedded profile when it opens the file, this will let it read the unmodified camera data so you can create a custom camera profile.

To select a custom camera profile you have created to be assigned to images in Capture One, select *Workflow/Show Color Management Settings* from the main menu. This brings up the *Color Management Settings* dialog box. Uncheck *Show Only Phase One Profiles* and set *Camera Profile* to the desired profile. You can either set *Color Management Workflow* to *Embed Camera Profile* or possibly *Convert to Destination*, depending on whether you want to use an image editor to convert the images to a working color space when you open them or if you want to pre-convert them in Capture One. The former method leaves you the option of converting to different working color spaces; the latter is better if you are going to use the files with applications that are not color managed. Embedding the camera profile may also increase the size of the files, depending on how large the profiles are.

System Requirements

Profile Mechanic can create profiles for RGB flatbed or film scanners or digital cameras. It does not support CMYK scanners.

Operating System

Windows 95/NT or later (this includes Windows 95, 98, 98 SE, ME, NT, 2000 and XP).

Mac OS/9 or OS/X.

Appendix A - How to Read the Profile Log

The profile log is a text file containing detailed information about the profile you just created. The information in the log is organized as follows:

Date -- the date the log was created.

Target Type -- the type of target used to create the profile.

Description -- the profile description.

Copyright -- the profile copyright notice.

Red, Green and Blue Primaries

Estimated CIE XYZ and CIE xy values for the red, green and blue primaries are given. The CIE xy values define the vertices of the gamut triangle displayed in the chromaticity diagram in the *Results* window. The white point for scanner profiles is always specified as D50.

The reported primary values are estimates and not direct measurements as there is no way to create a test target with pure red, green and blue color patches—consequently the values may not be accurate and should only be used for making relative comparisons between different scanners. In addition, slightly different values are computed depending on whether you use a CIE XYZ or a CIE Lab model. While scanner primaries are included in the scanner profile, they do not affect conversions from the scanner color space to the working color space as this is done using lookup tables.

Dmin and Dmax RGB values

These are the measured RGB values of the darkest and lightest gray patches in the target on a scale from 0.00% (black) to 100.00% (white).

For scanners, the Dmax value should be a little above 0.00% and the Dmin should be a little below 100.00%, indicating that none of the gray patches has been clipped. Since the darkest patch generally reflects (for flatbed scanner) or transmits (for a film scanner) some light, its measured value will usually not be 0%. Similarly, the lightest patch will absorb some light and its measured value will not be 100%. This is perfectly normal and not a cause for concern. If you are seeing values of 0% or 100%, this means that you are losing some shadow or highlight detail and need to re-scan.

For digital cameras, the situation is more complicated since an outdoor scene may include deep shadows that are darker than the darkest target patch or highlights lighter than the lightest patch. For studio photography, this should be less of a problem as the range of densities of the target should be representative of subject brightness values. In any case your target image should have Dmax at or very close to 0.00% and Dmin at or very close to 100.0%. If not, go back and adjust the target image to use the full range from pure black to pure white.

White, Gray and Black RMS Nonuniformity.

These are measures of the variability of the redundant white, gray and black patches scattered around the target (ColorChecker DC, ColorChecker SG and HCT only). Values greater than 5% to 10% indicate uneven target illumination.

Gray and Color Uniformity, Regression errors, and Delta E

These tables list the RMS uniformity, regression errors, and Delta E for each gray and color patch in the target.

Regression Error is only reported for CIE XYZ profiles and corresponds to the RMS error in XYZ between the measured target values and those predicted by the regression model. When creating CIE Lab profiles, *Regression Error* and *Delta E* are the same thing.

If the uniformity error for a given patch is large (> 5%), this indicates that the image of that patch may be noisy, include specks or be uneven for some reason.

The regression error indicates how far the measurement of a given patch differs from the predicted value based on the regression model. A large number (> 5%) may indicate some nonlinearity in the scanner, a problem reading the patch, uneven target lighting, problems with the spectral properties of the scanner light source, or simply an inconsistency between the target and the reference file.

These inconsistencies can arise from variations among individual targets in a batch, aging of the target, dirt on the target, or abrasion of its surface. In some cases, regression errors are reduced considerably when creating a custom reference file by measuring all the patches with a spectrophotometer, or by using a different target with a more accurate reference file. This means that errors may be a result of target inconsistency and not scanner nonlinearity. For this reason, *Eliminate All Residuals* (see Appendix C) is turned off by default since there is no point in modelling the inevitable small errors in the reference file. On the other hand, if you are using a custom measured target, you may want to select *Eliminate All Residuals* to increase the accuracy of the profile.

Even if your target has a few regression errors in the 5-10 Delta E range, this does not mean there is anything significantly wrong with the profile you created as the regression process averages the response over all the patches and normally still produces very accurate results even if a few errors are large. Errors larger than 10-20 Delta E may indicate a some kind of problem with the input image, reference file, target or scanner.

Delta E values represent the color differences between the values predicted by the regression model and the reference values expressed in standard CIE Lab ΔE units. A Delta E is roughly the minimum visible difference. Delta E values may be larger or smaller than the regression errors which are the errors in the CIE XYZ color space due to differences in the way these color spaces are defined.

Reported error values are computed by comparing each patch value as mapped to CIE XYZ or CIE Lab using the regression model to its corresponding value in the reference file. Actual errors will usually run slightly larger when a profile is used by a color engine to convert from the scanner color space. These additional errors result from roundoff error due to the use of integer arithmetic and interpolation errors due to the granularity of the 3-D color lookup table. Interpolation error depends on the interpolation method used by the color engine—while interpolation error cannot be entirely eliminated, it can be reduced by using a larger lookup table size (see Advanced Options). This is probably not worth worrying about unless you are using a custom measured target.

Appendix B - Error Messages

This section lists *Profile Mechanic* error messages listed alphabetically and explains what they mean and what you can do about them.

Cannot profile negative images

If *Profile Mechanic* determines that the brightness of the gray patches is reversed, it assumes you are attempting to create a profile using a negative image which is not supported.

Illegal reference file: <pathname>

Before reading a reference file, *Profile Mechanic* does a few simple tests to see if it is a valid file. If these tests fail, this message is displayed indicating that an improper or corrupted reference file has been specified or that the reference file is for a different type of target than the one you have specified.

Nonuniform target illumination detected

Some targets include redundant white, gray and black patches in various locations intended to be used as a check for nonuniform target lighting. *Profile Mechanic* examines these patches and issues this warning if it finds significant variation among these extra patches. If you are profiling a digital camera, this may indicate that the target was unevenly lit when you photographed it. If you are profiling a scanner, it may indicate that the scanner light source is not uniform over the scanning area. This is a warning and not a fatal error.

One of more gray patches not in increasing brightness order. Target lighting may be uneven.

Profile Mechanic examines the gray patches in the target to make sure the measured values of each progressively lighter patch are higher than those of the previous patch. If any of the values is out of sequence, this may indicate that the target was unevenly illuminated or that the target image is noisy. For targets such as the HCT which has many very closely spaced gray patches, this is not uncommon. If you are getting this warning, try selecting one of the *Smooth Gamma Curves* options in *Advanced Options* (see Appendix C) to reduce noise in the gray measurements.

Regression error

The regression process *Profile Mechanic* performs to attempt to model the scanner's response has failed. Normally this means there is a serious problem with the target image file or the reference file. If both files are OK, you can try changing to a different regression model (see Appendix C).

Some gray or color patches are non-uniform. Bad patches will be identified with an X when you click OK.

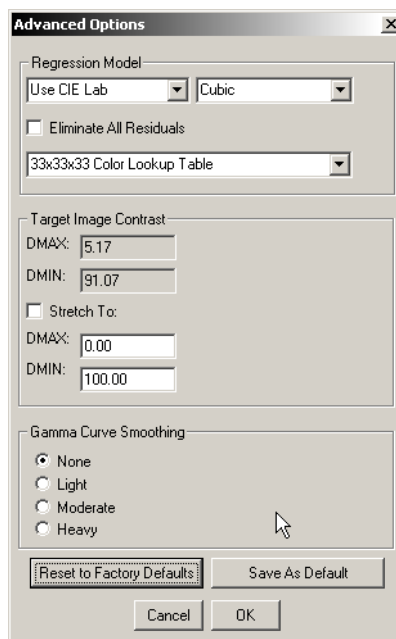
Profile Mechanic samples each color patch at 111 different points and averages the results. It also computes the standard deviation of the measurements and displays this error when that values exceeds a preset threshold. Generally patches may be nonuniform if the target image has dirt on it or if the image is unusually noisy. If the image is basically OK, you can increase its uniformity by applying a median or blur to it using your image editing software and retrying.

Target file is not a 24-bit or 48-bit color image: <pathname>

The target image must be scanned as a 24-bit or 48-bit color TIFF file. This error indicates that the image needs to be rescanned using the proper settings.

Appendix C - Advanced Options

This section describes the options available in *Profile Mechanic's* *Advanced Options* dialog box.



Regression Model

Regression Color Space (*Use CIE XYZ / Use CIE Lab*)

ICC scanner profiles can use either of two color spaces: CIE XYZ or CIE Lab. As a rule, CIE Lab is the preferable choice as it more closely models the characteristics of the human visual system, and thus the Lab equivalents of two colors whose XYZ values are very close can be much further apart. For this reason, regression using CIE Lab color space tends to produce smaller errors as measured in units of Delta-E which is a mathematical approximation of visual difference.

Regression Type (*Linear / Quadratic / Cubic*)

Profile Mechanic can perform linear, quadratic or cubic regression to model the behavior of the input device. If the test target has a sufficient number of color patches and the reference file is accurate, cubic regression will produce the most

accurate results. The *Macbeth ColorChecker* target does not have enough patches to perform a cubic regression. When this target is selected, quadratic regression is used when you specify cubic.

Residual Handling (*Eliminate All Residuals*)

Normally a profile's color lookup tables are generated by using a linear, quadratic or cubic model of the response of the scanner or digital camera. In most cases, the regression model, especially cubic regression, is a close approximation to the measured color response. You can check how well the model fits the data by looking at the *Delta-E* errors in the profile log. If all or nearly all the values are small (less about 2.0 or 3.0), the regression model is a good fit to the measured data. If any values are larger, this means either that the values in the reference file do not correspond accurately to the target or that the scanner or digital camera has nonlinear characteristics that are not fully modelled.

When you select *Eliminate All Residuals*, *Profile Mechanic* applies a nonlinear model to the residual errors from the regression model when creating the profile. This distorts the color lookup tables in the profile so as to precisely match all patches in the target to their corresponding reference values, but can introduce irregularities in the profile if the regression errors are due to inconsistencies between the target image and the reference file or if you are using a target with a small number of patches. Generally, we recommend using this option only be with high quality or custom measured targets.

Color Lookup Table Size

This settings lets you specify the size of the 3-D color lookup table generated. The 3-D lookup table contains the bulk of the scanner profile data—available choices are 17x17x17, 33x33x33, or 65x65x65. Larger color lookup tables can produce slightly more accurate profiles due to reduced interpolation error, but the size of the profile can increase dramatically. Approximate file sizes are as follows:

17x17x17	66Kb
33x33x33	430Kb
65x65x65	3.2Mb

If you plan to use your profile with a large number of small image files and are less concerned about precision, select a smaller size. If file size is of no concern and you want the most accurate possible results, use a larger size.

Target Image Contrast

By default, Profile Mechanic makes an important assumption, namely that the *Dmin* and *Dmax* patches in the target represent the lightest and darkest colors the scanner or digital camera can capture. To the extent this assumption is true, the default settings will work well, but there are a number of reasons you may wish to alter this default behavior. Problems with the assumption are usually caused by one of the following:

1. For transparency or flatbed scanners, the target fails to achieve the maximum or minimum possible density.
2. For digital cameras, the target has a narrower dynamic range than the camera and thus the darkest patch is not captured as pure black and/or the lightest patch is not captured as pure white.

The result of any of the above is that for some subject matter there may be loss of shadow or highlight detail when the profile you create is used to convert some image files from the scanner color space to a working color space, i.e. highlight detail may be blown out or shadows may be blocked. By stretching the target image contrast (see below for details), these problems can be fixed—using a contrastier target image reduces the contrast of the profile.

Target Image Contrast

When *Stretch To* is checked, the target image data corresponding to the *Dmin* and *Dmax* gray patches in the target are adjusted according to the values you enter below the checkbox. For reference, the *Dmin* and *Dmax* values read from the target are also displayed above the checkbox. If you have not yet specified a target image, these values are displayed as *N/A*. If you want to adjust the target image contrast, click *Cancel*, select a target image and align its overlay, and then click the *Advanced Options* button again. This should cause the *Dmin* and *Dmax* values measured from the target image to appear in the dialog box for reference.

Contrast values run from 0.0 for pure black and 100.0 for pure white. Normally, the measured *Dmax* and *Dmin* values will not occupy this full range. If you are profiling a scanner and are having problems with highlight or shadow detail, you can use these controls to stretch the range of the target image slightly to allow for subjects whose dynamic range exceeds that of the target. Setting the *Dmin* value to a value closer to 100.0 will reduce the chance of blown out highlights when applying the profile, but if you increase it too far, you may make it impossible to achieve a full white in scanner images. Similarly setting *Dmax* closer to 0.0 will reduced blocked shadows but may make it impossible to reach pure black in scanned images.

If you are profiling a digital camera, you should normally select this option with *Dmax* set to 0.0 and *Dmin* set to 100.0 so as to make the range of brightness values represented by the target fill the full range from black to white as captured by the camera.

If you have examples of pure white or pure black, you can scan these (using the same settings you use to scan your target) and then use the resulting RGB values to compute the correct values to stretch to. For example, if you are using a film scanner, scan a totally clear piece of film and also a totally black frame. To compute values to enter into the dialog box, use an image editor to examine the RGB scanned values from the image, and divide the largest of these three numbers by 2.55 (for 8-bit scans) or by 655.35 (for 16-bit scans). For example, if scanning pure black yields 8-bit RGB values of (5,7,3), use $7/2.55 = 2.75$ for the *Dmax* value; if scanning pure white yields (247,240,245), use $247/2.55 = 96.86$ as the *Dmin* value.

Smooth Gamma Curves

When *Smooth Gamma Curves* is selected, the sequence of measured gray patches is smoothed using sophisticated cubic spline smoothing techniques. This can be very helpful in reducing wiggles in the gray curve that can arise if you are using a target that has many closely spaced gray patches. Select the smallest amount of smoothing (*None*, *Light*, *Moderate*, or *Heavy*) that produces a curve without kinks. Smoothing is not recommended for targets such as the *ColorChecker* that have a small number of widely spaced gray patches.

Reset to Factory Defaults

Clicking this button returns all advanced option settings to their factory defaults.

Save as Default

Clicking this button saves the current advanced option settings. These default settings are reloaded each time you run Profile Mechanic - Scanner.