

# Colorimetric assessment of digital camera profile accuracy

by Gregory Firestone

## Introduction

The use of digital photography in the graphic arts industry is rapidly expanding. Digital camera prices are continuing to fall and image quality is improving with each and every new camera release. Digital photography provides a fast and inexpensive workflow compared to traditional photography. A photo can be taken and instantly transferred to the computer in a matter of seconds. There is no longer the need to wait for costly film developing and scanning. Digital photography has seen extended growth in product photography for catalogs where large numbers of products are now captured quickly and inexpensively compared to traditional film-based photography.

## Objective

As with any type of reproduction process, color accuracy and precision are key. It is crucial that the reproduced image match the reference image. This is especially important in product photography where one is judging the color of a product, such as a sweater, solely by the picture. It is also important that accurate color reproduction be repeated consistently. The purpose of this experiment is to determine if ICC color management provides better color accuracy than using the digital camera's default color space, e.g. sRGB.

## Resources

This experiment was performed using a Nikon Coolpix 5000 digital camera. GretagMacbeth ProfileMaker 4.1 software was utilized to create the ICC profile based on measurements obtained from the Macbeth ColorChecker DC color chart (Figure 1). The reference chart used to assess color accuracy was the Macbeth ColorChecker 24 patch color chart (see CMS workflow diagram). Assorted vegetables with memory colors were also incorporated as a source of reference for the human visual assessment.

## Procedures

### 1. Image Capturing

Setup the Nikon Coolpix 5000 by turning the flash off and

manually setting the white point of the camera using the white backdrop as the reference. Place the Macbeth ColorChecker and vegetables in front of the white backdrop. Take a picture and name the file Scene\_Raw.tif. Remove the ColorChecker and vegetables and place the Macbeth ColorChecker DC color chart in the exact same location as the previous chart. Take another picture. Name the file ColorCheckerDC.tif.

### 2. Digital Camera Profiling

Using Macbeth ProfileMaker 4.1 and the picture of the ColorChecker DC (ColorCheckerDC.tif), create an ICC profile for the Nikon camera. Name the file CP5000\_indoor.icc.

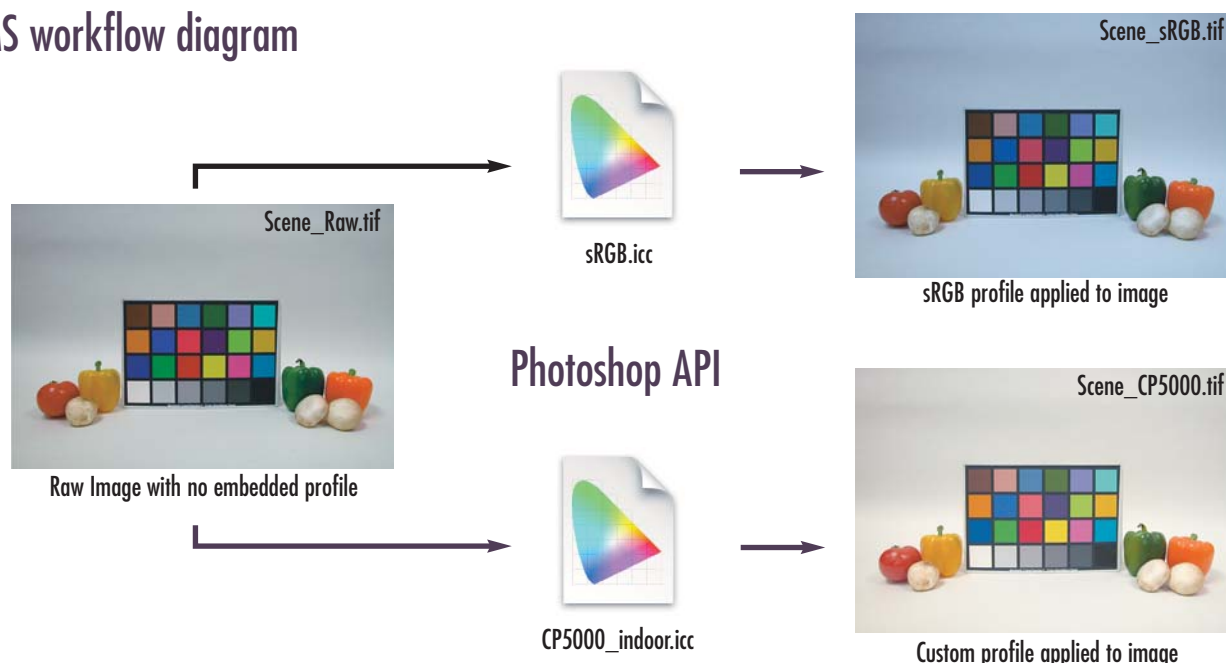


Figure 1. Profile creation workflow

### 3. Color Management

Set the Photoshop color conversion options to use the Adobe (ACE) CMM and absolute colorimetric rendering intent. Open the

## CMS workflow diagram



raw digital file Scene.tif without color managing. Assign the newly created ICC profile to the image and then convert the image to CIELAB using the predefined color settings. Save the file as Scene\_CP5000.tif.

Open the raw digital file Scene.tif once more. Assign the camera default color space profile, otherwise known as sRGB. Using the same color settings as before, convert the file to CIELAB. Save the image as Scene\_sRGB.tif.

### 4. Profile Accuracy Testing

Set the sample size of the eyedropper tool to 5x5 pixels. Inspect the CIELAB values for both images. Using the supplied CIELAB values for the MacBeth ColorChecker as the reference, calculate  $\Delta E$  values and analyze the results.

ColorChecker Patch	Default $\Delta E$	CMS $\Delta E$
D1 White	25.3	2.9
D2 Neutral 8	20.7	1.8
D3 Neutral 6.5	17.5	2.9
D4 Neutral 5	14.7	2.9
D5 Neutral 3.5	13.8	2.5
D6 Black	12.2	2.5

Chart 1. Neutral color patch  $\Delta E$  values from analysis

## Discussion

The CIELAB inspection revealed a dramatic difference between the default and custom built profile. Lower  $\Delta E$  values are indicate closer colorimetric reproduction. The average colorimetric difference of the default workflow was 18.2  $\Delta E$ . The CMS workflow yielded an average 5.4  $\Delta E$ . Clearly, the CMS workflow is much more accurate.

Most areas in the graphic arts aim for a  $\Delta E$  of 3 or less. One may ask why the ICC color managed workflow did not produce more accurate results. The reason is that color management software for digital cameras does not necessarily aim to produce the most accurate colorimetric results; instead, they aim to simulate traditional photography. The following is a quote from Scott Gregory, former Director of Kodak Color Management Systems Group, "In building a digital camera profile the aim is typically not to capture scene colorimetry. The aim is typically to render a scene much the same way conventional photography renders a scene. Each film has it's own unique mechanism for interpreting scene color and usually the goal of the digital camera profile is to do something similar like film."