An Alternative Method of Shade Selection for Indirect Dental Restorations

Joe Meng DDS & Michael Ryan DDS

Graduate Prosthodontics – Baylor College of Dentistry – The Texas A&M University System Health Science Center, Dallas, TX

Introduction

The matching of shades for “tooth colored” dental restorations continues to be a perplexing issue in restorative dentistry today, although many methods attempt to accomplish this task.

With the increasing esthetic demands of the contemporary dental patient, the fabrication of acceptable indirect, “tooth colored” restorations has become more challenging. Adequate and accurate communication between the dentist and laboratory technician are paramount in meeting these high patient expectations. Additionally, with the recent decline of dental technician training programs, the numbers of well trained laboratory technicians is also on the decline. This increases the likelihood of the utilization of non-local laboratory support, and thus further increases the challenges related to dentist/technician communication.

Recent advances in digital photography have made digital photography an increasingly popular way to communicate existing intraoral detail to technicians. Although digital images remain a viable option for communicating non-color specific detail such as tooth contour, craze lines, etc, problems still exist related to accurate color interpretation of digital images; this is due to factors such as, differences in cameras and their settings, lighting, environmental setting, and method of viewing.

Established in 1993, the International Color Consortium (ICC) created a standardized, vendor-neutral, cross-platform color management system, which allows the transfer of accurate color information between the native color spaces of different digital imaging devices. In short, the well accepted, and internationally utilized ICC specification allows digital images to be viewed by monitor or print with no theoretical color discrepancy. Additionally, when images are made with a known color entity, such as a neutral gray card (white balance reference), simple manipulation with computer software can be used to find the accurate color of the image. This allows the color information from RAW digital intraoral images to be used in tandum with tooth colored shade tabs to better replicate accurate tooth color in the fabrication of indirect “tooth colored” restorations. This technique attempts to overcome some of the existing shortcomings in dentist/technician communication related to shade and color, and may enhance results when used additionally with conventional shade matching procedures.

Purpose

The following process explains one way in which digital images can be manipulated though the utilization of software, post acquisition by a SLR (Single Lens Reflex) digital camera, to be viewed with accurate color by either computer monitor or digital print. Utilization of this technique is intended to aid a dental technician in fabricating a restoration with as close of color characteristics as possible to the reference teeth and shade tabs being communicated in the photograph

Rational for post processing RAW images to attain accurate color:

•RAW images contain no color interpretation or compression at the camera level (ie. no color information has been altered or arbitrarily discarded, as with JPEG).
•All digital cameras have inherent color inaccuracies.
•Changes in the object-camera distance or exposure will create different color between photos, even in the same camera.
•It is almost impossible to consistently correct color at the camera level unless photos are made in the studio setting with almost no variation.

Step-by-step Protocol

Step 1 – Acquisition of Digital Photographs

Required Equipment: (a) SLR digital camera, (b) Gray card, (c) Dental shade reference tabs

(a)

Canon® 30D with 100mm Macro lens and dual point ring flash –example of an acceptable camera setup.

Camera Requirements:
•SLR camera capable of shooting in the RAW image format.

(b)

WhiBal® calibrated neutral digital gray card (white balance reference), with known L*,a*,& b* values in the CIELAB color space.

Gray Card Requirements:
•Very neutral- near absence of color (a* & b*<±1).
•Flat Spectral Response – no metamerism.
•Light gray – more color information is captured in the "upper stop" of the dynamic range (L* =70-80) – best signal to noise ratio.

(c)

VITA ® 3D-Master
-A popular tooth shade reference guide.

Procedure

1.) Set the digital camera to record images in the RAW image format.

2.) Select the closest match of shade tab/tabs of the tooth/teeth being matched, as would be done conventionally.

3.) Make a digital photograph of the tooth/teeth being matched with the selected shade tabs and the gray card all included.

Step 2 – Color Correction of Digital Photographs

Required Equipment: A computer with RAW image processing software

Adobe® Photoshop CS2 is a popular program with RAW image processing capabilities

Procedure

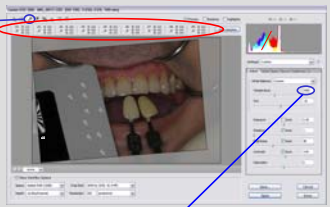
1.) Import a RAW image into processing software.

-Color Sampler Tool displays the relative uniformity of gray card in the unprocessed RAW image.

Image shot with a slightly "warm" white balance temperature intentionally (some feel that "warm" colors are more pleasing to the human eye)

2.) Use White Balance Tool to set the gray point of the Gray Card

- Corrects the white balance temperature (color) of the entire photo - makes the gray card's RGB values equivalent



Corrected, "color accurate" white balance temperature

3.) Correct the exposure to that specified by the RGB values specific to the gray card (should be reported by Mfr. of gray card)

Gray Card color attributes according to Whibal®

*L ≈ 75
a* < 0.5
b* < 0.5

→ R ≈ 184, G ≈ 184, B ≈ 184

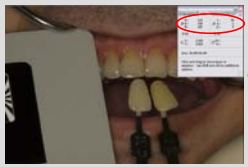
Resolution must be set to a min. of 300 ppi for a "lab quality" print to be made

* NOTE: White balance is the most important attribute in color correction. Exposure may be manipulated slightly outside of gray card values to aid in visualizing the colors more easily if desired.

4.) Export color corrected RAW images into a uncompressed (lossless), usable format (TIFF is recommended)

-Before and after TIFFs viewed in Photoshop

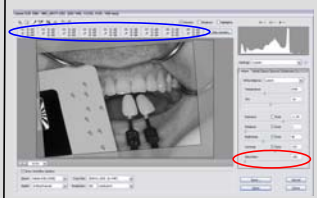
Before Color Correction



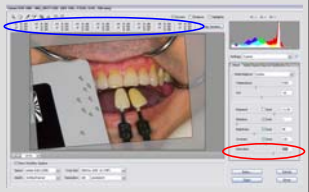
VS

After Color Correction

5.) If desired, color saturation (chroma) can be removed so that the shade value can be determined more easily (grayscale) or added to aid your technician in better visualizing the true colors (hue).



Saturation removed with no change in RGB values



Saturation slightly increased with insignificantly small change in RGB values

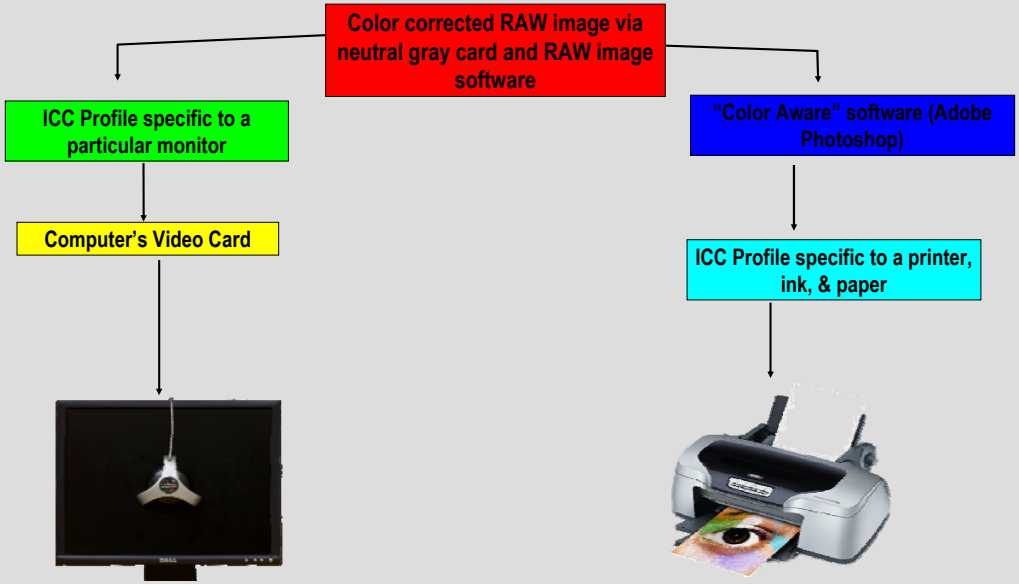
Step 3- Viewing Color Accurate Digital Photographs

Required Equipment: ICC calibrated CRT/LCD monitor or ICC calibrated printer, and a commercial ICC profiler

Procedure

1.) Use an ICC profiler to calibrate a monitor or printer. Most new printers come with an ICC profile specific to certain ink and photo paper, so an ICC profiler is not necessary.

2.) View images on the calibrated monitor or digital print. For printing, a "color aware" program, such as Adobe Photoshop, must be used to apply the ICC profile to the printer so the print will be color accurate.



LCD monitor being calibrated by an ICC profiler (Spyder2™, ColorVision by Data Color®).
*Laptop monitors not recommended for viewing color accurate images.

Inkjet Printer which can accept an ICC profile (Epson® R800) and print with high detail.

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Contact Information

Joe Meng
Resident
Graduate Prosthodontics
Baylor College of Dentistry
Email: meng.joe@gmail.com

Michael Ryan
Resident
Graduate Prosthodontics
Baylor College of Dentistry
Email: michaelryandds@gmail.com