F16 A Comparison of the Quality of Color Produced by Photographic Film and Digital Imaging as a Function of Degrees Kelvin

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The forensic odontologist relies on the faithful reproduction of film and/or digital photographs for investigative and evidencary purposes. The goal of this presentation is to deal with an evaluation of the differences in color reproduction from these two modalities. This presentation will impact the forensic community by encouraging further investigation utilizing more specialized equipment.

The development of digital imaging has empowered the forensic scientist with a multifaceted investigative instrument. Digital imaging offers instantaneous recording of evidentiary material and a wider range of storage and reproduction modalities. The forensic odontologist relies on image recording and reproduction to evaluate the evidence obtained on the initial investigation and to document the conclusions achieved from the painstaking processes of bite mark analysis and/or victim identification. It is vital to all investigators that accurate reproducibility of evidence imaging must be unquestionably accurate. While there has been much documentation on the comparison between photographic and digital imaging with respect to resolution vs. graininess, the literature is notably sparse on comparing the ability of the two media to faithfully reproduce evidence quality color documentation. Recognizing the need for such an evaluation, this

paper shall concern itself with some of the preliminary findings from a project designed to measure the temperature in degrees Kelvin of color images produced by the two media while maintaining the inherent variables as constants.

The objects to be imaged consisted of three plastic report binders: a red; a blue; and a green. Because of the inherent ability of certain polymers to fluoresce, all binders were manufactured by the same company and of the same material to ensure consistency thereby removing this variable from the equation. Two cameras from the same manufacturer were used: a Nikon F4 35mm film camera; and a Nikon D-100 digital camera. The same lens, a Nikon 35-70mm macro zoom, was used on both cameras. The lens was used in the macro mode with a lens to object length of approximately 40 centimeters and secured in a Quadrapod copy stand and a LabJax was used to aid in focusing the image. A 3,200^{o} Kelvin (tungsten equivalent) and a 4,800^{o} Kelvin (daylight photoflood) light bulb were alternatively placed in a single bulb light socket with an 8" reflector for illumination. Kodak Gold 35mm 200/ISO film was used and the digital camera was set to the same ISO setting. Because the film chosen was balanced for daylight, the digital camera's "white balance" setting was adjusted for "daylight". Setting the resolution of the digital image was not considered a factor in this experiment.

Each object, the red, blue and green binders, was imaged according to the following protocol: tungsten on film and then digital, daylight on film and then digital. A total of three exposures for each parameter per binder were made.

The film was developed by a commercial laboratory utilizing a C-41 process with instructions to not make any color corrections to the final 4x6 prints. The negatives of these images were scanned on an Olympus ES-10s 35mm scanner and stored on a CD. The digital images were printed on 4x6 photographic paper without color correction by direct placement of the compact flash card from the camera into a Hewlett-Packard #7550 printer. These digital images were also stored on a CD. In addition, all images were printed on ink-jet transparency film.

A Spectra #4143 Color Temperature Meter was used to measure the color temperature of the various images in degrees Kelvin. Measurements were taken of:

1. The 4x6 film & 4x6 digital prints from reflected daylight & tungsten light sources.
2. The CD stored film & digital images from an LCD computer monitor projected by Photoshop.
3. The transparencies through opaque glass backlit by daylight & tungsten light sources.

All measurements were taken in a darkroom environment. An initial analysis of the measurements showed that all the images taken in triplicate produced the same measurement. Because the measurement for each parameter would have been universally tripled, it was decided to reduce the statistical evaluation to one measurement for every triplicate image analyzed.

A total of ten parameters were considered for each color. The resultant measurements were entered into a spreadsheet, average differences were calculated, and graphs were promulgated and analyzed. While empirically one could say there may not have been any visual differences the measurements clearly illustrates a differences in color temperatures of 1,300^{o}, 1,370^{o}, and 650^{o} for red, blue and green respectively. No conclusions should be made on the results of this preliminary report. What the forensic odontologist should be aware of is the possibility that any judgment made on the basis of the color film or digital record may be different from the actual color seen with the naked eye. If one should present evidence based on film or digital reproduction the possibility exists that the defense might posture this as exculpatory evidence. Further investigation is encouraged.

Color, Variation, Imaging

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