Letter to the Editor:
Guidelines for the Handling of Color in IS&T Journal Papers

Driven by the nature of our Society, color has been one of the major topics of scientific papers published in this Journal, and it is quite clear that showing research results frequently has required reproducing color images in true color. In color reproduction, however, it is difficult to achieve the required level of color faithfulness, and in the past authors have not been able to afford paying the extra costs for color printing.

Journal papers are now published electronically, and color printers and monitors have become ubiquitous, so the scenario is changing, allowing for an extensive use of color. We would like to encourage even more use of color images, graphics, etc., wherever meaningful for the subject, or wherever appropriate to support the clarity of the paper. However, handling color is still not simple in general, and its extensive use may incur additional problems. We intend these guidelines to keep such problems to a minimum. Accordingly, we foresee different work paths, and hope to provide solutions for authors with different levels of color experience.

Author guidelines
General rules

1. Keep in mind that in the print version of your paper you may choose to have the figures printed in grayscale, which may also be the case when readers who do not have access to color printers, purchase, download, and print the PDF of your article. Hence, you should make sure that all color images or graphics also reproduce well in grayscale.
2. The default color space is sRGB (according to ISO/IEC 61966-2.1). Make sure that all figures, graphics, etc. have been prepared for this color space or converted into sRGB after preparation.

Why sRGB?
sRGB is the system color space in Windows 2000 and XP, and will be the default color space with Windows Vista. Mac OS does not generally assume sRGB, but has built-in color management capabilities, so that it will correctly display images and PDFs if they have appropriate profiles embedded. Moreover, most printer manufacturers assume RGB data to be sRGB if no color management is used, so that one should get reasonable results also on office printers.

How to create sRGB data
Non-Color Expert Level
Color conversions are carried out by means of a color management system using color profiles (ICC profiles). If you do not know how to create the proper color transforms, you are unlikely to require high color fidelity. To create a file properly, follow the simple guidelines given here.

Simple Guidelines for Achieving sRGB-like behavior on PCs
If you are using Windows 2000, XP, or Vista, then your system's default color space is sRGB. This is good news. Moreover, most monitor manufacturers have adopted the sRGB standard in a way that every monitor by default approximates sRGB. This approximation does not guarantee color accuracy, but it does ensure that the computer/monitor system is not entirely off in terms of color. In other words: If you display a graphic or image on your system, and you like what you see, then it is safe for you to claim that the data was prepared for sRGB.

Important Note: A precondition is that you have not modified the entire system, neither in terms of the operating system's color settings, nor in terms of the monitor. If you have modified color temperature, color balance, RGB gains, etc., the display most probably no longer follows an approximate sRGB state. In this case try to reset the monitor to its default settings using the onscreen menu.

Simple Guidelines for Achieving sRGB-like behavior on Macs
If you are using a Macintosh, the default setup is different than sRGB. The main difference is that the Mac uses a gamma of 1.8 instead of the 2.2 of sRGB. If you do not know how to convert color images into another color space, we recommend changing the default setting. Just open the Monitor Control Panel from the System Preferences menu, click on the "Colors" tab, and press the "Calibrate" button. If your monitor is in good shape, you can use the non-expert mode. Set the gamma correction to "2.2 TV gamma," and the desired color temperature to "D65" or "uncorrected." Some monitors, *e.g.*, LCD, provide a greater luminance range at a slightly lower color temperature, *e.g.*, D60, which may, in that case, be a better compromise. Note: Do not perform this manual correction if you are using a monitor calibration system (see below).

Making use of Monitor Calibration Tools
If you are using monitor calibration hard- and/or software, the sRGB state may also be void. In this case, you should use color conversion software (e.g., Photoshop) to convert the data into sRGB using your up-to-date monitor profile as a source profile and the sRGB profile as destination profile. If you do not know how to do this, carry out the following instead: Rerun your monitor calibration system and choose an sRGB setting if possible, or at least set the target gamma to 2.2 and the white point to D65 (or 6500 K).

Summary

To summarize, there are two ways to achieve the required sRGB based color data. The first one is to put the computer and monitor in a state where it approximates sRGB. In this case, you can take any color data as perceived on the monitor as valid. The second way is to leave the computer/monitor as it is, and to have a valid color profile available. Prepare all the color data so that you are happy with them. Afterwards, use the monitor profile as source profile and sRGB as destination profile and convert the data into sRGB.

Color Expert Level

We assume that you know how to convert color data into sRGB. If in doubt, follow the guidelines for non-color experts. We recommend that all color images have the sRGB profile embedded. Do not use color spaces different than sRGB even if embedded profiles in principle allow for this: Many web browsers or PDF viewers may not support embedded profiles, hence display and print quality may be compromised.

Color Plate Appendix

If you feel that sRGB limits your color data unacceptably, there is the option to include an appendix of color plates, which will not appear in the published paper version of the journal, but will be available as Supplemental Material on the IS&T website. For these color plates you can use any color space that can be described by a matrix profile (do not use LUT profiles!). It is mandatory that every image here has the respective profile embedded. You can replicate any image of the main text in the color appendix, and also add further images (at the discretion of the Editorial and Production Staff). You should add a description of how the images have been prepared, and what the reader should do in order to achieve an appropriate reproduction, i.e., specify the rendering intent. If the color space is large, an appropriate reproduction may be possible only on a monitor, or on a specific type of large gamut printer, etc. Let the readers know this.

Readers' Guidelines

All color images in the main body of every paper have been prepared for sRGB.

Monitor Viewing of Color Articles

The best way to enable faithful viewing of color images in articles is a calibrated display with a properly installed monitor profile. If you possess a monitor calibrator, make sure that the monitor is properly calibrated and profiled. If not, and you have a Mac, nothing else is required; just make sure that the monitor settings are somewhat reasonable (white does not look pink etc.). If you don't have a monitor calibrator and you have a PC, follow the guidelines in the section above, "Simple Guidelines for Achieving sRGB-like behavior on PCs."

On the Macintosh, most known PDF viewing software (including Preview and Acrobat) obeys embedded color profiles. In Windows, Acrobat also supports profiles, and makes use of monitor profiles, but defaults to sRGB if none has been installed on the system.

Printing of Color Articles

Printing color is less predictable than displaying color on a monitor. Depending on the printer type, paper, inks, printing speed, driver settings, etc., quite different results may occur. Though printer profiling can correct deviate color behavior, it cannot perform magic given sometimes very limited color gamuts. Hence, if color quality is essential to an article, make sure that you use a good printer with reasonable inks, quality coated paper, and high-quality driver settings.

If you know how to profile a printer, make use of this capability. Otherwise we recommend using the default settings of the printer driver, which should lead to reasonable results, since most printer manufacturers assume, more or less, an sRGB color space for the source data, i.e., the color space for which the article images have been prepared.

If the author(s) have included a color plate appendix with specially prepared images (larger color gamut etc.) they should also have provided special guidelines to get to the desired result, e.g., by specifying the rendering intent. These color plates are usually intended for experts who should strictly follow the authors' directives, and employ color management.

Appendix

To check if your system obeys color profiles, the following site provides a test document with a simple test to see if a PDF viewer supports embedded profiles: http://www.color.org/version4ready.html.

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