Light-emitting diodes bring dazzling color purity and calibration control to LCD display technology

Best...LCD...ever

These are difficult times for imaging professionals looking for the ultimate color reference display system. In the past, Barco, Sony and a few other manufacturers made CRT display systems capable of highly accurate color reproduction. These reference displays had robust tools for calibration and profiling to ensure accurate color rendition in such applications as Adobe Photoshop.

By now, LCD displays have all but replaced CRTs in the marketplace, even though LCD technology hasn't equaled the color matching abilities of high-end CRT technology. Yet LCDs do have some advantages over CRTs, such as the ability to produce sharp, flicker-free images and significantly higher luminance. The latter is important because luminance target values for display calibration (measured in nits or Cd/m2) should be based on the ambient conditions in which the display is used. Having high luminance means that LCD displays don't need to be used in the typical dim environment required for CRTs, with the extra benefits of a reduction in user eye strain, the size of the display and the heat it emits.

On the other hand, LCD technology does have limitations when it comes to calibrating and profiling. There are two basic processes of display calibration. One is to alter the display electronics using controls that physically affect the signal. The other process is to alter the image data values inside the graphic card by modifying the graphic card LUT (or CLUT: Color Look-up Table).

Unlike CRTs, LCDs have few options for making physical adjustments. Most LCDs offer control over only the intensity of the backlit light source, a cold cathode fluorescent lamp (CCFL). Many LCDs have on-screen controls that appear to apply other kinds of color adjustments, but often these use 8-bit precision lookup tables to modify the graphic card rather than adjusting the display hardware. This method almost always produces data loss that manifests as aliasing (or banding) in smooth areas of the onscreen image, a problem common with LCD displays. This makes it particularly difficult to determine if such banding is the result of the display system or in the image itself.

The new LCD 2180 WG LED

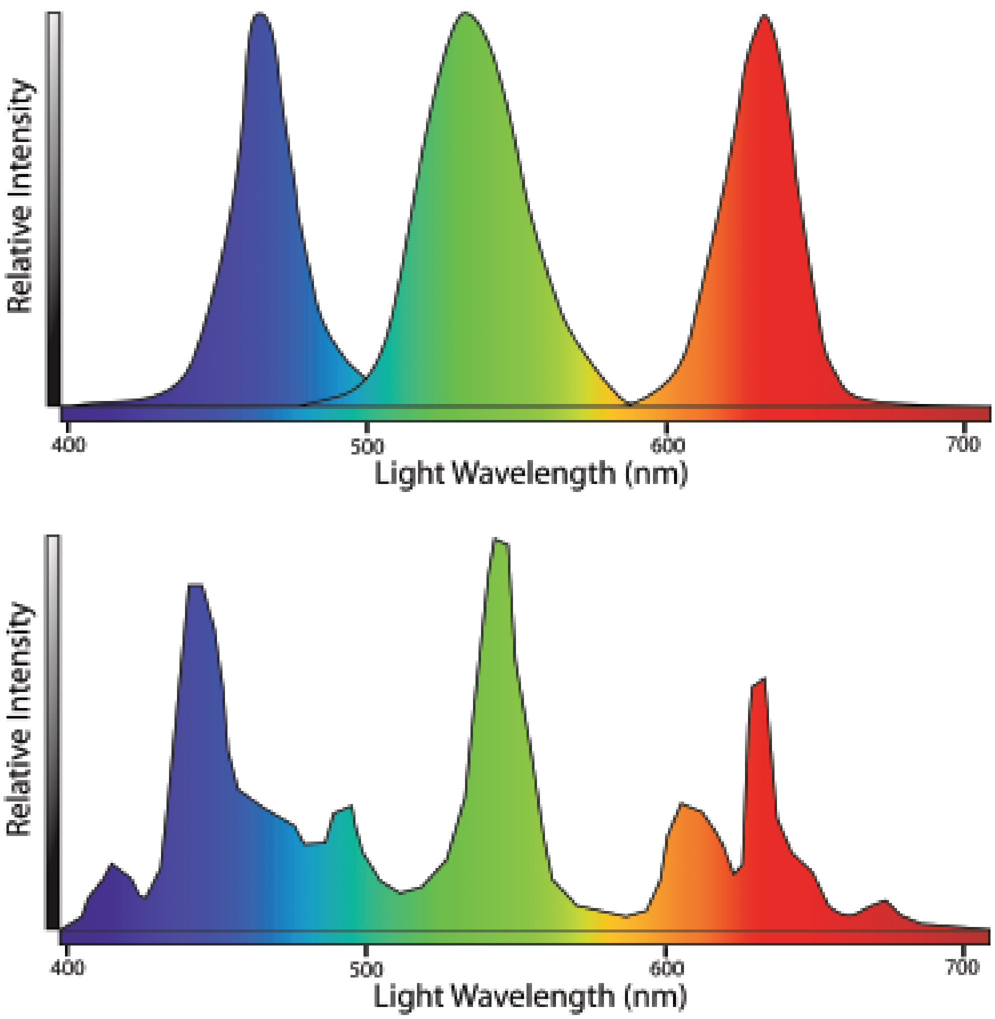

Figure 1: A spectral representation of the LED light source (top) compared to that of CCFL.

display from NEC addresses many of these shortcomings by replacing the CCFL light source with light emitting diodes (LEDs). This new technology produces many benefits, including a color gamut much larger than the sRGB gamut of nearly all displays. The NEC 2180 WG LED has a linear array of 48 individual LEDs, providing enormous control in creating a very pure form of white light. The array has alternating green, blue, green, red LEDs; the resulting white light passes through a light guide and curve mirrors to provide illumination, taking the place of the CCFL. A sophisticated cooling system constantly monitors the display and keeps the unit at optimal operating temperature.

Figure 1 shows how LEDs produce impressively pure light, as well as the extended color gamut. The gamut of the LCD 2180 WG LED exceeds that of Adobe RGB (1998)! Working in such a large color space means photographers can view every color in their images that can be contained within this color space. There's at least one other LCD manufacturer producing a wide-gamut LCD display using fluorescent backlighting, but LEDs have a number of technological advantages. First, the spectrum of fluorescent light is far from ideal, producing unwanted colors that require filtration, and that results in reduced luminance. **Figure 2** illustrates another reason such a wide gamut is possible with a comparison of the display's gamut to Adobe RGB.

Each of the three LEDs used to produce white light can be individually adjusted to produce a desired white point. This is similar to how the individual RGB electronics in CRTs could be adjusted to alter the white point calibration, something impossible to do with CCFL LCDs.

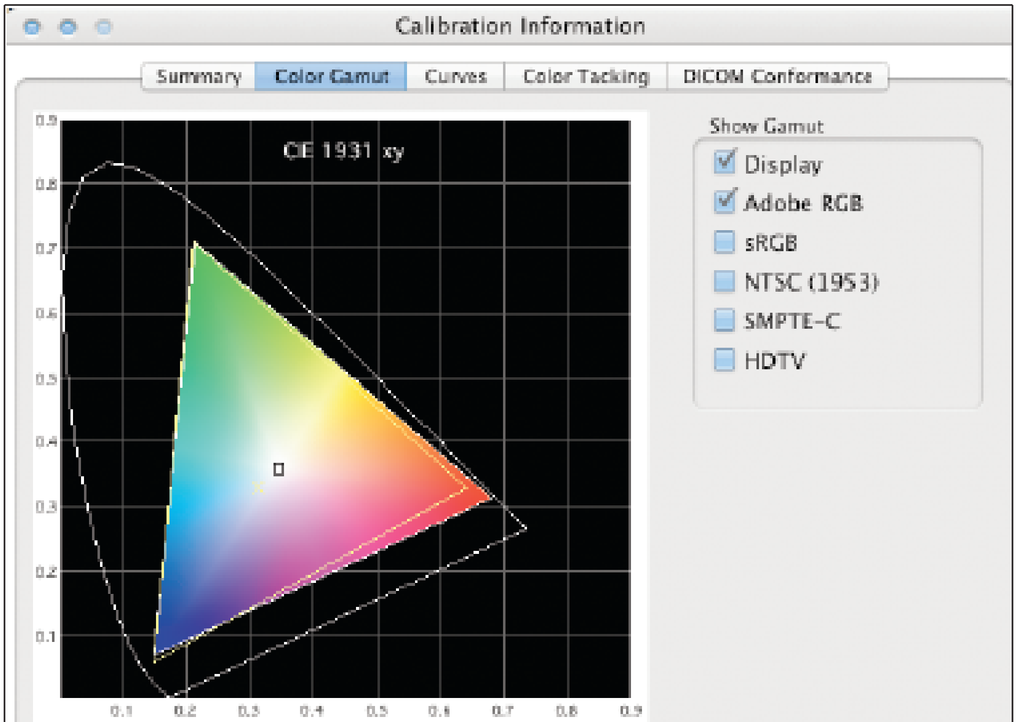

Figure 2: The SpectraView II software plots the gamut of the NEC 2180 WG LED over that of Adobe RGB (1998).

With these, the adjustments must be made at the graphic card by using a lookup table, or internally in the LCD itself. For adjustments other than white point setting, the NEC display has a 10-bit internal lookup table (in reality, the data is 8-bit to 10-bit and back to 8-bit like other "high bit" LCD displays).

Since the internal LUTs are used only for curve correction, not white point adjustment, there's far less data loss than with wide-gamut CCFL displays, which apply such corrections in a CLUT. The LCD 2180 WG LED can accept a 10-bit input data path for future functionality, once video manufacturers, operating systems, and applications can support the additional data. When viewing a black-to-white gradient in Photoshop, the result was the smoothest I've yet seen on any LCD, rivaling even the better CRT reference displays.

While the typical life of CCFL is approximately 25,000 hours of use, the LEDs in the NEC display typically have a lifespan of 50,000 hours.

The purity of the LED light source over the entire display is very even, thanks to a number of new technologies. Using the ColorComp correction system along with individual characterization at the factory, this display produces even color purity across the entire screen. This is a monumental technical task considering the generation of the light source using LEDs. When I filled a Photoshop document with gray over the entire screen, I was impressed with both the uniformity and purity of this display.

Typically, LCDs have problems with colors changing appearance when viewed at different angles, especially in gradients made in Photoshop, solid gray documents or neutrals. The problem isn't completely gone in the LCD 2180 WG LED, but the color shifting is greatly reduced, appearing only at extreme angles of view. This is due primarily to the high quality LCD "sandwich" of components that create the screen, not the light source itself.

The NEC 2180 WG LED ships with a modified GretagMacbeth Eye-One Display 2 colorimeter with a specially designed filter set mated for this wide-gamut display. However, the included SpectraView II software supports a number of other third-party colorimeters, such as the X-Rite Optix XR. The software provides a one-push-button calibration solution. Once I set the target values, the display communicates via the DVI display cable with the host software, and sets all the necessary parameters, including white point, luminance, gamma and contrast ratio. This truly makes the LCD 2180 WG LED a "smart monitor," much like the high-end CRT reference displays from Barco and Sony. Calibration is automatic and an ICC device profile is generated and loaded for use by any ICC-aware application. I was even able to set the TRC gamma to native to restrict additional compensation at the graphic card, an option I prefer and use with my Sony Artisan.

Note that a wide-gamut display may not be right for all users. Such a display still must define16.7 million colors like its sRGB cousin, but over a far larger gamut (about four times larger). Very subtle colors might be more difficult to see and edit onscreen. Consider a half-inflated balloon with 16.7 million dots painted on its surface. This is the sRGB display. Now blow up the balloon to twice its size and imagine how the dots move farther apart from one another. This represents a wide-gamut display. Subtle colors that were numerically close to each other are now spread apart, and that could make it challenging to edit such colors as subtle skin tones.

A wide-gamut display does give us more saturated colors outside sRGB, but don't assume it's trouble free. Viewing outside ICC-aware applications, like most Web browsers, the color appearance will likely be unacceptable. Non ICC-aware software treats all images as if they're in a color space resembling sRGB. The LCD 2180 WG LED does have a hardware switch to set the display behavior to mimic sRGB, but using it invalidates the current calibration and the associated ICC profile. There's no way to build a profile for this reduced-gamut behavior. I would like to have the ability to calibrate and profile for this limited color gamut as well as Adobe RGB (1998), and be able to switch on-the-fly via software.

Priced over $6,000, the NEC 2180 WG LED isn't for the budget-conscious user but for those seeking a state-of-the-art wide-gamut LCD reference display. NEC plants a strong stake in the market with this impressive display technology. It is the first LCD display I've used and lusted for, and I'd proudly place next to my old standby, a Sony Artisan. After working with this new LCD, I can say it's stunning, and that it addresses many of my previous concerns about LCD displays. I'm hoping the price will fall over time, as with most digital imaging technology. ■

NEC has posted an excellent PDF on this display technology at http://www.necdisplay.com/products/LCD2180WGLED_Techpaper.htm