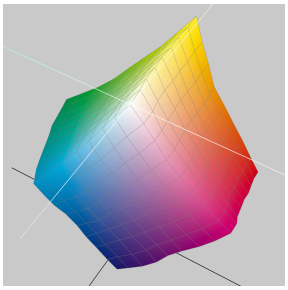
week::six
Introduction to Color Management & LAB

Understanding Device Dependency

Device-Dependent Color



- A digital representation of color that is tied to a specific device.
- Every device has a different **color gamut**—that is, the range of colors a device can read, create, or display.
- Examples:
  - RGB on a computer monitor, TV, or projector (think of the different appearances of color on all those TVs at an electronics superstore, or the monitors in the lab).
  - CMYK when printing (think CMYK for the VC Color print vs. inkjet printer). CMYK values will look different on different printers and different paper..

Device-Independent Color

- A method of storing color information that represents *absolute color*.
- When given a color number in a device-independent color model, that color will *always* be the same, regardless of other factors.
- **LAB** is the leading device-independent color model.
- All color must be converted to a *device-dependent* color model for viewing by using a **color lookup table**.
- *Speaking of LAB, how about a quick sidebar...*

Understanding the LAB Color Model

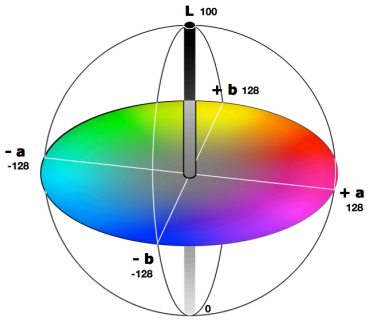
Origins

- Developed in 1976 by CIE (International Commission of Lighting)
- Also called CIELAB or L*a*b
- Technically speaking, you pronounce it L-A-B (like RGB or CMYK), though it is often called just “lab” as in “laboratory”.
- Acronym meanings:
  - L = Lightness/Luminosity
  - a = Simply means the “a” channel; it has no special meaning
  - b = Simply means the “b” channel; it has no special meaning

Key Features

- **Color** and **contrast** are separated completely.
- Conversion to and from LAB is (mostly) **lossless**.
  - You don’t pay for converting into this color model.
  - CMYK, on the other hand, is a “lossy” model to convert into due having a much small color gamut than RGB or LAB.
- Color gamut is **huge**.
  - This allows for both real and *imaginary* colors.
- LAB is a **device-independent color model**
  - When given a color number in a device-independent color model, that color will *always* be the same, regardless of other factors.
  - All color must be converted to a device-dependent color model for viewing via a color lookup table.

LAB Components



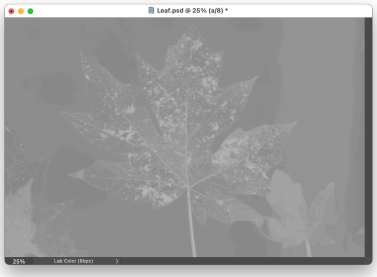
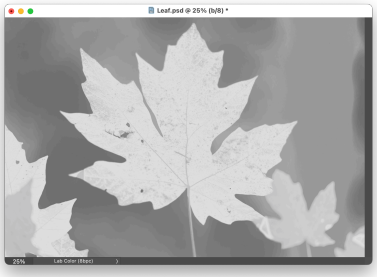
The L Channel

- Contains only **luminance** information.
- Is essentially a grayscale version of the image
  - However, it tends to be somewhat lighter than an actual grayscale version.

The a and b Channels

- Contain only **color** information.
- They are **opponent color channels**.
  - As you increase the intensity of one color, you decrease the intensity of the other.
- The **a Channel** controls the color range between **Magenta** and **Green**.
- The **b Channel** controls the color range between **Yellow** and **Blue**.

Example LAB Channels

		
L Channel	a Channel	b Channel

By the Numbers

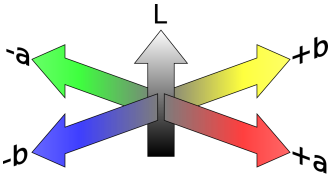
Nomenclature

- First off, LAB uses negative numbers (yikes!), with negative numbers in parenthesis.
- Example: 86L 9a (4)b

L Channel

- Ranges from **0 to 100**.
  - 0 is absolutely black
  - 100 is absolutely white
- The L channel does not have negative numbers.

a and b Channels



- Ranges from **(128) to 127**
- **0 is a valid value** and is **neutral in color**. (50 in L)
- 1–127 == Lighter gray in channel (0–49 in L)
- (1)–(128) == Darker gray in channel (51–100 in L)
- One way to think of the color channels:
  - Positive numbers == Magenta/Yellow/Red == Warmer colors
  - Negative numbers == Blue/Green/Cyan == Cooler colors

Ok, now back to color management and ICC Profiles...

How ICC Digital Color Management Works

Color Look Up Tables (CLUT)

- Lists of numbers that translate one color space into another.
- Based on real-world measurements and tests.
- Can be produced by a user with software (tedious) or downloaded (for most devices).

Central, theoretical color space (LAB) used as an intermediate space

- Requires that each device have a CLUT to and/or from LAB color.
- More efficient than device-to-device CLUTs because you only need one for every device instead of one for each device pair.
- LAB is a good intermediate space because it encompasses all perceivable colors.

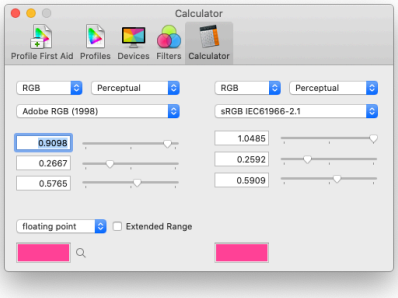
Working with Color Spaces

Overview

- Color spaces are a mathematical representation of the range of a real-world color device.
- Color spaces directly map colors in an image to colors of an input or output device.
  - Scanners, monitors, mobile devices, TVs, and printers have unique color spaces, though some attempt to share one in common.
- In essence, they apply real-world constraints on color models like RGB and CMYK.

Two Key Color Spaces

- **sRGB**:
  - A narrow-gamut color space for computer monitors, TVs, etc.
- **Adobe RGB**
  - A wide-gamut color space for prepress photo retouching and editing.
- Both of the spaces use the RGB color model, but produce different results for the same color number. This makes RGB a **device-dependent** color model.
- The screenshot is from Apple's ColorSync utility. Note how a color has different numerical output values, depending on which color space is used.



Two Other Color Spaces

- **P3**
  - Began as a color space for digital cinema projection
  - Similar in gamut to Adobe RGB, but does not cover as many of the key colors used in offset printing.
  - Used frequently by Apple for their built-in screens, including iPhones, iPads, and our lab iMacs.
- **ProPhoto RGB**
  - Somewhat new, and not used very often in graphic design.
  - Extra-wide gamut, encompassing 90% of the colors in LAB.
  - Used primarily by photographers outputting to wide-gamut output devices (multi-ink inkjet).
  - 13% of the colors are imaginary colors that do not exist!

Use with RAW Images

- RAW camera images can be assigned a profile while developing, applied once the image is exported or opened directly into Photoshop.

Color Management Strategies

- If you don't want to think about color management, use **sRGB**.
- If you know your print or digital workflow supports other, wide-gamut color profiles, then you can use profiles like **Adobe RGB** or **ProPhoto**.

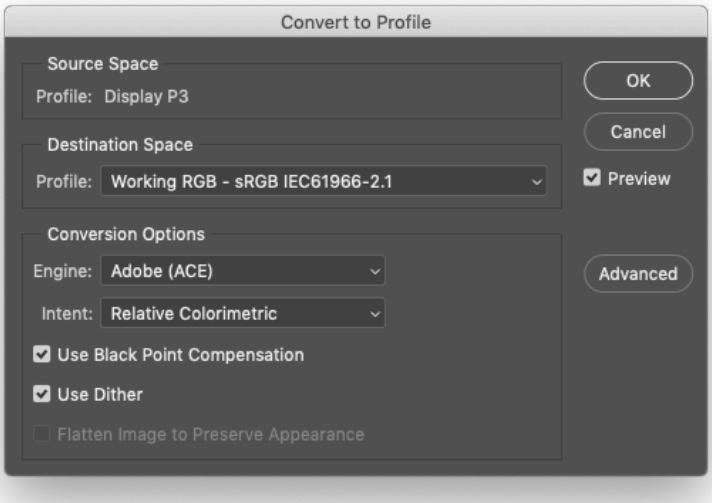
Conversion in Photoshop

Edit > Assign Profile...

- To begin managing a non-color-managed image.

Edit > Convert to Profile...

- To permanently convert a managed image from one space to another.
- This is the option used most-often, as almost all recently-generated images have an embedded color profile.



Retaining Profiles when Saving

- Be sure to include a color profile whenever saving or exporting an image.