Color Management Fundamentals
Wide Format Series

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Session overview

• Color management fundamentals, including basic color theory and management terms
• Get the best out of all of color technologies, regardless of the technology type
• Focus today on printing, with an emphasis on some wide format printing considerations
• Take a quick poll
Topics to be covered

- Color management defined
- Color space
- Color accuracy and Delta-E ($\Delta E$ or $dE$)
- Device dependent and device independent color
- Gamut
- Rendering intents & black point compensation
- Color transforms
- Calibration & profiling
- Spot colors
What is color management?

And why do we need it?
Color management is...

- A process, not a task
Color management is...

- A process, not a task
- Ensures color fidelity between devices
Color management is...

- A process, not a task
- Ensures color fidelity between devices
- Limited by each device
Color management is...

...like making toast...

by Steve Upton
Color management is...

...like making toast...

by Steve Upton
Color management is...

...like making toast...
Color management is...

...like making toast...
Color management fundamentals

Basic terms
Color space (L*a*b*)
Color space (L\*a\*b\*)
Color space (L*a*b*)

-128 0 +127

b*
Color space (L*a*b*)
Color space (L*a*b*)
Color space (L*a*b*)
Color inaccuracy

- Hue - color
- Chroma - saturation
- Luminance - brightness
Hue

Cooler  Actual  Warmer
Color
Where is your color?

Hue: 0
Saturation: 0
Lightness: 0
Hue

- Hue
- Saturation
- Lightness

L* = 100
White

L* = 0
Black

Gray

Red

Yellow

Green

Blue

- a*
- b*
- -a*
- -b*
Hue
Chroma - Saturation

Less Saturation

Actual Color

More Saturation
Chroma or Saturation

L* = 100
White

L* = 0
Black

a* = Red

-b* = Blue

-a* = Green

b* = Yellow

Gray
Chroma or Saturation

L* = 100
White

L* = 0
Black

-a*
Green

-a*
Red

-a*
Gray

-b*
Blue

-b*
Yellow

Hue: 0

Saturation: 0

Lightness: 0
Chroma or Saturation

- Chroma or Saturation

- L* = 100
  - White
- L* = 0
  - Black
- a*
  - Red
- b*
  - Yellow
- -a*
  - Green
- -b*
  - Blue

Hue:

Saturation:

Lightness:
Luminance

Darker  Actual Color  Lighter
Where is your color?

L* = 100
White

L* = 0
Black

b* Yellow

-a* Green

-b* Blue

a* Red
Where is your color?
Delta-E or $\Delta E$ or De
Device dependent color
Device dependent color

R = 201
G = 5
B = 2

R = 206
G = 3
B = 7
Device dependent color

CMYK = 1/84/95/2

CMYK = 5/93/88/0

CMYK = 0/97/90/8
Device dependent color

CMYK = 1/84/95/2

L*a*b* = 56/95/54
Gamut
Gamut
Gamut
Gamut
Gamut
Gamut
Color space
Color space

SWOP vs. GRACoL
Color space

SWOP vs. GRACoL vs. Inkjet
Color space

SWOP vs. GRACoL vs. Inkjet vs. Adobe RGB
Color space

SWOP vs. Toner vs. Inkjet
Gamut

Larger

Smaller
Gamut

Larger

Smaller
Spot colors
Spot colors – Pantone Bridge
Color management application

Decision time
Rendering intent

Larger Gamut

Smaller Gamut

In-Gamut Colors

Out-Of-Gamut Colors

1 3
2
6
5 4
Perceptual
Perceptual
Perceptual
Perceptual
Perceptual
Perceptual
Perceptual
Colorimetric
Saturation
Colorimetric – relative vs. absolute

Newsprint
Relative Colorimetric

Newsprint
Absolute Colorimetric
Banding

Original
Banding
Banding

- Original
- Perceptual
- Colorimetric
Banding

Original

Perceptual

Colorimetric
Black point compensation
Black point compensation

Possible $L^*$ Densities for Standard $L^*a^*b^*$ Colorspaces

- $L^* = 84$ (Newsprint)
- $L^* = 93$
- $L^* = 100$
- $L^* = 35$
- $L^* = 4$
- $L^* = 0$

Inkjet
Adobe RGB
Black point compensation
Black point compensation
Graphic program defaults
Graphic program defaults

- **Working Spaces**
  - CMYK: U.S. Web Coated (SWOP) v2

- **Conversion Options**
  - Engine: Adobe (ACE)
  - Intent: Relative Colorimetric
  - Use Black Point Compensation
Assigning vs. converting

Color Settings...
Assign Profile...
Convert to Profile...

Embedded Profile Mismatch

The document "Nikon.tif" has an embedded color profile that does not match the current RGB working space.

Embedded: Nikon LS-3510 AF
Working: ProPhoto RGB

What would you like to do?
- Use the embedded profile (instead of the working space)
- Convert document's colors to the working space
- Discard the embedded profile (don't color manage)

Source profiles:
- RGB: AdobeRGB1998.icc
- Rendering intent: Perceptual
- CMYK: ISOcoated.icc
- Rendering intent: Relative colorimetric with black point com...
Assigning vs. converting

**Assigning** = Change the way the image looks/prints

**Converting** = Keep the look the same
Assigning vs. converting

Assign = Not the same taste

1 Tb. = 1 Tb.
Assigning vs. converting

Convert = The same taste

1 Tb. = 4 Tb.
Assigning vs. converting

Original Color in GRACoL
23/92/53/17
40/50/14
Assigning vs. converting

Original Color in GRACoL

Assign SWOP 5
Assigning vs. converting

Original Color in GRACoL
23/92/53/17
40/50/14

Assign SWOP 5
23/92/53/17
41/51/10

Convert SWOP 5
24/93/61/19
40/50/14
Converting

GRACoL

SWOP
Assigning vs. converting

Assign

Convert

Assign

Assign
Calibration and profiling

Controlling your color
Calibration

- Calibration is *active*
Calibration

- Calibration is *active*
- Match a device to itself over time
Calibration

• Calibration is *active*
• Match a device to itself over time
• Bring to a repeatable state
Calibration

- Calibration is *active*
- Match a device to itself over time
- Bring to a repeatable state
- Tuning the guitar
Calibration

• Sometimes called “linearization”
• Linearization is only one part of calibration
Calibration – cameras

- Shutter speed
- Aperture
- White/gray balance
Calibration – monitors

- Brightness
- Contrast
- White point
Calibration – output devices
Calibration – output devices

- Per channel ink/toner limits
- Per channel linearity
- Total ink/toner limit
- Ink gray balance

- Usually through the use of a RIP
Calibration – output devices

- Per channel *ink* limits
Calibration – output devices

- Per channel *ink* limits

![Diagram showing ink limits with wet and dry states]

No additional saturation

No additional saturation
Calibration – output devices

- Per channel *ink* limits

- Wet: 92%
- No additional saturation: 89%
- No additional saturation: 96%
- Wet: 81%
Calibration – output devices

- Per channel linearity (ink or toner) [75%]
Calibration – output devices

- Per channel linearity (ink or toner)

25% - 75%
Calibration – output devices

- Per channel linearity (ink or toner)

<table>
<thead>
<tr>
<th>25%</th>
<th>Non-Linear</th>
</tr>
</thead>
<tbody>
<tr>
<td>75%</td>
<td>Non-Linear</td>
</tr>
</tbody>
</table>
Calibration – output devices

- Per channel linearity (ink or toner)

- Non-Linear: 75%
- Linear: 50% to 75%
Calibration – output devices

- Total *ink* limit

![Graph showing total ink limit from 280% to 400% with no darker indicated at 350%, 360%, 370%, 380%, 390%, and 400%]
Calibration – output devices

- Total *ink* limit

![Bar chart showing ink limit percentages from 280% to 400% with 340% marked as TIL (Too Intense Light) and no darker sections indicated.]
Calibration – output devices

- **Total ink limit**

![Diagram showing ink limits from 280% to 400% with湿 (Wet) and No darker annotations. The 340% limit is highlighted with a red circle.](image-url)
Calibration – output devices

• Total *ink* limit

280% 290% 300% 310% 320% 330% 340% 350% 360% 370% 380% 390% 400%

No darker

280% 290% 300% 310% 320% 330% 340% 350% 360% 370% 380% 390% 400%

Wet

280% 290% 300% 310% 320% 330% 340% 350% 360% 370% 380% 390% 400%
Calibration – output devices

- *Ink* gray balance

![Poor gray balance](image-url)
Calibration – output devices

• *Ink* gray balance

**Poor gray balance**

**Questionable gray balance**
Calibration – output devices

• *Ink* gray balance

- Poor gray balance
- Questionable gray balance
- Good gray balance
Profiling

- Profiling is *passive*
Profiling

• Profiling is \textit{passive}
• A snapshot of the device characteristics
Profiling

CMYK
L*a*b*
0/100/66/0
61/127/105
0/51/24/0
73/36/13
66/36/24/0
55/-10/-18
92/0/81/23
46/-55/16
0/0/0/30
78/0/0
Profiling

CMYK = 0/100/66/0
L*a*b* = 61/127/105

CMYK = 1/84/95/2

0/100/66/0

0/97/90/8

L*a*b* = 61/127/105
Color management is...

...like making toast...

[Diagram showing color management process]
Session summary

• What we learned
  – Basic color management concepts apply to getting the most out of all types of color technologies
  – Take charge of your color management setting and options
  – Color management is not a single task, rather a complete process

• To learn more, we have some resources for you
Additional resources

- [www.efi.com](http://www.efi.com)
  - ABCs of Color
  - Rendering Intent
  - Black Point Compensation articles
- [www.colorwiki.com](http://www.colorwiki.com)
  - Glossary of color terms
- [www.xrite.com](http://www.xrite.com)
  - Complete Guide to Color Management
  - A Guide to Understanding Color Communication
  - The Color Guide and Glossary
Additional World of Fiery sessions

• **May 27 – Color Management Fundamentals**
  • Learn the foundations of color theory and management to get the most from your design software and color technologies.

• **June 17 – Color Standards & Specifications**
  • Gain knowledge of the latest industry standards and how they apply to wide and superwide format printing and proofing.

• **July 8 – Color Management Inside Fiery XF & Fiery proServer**
  • Put your knowledge into practice and understand RIP-level color controls.
  
• Production Series for wide format printing starting this September, you can register your interest for these on the World of Fiery Webinars [home page](#)
Color management fundamentals

Questions?
Color management fundamentals

Thank you!