Color Management Fundamentals

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Agenda

- 12:00 – 13:30 Basic stuff
  13:30 – 13:45 break
- 13:45 – 15:15 ICC profiling and G7
  15:15 – 15:30 break
- 15:30 – 17:00 The prepress workflow
  ➔ 17:00 end / bonus material? (bar?)

Content (time permitting) D = demo

- Theory
  Light, color and vision
  Measuring & viewing color
  Printing = photography
- ICC principles
  Display profiling D
  Input (camera) profiling
  Output (printer) profiling D
- Pressroom
  G7® calibration D
  Standardized printing (GRACoL®, etc)

- Extended Gamut Printing
  Hard-copy proofing, validation D and tolerances
- Pre-press
  Soft proofing D
  Workflow / software settings
  Converting / assigning
  Rendering intents
  Handling supplied files & proofs
  Spot colors / CxF
  RGB color editing
- Secrets of success

What is Color Management?

- Controlling color by science instead of trial-and-error
- Goal: consistent color appearance

Pointers to related sessions

- Color – coded by track
- Military time (fighting bad color)

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Main color management goal

Match the appearance of an image, product, brand-color etc. from concept to output.

Why do we need color management?

- Agencies, brands, everyone wants consistent color, regardless of source or destination.

Main limitation: color gamut

Before color management

After color management (note device gamut limits)

Color is color management NOT?

- A perfect science
- A guarantee of perfection
- A cure for unpredictable devices

Key color management concepts

- Color management is based on measuring color
- Color measurement is based on human vision
- Color appearance is controlled by ICC profiles
- Profiles make color “match” on different devices
  - Or as near as possible
- Main limitations: color gamut / device variations

Elevator pitch for creatives

- Custom-profile EVERY monitor
- Use the right software color settings
- Edit images in RGB, not CMYK
- Always embed the ICC profile
- Always accept the embedded ICC profile
- Only view color in standard D50 lighting
But first, a little theory

- Light and color basics
- Human vision – how we see color, and how did they find out?
- Measuring color in units that match what we see
- How viewing conditions can dramatically affect what we think we see
- How printing and photography are really the same

Light, color and vision

White light contains all colors

The eye only "sees" Red, Green, Blue

The eye only "sees" RGB

RGB are the "primary colors" of vision
RGB mixtures can produce any color

RGB lights are ADDITIVE

Different ratios of RGB add together to produce an infinite range of colors.
CMY inks are SUBTRACTIVE

CMY inks subtract R, G or B from white light

Cyan subtracts red from white light

Magenta subtracts green from white light
Subtractive color mixing

Yellow subtracts blue from white light
Magenta subtracts green from white light
Cyan subtracts red from white light

Defining Color Vision (CIE*)
*Commission International de l’Eclairage (international commission on illumination)

CIE color vision experiments (1920s)

Visual matching functions
Amount of RGB light needed to match each reference wavelength

XYZ comes from rho, gamma, beta

CIELAB comes from CIEXYZ

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**L*a*b** is a "3D color space"

**L** (lightness axis)

**a** (red – green axis)

**b** (blue – yellow axis)

**a**, **b**? – just remember fruit

**CIELCH** – more intuitive
Where did LAB and LCH come from?

Color science is vision science

- Angle of view affects color
- Original CIE tests analyzed central 2° of retina

Angle of view affects color

- Later work used surrounding 10°
  - Slightly different results
- So there are two CIE "standard observers", 2° and 10°

How "standard" is your eye?

- We all see color slightly differently
- Color blindness is simply an extreme example
- All color workers should pass a color vision test

Human vision is not constant

- Varies dynamically due to ...
  - Mood
  - Memory
  - Personal preference
  - Adjacent colors
  - Ambient lighting
- etc.

Key variable: chromatic adaptation

- The human visual system's ability to compensate for changes in illumination color
  - Similar to camera "auto white-balance"
Measuring Color

Expressing what we see in numbers

- Measure an object, printed sample, color swatch, monitor – anything we can see
- Convert the visual experience into numbers

Standard units (e.g. LAB) can be used to:
  - Build an ICC profile
  - Check color accuracy
  - Specify a desired color, independent of process

Color measurement

- Color measurement would be impossible if we didn’t understand how we see color
- It’s all based on human vision

Colorimeters (inexpensive)

- 3 colored filters (approximating XYZ)
- Typical use – monitor profiling
Spectrophotometer
- About 32 spectral samples per reading
- More accurate and powerful (and expensive)
  Typical uses: print calibration & characterization (profiling)

Barbieri LFP  X-Rite i1Pro2  X-Rite i1Sis  Konica Minolta FD9

Spectro-densitometer
- Hand-held measurements of density, LAB Delta E, etc.
- Typical uses: print calibration and process control

Konica Minolta FD7  X-Rite eXact  Techkon SpectroDens

Imaging spectrophotometer (?)
- Imaging spectrophotometers: the wave of the future

Monday, 16:00 Standards

Standard measuring illuminants
- M0
  Legacy - unspecified UV content
- M1
  Matches D-50 (via software)
  shows fluorescence & OBAs
- M2
  UV-cut filter (hides fluorescence)
- M3
  M1 with polarizer (which cuts UV)

Measuring Color Error
How close are two samples?

Measuring error (Delta-E)
- Difference between achieved and desired color

Printed L*a*b* (reproduction)
Desired L*a*b* (reference)
**Delta E (ΔE\textsubscript{76})**
- Derived from CIELAB: 
  \( (\Delta L^2 + \Delta a^2 + \Delta b^2)^{1/2} \)
- Distance between two points in 3D Lab space

**Problems with Delta E\textsubscript{76}**
- Not "perceptually uniform"
- A proof might fail when it's visually acceptable
- Especially if the error is in chroma (saturation)

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**Delta E 2000 (ΔE\textsubscript{00})**
- Different equation in different color regions
- More visually uniform
- Better correlation to human vision
- Less sensitive to chroma errors

**Why ΔE\textsubscript{00} is better**
- Reference Measured

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**ΔE\textsubscript{76} (fail) vs ΔE\textsubscript{00} (pass)**
**Minimum visible Delta E**

- ΔE 1.0 = theoretical limit of perception

**Minimum visible Delta E**

- ΔE 1.0 = theoretical limit of perception

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**Viewing Color**

Illuminant spectrum affects color

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**Standardized viewing**

D50 defined by ISO 3664:2009
the only ‘standard’ way to view color

*NOTE: D50 is not the same as 5000°K*
(The Kelvin scale does not apply to fluorescent lights)

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**D50 vs. 5000°K**

- D-50 (Daylight)
- 5000°K (blue-filtered tungsten)

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**Metamerism failure**

Meat section D50 Office
D50 vs. typical office lighting

Printing is Photography
How color printing evolved out of color photography

“Color separation” principles

First tri-color color printing (1893)
- RGB camera separations direct from the subject
- Printed with "red", "blue" and yellow ink (no black)
  (Probable restoration)

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Traditional enlarger color separation
Separation negatives
- Cyan
- Magenta
- Yellow
- Black
Why add black to CMY?

- 100% C+M+Y doesn’t = black
  Due to inefficient “ink trapping”
- Increasing CMY densities just makes colors dirty
- Black ink adds shadow contrast
  Not possible with CMY

Slide film

- Makes “black” with just 3 CMY dyes

Photographic paper

- Makes “black” with just 3 CMY dyes

Offset lithography

- Equal CMY makes a muddy brown

Offset lithography

- Gray balance helps, but “black” is still gray

Offset lithography

- Adding black ink makes shadows “rich black”
Ideal inks

Typical real-world inks

Ideal vs. real-world inks

Basic ink-correction concept

- Reduce M & Y where Cyan prints
- Reduce C & Y where Magenta prints
- Reduce M & Y where Yellow prints

Original scene

No ink correction
Scene vs. no ink correction

Original scene | No ink correction

Scene vs. ink correction

Original scene | Maximum ink correction

No correction vs. ink correction

No ink correction | Maximum ink correction

Traditional ink correction methods

- Local darkening lightening of CMYK films or plates
- Dyes, acids, brushes, scrapers, years of skill
- Camera-back "masking"
  - Low-contrast positive films registered over RGB negatives
- Electronic scanners
  - Hardware-based "color computers" to automate the masking process

Hell C296 drum scanner (1968)

- Mechanical enlargement
- Analog "color computer"
- Volt meter
- Really cool oscilloscope

ICG digital scanner (1984)

- World's first color-accurate "soft proofing"
- Revolutionized scanner setup simplicity
Visual color management

Device-dependent color management

Device-dependent color management

ICC (the better way)
- International Color Consortium
- Initiated by Apple in early 1990s
- First ‘open’ Color Management System (CMS)
- Cross-platform (Mac / Windows / etc.)
- Defines standard color management rules

ICC Color Management

Main goals:
- Constant color appearance regardless of source or destination
- Automated "color matching"
Basic ICC principle

- Device-independent color
- Translating each device into a common ‘color space’ via its own ‘ICC Profile’
- Each profile is independent of all others
- So if one device changes, only its profile is affected

Device-independent color

ICC benefits: efficiency and accuracy

- Custom-made for each individual device
- Convert between device values & CIELAB

The Profile Connection Space (PCS)

Device-independent profiles

- Custom-made for each individual device
- Convert between device values & CIELAB

The Profile Connection Space (PCS)
**Conversion principle**

- **RGB pixels**
- Different pixel values, same color
- **CMYK pixels**

**The Device-Link-Profile (DLP)**

- Expert-level option
- Faster processing
- Special CMYK rules
- Same result as joining two regular profiles

**ICC profiling sequence**

- Stabilize* the system
- Calibrate
- Characterize
- Create the profile

*IMPORTANT: Calibration and color management will seem to fail if the system is unstable

**Display profiling**

Workstation monitors, still / cinema projectors

**Display profiling principles**

- baslCColor display
  [www.basicolor.de](http://www.basicolor.de)
- Spyder 5 Pro
  [www.datacolor.com](http://www.datacolor.com)
- i1 Display Pro
  [www.xrite.com](http://www.xrite.com)

**Good, cheap display profiling**
Self-profiling wide-gamut monitors

- EIZO
- NEC
- ASUS
- BenQ

Ideal color-critical monitor features

- Wide color gamut (100% Adobe RGB)
- Good cross-screen uniformity
  - With uniformity correction tool
- > 10-bit LUTs (better smoothness)
- High dynamic range (rich blacks)

Typical high-end monitor gamut

- LCD / LED monitors are very stable
  - One profile can last its lifetime
- Little need to re-profile
  - Re-profiling can cause variations!
- But check monitor settings daily!

Monitor profiling frequency?

- Avoid 1-chip DLP projectors; 3-LCDs are best
- Display screen test (free at HutchColor.com)
- Find optimum mode (usually “cinema” or “film”)
- Adjust hardware contrast and brightness
  - To avoid clipping or plugging
- Either select PC/Mac profile for best “look” (sRGB or Adobe RGB)
- OR make profile with gamma 2.2, white point “native”

Free monitor test image (www.hutchcolor.com/Images_and_targets.html)
Single-chip DLP – kills color

Clipping and plugging

Quantization (banding or “posterization”)

Demo: Projector profiling

- Display monitor screen test (free at HutchColor.com)
- Find optimum “color mode”
- Set contrast, brightness for no clipping or plugging
- If Adobe RGB or sRGB are good enough, don’t profile
- Or custom-profile with gamma 2.2, “native” white pt.
- Check for quantization (banding) on gray scale

Input Profiling

Camera, scanner

Scanner profiling
Best input profiling software on Earth

Class-leading features for commercial, fine-art and scientific photographers

Camera profiling (should you?)

- Essential - fine-art reproduction
- Advisable - products & catalogs
- Optional - sport, editorial, portraits

WARNING: camera profiles can be negated by lighting, camera settings, etc.

Camera profiling variables

- Light source spectrum
- Camera settings
- Target design, colorants, measurements, gloss, etc.

Camera re-profiling frequency?

- For general photography ...
  One profile can last a lifetime, if made intelligently
- Fine art repro, medical, catalog ...
  Make a per-session profile

Camera profiling guide

Free (of course) at www.hutchcolor.com

Output Profiling

(Press, proofer, desktop printer, etc.)

Sunday, 14:20 How-to
Monday, 10:00 How-to
**Printer profiling steps**

- Stabilize the system
- Calibrate (e.g. G7)
- Characterize (print and measure a target)
- Create the profile

*NOTE: Calibration and color management will fail if the system is unstable*

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**Printer Profiling Essentials**

- Software
- Measuring device

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**Printer profiling software**

- basiCCColor print
- CoPrA4
- i1Profiler
- basiCCColor.de
- ColorLogic.de
- X-Rite.com

... also Agfa, Heidelberg, Kodak, EFI, GMG, and others

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**IT8.7/5 (a.k.a. TC1617) target**

**NEW!**

- Vertical
- Horizontal

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**Printer profiling workflow**

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**Printer profile software variables**

- Total ink coverage / Total area coverage
- Black start
- Maximum black
- Black shape (Black curve)
- GCR (Black width)
Determine optimum TAC*

*Total Area Coverage
- Look for: Darkest patch (lowest L*) with no show-through (look @ back) or smudging (wet areas)

Gray Component Replacement (GCR)
- Replaces contaminating C, M and/or Y inks with black in dark colored areas
- Saves ink (maybe)
- Reduces color shift in neutral gray areas
- Easier press control
- Black actually increases CMY color gamut!

Black ink adds COLOR !!

Because black = 100c + 100m + 100y

100% “redness” (180 – 80)
20% “redness” (100 – 80)
Output (printer) profile components

- "Forward tag" (A2B)
  Converts CMYK to CIELAB from characterization data
  e.g. proofing source profile

- "Reverse tag" (B2A)
  Converts CIELAB to CMYK.
  Problem: many Lab values are "out of gamut"

Gamut Compression

`CIELAB` diagram

Gamut Compression

Out-of-gamut green

"Nearest" green

Visualizing color gamut

- Chromix ColorThink™

G7 Calibration

How G7 enhances color management
**ICC profiling sequence**
- Stabilize* the system
- **Calibrate** (this is where G7 happens)
- Characterize
- Create the profile

*NOTE: Calibration and color management will seem to fail if the system is unstable

**Calibration defined**
- Bringing a printer to a predictable state
- Pre-requisite before profiling
- Re-calibration should restore the original state

**Traditional (TVI) calibration achieves...**
- Standard TVI (dot gain) curves

**TVI doesn't control tonality**
- Both patches have same TVI but different tonality

**TVI doesn't control gray balance**
- Both patches have SAME TVI

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Because TVI is a ratio of reflectance
Not a direct indicator of "appearance"
**TVI doesn't control gray balance**
- Grays are also affected by other factors like ink hue, trapping, opacity, sequence, etc.

**TVI calibration – inconsistent grays**
- Digital
- Ink Jet
- Offset

**The G7 difference**
- Simple calibration method for ANY printing system
- Produces similar gray balance and tonality regardless of inks, substrate, etc.

**Core G7 concept: curves**
- Gray balance and tonality can be completely controlled just with simple 1-D curves
- G7 standardizes this idea, bringing shared neutral appearance to all printing systems

**Shared Neutral Appearance**
- Digital
- Ink Jet
- Offset

**Why is gray special?**
- It's the one color we can say is "right" or "wrong", simply by looking at it
- Grays appear correct if they match the viewing "white point" (e.g. paper)
Which one is gray? – (easy)

Which one is gray? – (harder)

Which one is gray? – (very hard)

The power of gray balance

How G7 enhances color management

- G7 manages gray balance and contrast at a machine level, without ICC profiles
- G7 calibration produces "pleasing color" without ICC
  Add ICC for maximum color accuracy
- G7 enhances profile accuracy
- G7 reduces the need to re-profile

Printer profiling frequency?

- Check printer accuracy as often as possible
  If drifted, try to restore original conditions (media / hardware)
- Re-calibrate as often as necessary
  If you can't restore original condition, re-calibrate to G7 and the profile should continue to work well
- Re-profile as seldom as possible
  Beware: re-profiling can cause unexpected changes
Standardized printing
Avoiding custom press profiling

ISO 12647-2 print standard (1994-2013)
- Defines ...
  - ink color
  - paper color and lightness
  - TVI* curves
  *(Tone Value Increase)

The GRACoL project (2004-6)
- Goal: define good commercial printing "appearance" as a standard ICC profile

GRACoL research – take 1
- Follow ISO 12647-2 exactly
- Tests on two offset presses and three laminate proofing systems
ISO result: unacceptable variation

GRACoL research – take 2
- Replace ISO TVI curves with P2P method (now G7)

G7 result: much closer match

GRACoL & SWOP (2006)
- Characterized Reference Print Conditions (CRPC)
  - Standard definitions of “print appearance”
  - GRACoL = commercial offset
  - SWOP = publication offset
  - Common targets to aim for in...
    - Creative, Proofing, Pressroom
  - Both look similar thanks to G7

ISO 15339 - seven CRPCs based on G7
- CRPC 1 cold-set news
- CRPC 2 heat-set news
- CRPC 3 quality uncoated
- CRPC 4 super-calendared
- CRPC 5 pub coated (SWOP 2013)
- CRPC 6 commercial coated (GRACoL 2013)
- CRPC 7 generic large-gamut

ISO 15339 common hue angles
ISO 15339 absolute (with paper color)

ISO 15339 with chromatic adaptation

GRACoL 2013 vs. GRACoL 2006

- Slight change in paper color
  - Aligns with new OBA-brightened papers
- Slight change in solids
  - Insignificant for most users
- Bottom line: almost no difference
  - OK to use either one unless EXTREMELY critical

GRACoL 2006 vs. GRACoL 2013

Extended-Gamut Printing
Going beyond CMYK

Main extended-gamut methods

- CMYK+OGV (or RGB+CMYK)
  - Adds Orange, Green and Violet (or Red, Green and Blue) to CMYK inks
  - Common in packaging (mostly offset and flexo)
- XCMYK
  - Extended gamut method for 4-color (CMYK) inks
**CMYK + OGV basic principle**

OGV

+ CMYK

= CMYKOGV

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**CMYK + OGV gamut**

OGV

+ CMYK

= CMYKOGV

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**New OGV calibration standard – “SCTV”**

- **Spot Color Tone Value**
  - Replaces legacy TVI calibration for spot color inks
  - Calibrates any ink for equal visual steps from 0 to 100%, regardless of screening, print method, etc.
  - Solves non-linear appearance of TVI calibration
  - Simulates how gradients look in Adobe software
  - Perfect for Pantone® and corporate color inks

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**SCTV vs. legacy TVI calibration**

SCTV

TVI

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**XCMYK – pushing the CMYK envelope**

- New 4-color offset printing method, color space and profile developed by Idealliance
- Much larger color space than GRACoL
- No extra plates or inks required
- Compatible with 7-color (CMYK+OGV) printing

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**XCMYK principle**

- More ink = more color
  (Within reason)
XCMYK - why do we need it?

- Extending offset gamut with extra inks (e.g. CMYK+OG or RGB) is expensive, complicated and poorly supported by Adobe software
- Traditionally, printers often increase C, M, Y or K densities to match a product or customer needs
- XCMYK simply standardizes the concept

Reference GRACoL proof

XCMYK

Typical enhancement

XCMYK method

- Print CMYK inks to high densities on good paper
- Use FM (or concentric) screening to enhance pastels
- Calibrate to G7
Typical XCMYK solid densities (status T)

<table>
<thead>
<tr>
<th>Color</th>
<th>Density</th>
</tr>
</thead>
<tbody>
<tr>
<td>C</td>
<td>1.4</td>
</tr>
<tr>
<td>M</td>
<td>1.4</td>
</tr>
<tr>
<td>Y</td>
<td>1.0</td>
</tr>
<tr>
<td>K</td>
<td>1.75</td>
</tr>
</tbody>
</table>

Typical solid CIELAB values

<table>
<thead>
<tr>
<th>Color</th>
<th>L*</th>
<th>a*</th>
<th>b*</th>
</tr>
</thead>
<tbody>
<tr>
<td>C</td>
<td>56</td>
<td>-37</td>
<td>-50</td>
</tr>
<tr>
<td>M</td>
<td>48</td>
<td>-4</td>
<td>75</td>
</tr>
<tr>
<td>Y</td>
<td>89</td>
<td>93</td>
<td>-4</td>
</tr>
<tr>
<td>K</td>
<td>16</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>R</td>
<td>47</td>
<td>68</td>
<td>48</td>
</tr>
<tr>
<td>G</td>
<td>50</td>
<td>-66</td>
<td>26</td>
</tr>
<tr>
<td>B</td>
<td>25</td>
<td>20</td>
<td>-46</td>
</tr>
</tbody>
</table>

XCMYK gamut

XOGV - best of both worlds

XOGV vs regular CMYKOGV

Getting started in XCMYK

- Go to www.idealliance.org
- Download free documentation
- Download free data set
- Download free ICC profile
XCMYK positioning

- "Specialty" printing
  - Requires top-quality equipment and consumables
  - Some operator re-training needed
- Doesn't replace commercial offset (GRACoL)
- Not for all jobs or all printers
- Augments, but doesn't replace, CMYK+OGV

Hard-copy Proofing
And validating proof accuracy

Proofing with ICC profiles

Testing proof system accuracy

- Proof new IT8.7/5 target with full color management
- Evaluate in Curve4 VERIFY (or equivalent software)

G7 verification software (examples)

Individual proof check

- Measure ISO 12647-7 Control Strip* on every proof

*free @ www.idealliance.org
Demo: Hard-copy proofing

- Assign GRACoL2013 to proof test page
  - Containing IT8.7/5
- Edit – convert to profile – (poofer profile)
  - Rendering intent: Absolute (or relative WITHOUT BPC)
- Print proof page
- Measure TC1617 in Curve4 VERIFY (or equiv)
- Check G7 Pass/Fail numbers

Suggested tolerances

- G7 Master Pass/Fail document
  - www.idealliance.org

Determining realistic tolerances

- What can your process achieve consistently?
- Sheet-to-sheet variation?
- Cross-sheet variations?
- Run-to-run variation?
- Consumable variations (ink, paper, plates etc.)?
- Inter-instrument differences?
- Work type, subject matter?
- Production cost vs. selling price?
- Etc.

Only promise what you can deliver!

- Clients always want 1.0 delta E
- But 1.0 delta E is an IMPOSSIBLE goal!
  - No printer on Earth can meet it in mass production
- Most printers are afraid to tell that to their clients
- So they end up losing money because they accept unrealistic expectations
- Communication is the problem, not technology

Typical measuring limitations (approximate)

- Between:
  - device types: ≈ 1.0 dE00
  - devices (same): ≈ 0.5 dE00
  - readings: ≈ 0.5 dE00
- Approximate total: 2.0
- Min. sane tolerance ≥ 2.0 dE00
**Soft proofing principles**

- Press profile
- Monitor profile

**Photoshop's Proof Colors command**

- Mac...
  Command + Y
- PC...
  Control + Y
- Shows approximately how an RGB image will print in the default CMYK Working Space

**Proof colors**

- Original RGB
- Simulated CMYK Print

**Photoshop soft proofing**

- CMYK files are displayed reasonably accurately, so long as a good monitor profile is selected
- RGB files can be pre-viewed as CMYK with View – Proof Colors (Mac: Command Y)
  Not perfect, but good enough for most work

**Accurate Photoshop soft proofing**

- **Proof Colors** only shows a crude soft proof
- Falsifies dynamic range and saturation
- Doesn’t show paper effect
- High-quality soft-proofing requires more effort

**Accurate RGB Soft Proofing**
Dimmable booth benefits

- Saves hard-copy proofing costs
- Provides a visual reference for white balance and exposure
- Simplifies color-matching of non-standard proofs, pre-prints, original artwork, product samples, etc.

Demo: Soft proofing in Photoshop

- Assign profile to match (e.g. GRACoL2013)
- View-Proof Setup-Custom
- Compare to hard copy in dimmable view booth

No viewing booth?

- Without a visual reference, how do you judge ...
  - Exposure?
  - Contrast?
  - Color balance?
- Simple: make the monitor the white reference

Donz white border trick

- DonzRGBactions
  - www.hutchcolor.com - Free
- Creates a white border inside the image
- Enlarges canvas to 125%
Undo border after viewing

- Reduces canvas to 80%
  (Back to original size)

White border trick benefits

- Provides a neutral reference when judging white balance by eye
- Provides a maximum-white reference when judging exposure by eye
- Simulates paper color of soft-proof

Prepress workflow

Software Color Settings are key!

How ICC device profiles control color

Getting color right

- EVERYONE in creative / production must use the same proofing, viewing & printing specifications
- Most important tips?
  Common software settings
  Accurate monitor profiles
  Accurate, tested hard-copy proofing
  Standard D50 viewing

Creative software settings
ALWAYS preserve embedded profiles

CMYK Working Space

Note: working spaces are ignored on images with assigned profiles

CMYK Working Space

Note: working spaces are ignored on images with assigned profiles

NEVER use Custom CMYK !!!

Crude 1980's Postscript tool
Burn any book that teaches it!

Custom CMYK tool

179 x less accurate than an ICC profile !!

1617 ÷ 9 = 179

RGB Working Space

- Should be equal to or larger than BOTH...
- The OUTPUT device (press)
- The INPUT device (e.g. camera)

LITTLE-KNOWN FACT
The “Working space” is only used if there’s no embedded profile. Otherwise it does NOT restrict color gamut
sRGB
Offset press
sRGB

Adobe RGB (1998)
Adobe RGB
Offset press

Digital SLR gamut vs Adobe RGB
DSLR / film
Adobe RGB

ProPhoto RGB
DSLR / film
ProPhotoRGB

ProPhoto RGB Danger Zone
“Illegal” RGB values (non-CIE)

Biggest CIE-Legal RGB Space
BestRGB
Only for real color geeks!
free at www.hutchcolor.com
Example of RGB clipping
Edited in BestRGB
Edited in Adobe RGB

Example of RGB Clipping
Smooth reds in BestRGB
Plugged reds in Adobe RGB

Example of RGB Clipping
Green channel BestRGB
Green channel Adobe RGB

Converting vs. assigning
The most asked question in color management

Assigning a profile
- Changes image appearance but not pixel values (RGB or CMYK)
- Defines how the image will look when converted

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Converting to a profile
- Maintains image color – changes pixel values
- Prepares the file to look right on a new device

How do you "Apply" a profile?
- You don’t
- It’s a meaningless statement
- It takes two profiles to do anything
  "Applying a profile" is like the sound of one hand clapping

Rendering Intents
- Perceptual
- Saturation
- Absolute colorimetric
- Relative colorimetric
  Adobe modification: "Black point compensation"

Perceptual intent
- “Pleasing color” when going from large to small color space
- Uses profile’s built-in “gamut compression”
- Less accurate than Relative with BPC
### Saturation intent

- Maximizes saturation at cost of hue accuracy
  
  Seldom used by anyone because color is too unpredictable

### Absolute Colorimetric intent

- Matches all colors as accurately as possible
- Used in proofing to simulate paper color
- **CAUTION:** Out-of-gamut colors and tones may clip or plug without warning
  
  Proof paper must be equal or brighter than simulated paper
  
  Proofer must have equal or greater color gamut

### Relative Colorimetric intent

- Same as Absolute except all colors are shifted to match the input and output profiles’ white points
- Used in proofing when proof paper is same color as simulation profile
- Also used to preserve original image contrast, but only if output space has equal or greater color gamut and contrast (black point)

### Relative with Black Point Compensation

- Developed by Adobe - provided freely to industry
- Modifies Relative intent to match both profiles’ black points as well as white points
- Recommended default for RGB conversion, except with extremely saturated originals

### Managing Supplied Files and Proofs

The most confident promises are often based on ignorance

- Just because it says GRACoL doesn’t mean it is
- Before giving a supplied proof to the pressroom, check its quality (color space and G7)
- If it fails, keep it away from the pressroom!
- Replace with an accurate in-house proof, or none
  
  Good G7 press control should come close to GRACoL without the need for a proof

### Supplied proofs – suspect them!
Validating supplied proofs

- Ideally ...
  - Check TC1617 from same system (usually not practical)

- Or ...
  - Compare to your internal proof

- Or ...
  - Compare to an absolute soft-proof

File doesn’t match the proof

- Ask client to accept your proof instead
- Ask client to correct the file (or proof)
- Charge client to color-correct the file
  - If you do this for “free” it better be covered by printing charges

File correction to match a false proof

The most valuable use of soft-proofing

- Create optimum soft-proof setup
- Assign whatever profile looks best
- Edit for best visual match
- Convert to output space (e.g. GRACoL)

Working with Spot Colors

Monday, 11:10  B & D

Specifying Pantone® colors

- IGNORE published CMYK %
  - Not based on standard printing
- Specify the color by name
  - But books can vary by 5-10 dE !!!
- Best: supply an actual chip
  - Printer measures it’s Lab and creates optimum CMYK for their printer

Simulating spot colors

- In Photoshop, assign the printer profile (e.g. GRACoL) to an image
- Select your desired color in Color Picker
- Photoshop displays best CMYK values
  - (But affected by profile’s GCR amount)
Picking a color

Out-of gamut example

In Gamut Example

Matching spot colors via CxF

Steve Smiley
- Color eXchange Format
- Spectral data embedded in document
- More accurate matching with different inks, substrates and lighting

Calibrating spot color plates? - SCTV

RGB Color Editing Tips
Creatives who avoid CMYK live longer and get richer
Smart image editing rules
- Stay in RGB - send in RGB
- Soft-proof in CMYK (if ending for print)
- Keep edits in ADJUSTMENT LAYERS
- Only judge color on a PROFILED MONITOR
  Check its accuracy
- Always EMBED the PROFILE on saving
- Always ACCEPT the embedded profile on opening

Efficient, photo-realistic RGB editing
- Set white and black
  Levels
- Exposure / brightness
  Gamma (Levels mid point) or Curves
- Gray balance
  Levels or Curves
- Global color edits
  Hue / Saturation

Adjustment layer modes
- Fabulously powerful
  My favorites in green
- Bottom 4 act like CIELCH
  Hue
  Saturation (Chroma)
  Color (Hue plus Chroma)
  Luminosity (Lightness)

CIELCH – the intuitive color space

Lightness normal

Lightness (+)
Lightness doesn’t alter chroma or hue

Normal L +
L –

Chroma doesn’t alter lightness or hue

Normal C +
C –

Lightness doesn’t alter chroma or hue

Normal
L +
L –

Chroma normal

Chroma (+)

Chroma (-)

Chroma doesn’t alter lightness or hue

Normal
C +
C –
Hue angle normal

Hue angle (+)

Hue angle (–)

Hue doesn't alter lightness or chroma

Exporting in RGB

- Sending RGB files for print
  Convert to Adobe RGB (1998) or just embed the file's native color space
  But make sure the printer can spell ICC!
- Sending to web
  Convert everything (RGB or CMYK) to sRGB

Reality Check

Secrets of successful color management
Getting Color Right

- Requires EVERYONE in the creative/production chain to use the same proofing, viewing & printing specifications
- Most important tips?
  - Standardized Photoshop color settings
  - Honor the embedded profile
  - Only judge color on a profiled monitor
  - Standard lighting

Secrets of success - creative

- Custom-profiled monitors
- Photoshop color settings
- Honor the embedded profile
- Edit photos in RGB, not CMYK
- Accurate hard-copy proofs
- Standard D50 viewing conditions

Secrets of success - production

- Stabilize the system
- Calibrate before profiling
- Test accuracy as often as possible
- Re-calibrate as often as necessary
- Re-profile as seldom as possible

Good news, bad news

- ICC color management is nothing short of magic, but nothing’s perfect ....
  - Faces can engage with the ventilator

When things go wrong DON’T PANIC

- Check RIP (DFE) settings
- Check device calibration
- Check media and ink
- Check client’s file
  - Wrong profile or intent?
- Check the proof or reference print
  - Was it made to a standard?
- If all else fails - pick up the phone

Reality check

- ALL printing systems vary to some extent
- A proof is a “simulation” of a perfect press
- Every press run is slightly different
- Evaluating “quality” is not an exact science
- Quality is proportional to price
- Color is subjective – quality can be personal
Managing expectations

- Color management is not a perfect science
- Treat it with respect and it will serve you well
- Expect perfection and you may be disappointed
- Be grateful for "near perfection"