Managing Tone for Spot Colors

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Who am I?

- Work with large consumer product companies
- Manage supply chain print quality
- Help brands realize consistent design intent
- Not a scientist
- Not a professor
- Not a mathematician
- Excel Junkie
Why am I here?

• Spot colors are commonly used in packaging to reproduce equity **brand colors**.
• It is increasingly common for packaging artwork to include **spot color solids, tints, overprints and extended color process** in artwork designs.
• Brands are increasingly looking to standardize quality through **specifications**.
• Today’s specifications for print do not address these important needs.
Background on this effort

• Measuring TVI of a spot color, April 2013
  • John Seymour for IDEAlliance
  • Computing TVI of spot colors using wavelength of maximum density DOES NOT WORK for a whole lot of spot color inks.
  • Colorimetric Tone Value (CTV) – Bill Birkett & Charles Spontelli, TAGA 2005

• Spot Colors and Tone Value, September 2013
  • Mark Samworth
  • deltaE-to-paper is a little better than Murray Davies spectral TV, but not as good as we would like it to be.
  • Future work should test different metrics as well as different data sets

• A Regression-Based Model of Colorimetric Tone Reproduction for use in Print Standards, April 2005 2013
  • William Birkett & Charles Spontelli for TAGA
  • Introduces Colorimetric Tone Value (CTV)
A quick example…

- Photoshop on the bottom, linear Status T MD on top.
A quick example...

- Photoshop on the bottom, ISO Curve A Status T MD on top.
SCHMOO

- Spot
- Color
- Halftone
- Metric
- Optimization
- Organization

...or should it be observation and optimization?

- A subcommittee of IDEAAlliance
Not Shmoo
Committee Members

Consultants
- Don Hutcheson @hutchcolor
- Steve Smiley @smileycolor
- Bob Hallam @pixelologie
- Ron Ellis @ronellisconsulting
- Mike Rodriguez @consulting
- Mike Strickler @mspgraphics

Ink Companies
- Rich, Danny @sunchemical
- Paula Gurnee @INX
- Jim Roth @flintgrp

Industry Groups
- Fazzi Joe @idealliance
- Dave McDowell @n pes

Technology providers
- John Seymour @quadtech
- Ray Cheydleur @xrite
- Chris Halford @xrite
- Thomas Lianza @xrite
- Stone Xianfeng Zhao @xrite
- Hanno Hoffstadt @gmcolor
- Juergen Seitz @gmcolor
- Mark Samworth @es ko
- Service Providers
- Marc Levine @schawk
- Garett Long @sgs
- Gary Russell @phototype
- Donald Schroeder @fujifilm
- Phil Sylvester @fujifilm
- Sam Ingram @clemson

Printers
- Steve Balschi @printpack
- Kiran Deshpande @chesapeakecorp
- Eileen Henry @hammerpackaging
- Bill Pope @graphicpackaging
- Awadhoot Shendye @northamericancolor
Challenges with current methods

- Not consistent across different print processes
- Not consistent across different ink colors
- Not consistent across different substrates
- In general, do not correlate with expected visual behavior (smooth, even development from substrate to solid ink)
Objectives

Identify a new metric for computing tone that will…

• Produce a consistent visual tone behavior
• Produce a consistent result across different inks, substrates, processes, and colors
• Use a standard tone target across different inks, substrates, processes, and colors (50 is a 50)
• Better mirror the design intent of the artwork
• Create a method that can easily be implemented into color measurement devices & QC tools
Not Objectives

• Matching the tint dE between different print conditions
• Perfect visual behavior
Test Data

Collect spectral ramp data (54 ramps)

• Paper to solid in discrete steps
• Mixture of processes, substrates, inks, and colors
• Create Lab tif for visual evaluation
Test Metrics

9 different metrics, spectral and colorimetric
• Status T Murray Davies (STD)
• Spectral Density (max filter) Murray Davies (SPD)
• Integral Base Normalized Value (IBNV) - Lianza
• Coefficient-based spectral filter (PTRU) - Russell
• Colorimetric Tone Value (CTV) - Birkett
• Colorimetric STR (STR) - Hoffstadt
• XYZ Magnitude (XYZ) – Long
• DeltaE-to-Paper (DEP) - Samworth
• L-star linearization (LSD ) - McDowell
Test Procedure

- Compute tone value for each metric
- Compute linear tone correction curve
- Compute corrected Lab or spectral value
- Render corrected Lab values to bitmap image for evaluation
- Final print run test using selected metric (TBD)
Status T Density – Murray Davies

- Industry-standard method (US) for color tone / ISO5-3
Spectral Density – Murray Davies

- Industry-standard method spot color tone / ISO 5-3
Integral Base Normalized Value (IBNV)

- Spectral filter, based in inverse paper spectra
XYZ Magnitude (XYZ)

- Sum of X, Y, and Z

![Graph showing XYZ Magnitude](image-url)
• Spectral filter, based on 3 coefficients
Colorimetric Tone Value (CTV)

- Based on $L_x$, $L_y$, and $L_z$ functions
Colorimetric Tone Value (STR)

- Based on S, T, and R functions
DeltaE-to-Paper (DEP)

- Paper-relative linear dE
Linear L-star (LSD)

- Uses L function with dynamic switch to a* or b*
Integral Base Normalized Value (IBNV)
XYZ Magnitude (XYZ)
PTRU
Colorimetric Tone Value (CTV)
Colorimetric Tone Value (STR)
Linear L-star (LSD)
DeltaE-to-Paper (DEP)
Findings

• Overall, colorimetry-based metrics produce more consistent visual development
• Status T & Spectral Density produce similar results
• PTRU showed best performance of spectral formulas, but requires use of coefficients for calculations
• CTV and STR are effectively the same formula
• LSD has appealing visual result, but requires thresholds to switch between L, a, and b linearization.
Results – CTV is preferred metric

- Produces consistent visual results across all samples
- Aligns with Adobe Creative Suite color rendering
- Colorimetric formula easily integrates in PDF
- Simplified formula easy to use in spreadsheet form
- Can be used with both spectral and colorimetric data
CTV Formula

To convert from Lab to $L_xL_yL_z$:

\[
L_y = L \\
L_x = L + \frac{116a}{500} \\
L_z = L - \frac{116b}{200}
\]

To convert from $L_xL_yL_z$ to Lab:

\[
L = L_y \\
a = \frac{500(L_x - L_y)}{116} \\
b = \frac{200(L_y - L_z)}{116}
\]

To compute CTV from Lab values, first convert the Lab values to $L_xL_yL_z$, then evaluate CTV:

\[
CTV = \sqrt{\frac{(L_x - L_x)^2 + (L_y - L_y)^2 + (L_z - L_z)^2}{3}}
\]
Next steps

- Continue to evaluate additional data
- Complete final project testing (press runs)
- Work with ISO committee to find a home for the metric (ISO 13655)
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Questions, Comments?