COLOR • CONDUCTIVE • FILM/SHEET • FLAME RETARDANT
STRUCTURAL • THERMOPLASTIC ELASTOMERS • WEAR

Color Communication: Evaluation and Tolerances

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ALLOY POLYMERS, INC. ESP Engineered Sheet Products Hueforia Colour Development Team of RTP Company Wiman

AGENDA

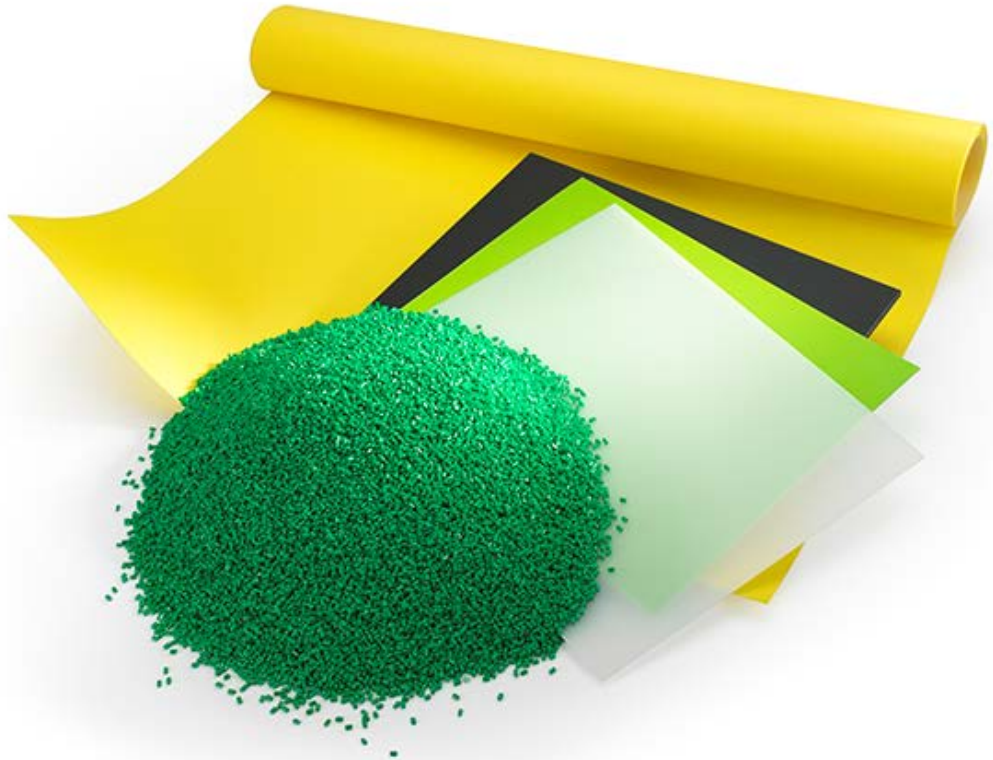
Today's Discussion:

- Brief intro to RTP Company
- Color Communication
- Color Spaces
- Color Evaluation and Tolerances
- Q & A

ABOUT RTP COMPANY

RTP Company is an **independent,**
privately owned thermoplastics compounder with **global** manufacturing, engineering support, and sales representation.

- 2,000+ employees
- $650+ million annual sales



CUSTOM SOLUTIONS

High-Tech Compounds to Unfilled Resins

- 60+ resins
- 100s of modifiers
- Broadest range of competitive compounds
  (From talc polypropylene to nanotube PEEK)

Annual Production

- 6,000+ commercial products
- 1,750+ new products per year

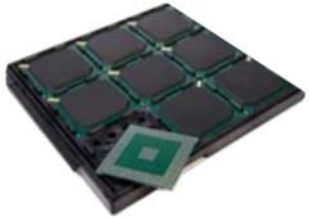
GLOBAL MANUFACTURING

RTP Company is a global compounder of **custom engineered thermoplastics**.

PRODUCT FAMILIES

Compounds formulated to meet performance requirements, from one property to multiple technologies

Color



Conductive

Flame Retardant

Thermoplastic Elastomers

Structural

Wear Resistant

Film - Wiman

Sheet - ESP™

MARKETS

Appliances

Automotive

Business & Cash Machines

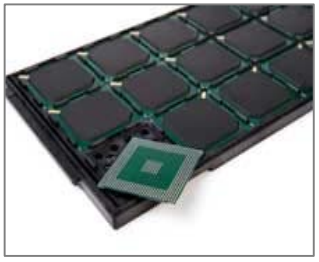
Construction & Agriculture

Consumer

Defense & Aerospace

Energy

Electrical/Electronics



Electronic Packaging & Data Storage

Industrial

Medical

Sports & Leisure

Color Communication:
Evaluation & Tolerances

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Color in the plastics industry

ISSUES WITH COLOR IN THE PLASTICS INDUSTRY

Lost in Translation

COLOR COMMUNICATION

COLOR COMMUNICATION

PMS 295 C

+ Pearl =

How do you describe the color you want your part to be?

How would you describe the color of a US penny?

- Shiny or dull / light or dark?
- Metallic / copper/ rusty?
- Brown / burnt orange?
- How would we match a penny?

COLOR COMMUNICATION

Let’s start by how we see color…..

Three things are needed for us to see color

Object

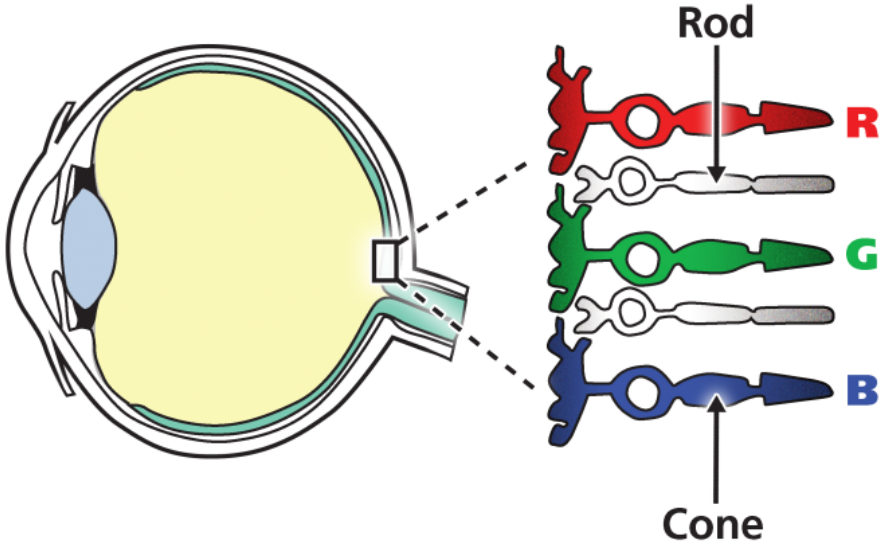
Light Source

Observer

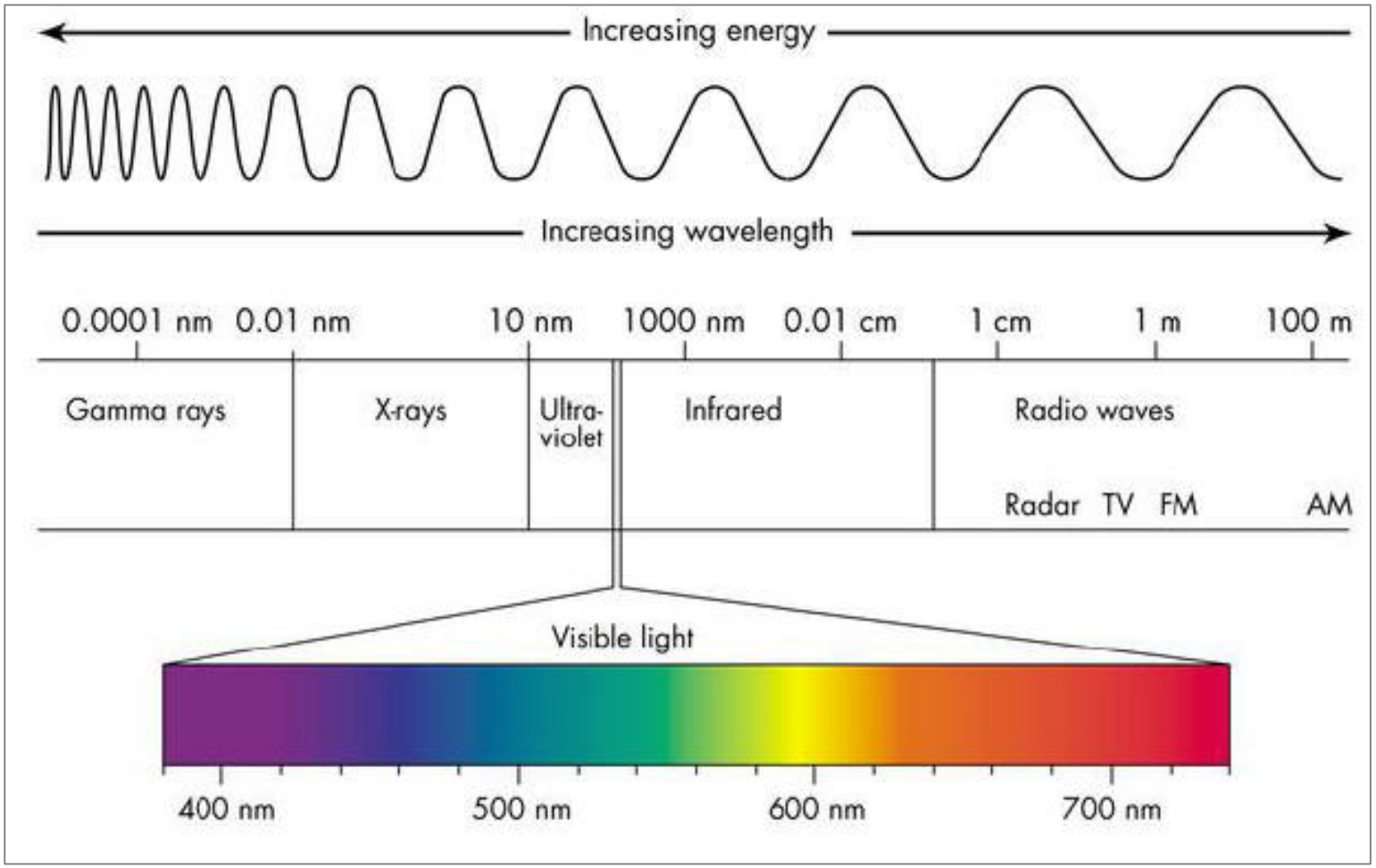
Two types of photoreceptors

Rods and Cones

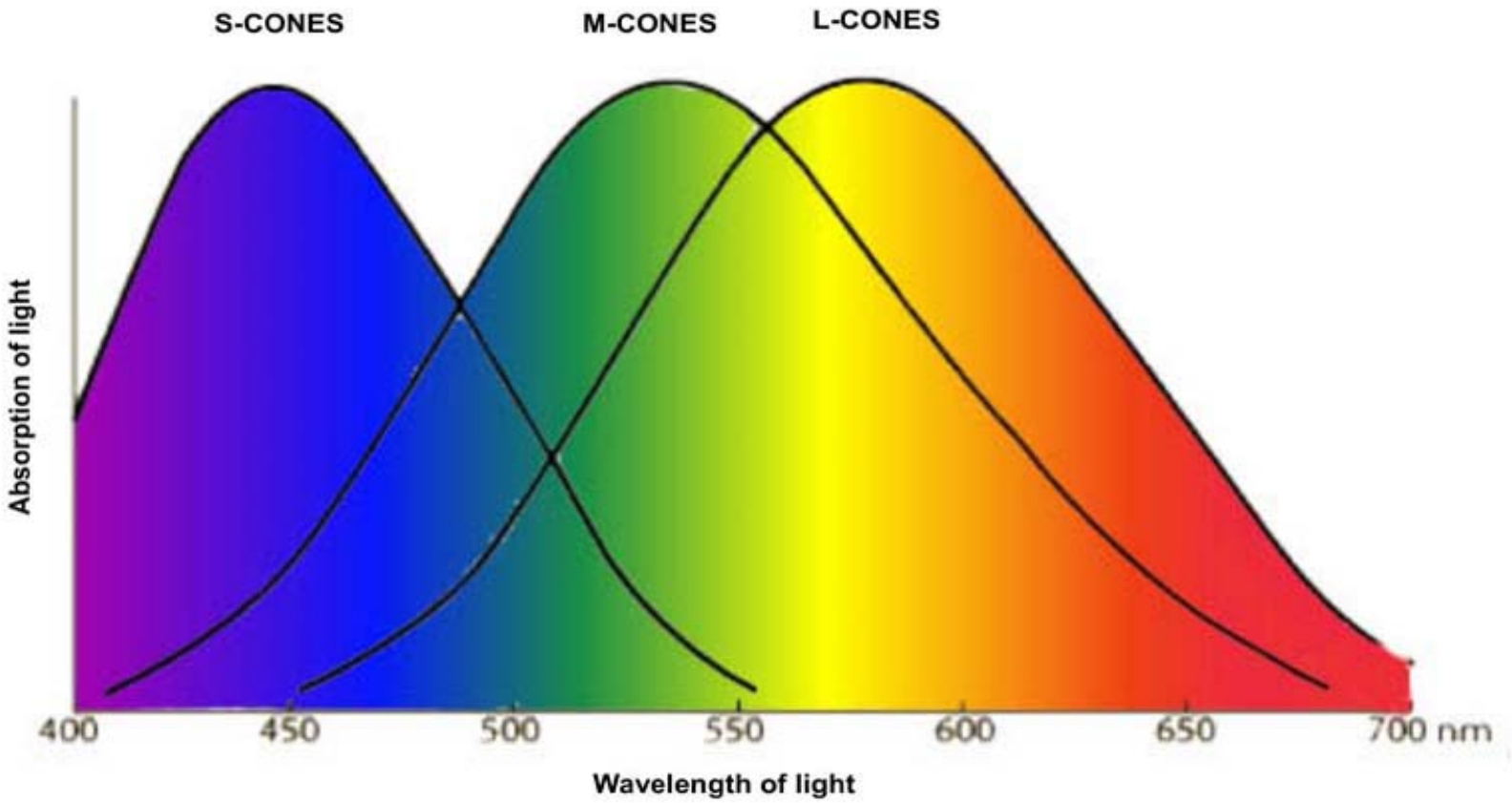
- Rods allow us to see in low light conditions.
- Cones allow us to see three primary wavelengths of color.



COLOR COMMUNICATION



COLOR COMMUNICATION



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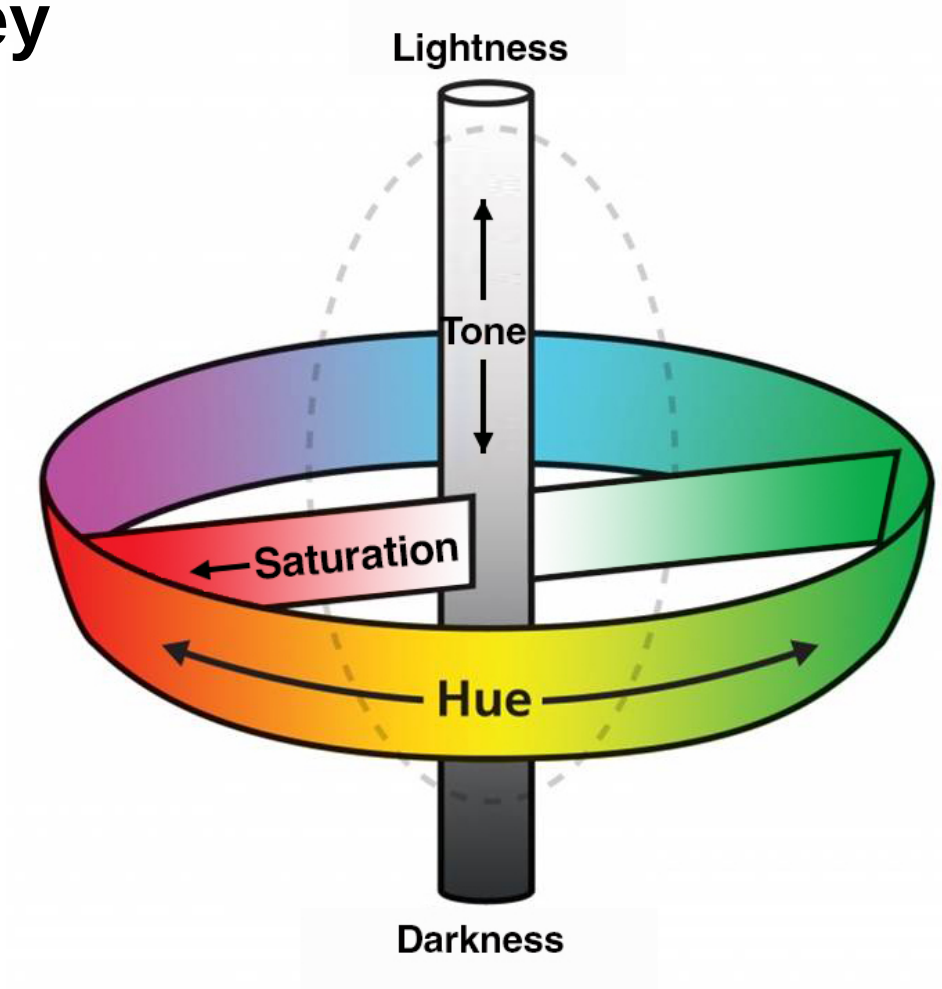
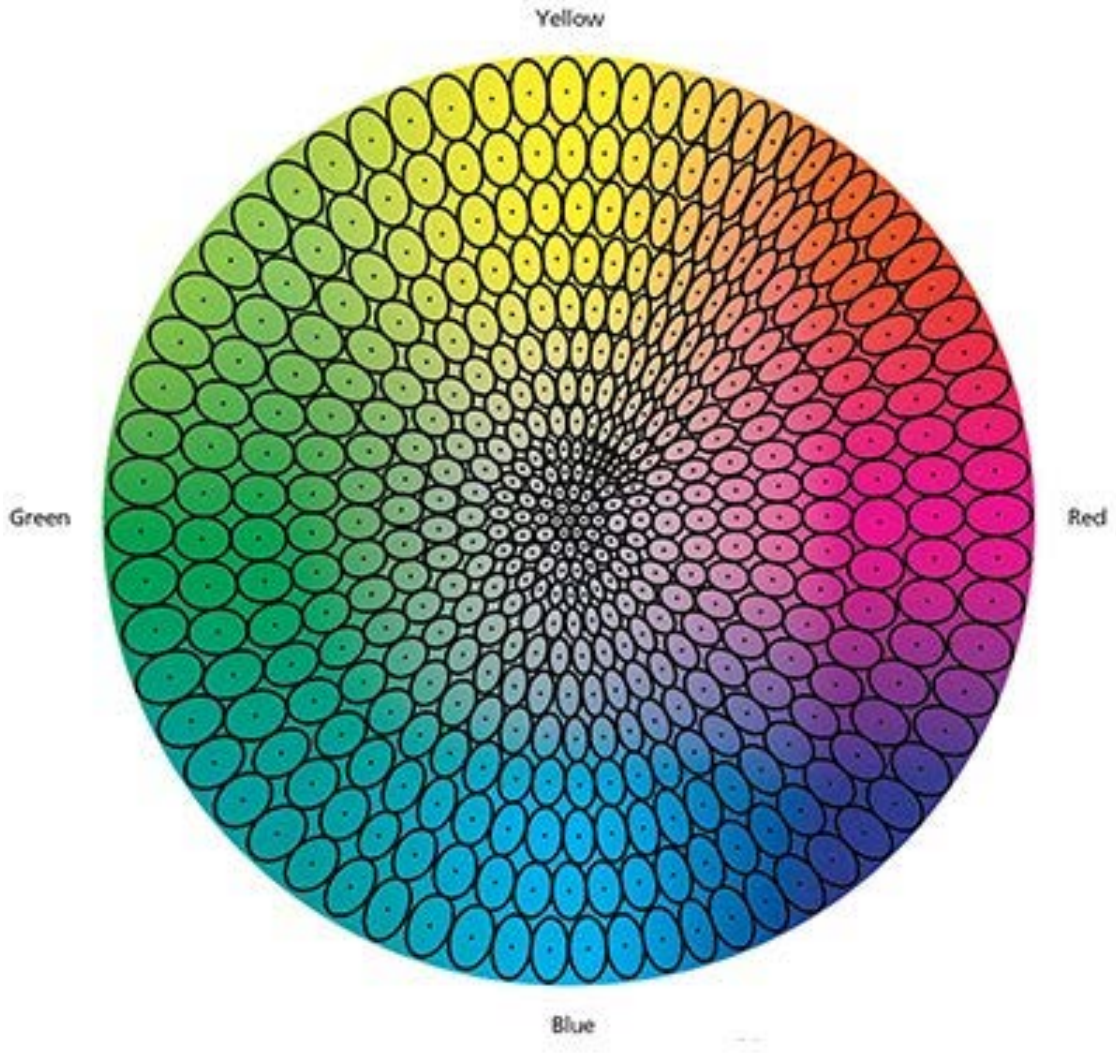
COLOR COMMUNICATION

Colors have three key attributes to help us describe them

- Hue
- Lightness
- Saturation



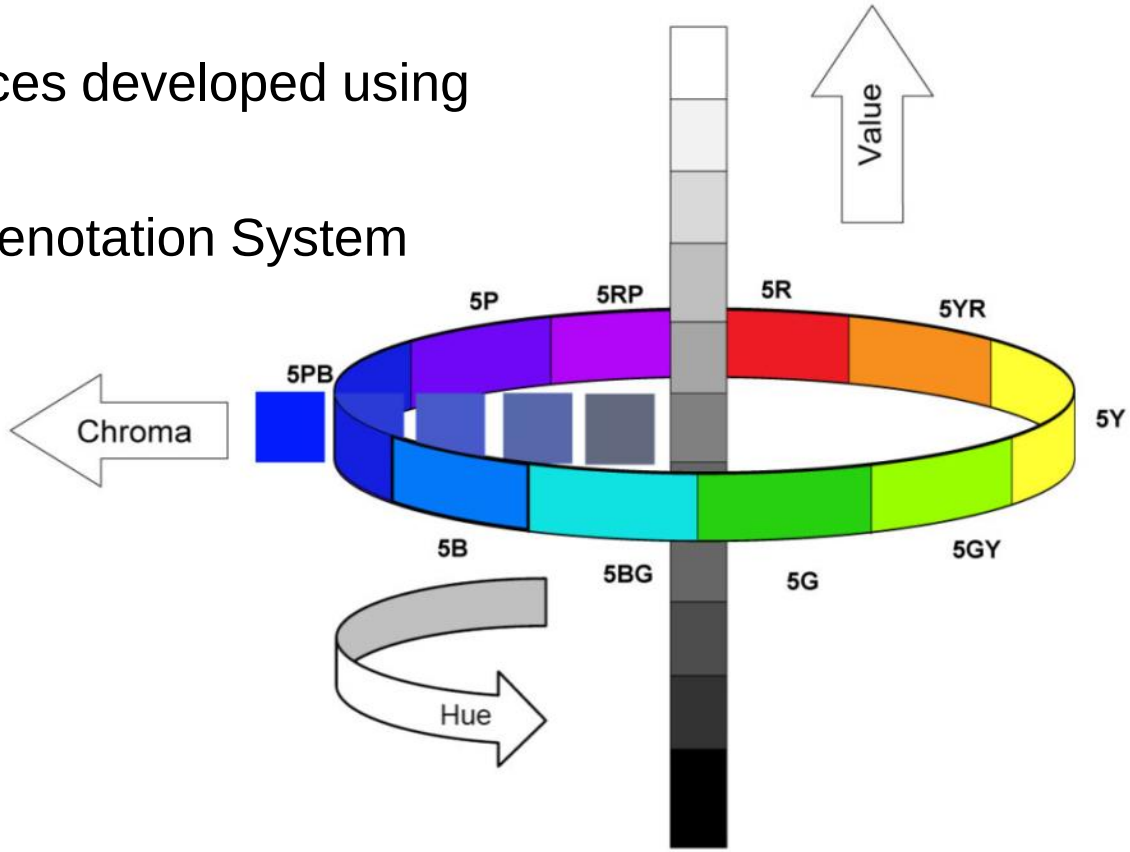
COLOR SPACE



Source: Munsell Color © 2018, X-Rite, Incorporated.

Munsell Color System

- Early 1900's
- One of first color spaces developed using paper color chips
- Revised to Munsell Renotation System and still in use today



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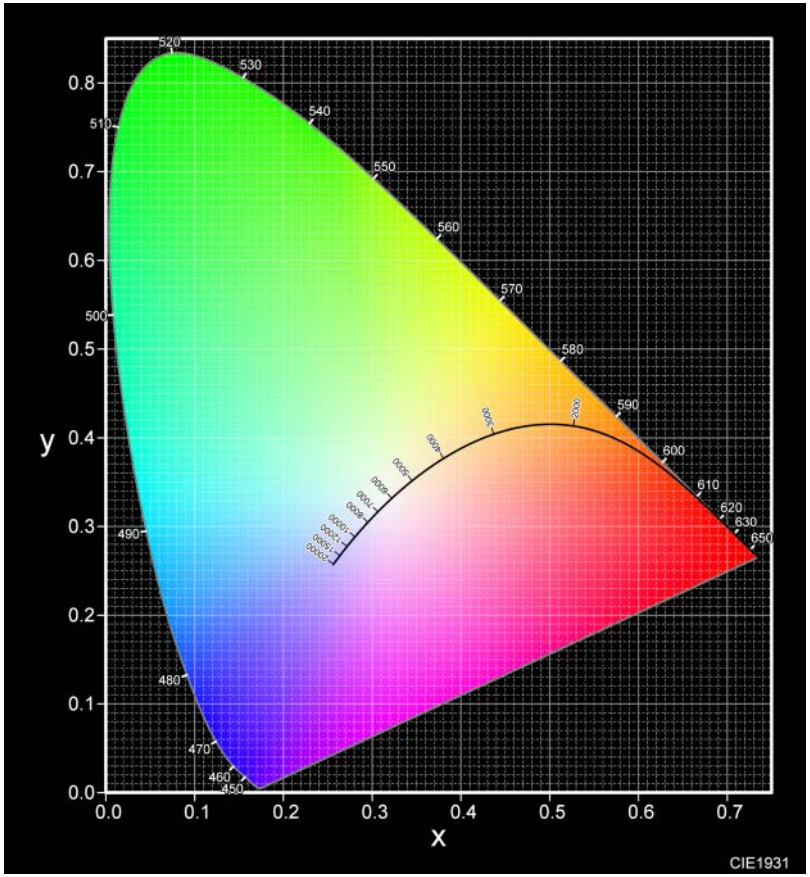
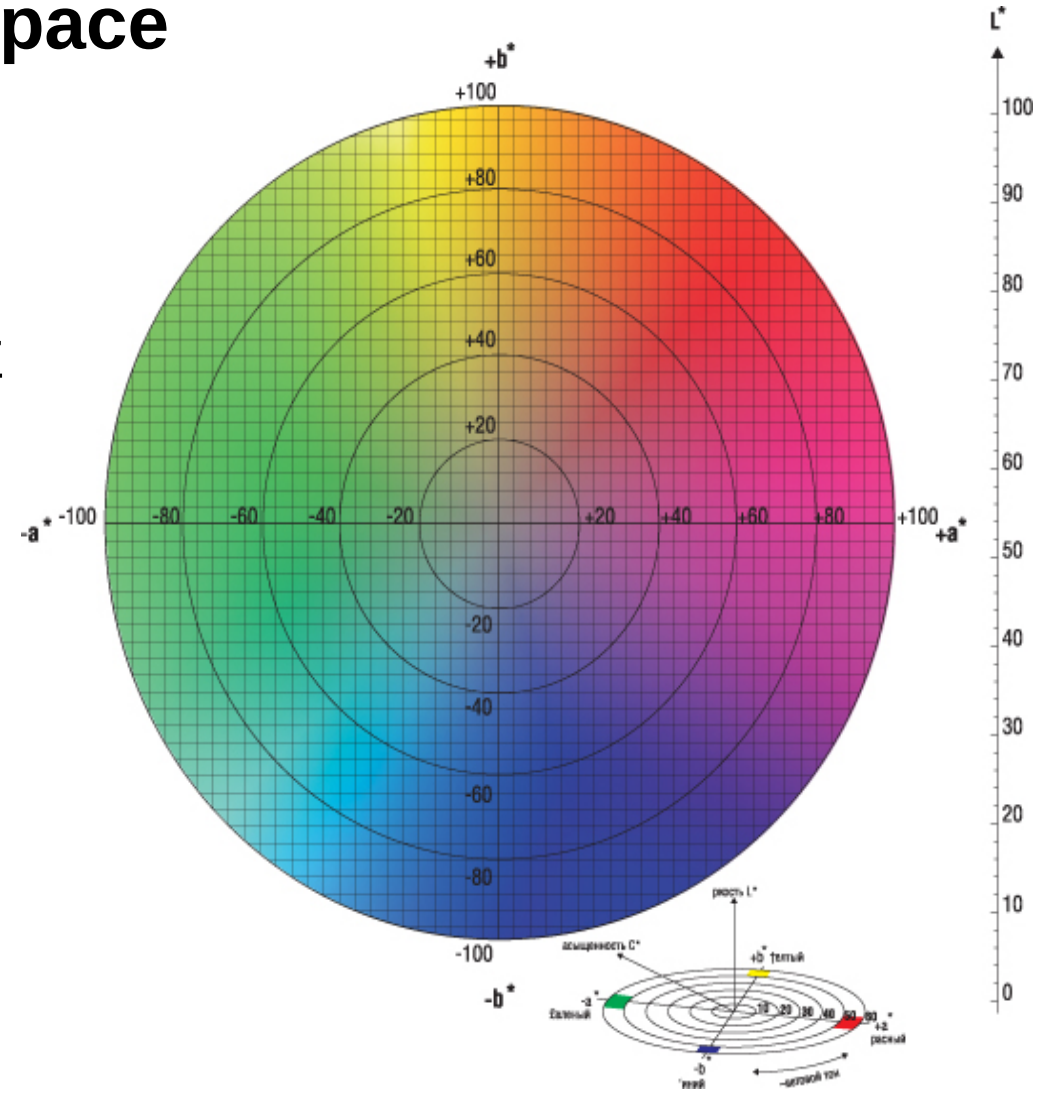
CIE 1931 color space

- Created 1931 CIE
- Quantified physical and perceived human color
- Created standard observer
- Still widely used



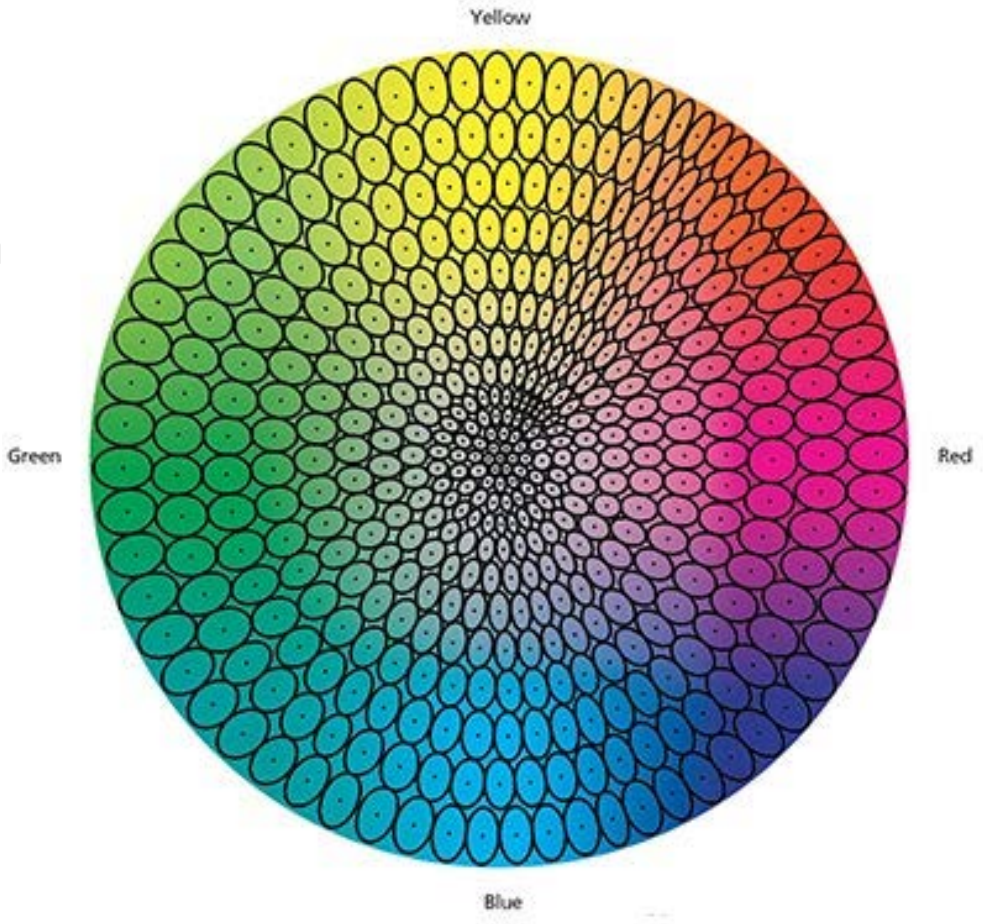
CIE LAB 1976 color space

- Created 1976
- Uniform color spaces
- Derived from CIE 1931 XYZ
- Widely used today



CMC l:c 1984

- Created 1984
- Ellipsoid color spaces
- Best representative of human
- Lightness / Chroma in D65
- Widely used today



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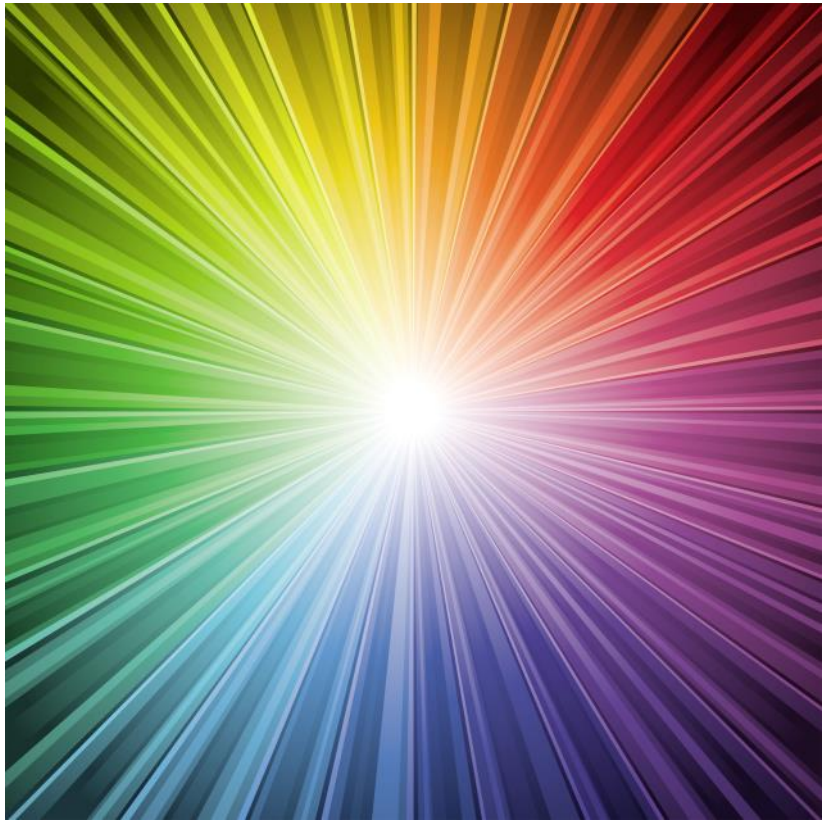
Other color spaces

CIE 94

- L*C*h*
- Meant to improve from CIE LAB 76

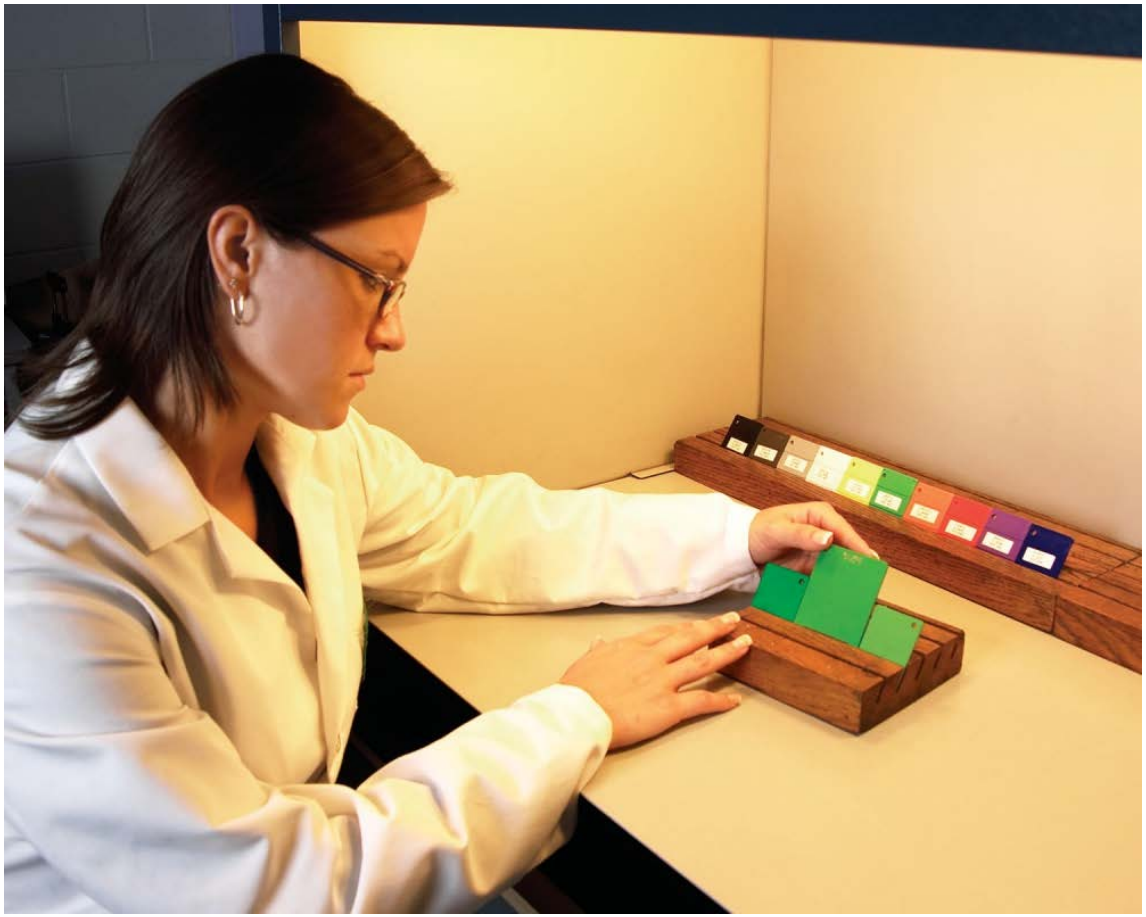
CIEDE2000

- Corrected 5 areas from CIE 94



What color space should I be using?

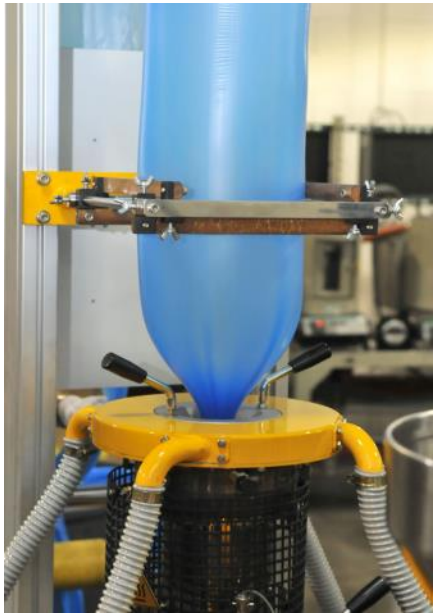
Color Evaluation



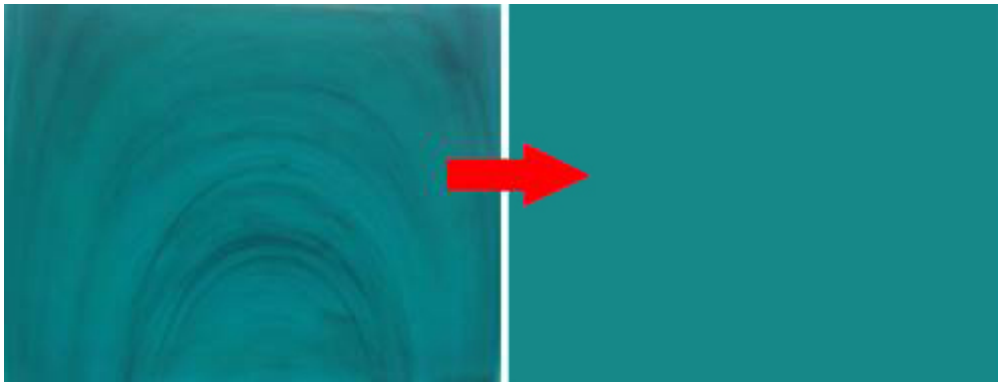
Color Evaluation Considerations

- Pre-established tolerances?
- Colorant inspection tools?
- Other criteria?

Color Evaluation

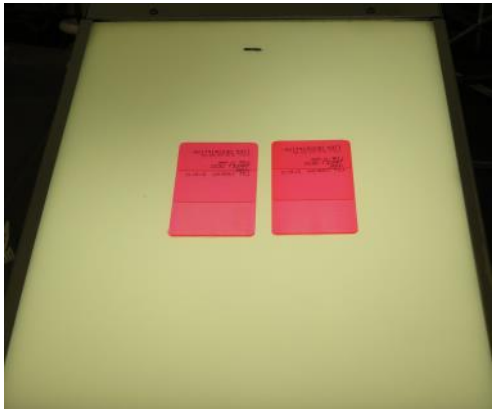


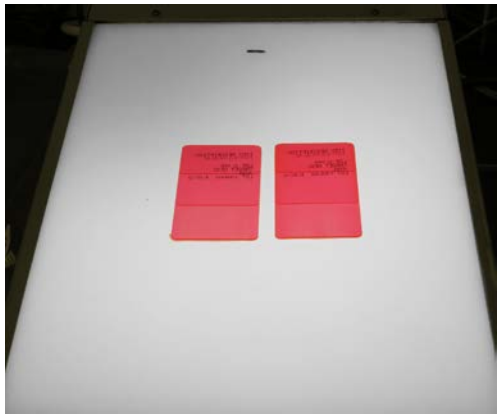
Visual Inspection



Defects

- Dispersion
- Contaminates
- Color distribution

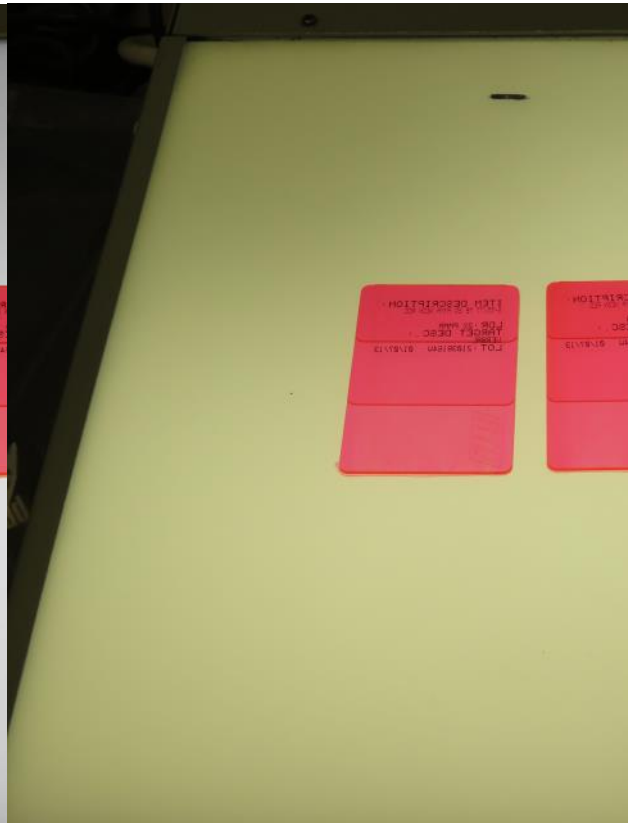




Visual Inspection

Opacity

- Critical for transparent colors
- Correct level of color
- Cost control



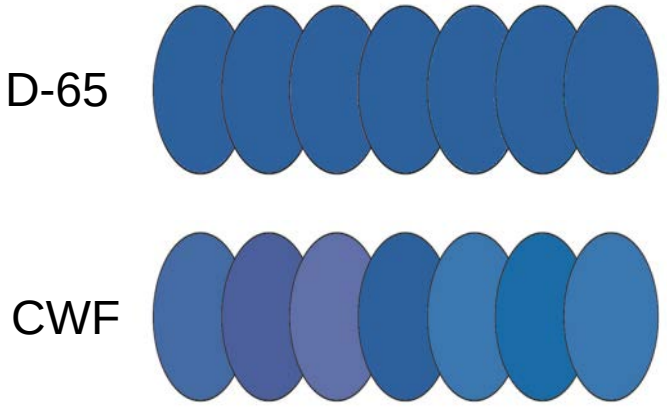
Visual Inspection

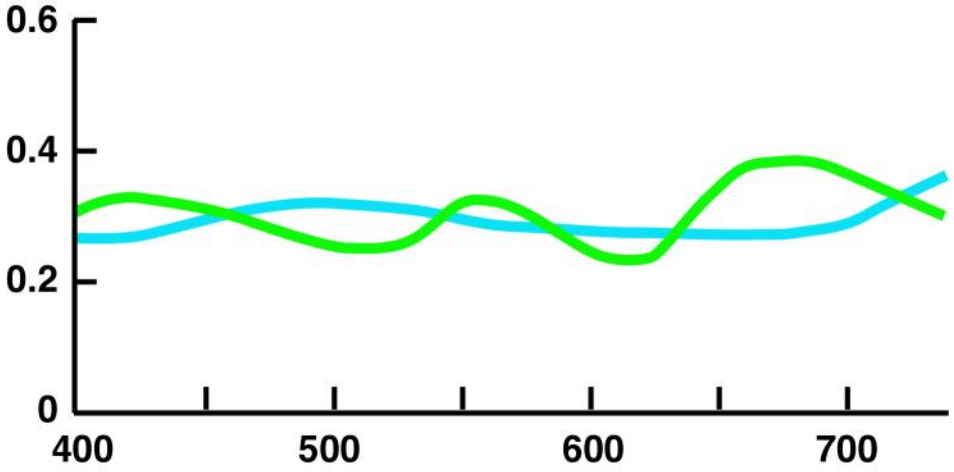
Color

- Light booth
- Light source
- Metamerism

Metamerism

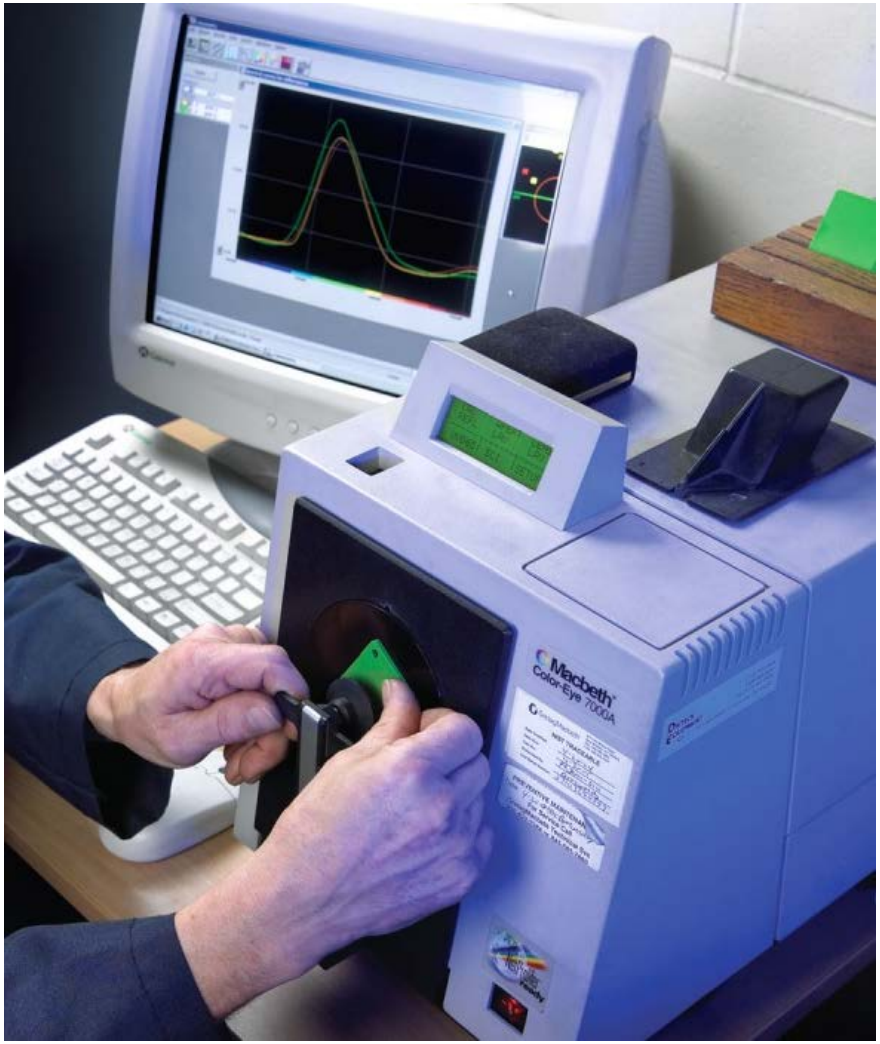
- Color matches under one light condition but not others
- Different colorant systems
- Identifiable with spectral curves





COLOR EVALUATION & TOLERANCES

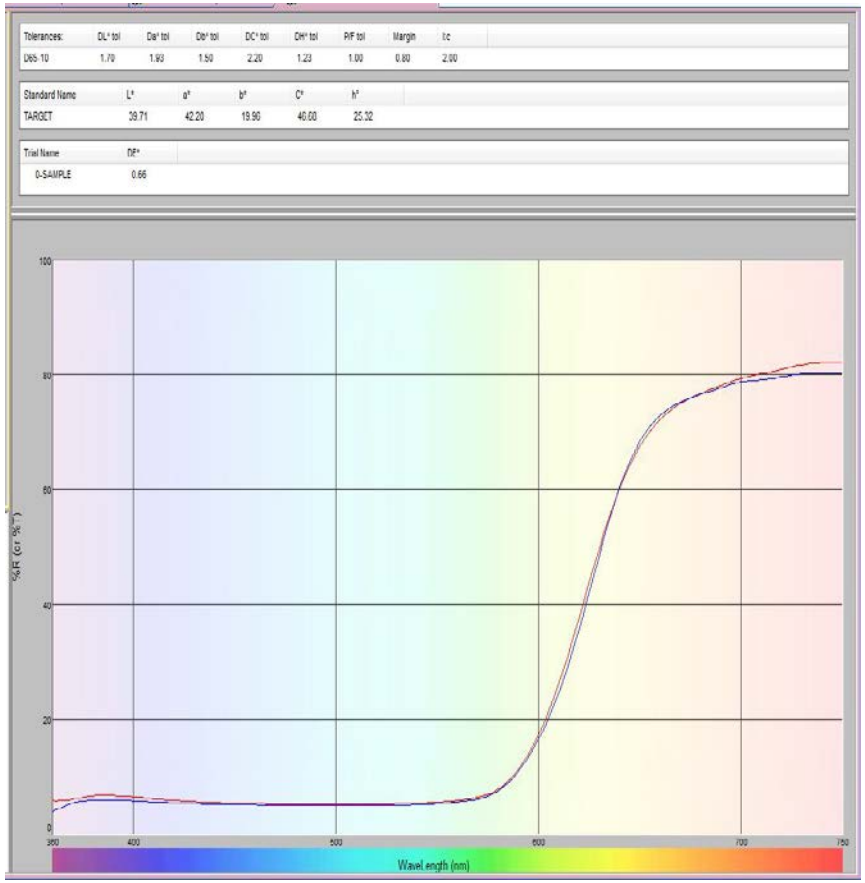
Spectrophotometer



COLOR EVALUATION & TOLERANCES

Spectrophotometer

- Precise tool for color interpretation
- Allows in depth analysis of color
- Different modes and options for gloss and texture and transmission or reflectance



Spectrophotometer

- Read same area/ texture as comparison
- Largest aperture on uniform surface
- Readings should confirm visual assessment

COLOR EVALUATION & TOLERANCES

“I just want my color to be the same every time!”

- *Every Customer*

COLOR EVALUATION & TOLERANCES

The best tolerance is one that meets your customer's needs and gives your production the widest processing window to operate.

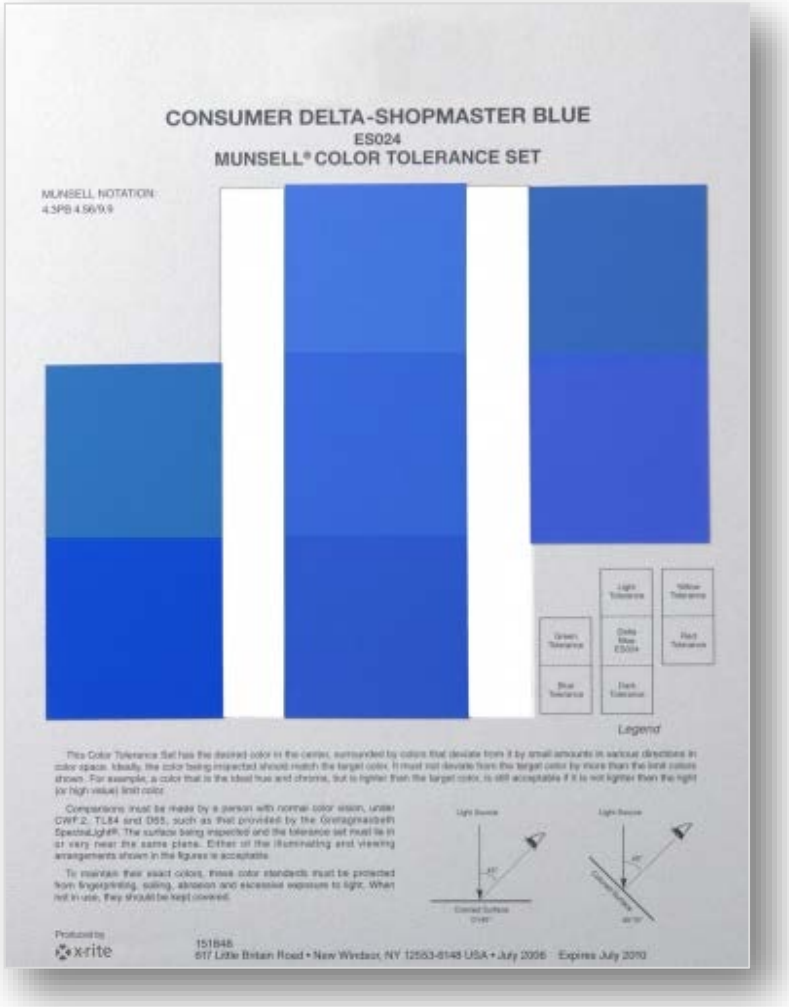
COLOR EVALUATION & TOLERANCES

Communication is KEY!!

Visual Tolerances

Tolerance set cards

- Useful information
- Costly
- Made with inks



Source: Munsell Color © 2018, X-Rite, Incorporated.

Visual Tolerances

Color chips

- Costly
- Best when in same base resin

COLOR EVALUATION & TOLERANCES

Visual Tolerances

Working Standards

- Limited to MB
- Limited hue ranges
- Easy to establish
- Not ideal for multifunctional MB

1.5% Light Limit

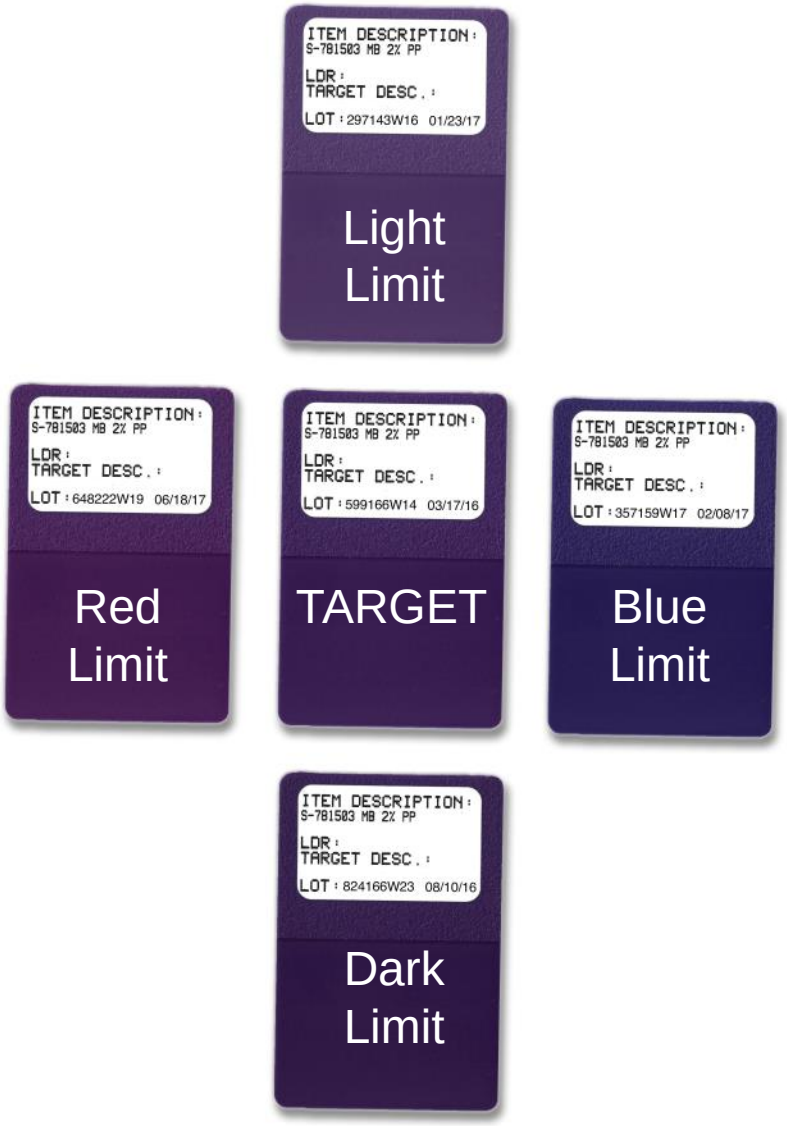
3% Target

4.5% Dark Limit

Visual Tolerances

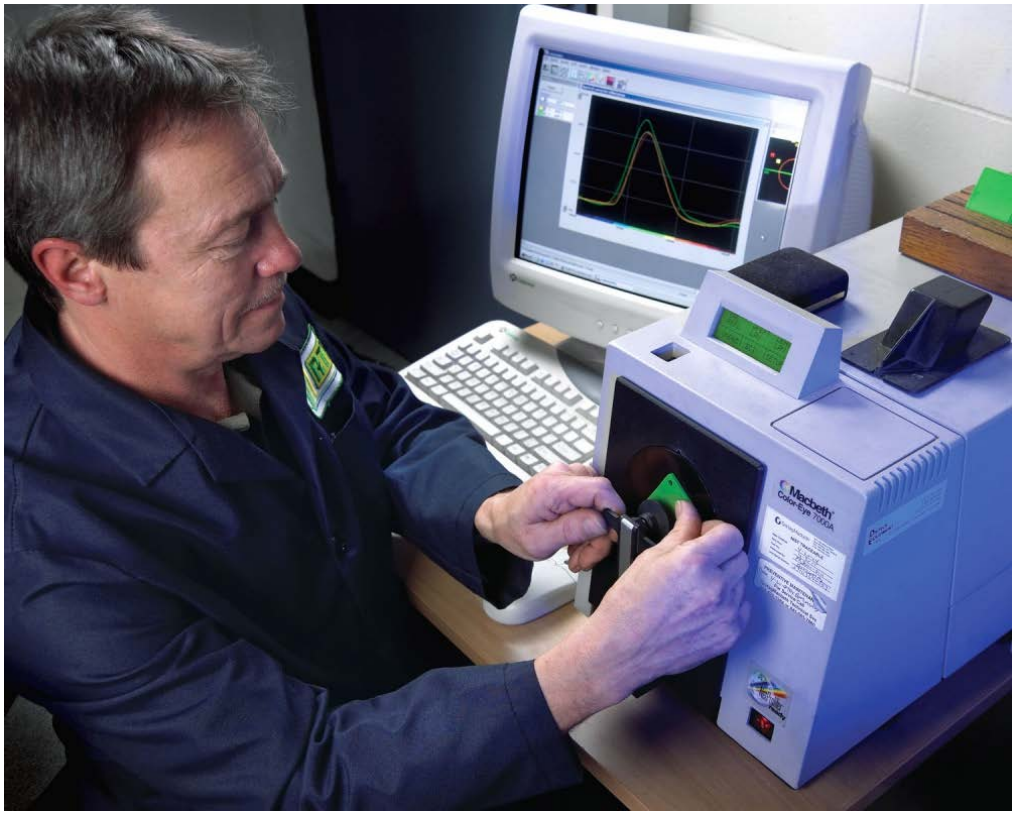
Lot history

- Takes time to establish
- Communication of lots critical
- Keep clean



COLOR EVALUATION & TOLERANCES

Spectrophotometer Tolerances



COLOR EVALUATION & TOLERANCES

Color Differences

ΔE

Tolerances:	DL* tol	Da* tol	Db* tol	DC* tol	DH* tol	P/F tol	Margin	l:c
D65-10	1.70	1.93	1.50	2.20	1.23	1.00	0.80	2.00

Standard Name	L*	a*	b*	C*	h°
TARGET	39.71	42.20	19.96	46.68	25.32

Trial Name	DE*
0-SAMPLE	0.66

delta E* or dE* = $[(dL^*)^2 + (da^*)^2 + (db^*)^2]^{1/2}$

COLOR EVALUATION & TOLERANCES

Color Differences

Tolerances:	DL* tol	Da* tol	Db* tol	DC* tol	DH* tol	P/F tol	Margin	l:c
D65-10	1.70	1.93	1.50	2.20	1.23	1.00	0.80	2.00

Standard Name	L*	a*	b*	C*	h°
TARGET	39.71	42.20	19.96	46.68	25.32

Trial Name	DL*	Da*	Db*
1-SAMPLE	-0.65 D	-0.08 G	0.10 Y

ΔL

delta L* or dL* = $L^*_{SAMPLE} - L^*_{STANDARD}$

ΔA

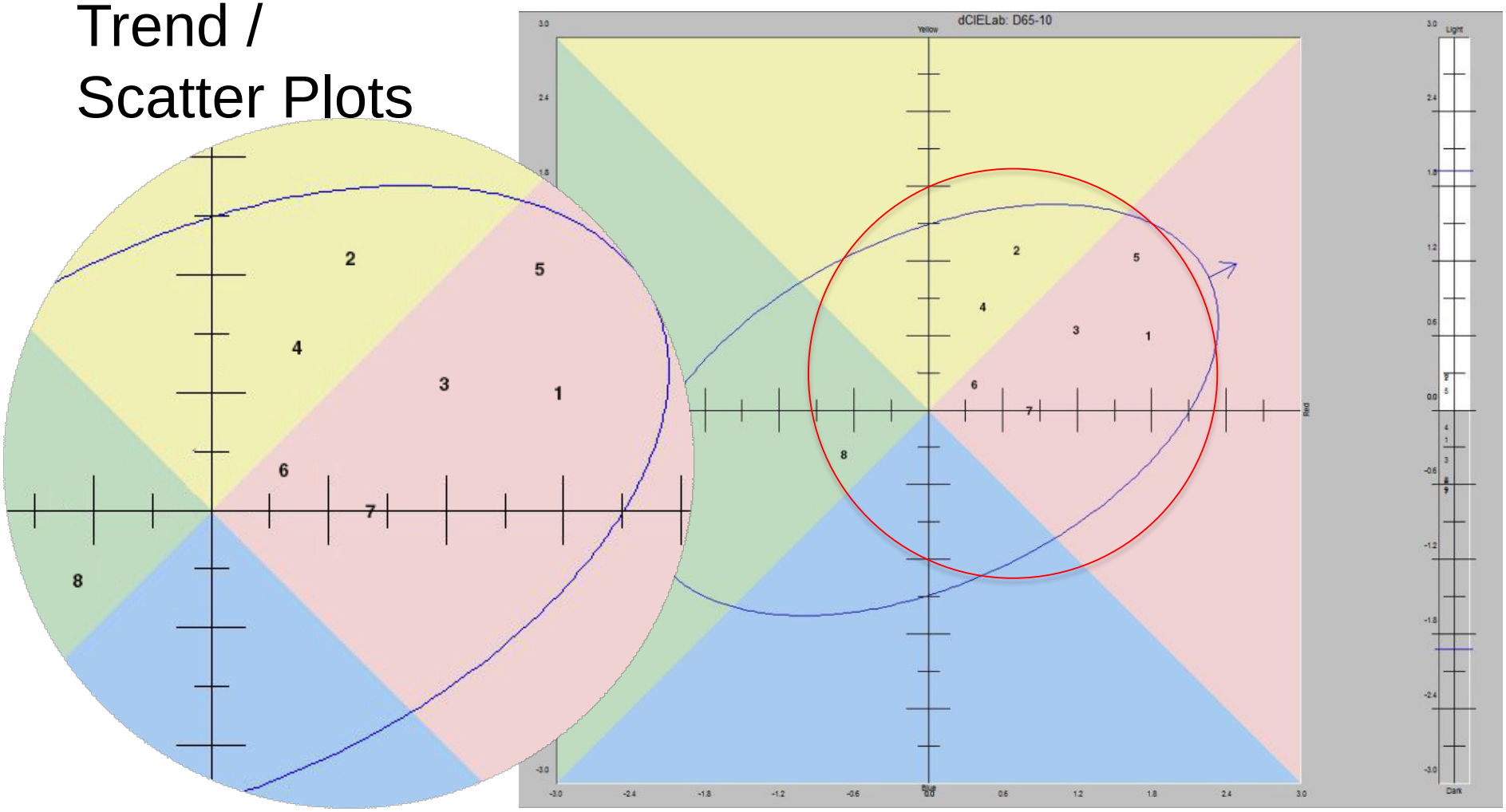
delta a* or da* = $a^*_{SAMPLE} - a^*_{STANDARD}$

ΔB

delta b* or db* = $b^*_{SAMPLE} - b^*_{STANDARD}$

Spectrophotometer Tolerances

Trend /
Scatter Plots



SUMMARY

- Communication
- Market awareness
- Tools of the trade

Thank You!

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