

Fundamentals of Color and Appearance

Module 1

INTRODUCTION

Color Science Educational Series



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A silhouette of a person carrying a child on their back, holding a spear and shield, stands on a grassy bank overlooking a lake at sunset. The sky is a gradient of orange and red, and the sun is low on the horizon, reflecting in the water. The background shows a line of trees on the opposite shore.

Since primeval times, color has played a critical role in determining human behavior



From triggering our primeval Fight or Flight responses...DANGER!!



To providing information that keeps us healthy



Color plays a pivotal role in the world around us. It influences our thinking, guides our actions, and elicits strong reactions.

From the homes we buy...



To the cars we drive...



The clothes we wear...



The foods we eat...



The liquids we drink...





The medications we take...



And the nature all around us...

For companies, color consistency is a key indicator of quality, safety, and brand integrity



Getting it right means everything

And as industry pioneers and industry experts



*we know this better
than anyone*

Fundamentals of Color and Appearance

The Importance of Color

Color Science Educational Series



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Two plastic bottles of water are shown side-by-side against a white background. The bottle on the left contains a yellowish liquid, while the bottle on the right contains clear water. The text "Which one would you drink?" is centered over the bottles.

Which one would you drink?



Would you trust these?



How about your favorite ketchup?

Or potato chips?





Would this upset you?



Which one would you buy?



Would this give you heartburn?



As a powerful form of communication, color is irreplaceable. The colors and color consistency of products, web sites, or corporate logos cause powerful reactions

Color Matters!



Color has come a long ways since our primaeval days.
Color is a science.
Let's Explore the Science of Color

Fundamentals of Color and Appearance

MODULES



1. Introduction
2. How we See Color
3. Color Attributes and Color Systems
4. Color Perception and Communication
5. Instrumental Color Measurement
6. Light, Illuminant, Observer
7. Color Scales and Color Differences
8. Instrument Geometry
9. Haze, Turbidity, Opalescence
10. Color vs Appearance
11. Luminescence

Fundamentals of Color and Appearance



Module 2

How We See Color

Explore the complex interplay of physics, chemistry, and biology that allows us to see and interpret color.

By understanding the roles of light, matter, and human vision, we gain a deeper appreciation for something we experience every day—the fascinating world of color.



Fundamentals of Color and Appearance

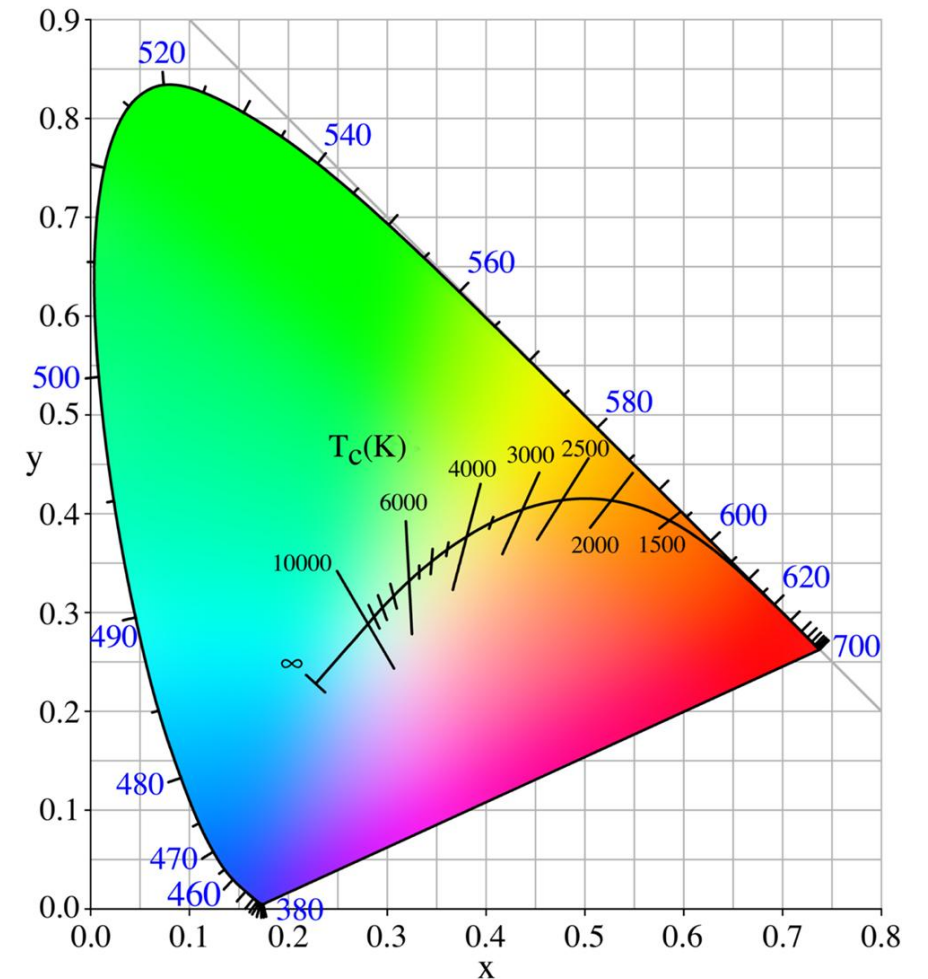


Module 3

Color Attributes and Color Systems

Explore the complex interplay of physics, chemistry, and biology that allows us to see and interpret color.

By understanding the roles of light, matter, and human vision, we gain a deeper appreciation for something we experience every day—the fascinating world of color.



Fundamentals of Color and Appearance



Module 4

Color Perception and Communication

Visual color assessment is subjective, shaped by individual vocabulary, environmental lighting, and personal differences in vision.

These variables significantly affect how we see and describe color. Recognizing these challenges is the first step toward achieving consistent, objective, and reliable color control.



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Module 5

Instrumental Color Measurement

This module introduces the science of color spectrophotometry and explains how instruments replicate the human eye's response using standardized lighting and controlled viewing geometry.

Transitioning from subjective assessments to objective, repeatable measurements enables color accuracy across teams, shifts, and global locations.



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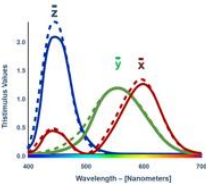


Module 6

Light, Illuminant and Observer

Here you will learn the difference between a physical light source and a standard illuminant, and how a spectral power distribution curve defines light uniquely.

We also cover the importance of the Standard Observer, a foundational concept in objective color science and instrumental measurement.

Light Source	Daylight	Incandescent	Fluorescent																																																
																																																			
Illuminant	CIE Illuminant D ₆₅	CIE Illuminant A	CIE Illuminant F2																																																
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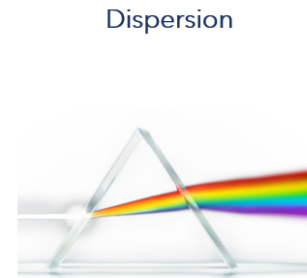


Module 7

Color Scales and Color Differences

Learn about the Opponent-Color Theory, delve into symmetric and asymmetric color difference calculations, and show how to apply them to define minimal perceptible and maximum acceptable tolerances.

We introduce the LCh color space and compare the Hunter L,a,b and CIE L*a*b* models used in color quality control.

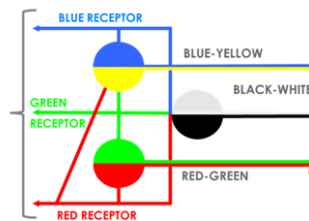


Dispersion

ROY-G-BIV

Red, Orange, Green, Blue, Indigo, Violet

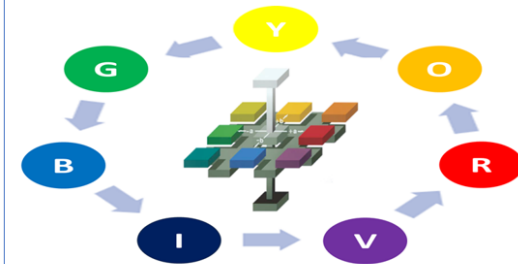
Opponent- Color Theory



Opponent Pairs

Red vs. Green
Blue vs. Yellow
Black vs. White

L, a, b Color Space



L, a, b

Red vs. Green
Blue vs. Yellow
Black vs. White

ROY-G-BIV

Red, Orange, Yellow
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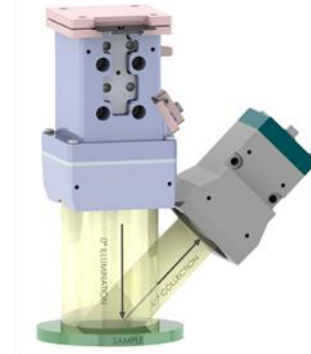


Module 8 Instrument Geometry

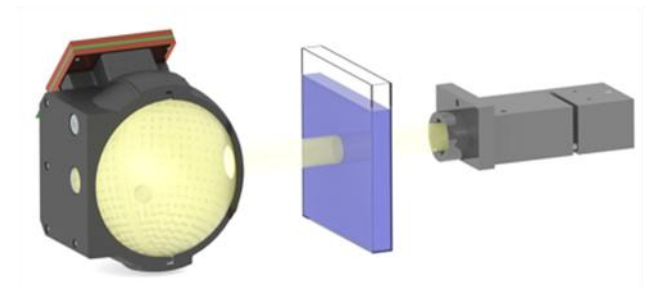
Learn the differences between diffuse and directional geometries—how they are designed, how they function, and their intended applications.

We explore specular included (SPIN) vs. specular excluded (SPEX) modes, and how these affect the evaluation of color versus color appearance.

Understanding these distinctions is essential for selecting the right method for your application and QC goals.



Directional Geometry



Diffuse Geometry

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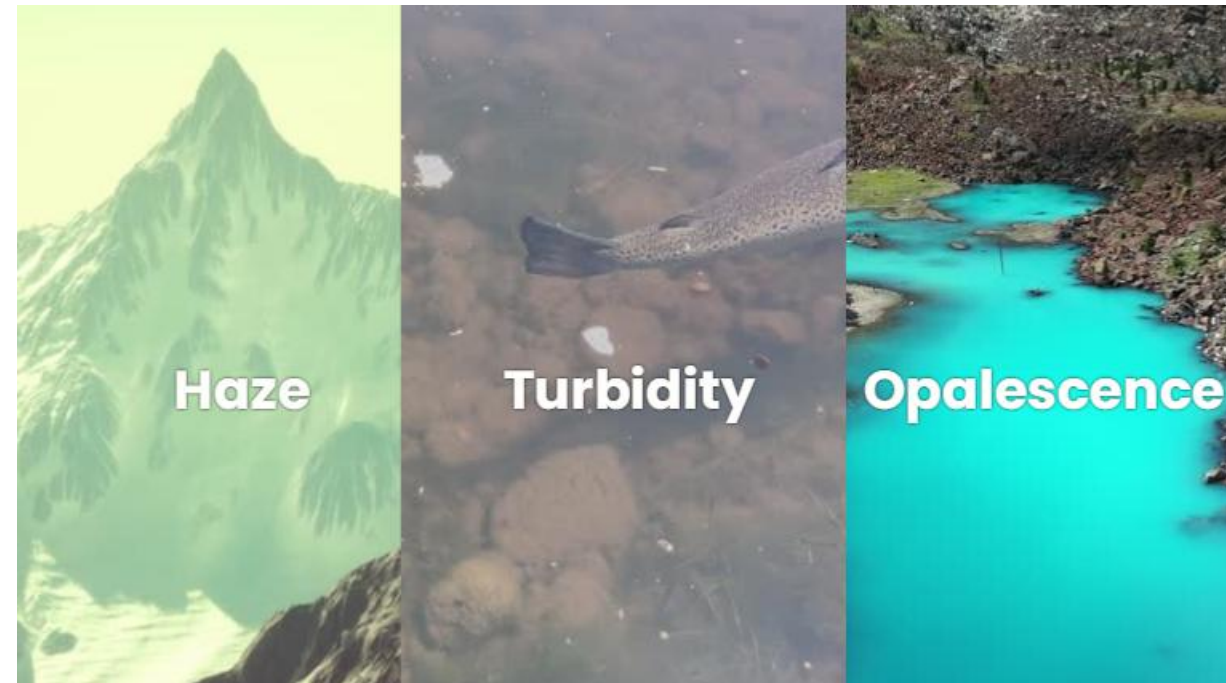


Module 9

Haze, Turbidity, Opalescence

Haze, Turbidity, Opalescence, focuses on how these optical indices are used to measure how light passes through a transparent or translucent sample and the visual effects of light scatter.

These metrics are vital for industries like beverages, packaging, plastics, and films, where product transparency and appearance are critical.



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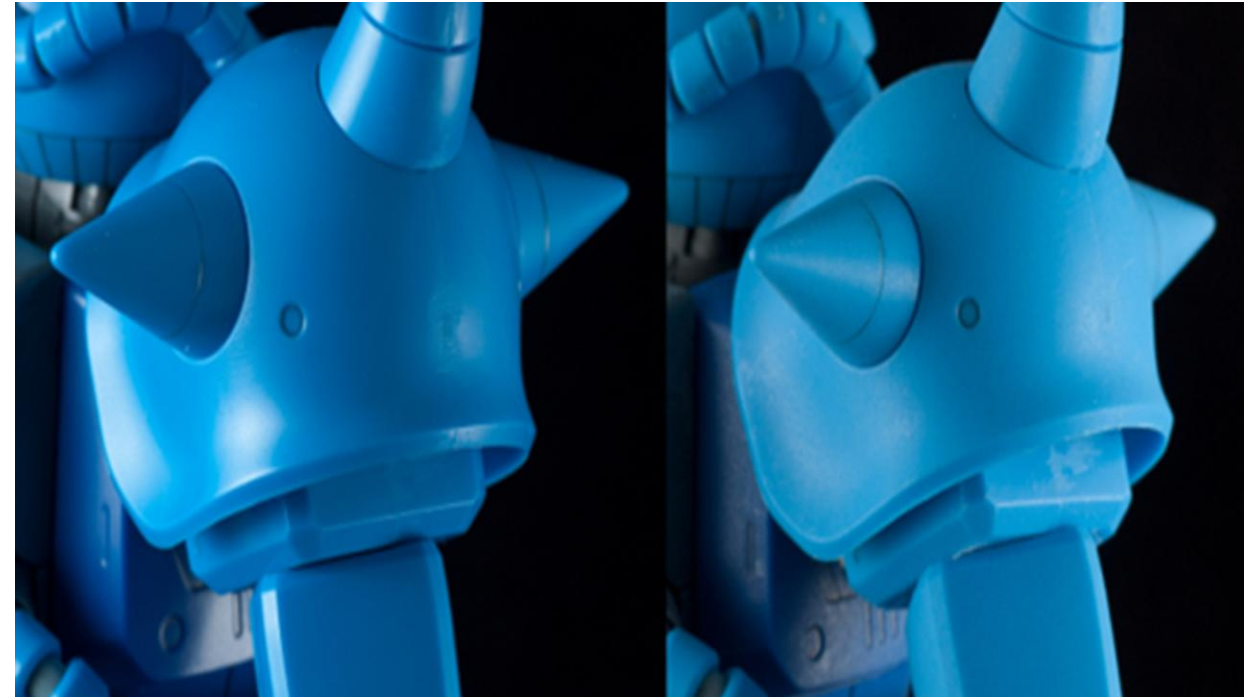


Module 10

Color vs. Appearance

The Laws of Reflectance and surface characteristics—such as texture, gloss, and roughness—influence how our eyes perceive color.

This is key to understanding the difference between color and color appearance, and how instruments are used to measure and communicate these visual differences.



Fundamentals of Color and Appearance

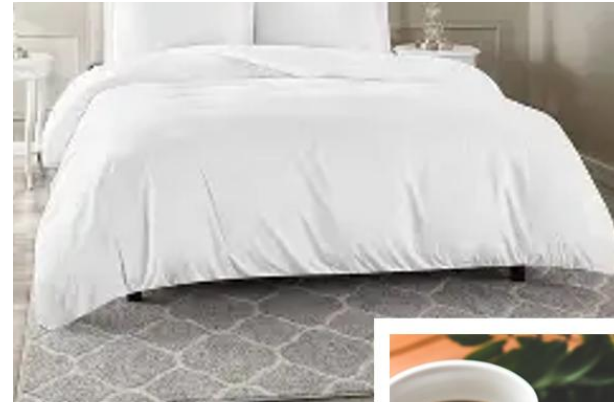


Module 11 Fluorescence

Fluorescence significantly impacts color appearance.

Fluorescent Whitening Agents (FWAs) and Optical Brightening Agents (OBAs) are used to enhance the perceived whiteness and brightness of materials.

These agents must be accounted for in color measurement, critical in coatings, detergents, textiles, paper, plastics, and safety colors



Fundamentals of Color and Appearance



Module 12

Targets and Tolerances

Targets and Tolerances explain how to set color targets and tolerances that balance visual acceptance with precise instrumental measurement to ensure consistent, reliable quality.

