A Revolution in Color Management – Prediction of Color Stability

Jim MacDonald, Business Line Manager for Industrial Paint and Coatings
BYK-Gardner USA

Importance of Color Stability

- Color is key in purchasing decisions
- Color harmony and long-term stability are crucial
- Sunlight exposure can fade colors over time
- Decay of fluorescent ingredients affects appearance

Color Fastness in Automotive Interiors

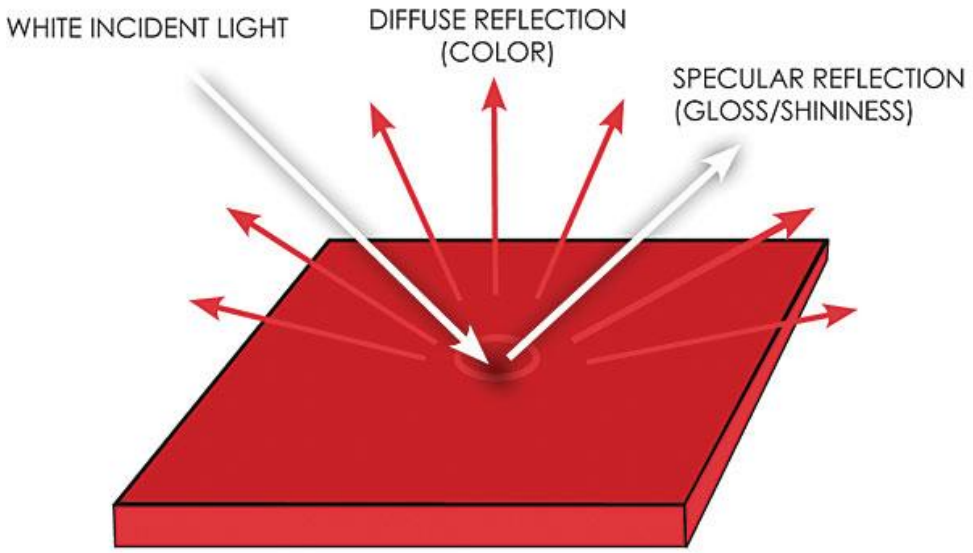
- Many car interior parts made from polymers
- Parts often manufactured in different locations
- Mismatched fading can lead to customer dissatisfaction
- Predicting color stability is essential for quality control

Factors Influencing Color Experience

- Color
- 60° gloss
- Fluorescence
- Combined effect creates overall appearance

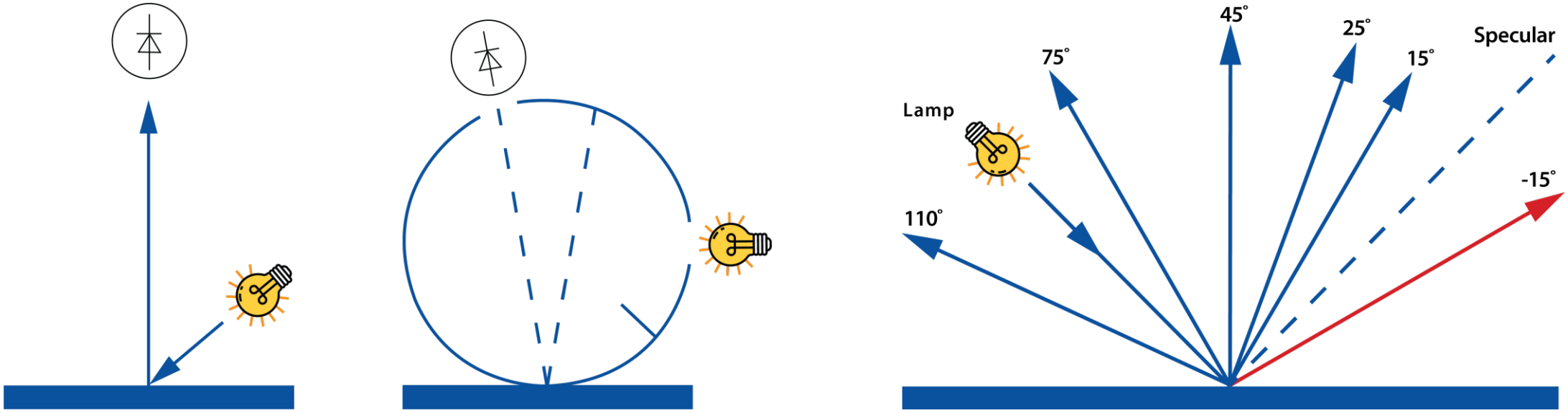
Evolution of Color Measurement

- Traditional: Color and gloss only
- Next generation: Includes fluorescence prediction
- Technology that combines a spectrophotometer and fluorimeter
- Enables quantifying fluorescence degradation over time



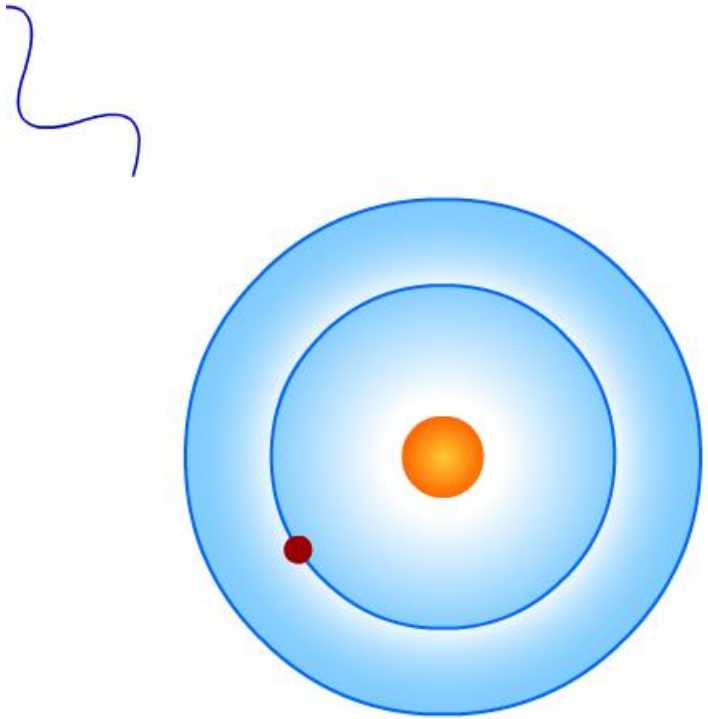
Measuring Color – Key Geometries

- 45°/0° - Replicates visual color assessment
- Diffuse/8° - Measures scattered light reflection
- Multi-angle - For special effect pigments



Principles of Fluorescence

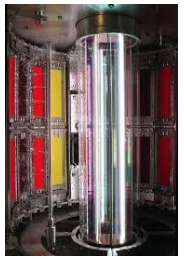
- Absorption of light energy by molecules
- Emission of longer wavelength light
- Occurs rapidly after excitation
- Distinct from phosphorescence (delayed emission)



Evaluating Fluorescent Energy

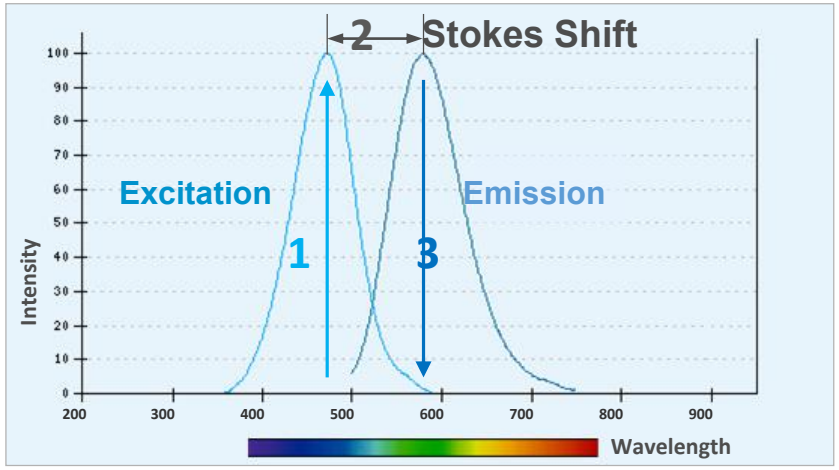
- Measure excitation and emission spectra
- Quantify intensity relative to concentration
- Account for equipment factors (light source, detector)
- Use standardized measurement conditions

- Spectrophotometers with UV-cut filter
  - Take two readings with and without UV component
    - Significant difference indicates fluorescence
    - Excitation only in UV region
- Natural / accelerated weathering tests
  - No clear indication why fading occurs



Stokes Shift Explained

- Emitted energy divided into heat and light: Stokes Shift
- Difference between excitation and emission wavelengths
- Results from energy loss during excited state
  - Fluorescent light has lower energy and a longer wavelength than excited light
- Allows separation of excitation and emission light
- Key parameter in fluorescence measurement



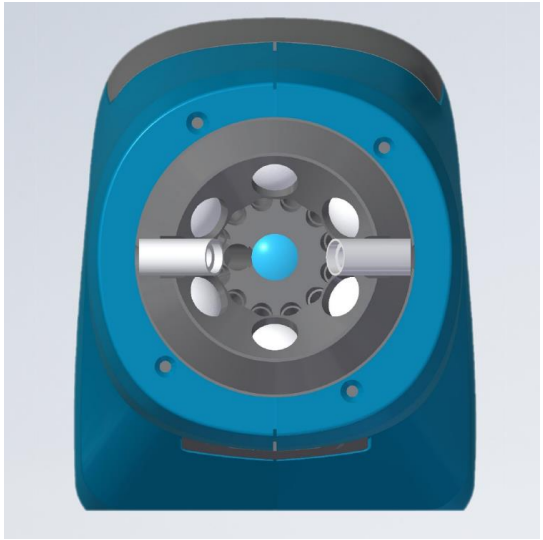
Excitement	Emission
UV	Blue/ Green/ Yellow/ Red
Blue	Green/ Yellow / Red
Green	Yellow/ Red

Innovative Technology

- A spectrophotometer and fluorimeter in one device

d:8° Geometry

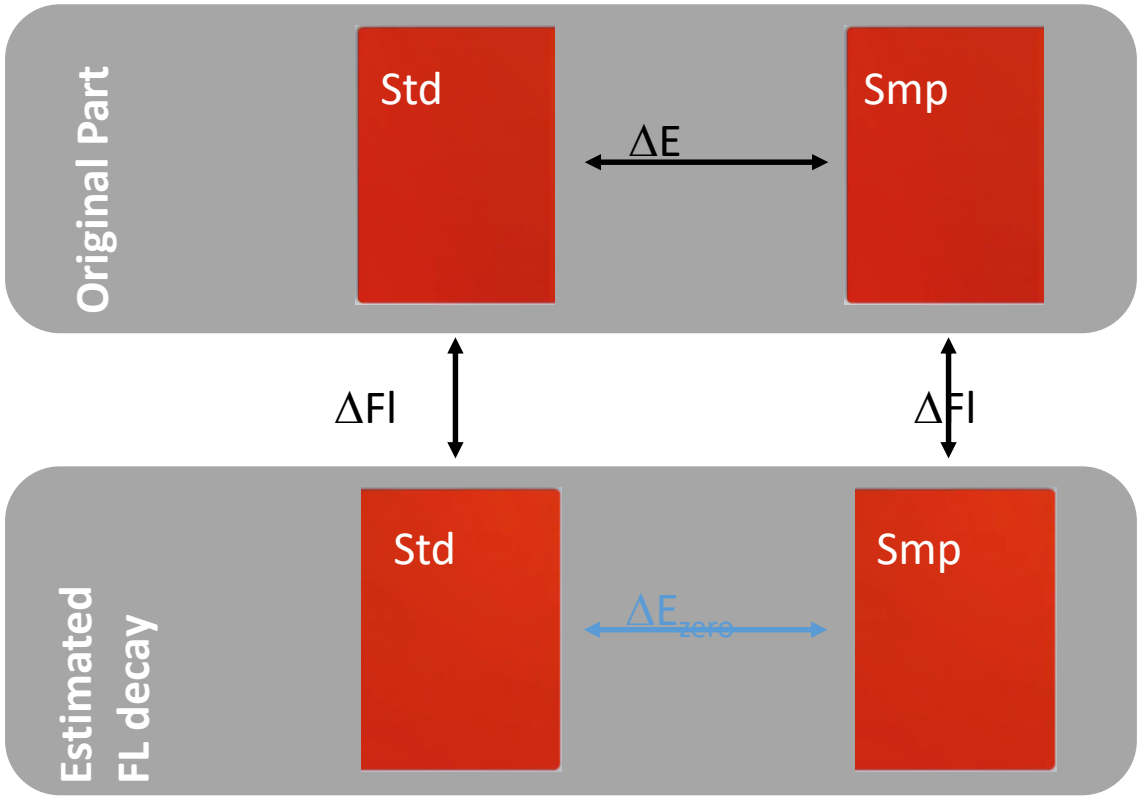
45°c:0° Geometry



- Monochrome illumination
  - 2 UV LEDs and 10 colored LEDs (360-660 nm)

Fluorescence Indices

- ΔFI - Indicates fluorescent energy emission
- ΔEzero - Estimates color change after fluorescence decay
- Enable quantitative tracking of fluorescence over time



ΔE = Sample - Standard

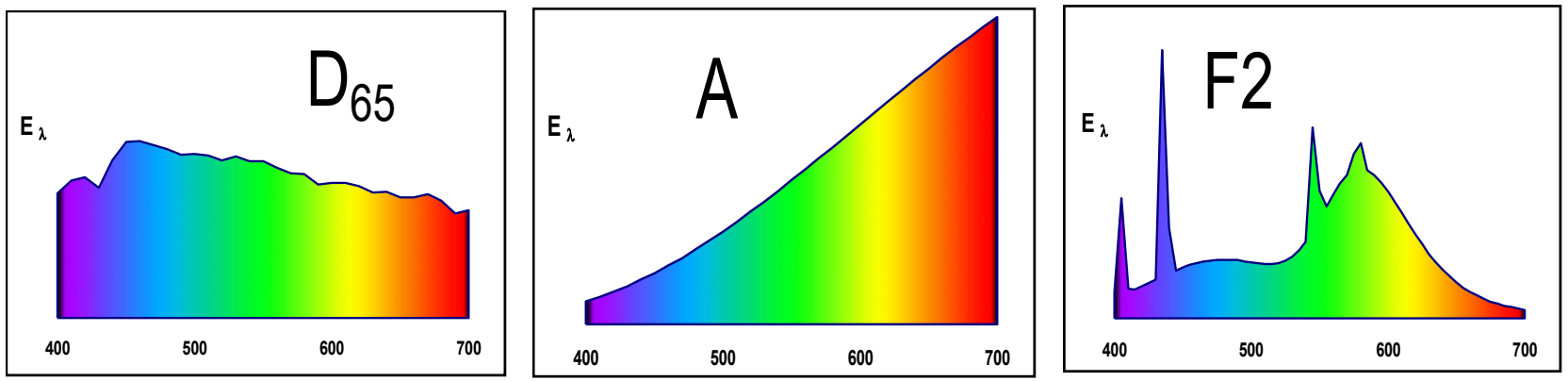
$\Delta E_{zero} = Smp_{zero} - Std_{zero}$

„zero“ = without Fluorescence

→ based on choosen color equation

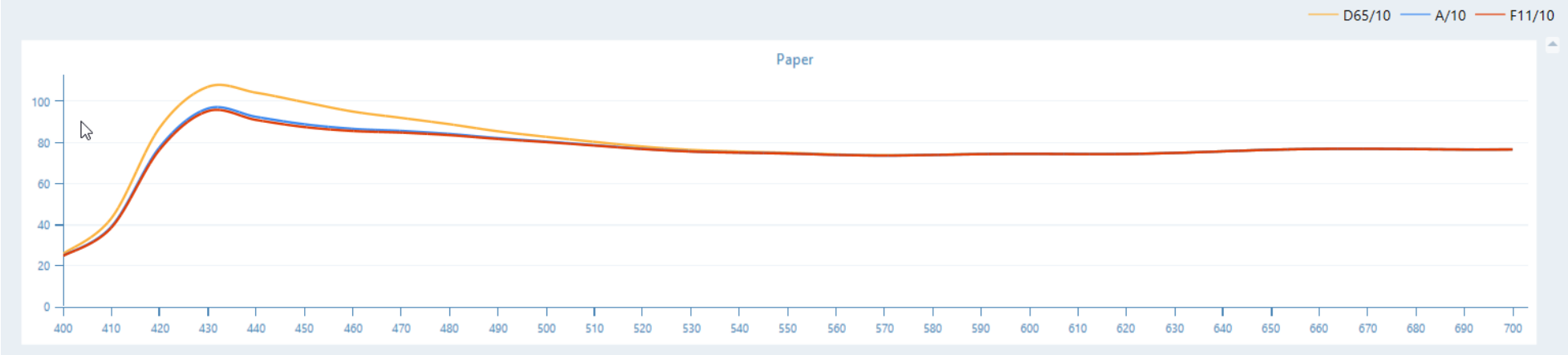
Different Instruments – Illuminants – Results

- Different illuminants (tungsten, xenon flash, LEDs) have a specific **S**pectral **P**ower **D**istribution (SPD)



Different Instruments – Illuminants – Results

- Depending on the SPD of a specific fluorescent pigment:
  - Will be excited differently by varying amount of light
  - Amount of emitted fluorescent light will also be different

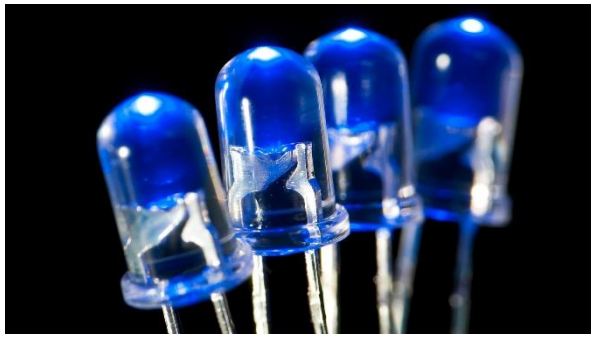


- The *unique fingerprint* for each color (spectral curve) is no longer valid for fluorescent material

Different Instruments – Light Sources – Results

- Depending on a light source a specific fluorescent pigment:
  - Will be excited differently by varying amount of light
  - Amount of emitted fluorescent light will also be different





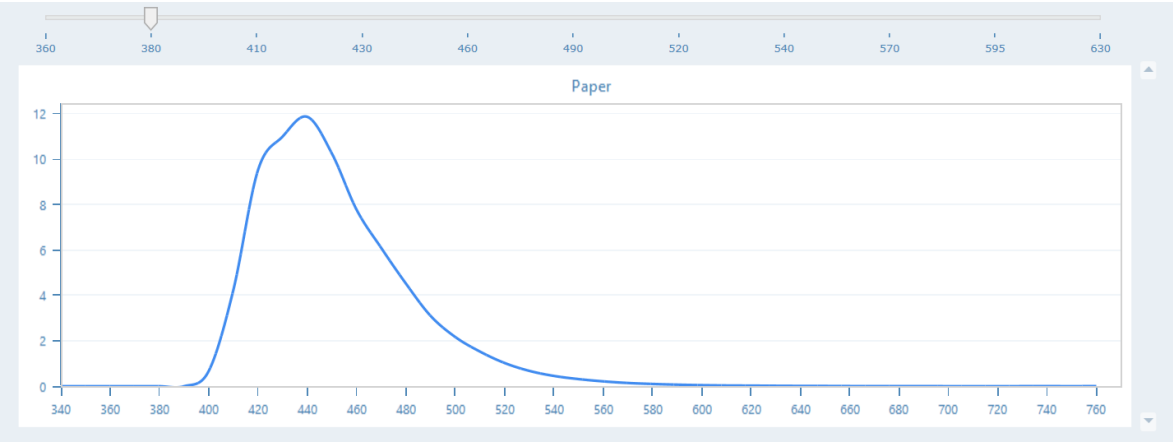
- Values measured with different spectrophotometers (different illuminants) are not comparable for fluorescent material

Predicting Color Stability

- Measure initial color and fluorescence
- Simulate long-term light exposure
- Calculate expected fluorescence decay
- Project final color after fluorescence elimination

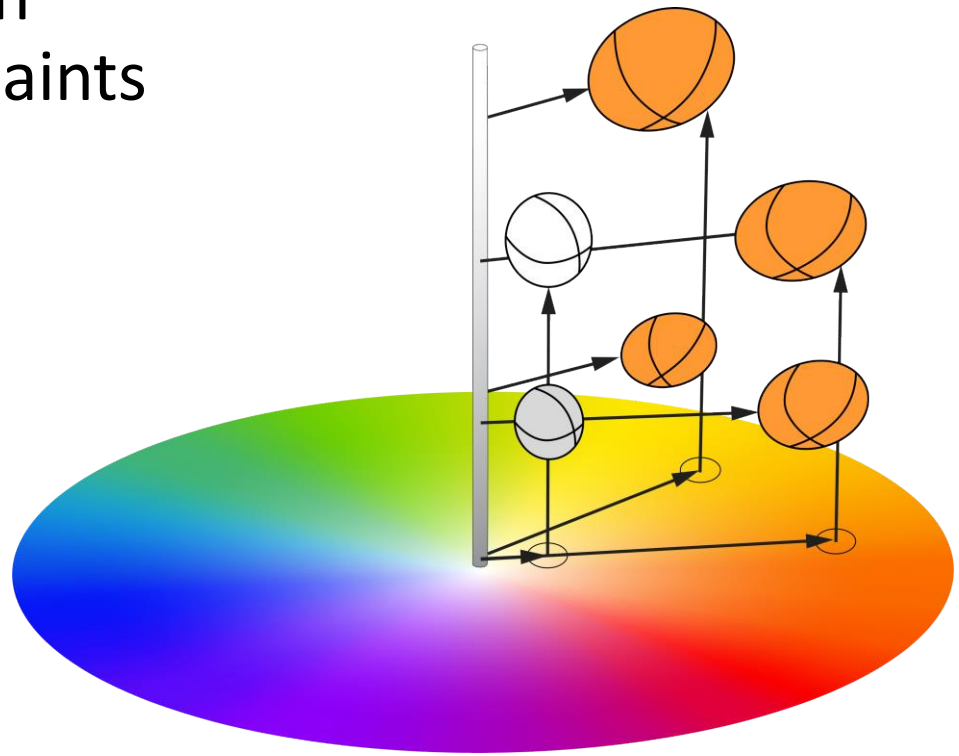
Quantitative Example

- Initial measurements: L*a*b*, gloss, fluorescence indices
- Accelerated weathering test results
- Projected color shift and gloss reduction
- Implications for color harmony in final product
- New technology graphs show fluorescence slider
    - For each monochrome LED the total spectral remission curve of the sample is shown (spectral remission at excitation rate + shifted fluorescent light)
    - Results of 12 LEDs can be toggled through by a slider for detailed analysis



Benefits of Advanced Color Management

- Early detection of potential color mismatches
- Improved quality control across manufacturing sites
- Enhanced long-term customer satisfaction
- Cost savings from reduced returns/complaints



Summary

- Color stability crucial for product quality
- New technology enables fluorescence prediction
- Combines color, gloss, and fluorescence measurement
- Allows proactive color management for better outcomes

Questions & Discussion

Jim MacDonald, Business Line Manager for Industrial Paint and Coatings,
BYK-Gardner USA
Jim.MacDonald@Altana.com