Optimizing Plastic Color Formulation:

SUSTAINABLE PRACTICES TO REDUCE WASTE

x-rite PANTONE®

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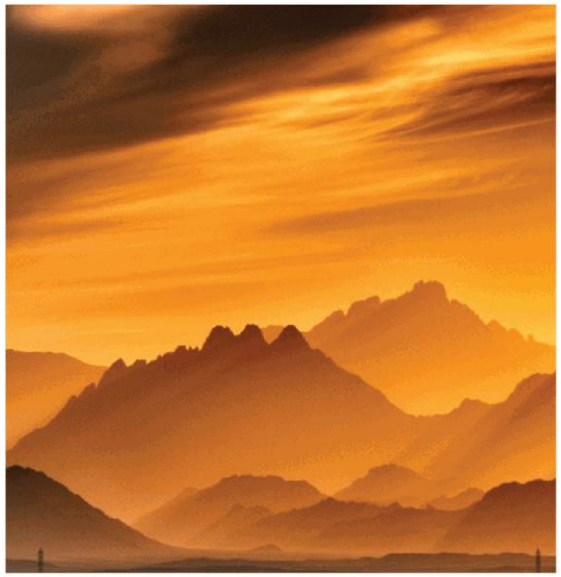


x-rite

PANTONE®

X-Rite Pantone
The leader in color science and technology.

- End-To-End Solutions to Control Color
- Leading Innovation for Color and Appearance
- 60+ Years of Experience
- Your Partner for Education, Consulting, Training, and Support

We enable customers around the world to achieve accurate and consistent color from specification throughout production.

What Our Customers Say About Us

AUSTIS

"…we can prepare five to six colors per day."

"The difference X-Rite solutions have made is unbelievable. It used to take two weeks to prepare a color – now we can prepare five to six colors per day. We cannot imagine life without our X-Rite solutions for color quality control, formulation and general color management."

MARCEL JANOVSKY,
PRODUCTION DIRECTOR

Ci62 + Color Formulation Software

CLARIANT

"…one colour, one formulation"

"Everyone wants to have one colour, one formulation that is the same throughout the world. We may advise them that one formulation is possible, but it also carries a much higher price tag. Often we help our customers reach a compromise that maintains the integrity of the brand at an affordable price."

PATRICK EMMEL,
HEAD OF COLOUR COMMUNICATION

Ci7800 + Color iMatch + NetProfiler

TEKNOR APEX

" …makes it the best choice as a partner for Teknor."

"X-Rite's focus on providing complete, end-to-end color measurement and management solutions makes it the best choice as a partner for Teknor and sets it apart from other companies in the color measurement and management space."

JOE ANDRADE
LAB MANAGER

Ci7800 + Color iMatch

Rewards of Enhancing Your Current Color Measurement Program

Improve Time to Market

New artwork can move through production up to 4x faster. Approval cycles are shortened, and minimal time is required to match colors across numerous substrates.

Align Physical & Digital

Set a clear, achievable color target for everyone to work from – from web design, to packaging, and beyond. This allows you to manage color expectations with high and realistic standards

Improve Quality & Compliance

A verified digital standard and technology-driven model gives you better insights to assess and evaluate the printers you use. This encourages transparency and builds trust in your relationships with printers

Optimize Spend

By reducing rework, you narrow your costs and turn those funds into profitability.

Consumer Products & Materials

Customer Challenges

In addition to trying to keep up with consumer trends, CP&M brands and suppliers must also contend with increasing demands for better color quality, limited resources, supply chain disruptions, staffing issues, and governmental concerns for the environment.

X-Rite Solution

Reevaluate and digitize the production cycle to improve color quality, minimize waste across the global supply chain. and create an environmentally-friendly process.

- Specify using physical and digital color standards
- Formulate using software that yields better matches in fewer steps and works off waste
- Measure using industry-leading handheld and benchtop spectrophotometers
- Control using QC and optimization software

Color Measurement for a Sustainable Workflow

The Key to Sustainability is Digitization

To compete in today's market, plastics brands, suppliers, and manufacturers must master digital color across a connected value chain. This means replacing prototypes with 3D virtual representations, utilizing recycled raw materials, achieving accurate formulations the first time, and monitoring color accuracy throughout production to catch color drift early.

Digitizing color and applying color management at each stage will ultimately pay for itself through effective color communication, faster production with less waste, and customer loyalty. It will also help us protect our planet.

An end-to-end lifecycle that focuses on color can help you:

- Fulfill your customers' color demands
- Ensure color consistency with varying batches of recycled raw material
- Accelerate material color and appearance approval
- Minimize color surprises at delivery
- Actively decrease your global footprint

Formulating Plastic Color

Essential Elements of Color Formulation

Pigments

Insoluble, finely ground particles that provide color by reflecting certain wavelengths of light.

Organic vs. inorganic pigments

Special effect pigments (pearlescent, metallic, fluorescent)

Provide **opacity**, **color strength**, and **UV resistance**

Additives

Specialty chemicals added in small amounts to improve or modify the properties of a formulation. They **enhance performance**, **extend shelf life**, **improve application**, or **protect the material**.

UV stabilizers, antioxidants, dispersing agents

Impact on color stability and processing

Resins

Resins are **binders or film-forming agents**—they hold pigments and other components together and help them adhere to surfaces. Provide **structure, adhesion, and durability** in coatings, adhesives, and plastics.

Types: Natural vs Synthetic

Affect gloss, hardness, flexibility and chemical resistance

Colorants

Colorants includes **both pigments and dyes**—any substance that imparts color to another material.

Types: Dyes (Soluble), Pigments (Insoluble)

Proper Technology and Tool Set for Optimal Color Formulation

Color measurement (spectrophotometers)

Software tools for formulation and prediction

Processing equipment: twin-screw extruders, injection molding machines

Importance of calibration and standardization

Tips and Tricks for Reducing Waste

Build and Maintain Your Formulation Library

- Building a data library **streamlines color formulation processes.**
- Data libraries **improve consistency and speed** in color matching.

Formulation libraries are databases of past color matches, pigment combinations, and processing parameters.

- **Benefits**:
  - Reduces duplication of effort
  - Speeds up development of similar colors
  - Provides a reference for troubleshooting
- **Best practices**:
  - Include metadata like polymer type, processing conditions, and end-use requirements
  - Regularly update with new formulations and outcomes
  - Integrate with digital color measurement for faster retrieval

Good documentation is a cornerstone of efficient and scalable color formulation.

Trial Minimization: Digital Color Matching & Predictive Modeling

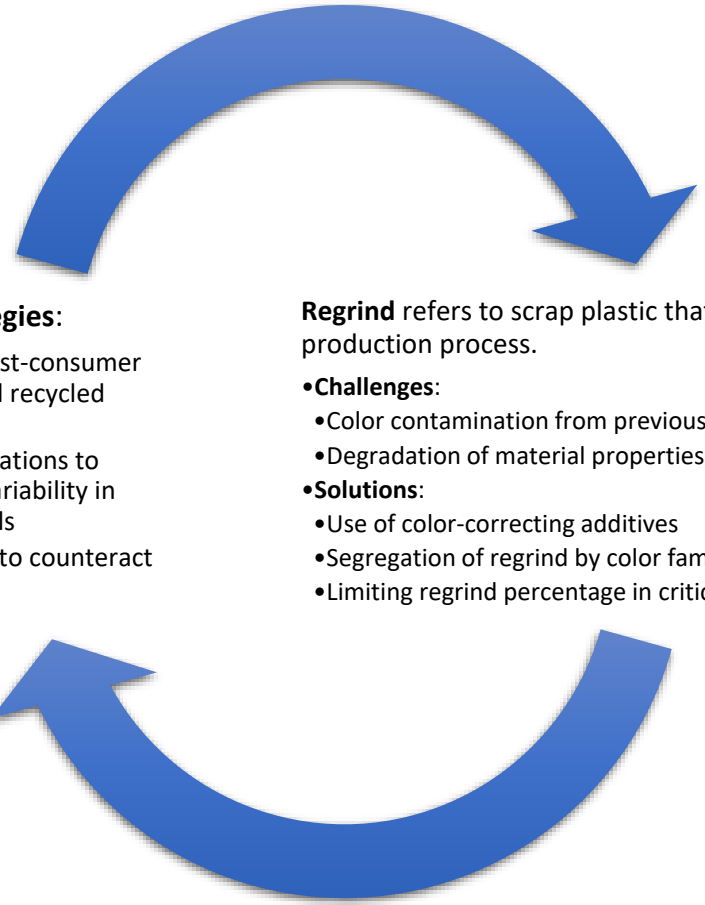
1. **Digital color matching** uses spectrophotometers and software to simulate how a pigment will appear in a specific polymer matrix.
    - **Advantages**:
        - Reduces the number of physical trials
        - Predicts metamerism (color changes under different lighting)
        - Saves time and material

2. Predictive modeling involves using historical data and algorithms to forecast how a formulation will behave during processing.

- **Applications**:
    - Predicting color shifts due to heat or shear
    - Estimating pigment loadings for target shades
    - Optimizing additive combinations

These tools help formulators make informed decisions before going into production, significantly cutting down on waste and cost.

Regrind and Recycling Strategies



Recycling strategies:

- Incorporating post-consumer or post-industrial recycled content
- Adjusting formulations to accommodate variability in recycled materials
- Using stabilizers to counteract degradation

Regrind refers to scrap plastic that is ground and reused in the production process.

- **Challenges**:
  - Color contamination from previous batches
  - Degradation of material properties
- **Solutions**:
  - Use of color-correcting additives
  - Segregation of regrind by color family
  - Limiting regrind percentage in critical applications

These strategies support sustainability goals while maintaining color qua

Common Challenges and Solutions in Plastic Color Formulation

Achieving Desired Color Outcomes

Challenges

Color Fading

Exposure to UV light, heat, or certain chemicals can degrade pigments over time.

Inconsistency

Variations in pigment dispersion, processing conditions, or raw material quality can lead to batch-to-batch color differences.

Contamination

Residual pigments from previous runs or incompatible additives can alter the intended color.

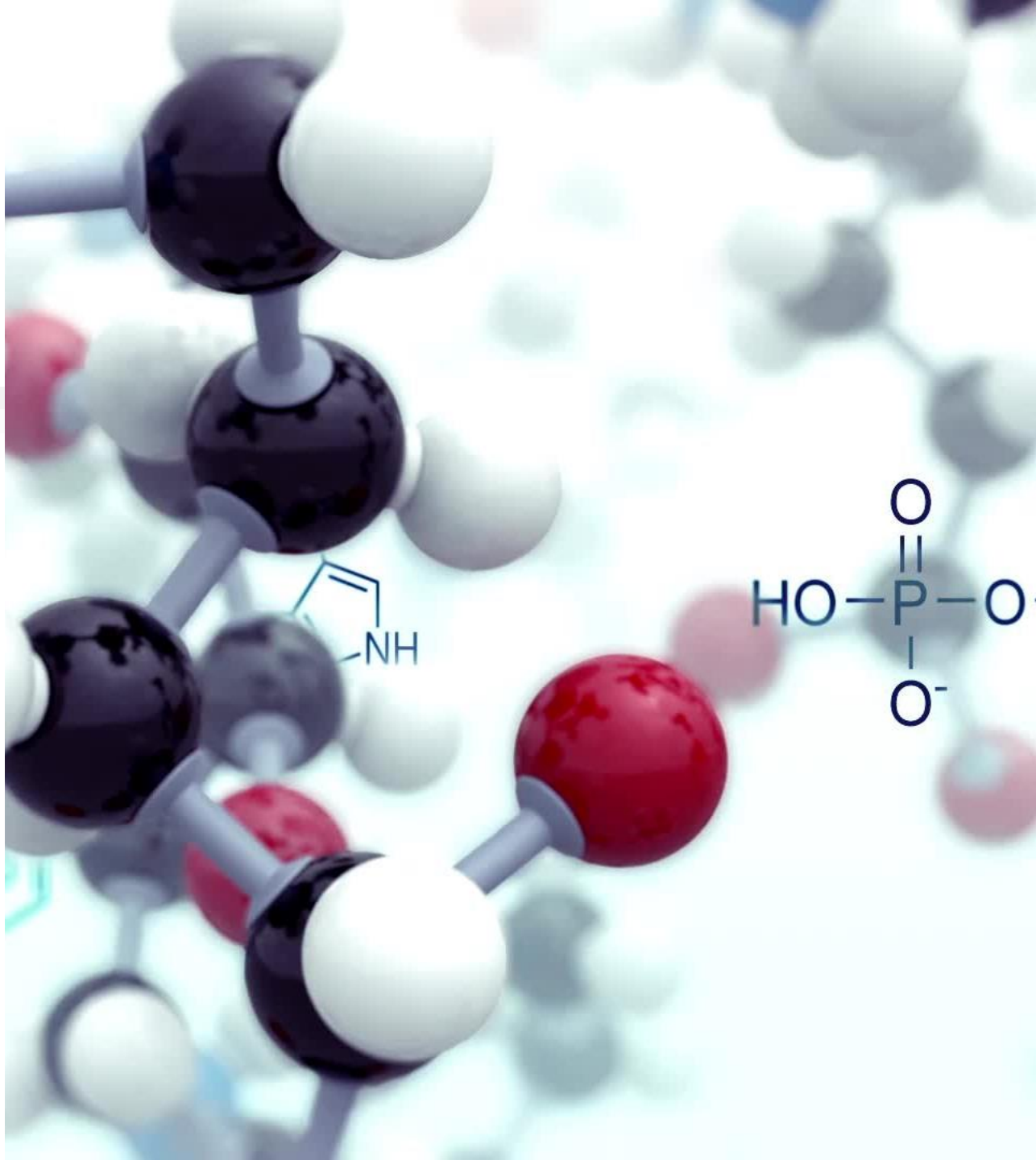
Solutions:

- Use **UV stabilizers** and **antioxidants** to protect pigments from degradation.
- Implement **tight process controls** and **standard operating procedures** to ensure consistency.
- Use **purging compounds** and **dedicated equipment** for sensitive or high-precision color runs.
- Employ **spectrophotometric analysis** to monitor and correct color deviations in real time.

Material Compatibility

- **Challenges:**
  - Different polymers (e.g., PP, ABS, PET, Nylon) interact differently with pigments and additives.
  - Some pigments may migrate, bloom, or not disperse well in certain resins.
  - Additive packages may interfere with color development or stability.

- **Solutions:**
  - Select **polymer-specific pigment formulations** or masterbatches.
  - Conduct **compatibility testing** during the development phase.
  - Use **carrier resins** in masterbatches that match the base polymer to improve dispersion.
  - Adjust **processing parameters** (e.g., temperature, shear) to optimize pigment performance.



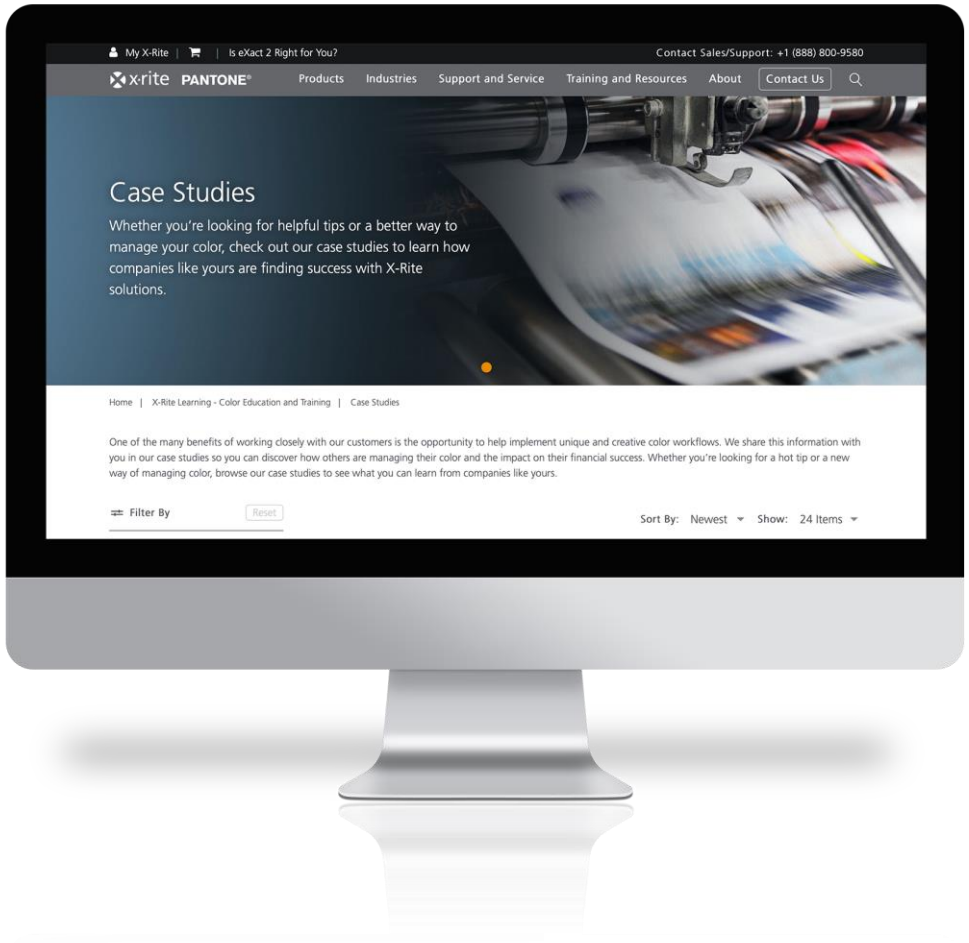
Environmental Factors

- **Challenges:**
  - **Temperature**: High processing or ambient temperatures can cause pigment degradation or color shift.
  - **Humidity**: Moisture-sensitive pigments or hygroscopic polymers (like Nylon) can affect final color.
  - **Light Exposure**: Prolonged exposure to sunlight or artificial lighting can lead to fading or yellowing.
- **Solutions:**
  - Use **heat-stable pigments** and **processing aids** to maintain color integrity at high temperatures.
  - Store and process materials in **controlled environments** to minimize moisture uptake.
  - Incorporate **light stabilizers** (e.g., HALS, UV absorbers) into formulations for outdoor or high-exposure applications.
  - Perform **accelerated weathering tests** to predict long-term color stability.

Certification, Consultation & Training

X-Rite Learning Center offers both in-person and online training from Solution Architects and Industry Experts to help you improve color quality and ensure your team is up to speed on industry insights, device specifics, and more.

- **Color iMatch Training**
- Online Learning
- Remote Training
- Seminars
- Consulting
- Onsite Training

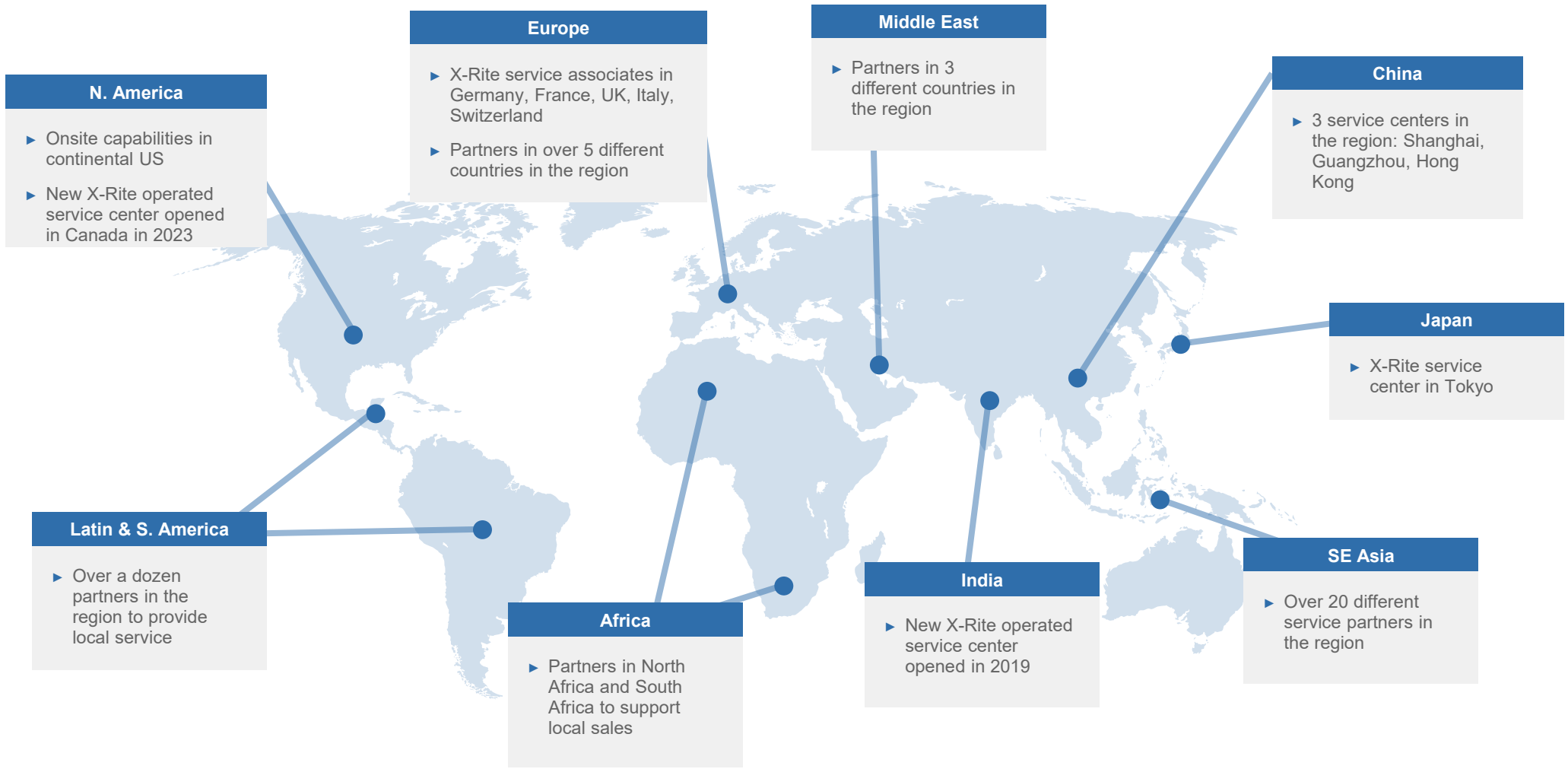


Color Education

Enhance the quality of your work and customer satisfaction with educational resources developed by our team of Color Scientists, Solution Architects, and Industry Experts.

- Webinars
- Whitepapers
- Application Resources
- Case Studies
- Color Blog

Regional Support & Service



N. America

- Onsite capabilities in continental US
- New X-Rite operated service center opened in Canada in 2023

Europe

- X-Rite service associates in Germany, France, UK, Italy, Switzerland
- Partners in over 5 different countries in the region

Middle East

- Partners in 3 different countries in the region

China

- 3 service centers in the region: Shanghai, Guangzhou, Hong Kong

Japan

- X-Rite service center in Tokyo

Latin & S. America

- Over a dozen partners in the region to provide local service

Africa

- Partners in North Africa and South Africa to support local sales

India

- New X-Rite operated service center opened in 2019

SE Asia

- Over 20 different service partners in the region

Ask Us Anything

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