

# Globalization— The Key Driver for Color and Appearance Evaluation Market



**P**aint and coatings manufacturers rely on the fact that their products enable their customers to differentiate themselves from competitors. Color is a critical aspect of the paint or coating that is providing the differentiation. Accurate and consistent color measurement at facilities located around the globe is necessary to achieve the level of quality demanded by consumers. Advances in software, combined with Internet access, are making it possible for international companies to meet local market needs while retaining central control of materials and data. The overall result is improved service at reduced cost.

## IMPORTANCE OF COLOR

Paints and coatings serve both protective and decorative functions. To the consumer, the immediate impact of a coating is its appearance. "Color is used to transform a sometimes 'colorless' object into something that is more aesthetically and visually pleasing. The color and

surface effects enhance the shape and/or texture of objects to be more pleasing to the consumer, architect, or designer," explains Norm Demers, applications support manager with Konica Minolta Sensing. "Humans are heavily influenced by our eyeballs and because of this paints and coatings have become the most efficient way of improving product aesthetics," adds Brian Failor, director of sales, North America, Automotive & Industrial, for X-Rite, Inc. "The coloration of a product is the most value-adding step typically done to a product and can greatly influence the perception of a product."

Most importantly, brand identification and perception of quality are closely linked to color and appearance of consumer items. "As humans see 'in color,' most will associate color (and appearance) of a product with its quality. They see and recognize these colors and automatically think of the brands they represent," notes Val Cosh, sales manager, Color and Appearance, with GTI Graphic Technology, Inc. "First impressions count and for

most products that first impression is visual," stresses Kenny Thomas, product manager, Paint and Coatings, with Datacolor.

"Depending on the product, appearance factors such as gloss, haze, or texture differentiate luxury products from commodities. These perceptions translate directly into economic value."

Consistency of color and appearance are also critical. Rob Morris, director of marketing and customer relations for Ocean Optics, Inc., stresses that "color and appearance are among the basic parameters of quality control in a number of different manufacturing industries, but in particular for paints and coatings." Variations in color are viewed as poor quality, according to Jan-Paul van Maaren, vice president and general manager of GretagMacbeth's Color and Appearance Business Unit. "The globalization of the supply chain is more apparent today than ever. It is increasingly important to consistently and accurately match component parts manufactured in different locations around the world," he says.

by Cynthia Challener, JCT COATINGS TECH Contributing Writer

"The uniformity or harmony among all individual parts is particularly important," adds Sandra Weixel,

business manager plastics/product manager color for BYK

Gardner. In the case of a car, she says, the exterior finish harmony between horizontal and vertical parts is critical. Equally significant is how add-on parts such as bumpers, spoilers, mirror housings, or other decorative trim parts match the adjacent

body panels. Differences are especially obvious on models with panels

having very tight fits to each other. The same

is true for appliances, electronics, and other consumer products.

## COLOR MEASUREMENT

The importance of color necessitates a means for accurately measuring it. "Each individual has a different perception of color, and it is very difficult to communicate that perception from one person to another," notes James Fusco, technical coordinator for Paul N. Gardner Company. The subjective nature of human color perception has several causes. According to Ms. Weixel, eye fatigue occurring with increased age results in objects appearing more red and yellow. Color perception is also influenced by moods, and gender plays a role in how people perceive things. To complicate the issue further, viewing conditions, including the light source and degree of light diffusion, and surface conditions also contribute to a person's perception of color and appearance. "Human perception of color is surprisingly variable. It is a psychophysical response to both light source and object," adds Mr. Thomas.

Instrumentation provides paint and coating manufacturers with a means to both measure color and communicate regarding color properties in an internationally accepted language. The international standard color system, the CIE Lab System, is based on three parameters. The L value corresponds to lightness, the B value to the blue/yellow content, and the A value to the green/red component of a color. "Current measurement technology objectively and reliably describes a product's color as well as the direction and magnitude of color differences," Mr. Thomas explains. "Modern color measurement systems directly describe an object's interaction with light. Two objects with identical interactions will appear to be the same color—to all observers—in all light sources," he adds. Mr. Cosh adds

that "being able to communicate color on an instrumental basis (i.e., spectrophotometer) using various color space equations (such as Chromaticity xyY, CIE Lab, CIE LCh, etc.) allows a coatings company to communicate directly with pigment suppliers about their needs."

Measurement of color is important not only with regard to consistency of the final product. Many paint and coating manufacturers rely on color measurement throughout the production process and even after the product reaches the retail store. "As paint and coatings producers modify formulations to meet new performance criteria and environmental regulations, they must continue to meet customer expectations for aesthetics," says Mr. Failor. He also notes that there are many processes, from the paint formulation to the application of the paint, which can impact the final color of the paint. "Color measurement tools and formulation software, which are not tricked like the human eye, provide an objective technique for monitoring and assessing color at different stages of the process to ensure an aesthetically pleasing end product."

Monitoring processes can have additional benefits as well. "Reasonably inexpensive optical sensing equipment can make it feasible to more efficiently evaluate color throughout the production run, which can ensure less waste, improved processes, and overall better control of the final product," states Mr. Morris. One example is the use of color measurement to detect process variations. "Analysis of color, especially spectral analysis, is a very useful tool for diagnosing causes of process variation, and can allow for effective prediction of process changes and enable producers to maintain properties within customer acceptability limits," comments Mr. Thomas.

On the retail end, some paint manufacturers have used color instrumentation and formulation software to create an interactive color matching experience for consumers. "Not only do these systems allow the consumer to perform the color match themselves, they can view the colors in a virtual room and are supplied with recommended complementary colors for trim and accent," explains Mr. Cosh. "The end result is that coating producers distinguish themselves and their products from others in the marketplace."

Whether used in the manufacturing setting or a home improvement store, color measurement instrumentation today consists of much more than just the measurement device. "Instruments do not work in an isolated environment anymore. Software and middleware, plus global connectivity through the Internet, are making it possible for paint and coatings producers to offer a much wider range of colors while exercising increased control," state Mr. van Maaren. Spectrophotometers are the most com-

mon instruments used today. Colorimeters, gloss meters, and light booths are also standard equipment.

Spectrophotometers are available in benchtop and hand-held versions and come with a range of software capabilities depending on the manufacturer, according to Hal Good, director of marketing services with HunterLab. X-Rite's Mr. Failor adds that "coatings are so diverse in their application, which can achieve such varying visual effects (from special effect coatings in the automotive industry to trade-sales paints we use in our homes), that instrument selection is important to achieving necessary results." Portable instruments are receiving a lot of attention, according to Mr. Fusco. "Portable devices provide a means to gather reliable data quickly in a wide range of locations. The data can be evaluated at the time, or taken back to the lab and downloaded for more detailed analysis and historical comparison."

Spectrophotometers work by resolving light reflected from the surface of the coating into its spectral components. A photoelectric detector quantifies the reflected light. "To fully characterize special effect colors, spectrophotometers with different angles are needed," notes Ms. Weixel. A variety of instrument geometries are available including 0/45 or 45/0, Spherical, Multi-Angle, 0/0, and 0/30, with many existing in both contacting and noncontacting designs. "Many coatings companies use Spherical or 0/45 geometry instruments interfaced with software to do color matching (formula prediction). Automotive coatings containing special effect pigments require the use of a Multi-Angle instrument," explains Mr. Failor. X-Rite also offers instruments designed to function in harsh production environments to enable real-time data collection.

Gloss and waviness are appearance properties measured by instruments. Glossmeters directly illuminate the surface and measure the specular reflection. Different geometries are also used in this case to get a clear differentiation over the complete range from high gloss to matte, according to Ms. Weixel. Waviness can be measured as well. BYK-Gardner's wave-scan DOI uses a diode laser source to illuminate the sample. The reflected light intensity is evaluated at the specular angle as the instrument is moved along the surface.

All of the instruments just described allow the user to quantify and assign values to the color and/or appearance of a coated product. According to Mr. Cosh, though, visual evaluation remains the most important analysis of color. "Even if quantified values for a color are within specification, they may not be aesthetically pleasing. Ultimately, a visual assessment under controlled lighting conditions using a Light Booth will clearly allow the coatings supplier to approve or reject a product."

## GLOBALIZATION DRIVES DEVELOPMENT

As for other suppliers and supporting industries for the paint and coatings market, consolidation and globalization of major paint manufacturers has and will continue to be a key driver for the color and appearance measurement sector. These changes present challenges as well as provide opportunities. "Color and appearance instrument providers face an ever-evolving need for producing extremely technical products that provide users with better, faster, and concise information in a package that can be easily implemented and used, regardless of background and training, by people around the world in real-time," says Mr. Failor.

Consolidation in the paint and coatings industry has meant that there are now a handful of companies dominating the market. GretagMacbeth and X-Rite have responded to this changing environment with a planned merger expected to be completed by July 5. "We have observed that customers of color measurement instrumentation and software in the coatings, textiles, digital photography, and other markets are growing in size. Technology is moving fast, too. We need to be bigger ourselves in order to be able to support these larger customers," says Mr. van Maaren. Mr. Failor adds that "the merger will enhance X-Rite's ability to deliver better systems to all markets and emerging markets not defined today."

As customers grow, they are also able to put more price pressure on their suppliers. "Paint and coatings manufacturers have gone from being regional to being global, and today they are making acquisitions in regions of the world where disposable income is growing," Mr. van Maaren notes. "The paint industry seems to be shrinking," adds Mr. Good. The global economy is having an impact as well. "With current exchange rates, U.S. products are more attractive in Europe, but unfortunately many European products have become out of reach for U.S. customers," explains Mr. Fusco.

A key impact of globalization has been the need for improved communication. "The ability to provide effective technical and industrial support across a global supply chain remains a key component of success for paint and coatings companies," underscores Mr. Thomas. Improving instrument repeatability and inter-





Photo courtesy of GTI Graphic Technology, Inc.

instrument agreement are also key issues, adds Mr. Demers.

The need for color consistency is the underlying driver for the market today for many reasons. Companies that are expanding into emerging areas of the world must be able to provide the legacy colors expected by the local markets, because the consumer links poor color consistency with poor quality, according to Mr. van Maaren. "These companies need assistance in developing formulations that will match colors based on desired materials."

"It is imperative that there be color consistency throughout the supply chain, thus presenting a challenge of economics: Does the coatings producer insist and specify that their suppliers use the same color instrumentation and controlled lighting that they do?" poses Mr. Cosh. "For some ven-

dors in the supply chain, high-end color measuring instrumentation may be too expensive for purchase. Conversely, losing vendor privileges with a large customer because they did not use the specified equipment would not be a financially sound decision. A compromise would have to be met to assure the quality and consistency throughout the supply chain."

As paint manufacturers become more global, they also need to be aware of varying country environmental regulations. Language is another issue with which they must contend. "Add in constantly changing software platforms and the advanced mathematical models used for color matching, and it is obvious that color analysis and formulation have become increasingly complex," Mr. van Maaren adds. "Many paint and coatings producers that previously relied on in-house software development are now turning to external providers."

## SOFTWARE DEVELOPMENT LEADS THE WAY

Advances in color measurement technology have largely occurred in the software and middleware provided with instruments rather than the optical capabilities. With parts being manufactured all over the world, and paint and coatings producers providing local support for their customers, the ability to routinely calibrate instruments in different plant sites, access central data for local applications, and communicate results

rapidly and efficiently is critical. Instrument manufacturers are focusing efforts on improving these aspects of their offerings.

Many of these latest developments revolve around the Internet. "Advances in online software have allowed for connectivity, without large infrastructure investment, between vendors, suppliers, and customers. The improved communications and real-time information help companies reduce costs with improved efficiencies and reduced support requirements," explains Mr. Failor. A reliable digital work flow is the key to the future for managing color and appearance measurement for global paint and coatings companies, according to Mr. van Maaren.

Datacolor designed its Datacolor SPECTRUM as a complete color information management suite to address the need for digital color communication, remote visualization, and more flexible deployment options throughout the supply chain, according to Mr. Thomas. "We have used our understanding of customer decision processes to balance ease-of-use and quick startup with flexibility and interoperability," he says. Datacolor also maintains an awareness of the different trends occurring in various segments of the coatings industry, and develops technology and methods to address resulting needs, such as customer retention, cost optimization in formulation, lower cost instrumentation for specific tasks, and color information management systems to allow more economy of scale.

The latest product from Datacolor is its color and formula-finding tool Datacolor SELECT2™, which can be combined with its DC 1005™ spectrophotometer, a lower priced instrument with repeatability (under 0.001DE CIE94) and inter-instrument agreement (under 0.4DE CIE94), according to Mr. Thomas. The Datacolor SELECT2 software includes unlimited formula storage, dispenser integration, and label printing and reporting. It also integrates seamlessly with the company's color harmony and visualization products, Datacolor COORDINATE and Datacolor DECORATE, and its monitor calibration tool, Datacolor SPYDER2.

GretagMacbeth's combined instrument, software, and middleware offerings are designed to provide a wholly integrated, reliable digital workflow utilizing the capabilities of the Internet. The new Color i37 is a fully automated spectrophotometer with embedded profiling that eliminates color variability in the design, specification, and production of products or product components, according to Mr. van Maaren. The instrument periodically prompts the operator to verify performance. If color drift is detected, the operator can quickly and easily correct the instrument onsite through NeuProfiler® 2.1, GretagMacbeth's Internet-based software application. "Traditionally, instruments

have been calibrated only once per year when sent back to the manufacturer. The instrument could be performing out of specification for an extended period of time under this system. Today, color match is so critical that this approach is unacceptable. With the Color i®7 and NetProfiler, calibration should never be an issue."

Color i®Match formulation software from GretagMacbeth is a rules-based system that provides worldwide access to a central database of information. Local plant sites can access the information using their local language to develop formulations specific to their customer base. Certain "jobs" can be created using specific filter criteria (country environmental regulations, UV properties, etc.) and saved for reuse. The information stored in the database can also be used to track trends and conduct analyses, both on a local and worldwide basis. "This software makes it possible for companies to reformulate products to meet local color demands using a limited set of pigments," Mr. van Maaten comments. "The multi-flux match engine is a powerful mathematical model that often enables the user to generate formulas that provide excellent color matches on the first attempt."

X-Rite offers Color Master Web Edition for Formulation and Quality Assurance, a product designed to enhance communication by working through the Internet. They also have recently released SpectroSync, profiling software that enables closer inter-instrument agreement throughout a manufacturers' supply chain.

Konica Minolta has been working with Ciba Specialty Chemicals to develop COLIBRI formulation software for the paint and coatings industry. "This comprehensive and powerful program is designed to solve many of the color formulation challenges facing the coatings industry today," Mr. Demers says. "One of the main features of this truly multi-flux software is the ability to perform color formulation for a wide range of applications including opaque, translucent, transparent stains, metallic, and special effect shades," he adds.

## PORTABILITY AND MORE

Other developments are related to the consolidation of different measurement capabilities into a single instrument. Konica Minolta's CM-2600d allows the user to evaluate a coating with and without the effect of gloss, without the need to recalibrate between measurements. The Spectro-Guide Gloss from BYK-Gardner incorporates a glossmeter and enables the measurement of color and gloss in one instrument.

Increased portability also remains a driver for technological development. "Miniaturization and au-

tomation are buzz words for the paint and coatings industry. Instruments need to become smaller and smaller, but with the same accuracy as large benchtop units. Developments in electronics make this goal increasingly achievable," says Ms. Weixel. Mr. Morris adds that advancements in the use of optical fibers have also made it possible to bring the instrument to the sample. Easier to use data collection and processing platforms have also contributed to increased portability of instruments.

X-Rite will be launching a new noncontact technology in the fall of 2006 that will give manufacturers the ability to cost effectively perform process control in a real-time mode for color and better improve and understand the variables that affect color in a process, according to Mr. Tailor. "The flexibility, ease of maintenance, and price point of this new instrument will inevitably lead to the ability to have closed loop control of the process variables that affect coloration of a product," he says.

Light booth producer GTI will introduce a newer version of its Professional Desktop Viewer (PDV) that will be "foldable" for easy transport, yet still include multiple light sources for critical color matching. "This PDV model will be extremely valuable to those who want to view color in a confined area and to those who want to have the ability to view color from one location to the next," comments Mr. Cosh.

GTI has also found that the ability to match digital colors with physical colors has been a key technology driver. "As more and more industries begin to use digital samples for end user viewing, it is critical that these digital samples closely match actual physical samples. It is important that the monitors being used are calibrated and profiled properly for creation and viewing of the digital sample, as well as the lighting conditions for viewing of, and matching to, the physical sample. At GTI, we offer the ability to control the intensity of light sources within our Color Matching Booths to match that of the monitor for the digital sample, with minimal effect to the color temperature of said source. This process is commonly referred to as 'Soft Proofing,' and we have seen an increase of interest and application of it in the coatings industry."

Several companies have also developed products specifically for the automotive coatings market. With BYK-Gardner's wave-scan dual, launched at the beginning of 2006, orange peel on medium-to-low gloss surfaces can be measured. For the automotive industry, substrate roughness can telegraph through the clearcoat and cause a "fuzzy appearance," according to Ms. Weixel. "Because e coat and primer coatings are often semigloss finishes, the only way to measure orange peel was by applying a clear tape, which is highly user de-

pendent and meaningful only for long wave values. With the wave-scan *dual*, medium-to-low gloss finishes can now be objectively measured, and the surface quality can be optimized and controlled after each coating layer."

X-Rite recently launched CarFlash, a system for automated collection of color and appearance information that streamlines information flow. According to Mr. Failor, this type of technology allows end users to see in real-time the impact a process parameter is having on the aesthetics of a product, and allows one to react before an unacceptable product is produced.

GTI's Color Harmony Inspection System (CHIS-1) is used to evaluate the color harmony throughout a vehicle from painted parts to molded parts on the exterior. "The system can be used to evaluate the color harmony inside the vehicle as well, something a traditional 'Harmony Room' cannot provide," Mr. Cosh notes. He adds that the CHIS-1 offers multi-angle lighting on a transportable frame that allows the user to place it throughout different areas of the vehicle for proper harmony inspection at a cost much less than that of Harmony Rooms.

## FUTURE DIRECTIONS

Further globalization and consolidation within the paint and coatings industry will continue to be the main drivers for technology development in the color and appearance market. Expansion of digital workflow may even increase the use of color in the future. "Color is very important to the consumer, and offers manufacturers a key point for differentiation. Traditionally, color management has been quite expensive, though, and has kept manufacturers from maximizing the potential use of color," asserts Mr. van Maaren. "With advancing technology that utilizes the Internet, we can develop much lower cost means of managing color changes. I foresee an explosion of color across a wide range of consumer product industries. Paints and coatings will be at the center of that growth."

New technology has improved our ability to measure and quantify color and has enhanced global communications. However, notes Mr. Cosh, it is imperative to remember that the primary factor in evaluating an item is how it appears to the viewer. "Basic color principles state there are three items needed to view color: an observer, an object, and a light source. Without any of these three items, color cannot be viewed." As software and middleware technology continues to advance, it will behoove those involved to remember this basic fact. 