Sustainability Revisited:

The Coating User Perspective

by Cynthia Challener
JCT CoatingsTech
Contributing Writer

Operating in a sustainable manner has become a priority for companies around the world. Suppliers of raw materials for coatings production and coatings formulators have incorporated sustainable practices into their daily business activities. Their customers, too, have corporate sustainability philosophies that directly impact coatings operations.

JCT CoatingsTech spoke with a number of coatings end users about how the desire of companies to function in a sustainable manner has affected their coatings activities, including coating selection, R&D efforts, application methods, and relationships with suppliers. Their thoughts are presented.

Contributors providing insight for the article include Ralph Huber, department manager for Technology Communications with the BMW Group; Jill Seebergh, associate technical fellow with Boeing; Andy Rogerson, senior chemical testing engineer at the California Department of Transportation (Caltrans); Mark Nichols, technical leader in the Paint Research, Materials, and Nanotechnology Department at Ford Motor Company; Tim Weingartz, head of Paint Material Development and Release at Ford Paint Engineering; Maureen Midgley, executive director of the Global Paint & Polymers Center at General Motors; Joyce Dever, chief of the Durability and Protective Coatings Branch (RXD) at NASA's Glenn Research Center; Luz Marina Calle, lead scientist for Corrosion Technology with NASA's Kennedy Space Center; and Jim Gregory, general manager of St. Charles Cabinetry.

Above photo courtesy of General Motors.

JCT: ***Has the incorporation of sustainable practices affected the choice of resins, additives, or overall formulation types you use in your coating operations?***

Jill Seeburgh, Boeing: Boeing has set aggressive and transparent enterprise-wide performance targets to drive environmental thought and action throughout our operations. By 2012, we are targeting 25% improvement goals for solid waste recycling rates, energy efficiency, greenhouse gas emissions intensity, and hazardous waste reduction at our major manufacturing facilities.

As one part of our efforts in this area, we are developing alternative materials and processes for manufacturing and maintenance—including coatings technologies. Boeing uses both waterborne and high-solids formulations that meet federal, state, and local regulatory requirements. While these current systems represent a significant reduction in VOC content, we continue to aggressively develop and evaluate zero-VOC technologies, including UV-curable coatings, powder coatings, and appliqué (extruded organic films).

At all times we must consider the needs of our worldwide base of customers, partners, and suppliers and the various EH&S requirements found in different locations. So we must formulate new technologies that are proactive to respond to all scenarios. Of course, the environmental solutions that we come up with will have far reaching impact across that network.

Specific key initiatives with respect to reformulation have included high-solids coatings, elimination of hexavalent chromium from corrosion-inhibiting conversion coatings and primers, and replacement of toxic pigments such as cadmium and lead.

Ralph Ituber, BMW Group: The BMW Group's focus at all sites is on water-based paints with low-solvent content. Our Munich plant's VOC emissions level is 25% below the legally prescribed limits. At our MINI plant in Oxford, we have implanted our Integrated Painting Process (IPP), which completely eliminates the primer coat application and oven stage, resulting in reduced use of solvents. IPP brings energy savings and a reduction in emissions in the paint shop of well over 10%. Beginning in late 2007, our Landshut, Germany plant, where plastic components are produced, began using a waterborne clear paint, reducing solvents in the exhaust air by 85%.

Furthermore, powder based paint technology is used for the last coat of paint at BMW's Regensburg, Dingolfing, and Leipzig plants. With this technology, neither water nor solvents are required for clear paint application. Thus, no wastewater is generated, nor does the paint shop equipment need to be treated with chemical cleaning agents. Furthermore, application by means of high-rotation bell sprayers with direct recycling of excess material in a closed system ensures almost total use of the powder.

BMW also uses as part of its Clean Production program a hydrofiller system, which is a water-based filler material that reduces solvents by 67% compared with conventional filler materials. In this stage of the paint process alone, the hydrofiller system is able to save approximately 247 tons of solvent a year in the BMW plant in Dingolfing. At the same time, this material enhances both appearance and functional quality.

Mark Nichols, Ford Motor Company: Several years ago we initiated a program called the "Factory of the Future." This program entailed evaluating all available coating technologies in terms of how they might affect the environment, our customers, and the company itself, and was carried out in partnership with our supply base.

With the data gathered during this study, we determined that the most effective approach going forward for Ford was the use of a high-solids 3-wet process. This technology provides both an ecological and economic benefit, and therefore is a prime example of our commitment to sustainability.

Maureen Midgley, General Motors: Coatings manufacturers have been focusing on VOC reduction in response to continuously stricter regulatory requirements. But the CO_2 footprint of painting operations must also be considered. In the case of automotive coatings, waterborne is not necessarily the best choice when CO_2 emissions are taken into account. Water must be flashed off, for example, which consumes a lot of energy. The industry is grappling with these issues; both factors are in the decision matrix.

At GM, we have successfully implemented a 3-wet solvent process in one of our Mexico plants, as well as designed and validated a 3-wet waterborne process for future plants. Many of our plants are also converting to the new thin film pretreatment technology that reduces heavy metals and requires less water and energy, providing significant dollar savings while benefiting the environment.

Andy Rogerson, Caltrans: At the California Department of Transportation, our philosophy for over 30 years has been to use materials and processes that minimize environmental impact and maximize performance, so sustainability isn't a new concept for us. We are dealing with the public, of course, and must consider the impact on the safety and health of large numbers of people when developing coating formulations and considering application requirements. Most of the coatings we use today are waterborne. Some are solvent-based, but currently we are evaluating the health and safety aspects of some exempt solvents.

Joyce Dever, NASA Glenn Research Center: The Durability and Protective Coatings Branch at NASA Glenn focuses on materials for high temperature aerospace applications. Our current projects include coatings for high temperature components of aircraft engines and coatings for leading-edge surfaces of vehicles re-entering the atmosphere from space. These efforts are part of an overall aeronautics program to enable future aircraft with improved fuel efficiency, lower emissions, and lower noise.

Specifically, my branch develops coatings that are oxidation-resistant thermal barrier and environmental barrier coatings that must be durable to temperatures which can exceed 2000°F and retain their properties under these conditions. There are limited materials that can survive these temperatures and serve as protection for the underlying substrate material. Most are ceramic oxides that are applied onto a component through plasma deposition methods or vapor deposition processes. Mitigation of environmental impact is incorporated into the coating deposition process. For example, dust collection devices are used to keep the fine powder particles contained.

We also have strong in-house testing expertise including laboratories that simulate application environments with respect to high temperature, combustion, mechanical load, and other factors. We develop models to assess the lifetime of coated components and the effect that coating degradation would have on the life of the underlying substrate materials.

JCT: ***Has the focus of your R&D efforts been noticeably changed as a result of the need to develop more sustainable coatings systems?***

Andy Rogerson, Caltrans: Our R&D efforts focus around development of formulations to meet regulatory requirements. We need to do this ourselves because the paint manufacturers typically do not introduce new paints until the regulations go into force. We need to know that coatings will perform to our specifications well in advance of the change in regulations, so we have to develop our own formulations.

Maureen Midgley, General Motors: Seventy percent of the environmental impact of an automotive assembly plant is generated in the paint shop—that includes energy consumption, VOC emissions, CO_2 emissions, water consumption, and waste generation. So, at GM, we are looking very closely at our paint operations to identify opportunities for reducing chemical use in whatever way possible and for finding ways to minimize the temperature necessary for curing coatings.

Every single process is under investigation, from pretreatment and electrodeposition primer, to the topcoat and sealers. We are also doing a lot of process development work to identify ways of reducing or optimizing the requirements for additives in our coating formulas.

Water usage is another area of focus. We believe that water consumption will become an increasingly significant issue as this resource is limited. As a result, we are working on development of new technologies to help reduce the amount of water required by our painting operations. To date, we have successfully implemented a new program in five of our plants, including our plant in Australia, which is located in an area that has suffered drought conditions for the last five years. The new program has achieved a 20% reduction in water consumption at the site.

Tim Weingartz, Ford Motor Company: In the coatings group, we hold true to the three core elements of sustainability—social equity, economic benefit, and minimal ecological impact, which roughly translate to quality, cost, and environmental performance.

Running a sustainable paint shop is an important issue for Ford. Reducing wastewater, recycling materials, lowering our energy consumption—these are all considered when we look at any new project.

Today, all projects now begin with a lifecycle analysis. We have developed our own tools for evaluating materials and processes with respect to their full impact on the environment. And we get a great deal of support for these activities from our suppliers, who provide the information we need on the coatings that we use.

Near term, Ford is focused largely on reduction of energy consumption. The paint shop is the biggest consumer of energy in the whole plant, so we are focusing our efforts on this area and are evaluating a number of different technologies.

Boeing 787 *(photo courtesy of Boeing).*

Jill Seebergh, Boeing: More than 75% of Boeing Commercial Airplanes' research and development effectively contributes to improving the environmental performance of our products.

New coating technologies are identified, developed, and evaluated based on a lifecycle view of environmental impact. This includes the

characteristics of the materials themselves (e.g., no VOC, low VOC, bio-derived); requirements for application, maintenance, removal, and disposal; and the potential for the coating to enhance vehicle performance (e.g., weight reduction, drag reduction). Improving durability is a key initiative, whereby the environmental impact of maintenance and depaint/repaint operations is reduced by significantly extending the service life of the coating system.

For the 787 airplane program, Design for the Environment (DfE) considerations were included early in the airplane development and design processes, and the requirements resulted in increased utilization of existing environmentally preferred materials and processes

(low-VOC coatings, and chromium and cadmium alternatives). In addition, the extensive use of composites (with the improved fatigue and corrosion resistance) has allowed us to reduce the use of hexavalent chromium for corrosion inhibition (exterior primers and sealants) on the 787.

Luz Marina Calle, NASA Kennedy Space Center: During the Apollo program, we discovered that the space center in Florida is located in one of the most corrosive environments in the world. As a result, we established an atmospheric exposure facility near the launch pads to evaluate coatings and began establishing standards and qualifying procedures for commercial materials for use on the launch pads and ground support equipment. Today, we know that we must consider corrosion issues at the design stage, rather than after a failure, and our corrosion lab has evolved into a center for development of novel protective coatings.

As our knowledge of corrosion has grown, so has our understanding of the impact of corrosion and protective coatings on the environment. During the early stages of the space program, we concentrated on solving our corrosion problems and sought the most protective coatings, which at the time included components that are now banned or limited in their use due to the harmful effects of some of their components on humans and the environment.

As we search for new corrosion protection solutions today, we are incorporating sustainability as a key part of our research activities. The new Constellation program at NASA, which will replace the Space Shuttle program, requires new launch rockets, launch pads, and support equipment, and will also require new protective coatings.

For the first time, we are conducting an analysis of lifecycle costs for all aspects of the program, including the coatings. It is very important to NASA that the Constellation program be sustainable and achieved at minimum cost.

Our research is focused on development of a smart coating that can detect corrosion when it occurs and respond by releasing a corrosion inhibitor. The presence of corrosion is indicated by a color change. The system will decrease costs by reducing inspection time and through prevention of extensive damage due to corrosion.

Our group is also developing a refractory material for protection of the flame deflectors at the launch pads. We have had problems with these materials throughout the Space Shuttle program and now are looking for an alternative material that will meet both safety and sustainability requirements.

JCT: ***Have you seen noticeable changes in application technologies that can be directly linked to the need for more sustainable coatings operations?***

Jill Seebergh, Boeing: Boeing uses or is developing environmentally progressive processes for application and removal of coatings. For example, "paint-on-the-line" technologies allow coatings to be applied and cured on the production line, eliminating paint booths and their associated energy requirements as well as reducing production flow time by not having to move aircraft from production line to hangar and back.

For coating application, we use electrostatic spray guns to reduce waste and we are evaluating technologies such as Nitrotherm to reduce coating consumption. We are also developing in-mold coating systems for composites to eliminate the necessity for spray application.

We have recently begun to use water-based spray-on/leave-on coatings in lieu of abrasive sanding for surface preparation of 737s, which reduces hazardous waste as well as ergonomic injuries. Depainting is also a big issue for us, so we continue to develop and evaluate paint removal methods that eliminate the use of toxic materials such as methylene chloride.

Maureen Midgley, General Motors: One example of a new application technology is our bell-bell application. This system significantly reduces the amount of material required in the coating process, and

also allows for reduced downdrafts in the paint booth, which saves energy.

Joyce Dever, NASA Glenn Research Center: Our high temperature coatings are generally applied by plasma spray coating or vapor deposition—these are one-step processes. For coatings which require multiple layers, we can sometimes apply multiple layers in a single run. We are also pursuing advanced deposition processing techniques that will allow multiple layers of different types of coatings to be deposited in a single run. By keeping the processing of multilayer coatings to a single run, power and cooling water are minimized and the coating properties are improved. Also, wherever possible, recirculating cooling water baths are used to reduce water consumption.

JCT: ***What about recycling?***

Mark Nichols, Ford Motor Company: Recycling of paint sludge is an issue that Ford is closely evaluating. There are some solutions out there, but none are perfect yet. We want to find ways to reuse these materials and convert them into value added products. To that end, we are looking at both the materials and processes that we use and seeing opportunities for changing them so that our sludge and other "waste" products can be made more reusable.

Maureen Midgley, General Motors: At GM, we have a goal of recycling a minimum of 95% of materials we use in the paint shop. At this point we have surpassed that goal, attaining a level of 97–98%. This has been possible by working with companies that need inert material as filler. Our paint sludge has been an ideal solution for them.

Jill Seebergh, Boeing: As of December 2008, all of Boeing's major manufacturing sites have been certified to the ISO 14001 environmental management system standard. This provides a common approach for continually improving environmental goals for reducing pollution and waste, increasing recycling rates, and improving energy efficiency. With respect to recycling associated with coating materials and processes, one example is provided by the Boeing site in St. Louis, where paint and solvent waste is sold and recycled for power generation.

JCT: ***How has the growing importance of sustainability affected your relationship with coatings suppliers?***

Jill Seebergh, Boeing: Boeing maintains strong relationships with aerospace coating suppliers, working collaboratively to develop and test new and improved products. These partnerships allow us to leverage the latest technologies developed in the coatings industry, including those that pertain to sustainability. Boeing also has an enterprise environmental strategy to "inspire the aerospace industry through action and collaboration," which applies to our interactions with the coating supply base.

Tim Weingartz, Ford Motor Company: We have a great relationship with our three major coating suppliers in North America and with other paint formulators from around the world. And that positive interaction helps make our job all the more exciting. These companies are facing the same issues that we are, and therefore we are very much in tune with each other regarding sustainability efforts and goals.

At Ford, we are also working closely with automation suppliers to execute a lean approach to coatings application. The innovations these firms bring to the table are also very exciting and have a direct impact on waste reduction, maximization of material usage, and minimization of water and energy consumption.

Maureen Midgley, General Motors: Sustainability has strengthened the relationships we have with our suppliers. They all have the same concerns for the environment that we do, and even small improvements that they make in coating materials or application technology can provide dramatic benefits in our operations. I am not aware of any key suppliers that aren't working on sustainability issues such as carbon footprint, VOC reduction, and recyclability.

What we have with our suppliers, in fact, is a very symbiotic relationship—we need each other to ensure that efforts are focused on development of the right products. Suppliers need to know what we are looking for, and we need to be aware of the advances they are bringing to the table. As a result, it is crucial that we work closely together.

JCT: ***What, if anything, would you like to see from coating formulators that would enable you to more effectively pursue your own sustainability initiatives?***

Maureen Midgley, General Motors: We would like to see the coating manufacturers and equipment manufacturers work more closely together so that coatings producers

don't introduce new formulas that require new application equipment to be developed.

As far as coatings technology goes, we would also like to see coatings that don't require energy—or at least require much less energy—to cure. UV- and plasma-cured coatings are being developed, but we would like to see this technology, or other alternatives, brought to market much more quickly.

In the longer term, there are state governments that would like to mandate cool paints that prevent heat from passing into the vehicle. Why not more sophisticated coatings that can transfer heat energy to the car battery, providing energy for the car?

Andy Rogerson, Caltrans: We would very much like to see paint manufacturers introduce new products well in advance of the time when new regulations take effect so that we can have an opportunity to evaluate their performance. It would also be nice if more paint companies offered products that meet the requirements of California's South Coast Air Quality Management District (SCAQMD) so we would have more products to choose from.

Joyce Dever, NASA Glenn Research Center: NASA Glenn strongly supports environmental management, including working with vendors who value recycling and environmentally friendly practices. It is helpful when vendors use their websites to describe their environmental management practices.

JCT: ***Are there any particular coating-related developments that you would like to mention that highlight your efforts with regard to sustainability?***

Jill Seelbergh, Boeing: Reducing the environmental footprint, improving performance, and reducing the costs of aerospace coating operations are not necessarily mutually exclusive objectives. The implementation of non chromated sol-gel surface treatments for the exterior decorative painting process of Boeing commercial airplanes succeeded in improving adhesion as well as in eliminating hexavalent chromium and the associated contaminated rinsewater. Likewise, the basecoat/clearcoat technology we are evaluating for exterior applications holds promise for improving durability and reducing hangar flow time as well as for saving energy costs associated with application.

Mark Nichols, Ford Motor Company: Almost all projects we are working on at Ford today are related in some way to lean processing. In our paint operations, our new zirconium oxide pretreatment process eliminates steps and significantly reduces water and energy consumption while replacing heavy metals with more environmentally friendly ingredients. Our wet-on-wet processes eliminate steps in the painting process, too, which reduces energy consumption, CO_2 production, and VOC emissions.

Andy Rogerson, Caltrans: We have established standards for coatings used on bridges and other infrastructure that eliminate the use of lead and chromium. Most recently, we have published revised specifications for glass beads used in traffic paints. The new standards affect the allowable levels of arsenic, antimony, and lead in the glass beads.

Separately, with regard to application of coatings on public structures, we only use contractors certified by the Society of Protective Coatings (SSPC). This requirement helps ensure that contractors doing work for Caltrans are aware of all environmental, health, and safety regulations plus have knowledge of the best practices for minimizing the environmental impact of the paint job.

Jim Gregory, St. Charles Cabinetry: St. Charles Cabinetry, a division of Viking Range Corporation, introduced in April 2008 a new full-overlay line of cabinetry made of brushed stainless steel and powder-coated cold-rolled steel. These products offer consumers colorful, eco-friendly, and hypoallergenic cabinetry. They are not only aesthetically appealing (they come in 23 different colors) and intuitively functional, but also have the lowest possible environmental impact throughout the manufacturing process and when in use. No VOCs are emitted during the coating process and the coated cabinets also do not "off-gas" VOCs into the air.

Through the quality improvement of our powder and color control we have been able to achieve a massive 30% reduction in reject rates, not only improving the environment and sustainability of our resources, but also having a huge cost savings in the process through higher productivity. CT