green decisions

What a tangled web we weave when first we design with the environment in mind. By Jean Thilmany

ifecycle science is a complex and, until recently, fairly obscure field of endeavor.

But the exploding green movement, a host of environmental compliance laws, and the adoption of green principles within the building industry have pushed lifecycle analysis into the forefront of manufacturers' minds as they become more focused than ever on green design, production, and distribution.

Many manufacturers also need to comply with a tangled web of regulations, verify compliance, and home in on design, manufacturing, and shipping practices to isolate methods ripe for environmental cleanup—all much easier said than done, of course.

To help, product manufacturers are now taking a page from the building and construction industry, which formalized green building methods in the late 1990s. The Leadership in Energy and Environmental Design Green Building Rating System, developed in 1998 by the U.S. Green Building Council of Washington D.C., set standards for environmentally sustainable construction. Now, architects and others in the building industry can pass an exam to become LEED certified.

While green manufacturing standards don't exist, manufacturers are responding to customer demand for environmentally friendly products. And manufacturers in certain industries—notably automotive and electronic—must comply with a growing list of environmental mandates, said Peter Bilello, vice president of product lifecycle management consulting firm CimData of Ann Arbor, Mich.

The mandates include the European Union's Restriction of Hazardous Substances Directive, or RoHS, which restricts six hazardous materials, including cadmium and lead, in the manufacture of various types of electronic and electrical equipment. Likewise, the EU's Waste Electrical and Electronic Equipment Directive, or WEEE, puts the responsibility for the disposal of waste electrical and electronic equipment on manufacturers.

For automaker's EU's End-of-Life Vehicle Directive specifies the materials and chemicals that can be included in particular amounts in automotive parts. By 2015, about 90 percent of a vehicle must be recyclable, according to the Automotive Industry Action Group of Southfield, Mich.

"If a company's market is in Europe, they'll have to care about this," said Marc Halpern, a research director at Gartner Group, an information technology research company.

Gathering the Numbers

So where does a manufacturer start in order to get greener? The task can seem overwhelming. The answer lies in analyzing and managing the life of the product, from design through disposal, Halpern said.

"Lifecycle management is a discipline for guiding products from ideas through retirement to create the most value for businesses," Halpern said. "It has to do with overall strategy of a company, what products they introduce and retire."

The reasoning goes like this. By analyzing the entire product lifecycle, manufacturers get a bird's eye view of every step the product takes. By considering the environmental ramifications of each individual production step, manufacturers can do away with waste and create the greenest product possible, he said.

Sounds straightforward. But things can quickly become complex.

According to Bilello, "One thing you have to look at is the footprint of all the energy that went into producing everything in it. And an OEM won't be responsible for all of that content. The suppliers produced a lot of the product's content. So then you have to get all that energy use information from the supplier."

For true environmental impact numbers, manufacturers need more than a list of materials and the record of all the energy used to make each component.

"Then you have to think of shipping, like via air or truck," Bilello said. "And you need to account for shipping the part to the plant and then the product to where it's going. The fuel used there changes the carbon footprint."

These numbers can be tracked in a manufacturer's product data management software, which can act as a central repository for all information about a product.

Several vendors such as PTC and Siemens PLM Software make products that track environmental performance of products, parts, materials, and suppliers. Many products are integrated with a company's supply chain and product development systems.

IBM offers Environmental Product Lifecycle Management, which includes software and consulting services, and assists clients in analyzing every phase their product passes through to ensure environmental compliance.

Daunting Task

But the obvious question is, where do the numbers come from for such information as fuel used for transport or energy used for assembly?

According to Bilello, the numbers can be extrapolated: figure out how many miles your product was shipped, and you can sort of determine fuel used.

"It's a daunting task, because people have never tracked this kind of information before," Bilello said. "OEMs are struggling and suppliers are struggling. To get the true footprint, an OEM has to go to a supplier and say, 'I bought this component, but I don't know what's in it.' Then, the supplier also has to trace back everything, even the solder, right down to the raw material level.

"Manufacturer's aren't just buying a part," he said. "They're buying all the information related to that part, like how can it be recycled and what's used to make it."

The job of tracking down obscure information and minute sourcing to even the traces of chemicals used in products can be overwhelming.

The answer for most manufacturers is to move slowly toward green, said Andrew Wertkin, vice president of InSight products technology at PTC in Waltham, Mass.

▼ Lifecycle assessment tools, like this from Sustainable Minds, show engineers the environmental ramifications of design decisions.
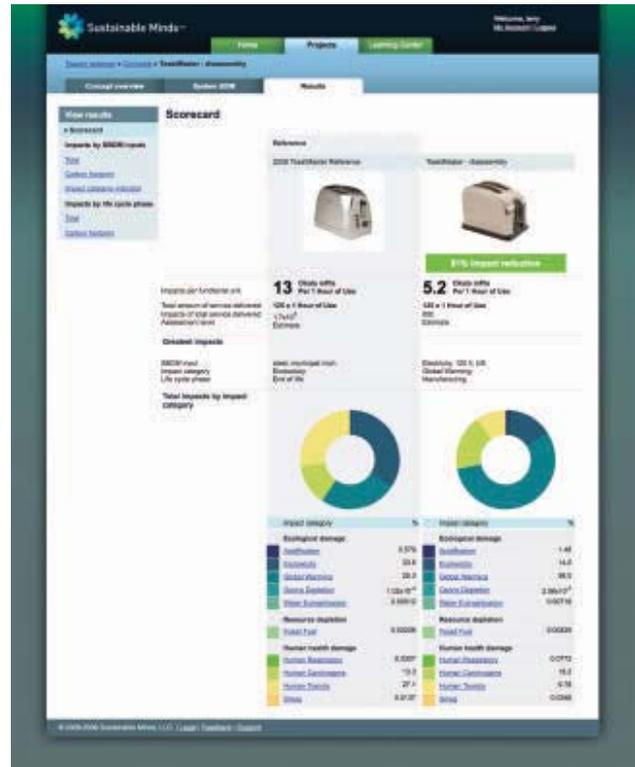
The company makes PTC's InSight Environmental Compliance software.

"A manufacturer might say, 'We have X number of products in the field and we know nothing about them environmentally,'" Wertkin said. "Companies can take a practical approach and start by looking at the parts that are most concerning to them."

Green Adjustments

According to Halpern, for the design engineer, green design means analyzing decisions with an eye toward how they affect the environment.

"So as you're doing design, you're selecting materials that are recyclable," Halpern said. "But then there could be tradeoffs—like materials that are recyclable might not have the characteristics for product performance that you need. So then you might pick a recyclable material and do FEA and decide that if you add an extra stiffener or weld point, this material might work."

A number of lifecycle assessment software packages have been released in recent years to help designers. Sustainable Minds develops software, for example, that is intended to give engineers pertinent supplier and material information, which allows them to weigh each design decision from an environmental standpoint, said Terry Swack, chief executive officer of the company in Cambridge, Mass.

Applications like these can compare potential product materials, for example, from an environmental standpoint to determine the best material to meet green goals.

"It's all about comparisons. There's no such thing as a green product, so all you can do is create a benchmark to work toward," Swack said. "The software lets the product development team model the potential effects of sustainability so they can make rapid tradeoff decisions as they're exploring different options."

For example, to determine how the assessment software would work for them, a medical device consulting firm populated the software with its previous client projects. What they found was interesting. The software revealed several environmental shortcomings in those products.

"So we gained valuable insights for future design decisions," said James Rudolph, an industrial designer at the consulting company, Farm in Hollis, N.H.

Swack started Sustainable Minds three years ago, after witnessing the growth of the green building movement. She realized product developers were casting about for similar environmental standards to those formalized by the Green Building Council. Short of that, they needed a way to benchmark their own products from a standpoint of environmental impact.

Manufacturers still don't have formal green production methods; but there is a quickly growing awareness of design for sustainability, Swack said. Tools that analyze the lifecycle can help find waste and help make decisions.

"People don't know what green means in product manufacturing," Swack said. "There's no courseware, no metrics, no standardized education process, and no tools. When you're looking at designing a product, and you're making decisions, you have to ask yourself, which choice is greener? How would you know on your own?"

That is the purpose of lifecycle assessment software. By using the tools to run an early analysis, engineers can see what would cause the greatest environmental impact across the product's whole lifecycle, Swack said.

"You look at materials or manufacturing and transportation and end-of-life methods and all the consumables used," she said. "Then you can see what kind of impacts your design decisions would have, whether that's toxicity or global warming or anything else, and then you can make design changes to improve those numbers."

Lifecycle assessment is a research focus for the Green Design Institute, an interdisciplinary research project at Carnegie Mellon University of Pittsburgh.

The institute maintains a Web site, www.eiolca.net, that evaluates a commodity or service and its supply chain to estimate the materials, energy, and environmental consequences resulting from its production.

The Web site uses the Economic Input-Output Life Cycle Assessment, a method developed by economist Wassily Leontief in the 1970s and based on his earlier work from the 1930s, for which he received the 1973 Nobel Prize in Economics.

According to the institute, the EIO-LCA method "estimates the materials and energy resources required for, and the environmental emissions resulting from, activities in our economy. It is one technique for performing a lifecycle assessment, an evaluation of the environmental impacts of a product or process over its entire lifecycle. The method uses information about industry transactions—purchases of materials by one industry from other industries—and the information about direct environmental emissions of industries to estimate the total emissions throughout the supply chain."

Engineers also call upon lifecycle analysis software to ensure their products comply with environmental regulations. The number of manufacturers who will need to meet those regulations represents a growing market for software makers.

According to Halpern, "I know of a number of companies that need to become compliant with European Union mandates. If their markets are in Europe, they'll have to care about regulatory requirements."

Bilello predicts that those mandates—coupled with environmental awareness—are why lifecycle assessment tools will become critical to engineers in the very near future.

"Nowadays, engineers can't get away with just designing a product and forgetting about it," he said. "Product lifecycle management and lifecycle tools are critical to designing for the environment in a holistic manner." ∎