LEAN & Green

Environmental performance and product design

Managing the environmental performance of products makes good business sense. It can be a powerful source of cost savings and creative inspiration that leads to better design and a competitive advantage.

by Ralf Nielsen, Duncan Noble, P.Eng., and Steven B. Young, P.Eng.

From selecting technologies and materials, to specifying manufacturing processes, packaging, use, reuse and ultimately the product's final disposal, engineers' decisions influence environmental impacts during all stages of a product's lifecycle. The challenge of improving the environmental performance of products can often lead to products or processes that are more innovative, environmentally sustainable and profitable.

The Design for Environment approach

Defined as the practice of including environmental considerations in product development, Design for Environment, or DfE, is a practical approach engineers in many industries are using to foster innovation and create value for business and society. DfE is a systematic approach to integrating environmental criteria into the product development process, with the goal of reducing the environmental impacts of products and processes. DfE can be used to focus on particular areas, such as packaging or material selection. However, it is most effective when multidisciplinary teams use a whole-system engineering approach from the outset of product development.

Whole-system engineering:

- treats products as "integrated systems," not simply a collection of materials, components and technologies;
- focuses on optimizing the entire product system's functionality and value;
- requires collaboration among traditional engineering disciplines and other business specialties, such as marketing, accounting and operations; and
- results in multiple benefits, including lower production, operating and capital costs; improved performance; and reduced use of materials and energy.

A DfE program brings environmental considerations into the mix of such traditional design criteria as performance, cost and aesthetics. The product development process does not have to be reinvented; rather, DfE provides opportunities for new information and approaches to become a part of the existing process.

Integrating DfE into product development involves three main tasks:

- researching new types of information, including the environmental impact of materials, components and processes;
- identifying new information sources, since environmental information must be collected from both upstream suppliers and downstream partners; and
- making different types of decisions. You may have to choose between either satisfying environmental criteria or fulfilling other product requirements. But often, a whole-system engineering approach results in win/win solutions that meet both goals.

Product development teams can use numerous tools and methods to support these tasks, ranging from simple checklists and matrices, to complex lifecycle analysis software. The range and complexity of the tools used will depend largely on your program goals, the decisions you anticipate and your budget.

Frequently, DfE pilot projects focus on the redesign of existing products, enabling tools and methods to be tested within a real product development environment, without affecting the critical path of new product development. Pilot projects provide an opportunity to profile the environmental impacts of "typical" products. Results are often used to modify next generation product development.

Whatever the methodology and tools selected, the common theme is that DfE uses lifecycle thinking to consider the entire product system–from resource extraction, to component production, assembly, distribution, use, reuse and, ultimately, the end of the product's life.

Taking stock of the benefits

Why is DfE important in today's marketplace? For one thing, it can provide your company with a competitive advantage. End users and business-to-business customers are demanding measurable and verifiable environmental performance from their suppliers. Many larger companies are heavily dependent on suppliers and now require that environmental considerations be included in their operations and product development. The market prefers products and services that reduce consumables and are energy efficient, durable/reliable, recyclable and produced with cleaner production processes.

Incorporating DfE into the earliest stages of product design can help you meet these demands. DfE also enables differentiation of products in the marketplace, improves brand image and attracts ethical investors.

The DfE approach also leads to more cost-effective operations. How? Good design reduces costs. DfE optimizes the use of energy and materials throughout a product's lifecycle, providing opportunities for cost reduction at all lifecycle stages. By integrating DfE into product development, engineers can evaluate and optimize raw material choices, production methods, distribution channels, product use and end-of-life options. These steps can reduce production costs and the cost of ownership, while continuing to emphasize product quality and performance.

Finally, DfE can reduce environmental impacts and potential liability. DfE considers the waste and emissions created during the manufacturing process, thus promoting pollution prevention and reducing environmental compliance costs and liability. This, in turn, decreases environmental impacts and reduces uncertainty with respect to future environmental requirements and regulations. For these reasons, integrated DfE programs can improve access to insurance and financing, and achieve better community relations.

Fostering innovation

At a higher level, DfE can stimulate innovation among product development teams by requiring them to ask fundamental questions about customer needs and how a new product, service or technology could meet those needs. Some of the most innovative examples of DfE come from replacing the periodic acquisition of goods with a continuous flow of service–such as providing cleaning services to manufacturers instead of bulk chemicals. This aligns the interests of both producers and consumers, and can dramatically improve environmental, technical and financial performance.

Because DfE requires an understanding of the full lifecycle of a product, it provides an opportunity for development teams to develop a more holistic understanding of the entire system of product realization, use and disposal. Incorporating DfE into product development can provide fresh perspectives on established practices, original

–Mini-case #1–
Remanufacturing at Xerox

In 1990, Xerox developed its Environmental Leadership Program, which was aimed at making Xerox an industry leader in Design for Environment (DfE) techniques. Over the past decade, Xerox has integrated environmental and health and safety criteria into its product development and delivery. These criteria include efficient use of energy and materials, low emissions and noise, minimal use of hazardous substances, and parts reuse and materials recycling.

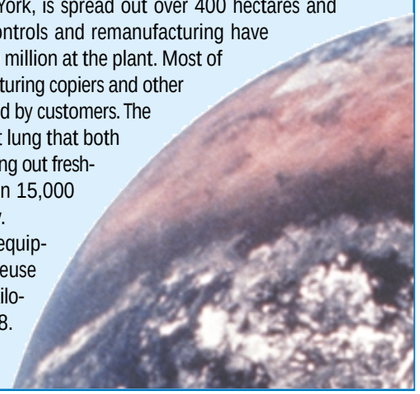
Environmental considerations are communicated to product engineers early in product development. Business teams and environment, health and safety specialists regularly assess products under development to ensure that DfE criteria are integrated into new designs.

One example of the success of Xerox's integrated approach is its new Document Centre 265 digital copier, which is designed to make extensive use of replaceable subassemblies and reusable parts. Xerox has developed processes to remanufacture or recycle 97 per cent of the component parts for this product.

According to Jack Azar, director of environment, health and safety at Xerox: "In the long run, it's cheaper to reuse a part [in manufacturing] than to recycle it." In recycling, parts are usually destroyed so their materials can be reused. In remanufacturing, parts are removed and refurbished to as-new standards, tested and then installed in new products.

Xerox's plant in Webster, New York, is spread out over 400 hectares and employs 8900 people. Pollution controls and remanufacturing have yielded annual savings of $U.S. 250 million at the plant. Most of these savings come from remanufacturing copiers and other machines previously owned or leased by customers. The plant has been compared to a giant lung that both exhales and inhales—not only pushing out freshly built machines, but also pulling in 15,000 used ones a month for disassembly.

Xerox estimates that, through equipment remanufacturing and parts reuse and recycling, it diverted 66 million kilograms of waste from landfills in 1998.



insights and new ideas. Fundamental questions about the product system will often arise during the process. For example, if the product's disposal will result in a major environmental impact, the team may consider a product take back or material recovery system that provides a valuable source of materials or components (see Mini-case #1: Remanufacturing at Xerox, on p. 45).

One of the main strategies of DfE is to optimize the product's production by selecting less hazardous materials, reducing energy consumption and use of consumables, and designing for ease of assembly and disassembly. Given the proper relationships, the lessons learned "in-house" can be extended to suppliers of materials and components.

With its foundation in the discipline of design, DfE also has a significant creative component. DfE projects often use creative, exploratory exercises to generate product, process or solution ideas. With an experienced facilitator and a motivated team, these exercises can often generate radical design alternatives that offer significant reductions in the environmental impact of the product system, and business value through reduced costs and/or enhanced marketability.

Putting it in context

To be successful, a DfE program should be part of an overall environmental strategy linked to your company's core business strategy (see Figure 1). Whether your environmental strategy is compliant, market driven or fully integrated,[1] it needs to reinforce and support other components of your business strategy.

One approach to implementing DfE that may be consistent with an organization's existing environmental management is integration with the International Organization for Standardization (ISO) 14001 standard for environmental management systems. ISO 14001 is a living system that enables a company to integrate environmental considerations into all business processes. Consistent with ISO 14001 requirements, an organization can use DfE approaches to define areas where significant environmental issues may exist along the full lifecycle of products or services. Such a program can help achieve both business and environmental goals, making improvements to the product through its lifecycle.

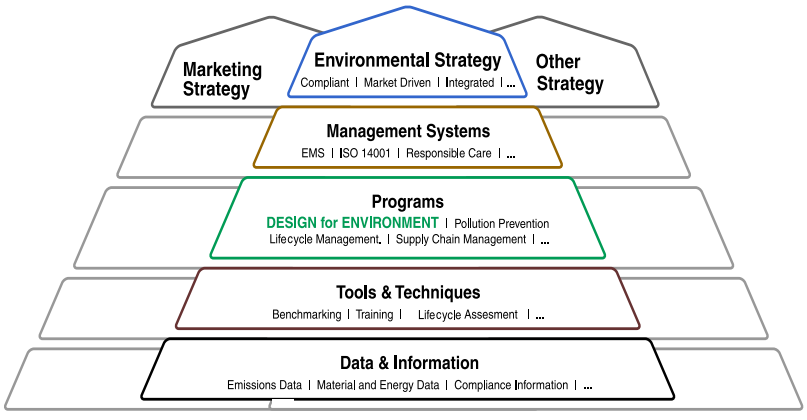
Key success factors

DfE programs that have fostered innovation include those in which:

- environmental strategy and performance are an integral part of senior management's strategic visions and plans;
- the company has a clear environmental strategy with respect to partners, customers, suppliers and public opinion;
- the DfE program has high quality leadership and a network of support; and
- members of product development teams are empowered to optimize environmental aspects.

For more information, see the NRC - IRAP Design for Environment Guide at http://www.nrc.ca/dfe or the Canadian Standards Association standard *Design for Environment (DFE)*, Z762-95. ◆

Figure 1. Design for Environment in Context



–Mini-case #2– Siemens North America Motor Operations (NAMO)

Siemens NAMO produces electric motors for automotive applications at its London, Ontario, plant. The company uses a highly integrated approach to production, minimizing the use of resources and production of waste, wherever possible. Siemens has integrated environmental criteria into its product development process, requiring designers to use Design for Environment (DfE) checklists and guidelines for restricted and preferred substances.

The company first used the principles of the ISO 14040 standard for lifecycle analysis (LCA) and DfE in 1997 to redesign a brush-less motor. This motor runs for 10,000 hours, compared to 2000 hours for the old design. It is assembled, rather than welded, reducing manufacturing costs and promoting ease of disassembly. The new design has an 80 percent longer life expectancy than that for a regular fractional horsepower motor.

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