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GREEN ELECTRONICS/ GREEN BOTTOM LINE

Newnes

Green Electronics
Green Bottom Line

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Environmentally Responsible Engineering

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CHAPTER 16

DfE for Engineering Managers: Making It Count—DfE and the Bottom Line

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Introduction

It is easy to assume that designing products to be friendlier to the environment is a good thing. In a business, the question becomes much more complicated. Two primary reasons for this are that it often is not obvious which choices in product design are true environmental improvements, and if there is a greener choice to pursue, it often is unclear whether the choice offers any advantage to the firm seeking to adopt it.

From a pure business perspective, it is possible to ignore the true environmental value, at least in the short run. After all, if the green alternative offers business advantages, then it is worth doing in its own right. This sometimes happens with trendy or well-marketed "green" stunts. But, in the long run, any environmentally preferable product design must be a credible one, and so companies adopting DfE also must take care to be sure that they are making a positive difference.

These issues make the job of the engineering manager seeking to "green" a product quite difficult. And this complexity must be managed while assuring that product performance, time to market, and price are not compromised. Although this holds considerable challenge, some ways to approach these problems can maximize the potential gain in both environmental performance and the corporate bottom line.

How Green Is My Product, Really?

As we find in everyday life when asked "Paper or plastic?" environmental preferences in a product often are difficult to assess. The difficulty comes in large

part from the variety of ways that a product can affect the environment. This is accompanied by the need to consider all aspects of a product and the material used to make it, going back in the supply chain and forward through the complete life cycle of the product.

Generally, environmental impact is broken down into three types:

- *Use of limited or nonrenewable resources.* The very existence of a product implies that resources are used to make it. This means that some transformation of material has been made that may result in the material becoming unavailable for future generations. The best-known example of this is fossil fuel, which is associated with virtually every product on the basis of transportation alone.
- *Toxicity.* Transformation of material into new forms may either create substances that cause harm, as in the case of certain organic materials, or move toxic substances to places where they can do harm, as in the case of heavy metals.
- *Destruction of ecosystems.* The classic issue here is destruction of natural environments such as rain forests. It is important to remember here that the facilities used to manufacture a product involve this impact and, in fact, can represent one of the more serious aspects of environmental impact by a product.

Beyond these different types of impact is the problem of looking at the entire life cycle of a product. To do this accurately means going back all to way to the original mining operations that produced the raw metals, oil, and any ceramics or glass used to make product components. Similarly, the life cycle of the product moving from design and manufacturing into use and ultimate disposal also must be assessed.

Other parts of this book go into great detail on the means for evaluating these types of environmental impact. From such tools as life-cycle analysis or similar methods, it is possible to come up with some sense of what is environmentally better. However, looking at these models, two things are clear. First, they entail value judgments. For example, a liquid crystal display (LCD) offers greater energy efficiency than a cathode ray tube (CRT) device. However, this benefit may be offset by the toxicity of the mercury and other chemicals that make up the LCD device (of course, the CRT also has lead in its glass screen). The trade-off pits the environmental impact attributed to a watt of energy against that associated with a microgram of mercury. That is, the value of the resources used and harm done to create that watt of energy are being weighed against the harmful toxic effects from mercury. There is no explicit way to normalize these very different types of impact, so in taking on an assessment of alternatives, it is important to look at the judgments involved.

Perhaps the more obvious problem with such assessments is that they are expensive to perform on a product as complicated as most electronic products. Imagine all of the components of LCDs and CRTs, and all of the types of impact from resource use, toxicity, and ecosystem for these components. The expense of such analyses is apparent.

These problems have led many electronics firms to avoid such analyses altogether and instead rely on standards developed by third parties. Historically, the complexity of making environmental trade-offs has led such standards to take the form of government regulation. In fact, the management of the environment by government is moving swiftly into the territory of product design, through such actions as material bans (e.g., ozone depleting chemicals such as CFCs) and material handling requirements (e.g., hazardous material disposal or product take-back laws). However voluntary standards also are growing in popularity, as a tool of government as well as a tool for industry and other environmentally motivated groups. A brief discussion of these follows.

Legally Mandated DfE

While DfE often is seen as a largely voluntary activity, no engineering manager today can ignore the fact that legal requirements are creeping into the product design process. Governments throughout the world have recognized that the most effective means for improving the environment is to move away from regulating smokestacks and work upstream to change the way products are designed and manufactured. Some examples of where regulatory developments are likely to affect product design now and into the early 21st century include the following.

- Material bans and restrictions:
  Bans on lead, mercury, and other toxic metals.
  Bans on ozone depleting substances.
  Efforts to ban halogen-containing substances.
  Use of recyclable materials for containers and packaging.
  Restrictions on endocrine-disrupting substances.
- Product handling regulations:
  Manufacturer take-back laws for packaging, batteries, and products.
  Restrictions on movement of waste for recycling or disposal.
  Disposal bans, such as the banning of CRT disposal in landfills.
- Others:
  Product labeling requirements such as disposal warnings.
  Designation of numerous substances as toxic.
  Public disclosure requirements for wastes and toxic substances used.
  Carbon taxes associated with efforts to reduce global warming.

It is beyond the scope of this chapter to elaborate on all aspects of the emerging regulatory picture, but it is critical for all companies to keep a close watch on such developments to avoid missing a critical item that could force changes in a product at a point where it is expensive to do so or, worse, cause a company to be subject to legal action and negative public image as a result of simply not being aware of a requirement.

Ecolabels

Voluntary Standards for Design

The idea that product design is the origin of many types of environmental impact has led governments and others to develop a set of environmental design standards that, taken together, constitute what are called *ecolabels*. Generally, these are voluntary standards applied to a product and a label the firm may associate with the product for marketing purposes after verification of conformance to the standard either by the company itself or a third party.

The last ten years has seen a proliferation of ecolabeling programs throughout the United States, Europe, and more recently, Asia. Increasingly, these programs have targeted electronic products as a reaction to the growing importance of these products in our daily lives. Some of the more prominent programs are listed in Table 16–1. While these programs do not target every electronic product, their guidelines generally are transferable from one product to another, given the similarity in basic components that all electronic products share.

Industry Driven Standards

While ecolabel programs offer a convenient means to approach design for environment, disagreement has centered on the validity of some of these standards

TABLE 16–1 Examples of Ecolabel Programs with Standards for Electronic Products

Program	Sponsor/Applicability	Comments
Energy Star	U.S. government, also adopted by Japan and other countries and used as basis for other energy standards	Deals only with energy efficiency; one of the most widely recognized labels
Blue Angel	German government	Widely recognized in Europe and beyond; focus is on design for recyclability
Nordic Swan	Norwegian government	Recognized in Nordic countries; one of the most stringent standards
EU Ecolabel	European Union	Newer program intended to replace member state programs; so far it has not affected German, Nordic, Swiss, and other European programs
Green Seal	U.S. nongovernment organization	Few participants
TCO 92, 95, 99	Swedish labor organization	Office products only; widely adopted for video display terminals and similar devices; strong focus on worker safety features plus environmental attributes

as well as how they are applied. In some cases, the requirement for lengthy third-party verification has been a deterrent to companies in terms of time to market. And often the organization responsible for developing the standard lacks the technical knowledge to fully judge the feasibility of the standard. As a result, there are a few movements to develop industry-sponsored standards.

One example is the European Computer Manufacturer's Association (1997), which is developing a declaration standard for computers and other electronic products. Also, the International Standards Organization (ISO) is working on a standard for ecolabeling programs in an attempt to assure fair, valid standards.

Corporate Standards and Specific Problem-Solving Efforts

In adopting standards, companies are accepting both the scientific evaluation and the judgment of the standards organization, even though they may not fully agree with them. Some firms have taken the approach of developing their own standard as part of a corporate commitment to the environment.

In addition, many have focused on making design changes in specific areas where a known environmental problem exists. Such efforts often are associated with some of the more innovative aspects of DfE. Examples include design of product enclosures for recycling, replacements for lead use in PWB solder, replacements for mercury-containing backlights in LCDs, and less toxic batteries.

Whether following a standard or innovating on its own, the assumption being made by companies here is that design for environment is better, or at least will be perceived as better and thus offer some benefit to the firm adopting it. More often than not, this benefit is not so obvious.

What Green Alternatives Are Worth the Investment?

Firms seeking to invest in environmental improvements in their products also must ensure that these investments will meet the needs of corporate shareholders in some way. If there is no connection between a green design and the bottom line, such design efforts will fail in the long run. Thinking about the ways that product features are linked to the bottom line means that an environmentally preferable design must either decrease the cost or risk to the firm in producing the product or increase the value of the product in the eyes of the customer. There are several ways in which DfE meets these objectives, although some are far less certain than others.

Decreased Costs and Risks

While the potential for a green design to result in increased product sales or profit margins may be tenuous, the benefit of lower cost is easy to see. Admittedly, applying DfE principles could result in higher, not lower, product cost, as more expensive materials or more features (e.g., energy-saving modes) are added. Still,

some designs offer savings, not only in product cost-of-goods, but in the total life-cycle cost of the product as well.

Some examples of where a product can be made more cheaply by DfE are

- *Design for recycling and design for manufacturing are compatible.* Products designed to be recycled often are easier to make and service, in addition to being more cost effective to handle at end of life. For example, recycle-friendly snap-fit parts require fewer fasteners and are quicker to assemble, reducing manufacturing costs.
- *Dematerialization saves in two ways.* Using less material means less material paid for to make a product. If the mass or volume reductions are substantial, significant savings may emerge in transportation and handling costs as well.
- *Design for recyclability leads to fewer types of materials and common parts.* The discounts from increased purchase lot size can yield significant cost advantages in some cases.
- *Reduction of toxic components is cost effective.* Reduction of toxic components means that, when the product is disposed of at the end of its service life, the user may not be subject to the increased costs associated with hazardous waste handling.
- *Manufacturing efficiency can be gained by careful choice of specification tolerances.* These practices can assure that scrap is minimized without compromising quality.
- *Improved energy efficiency results not only in energy cost savings but also in lower heat production.* This can reduce the need for expensive cooling fans in the product and lower cooling costs for the user.

Note that some of cost savings here are not attributable to the manufacturer but to the service provider or customer. While this sort of savings is valid in terms of lower cost of ownership, it may be more difficult to attach a corporate benefit to the product design. However, as governments and customers demand that producers take responsibility for products throughout their useful life, more of these savings will come back directly to the bottom line. Those companies with the forethought to design with this in mind may reap the benefits later on.

Some DfE endeavors are founded on the prediction that future costs or risk of regulatory impact may affect a company's future performance. For example, some countries are seeking to ban lead in products and so a firm with access to lead-free manufacturing technology will be at an advantage if such laws come into wide adoption. Similarly, future liability owing to product safety or waste disposal may be mitigated if design alternatives take this into account. Because environmental issues are complex and require that the needs of many parties be considered, environmental performance increasingly will be the target of regulatory authorities throughout the world, as well as that of insurance and financial institutions who have a stake in a company's future performance.

Cost savings and risk reduction always are desirable, but these factors alone are not enough to drive the level of environmental improvement being pursued today

by electronics firms. More critical is the ability of a green product to enhance revenues and profit margins through increased customer value.

Increased Customer Value

Increased customer value means that either the customer will pay a premium for the green product or will give preference to that product, other things being equal. Market research in this area suggests that some customers say they are willing to pay extra for green products, but most often, they are willing to give preference among equivalent products (Environmental Research Associates, 1998). This, of course, assumes that the greenness of the product is apparent to the buyer—something that requires both a clear environmental message and appropriate exploitation of that message through marketing.

Earlier, the adoption of standards or ecolabels was described as a common approach to managing green design. In addition to simplifying the process of identifying and validating green alternatives, these standards offer the credibility of third-party endorsement and are more easily recognized by customers. In some cases, consumers give these standards preference and thus firms who adopt them have the edge when purchasing decisions are made. For example, the U.S. federal government is mandated to purchase Energy-Star-compliant office equipment and some parts of the German government prefer Blue-Angel-labeled equipment.

Still the very nature of standards is that they can be adopted by many firms, and this limits the potential competitive advantage. It follows that nearly all major computer manufacturers offer Energy-Star- and Blue-Angel-labeled products.

Adding to the demand for ecolabels are specific customer demands for such attributes as energy efficiency or recyclability, which have relatively obvious user benefits. Governments throughout the world, large institutions, and private corporations are among the customers who most often include specific environmental requirements in their purchase criteria, and the firms that understand these needs and are prepared to address them can be at significant advantage.

Finally, many investments in green design are made with the hope that enhanced brand image will result. This type of investment has been more common in such industries as energy, petrochemicals, and automobiles but is also the reason "of last resort" when investment in doing good simply feels like the right thing to do. While this benefit may be the least quantifiable, it is surprising how many corporate environmental efforts, including design for environment, are founded primarily on this basis.

Beyond Making a "Better Box"— Using DfE to Rethink Entire Products and Services

While redesigning products is the major focus of this book, it is worth mentioning that redesign of business processes is an important strategy being explored by electronics firms. For example, some companies have invested in development of

take-back infrastructures, betting on the trend toward producer responsibility and that having such infrastructure will provide competitive advantages. There also are other forms of what is termed *reverse logistics*, where companies seek to find customers for materials that they produce as a by-product of their operations. One example is the recycling of plastic case materials for automobile parts.

The assumptions made so far in this discussion are that we are taking a given product and either redesigning or substituting parts of it to reduce its environmental impact or offering services to handle the wastes produced during the life of the product. A much more fundamental approach is to go back to the core features and benefits that a product is meant to provide and totally rethink how those benefits might be delivered in a far more environmentally conscious way. This perhaps is the most risky yet most potentially profitable approach to design for environment, and few firms have ventured into this arena. One very modest example of this is leasing versus purchase as a business model. Firms that lease products rather than sell them are motivated to maximize the service provided at minimum product cost. They also are motivated to reduce end-of-life costs through better up-front design, since they will endure all life cycle costs for the product.

Finally, there is the environmental impact of a product as it performs its functions in the larger scheme of society as a whole. Electronic products, perhaps more than any other class of products in the late 20th century, have altered the lives of everyone from office workers in North America to cell-phone users in remote locales in developing nations. In the process of changing our lives, electronic products produce ancillary types of environmental impact that can be either positive or negative. For example, computers held the promise of the "paperless office" and yet they've contributed more to the increased use of paper than its elimination so far. The recent trend toward electronic telecommunication holds the promise of reducing transportation as people have less need to travel to the office or to faraway destinations to perform the functions of daily life.

All these aspects of electronic products hold vast opportunities in designing a better future (Day, 1998). While few if any electronics companies have taken DfE to the point of redefining their business on the basis of environmental performance, such efforts may offer the most dramatic returns in the future and undoubtedly are being explored by progressive firms concerned about their long-term success.

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