Tools for Design Teams

There are many methods or tools that can inspire companies to develop innovative environmental attributes in products. It is important to choose a design tool that will be effective within the culture of the manufacturing company and its existing product development process. There is no one "right way" to integrate DfE into product design. What is important is that there is a system in place that motivates product design teams to consider environmental impacts of products and draws upon their aggregate creativity and ingenuity. This is an overview of various DfE integration methods or tools.

The Importance of a Product's Life Cycle

Once a product is designed, its environmental impacts are largely fixed. It is important, therefore, that DfE tools be applied early on in the product realization process at a stage when designers have the biggest influence on environmental impacts. The design stage also offers an opportunity to invent new product features that enhance the environmental attributes of the product and distinguish it in the marketplace.

These DfE tools can range from a series of basic questions that are used by design teams to evaluate products to computer programs that calculate environmental impact data. What they all have in common is evaluation of the entire life of the product.

Use of Checklists

The most basic DfE tool is a series of questions or a checklist that is included in a product design procedures manual. The product design team is required to answer these questions as a team, early on in the product design process. The questions serve both as a means to compare a newer version of a product to an older one and as a means for inspiring designers to think creatively about new potential product features.

Checklist questions generally have "yes or no" answers with respective values of 1 and 0. The total sum of the answers to the questions is used to measure the environmental impact of the product.

Checklists can be combined with open-ended questions, flow charts, or matrices (see the following sections). They can also be used as an initial tool, then followed by use of a computer software tool that provides quantitative data about environmental impacts of materials.

DfE Checklist Questions
examples for each stage of the product's life cycle

Premanufacture Supplier (supplier survey questions)
What percentage of your suppliers for this product or part have an environmental management system (EMS) in place?

Product Manufacture
Are carcinogens, mutagens, teratogens, or any potentially regulated chemicals used in the product or process?

Distribution, Packaging
Is reusable transport packaging used between company facilities?

Product Use, Maintenance
Does the product avoid "one-time-use" cartridges, containers, or batteries?

End-of-Life
Are the materials used in the product easy to separate and identify by type?

Use of Open-Ended Questions

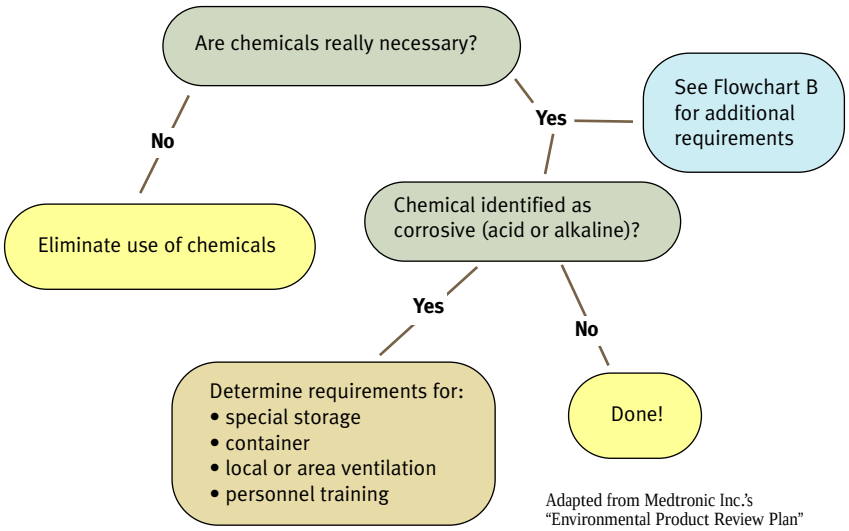
The purpose of including open-ended questions when integrating environmental attributes into products is to facilitate design changes. These questions can take the design team beyond deciding if and where there are environmental impacts to what improvements can be made. An example of an open-ended DfE question is, "How can we design this product so that it will be easy to disassembly?" This type of question draws upon the ingenuity of the design team members to come up with innovative design changes.

Use of Flow Charts

Flow charts offer a visual, decisive method of analyzing a product's design features in relation to the environment. By using flow charts, a product design team can easily progress through key decision making points. For example, in one of the flow charts that is part of Medtronic Inc.'s "Environmental Product Evaluation Plan," the

first question is "Are chemicals really needed?" If a product and its manufacturing process do not require chemicals, the evaluation is complete. If chemicals are needed, the design team must complete this flow chart and a related flow chart, and fill out justification paperwork. The result is a built-in incentive to minimize the use of chemicals in the design of products, since fewer chemicals means less paperwork and justification. This can prevent the accrual of costs over many years, due to unnecessary use and disposal of chemicals.

Flow chart questions: example



Adapted from Medtronic Inc.'s "Environmental Product Review Plan"

Use of Matrices

The results of checklist questions can be entered into matrices, which can help a designer identify the weaknesses and strengths of environmental attributes in products. For example, if the matrix shows a relatively negative total score for both distribution/packaging and solid residue, the design team may want to focus on reusable transport packaging. In contrast, if product use and maintenance are relatively positive, the design team may want to recognize this success and put less effort into such areas as energy efficiency.

Matrix: example

Life Stage	Environmental Concern					Total
	Materials	*Energy Use*	*Solid Residue*	*Liquid Residue*	*Gaseous Residue*	
Premanufacture	0	10	0	0	5	15
Product Manufacture	0	5	0	0	0	5
Distribution, Packaging	0	5	0	0	0	5
Product use, Maintenance	5	30	5	25	0	65
End-of-life	0	5	0	5	0	10
Total	5	55	5	30	5	100

Adapted with permission from Industrial Ecology by T.E Graedal and B.R. Allenby.

In this example, the matrix shows a low relative score in distribution and packaging and in materials use. In contrast, energy use has a relatively high score. Because of these results, the design team could focus on reducing the amount of packaging in the product and celebrate their achievements in energy efficiency.

Life Cycle Analysis Software

During a true life cycle analysis, or LCA, an inventory of all the major environmental inputs and outputs associated with a product during its lifetime are measured. This inventory is then evaluated both qualitatively and quantitatively to identify the most significant aspects. The advantage of using an LCA tool is that environmental impacts are assessed as accurately as possible. Designers should use geographically appropriate databases when using LCA.

Full LCA analysis allows a design team to see a comprehensive picture of the environmental aspects of a product and provides detailed insights into the product. The disadvantage of full LCA methodology is that compiling the necessary data for a complex product can take a significant amount of time and resources. Full LCA can be used to augment other DfE options such as checklists or open-ended questions.

An alternative to full LCA is "streamlined life cycle analysis" (SLCA). Many tools such as matrices use SLCA, where impacts throughout the entire life cycle of a product are considered but not quantified into an exact value. These tools rely on the value judgments of the user to weight impacts. For example, if the manufacturer is located in an arid climate where water usage is of great concern, the amount of water used may be given a higher impact value (i.e., 2 or 3 instead of 1).

Summary

There are many methods or tools available for integrating DfE into product design. The tools can range from a basic list of twenty questions to a complex, complete LCA analysis tool. Which tool or combinations of tools to use is a choice that product manufacturers need to make depending upon their needs and resources.

Using a DfE tool, whether simple or complex, can have large impacts on improving product design. Tools can be customized and built upon as the implementation process matures. It is important that the tool becomes part of the required product design process. By integrating DfE tools into product design, product costs can be significantly reduced and the manufacturer can gain a competitive edge in the marketplace.

Go to www.moea.state.mn.us/berc/dfetoolkit1.cfm to download a tool from the Minnesota Office of Environmental web site.

References:

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