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TenStep Supplemental Paper

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Design for Environment (DFE)

Design for Environment (DFE) is the systematic consideration during design of issues associated with environmental safety and health over the entire product lifecycle. DFE is being applied to the design of new products and the modification of existing products, processes, and facilities.

Objective of DFE

The objective is to minimize or eliminate, during design, the anticipated waste generation and resource consumption in all subsequent lifecycle phases: construction, operation, and closure (or production, use, and disposal).

Design for Environment (DFE-Eco-design) primarily refers to product-related environmental care meant to diminish the negative environmental effects of a product before it is produced, distributed and used. DFE examines the disassembly of products at the end-of-life and reveals the associated cost benefits and environmental impact of revision, reuse and recycling.

A Design for the Environment (DFE) program helps businesses incorporate environmental considerations into the design and redesign of products, processes, and technical and management systems. Initiated by US Environmental Protection Agency's (EPA's) Office of Pollution Prevention and Toxics (OPPT) in 1992, DFE forms voluntary partnerships with industry, universities, research institutions, public interest groups, and other government agencies.

DFE benefits

DFE offers businesses the opportunity to improve environmental performance while simultaneously improving their profits. Companies that implement DFE find that it:

- Reduces environmental impact of products/processes.
- Optimizes raw material consumption and energy use.
- Improves waste management / pollution prevention systems.
- Encourages good design and drives innovation.
- Reduces costs.
- Meets user needs/wants by exceeding current expectations for price, performance and quality.
- Increases product marketability.

DFE can also provide a means for establishing a long-term strategic vision of a company's future products and operations. In general, DFE is an enabling force to shape more sustainable patterns of production and consumption

DFE Internal and External Drivers

Motivation to implement DFE can come from two different directions:

- Internal drivers: Factors within the company
- External drivers: Factors caused by the immediate surroundings.

Internal Drivers

Need for increased product quality. A high level of environmental quality will improve product quality in terms of functionality, reliability in operation, durability and repair-ability.

Image improvement. Communicating a product's environmental quality to users through an environmental "seal of quality," such as the Environmental Choice Label or a good report in consumer tests, can improve a company's image appreciably.

Need to reduce costs. Companies can make use of DFE strategies to benefit financially by:

- Buying fewer materials for each of its products.
- Utilizing energy and auxiliary materials more efficiently during production.
- Producing less waste and lowering disposal costs.
- Disposing of hazardous waste.

Need to stimulate innovation. DFE can bring drastic changes to the product system level - the combination of product, market and technology. Such innovations can provide entry into new markets.

Employee motivation. Morale increases when employees are empowered to help reduce the environmental impact of the company's products and processes. DFE can also heighten employee motivation by improving occupational health and safety.

A sense of responsibility. An increasing awareness that business must play a vital role in working towards sustainable development can work as a strong incentive for implementing DFE.

External Drivers

Government Policies. Product-oriented environmental policies are growing rapidly in northern Europe, the United States and Japan. Some examples and trends include:

- Legislation on "extended producer responsibility" and "take-back obligation." Germany has introduced a take-back obligation for goods such as television sets, computers and cars. The U.S. Environmental Protection Agency requires discharge disclosures for certain types of generators.
- Introducing eco-labeling programs for products or product groups.
- Providing environmental information on products and processes, requiring businesses to pursue more pro-active environmental communication policies.

- Developing industrial subsidy programs to motivate DFE activities and encourage companies to carry out research into potential environmental improvements.
- Terminating subsidies on energy-intensive production methods and energy/raw material consumption.

Market demand/competition. The needs/desires of suppliers, distributors and end-users are potent tools for environmental improvement. Some examples and trends include:

- Requirements by some companies - generally large organizations - for environmental safeguarding declarations from suppliers. Some organizations are systematically looking at their entire supply chain and imposing new environmental standards or other measures of environmental performance.
- Boycotts or other actions by consumer organizations /environmental groups. For example, Greenpeace successfully influenced industry to develop GreenFreeze, an ecologically efficient refrigerant made of propane and butane that can replace environmentally harmful chlorofluorocarbons (CFCs).
- Environmental requirements incorporated into consumer product testing. If a product fails to get a high score on these requirements, it will no longer qualify for the title of "best buy" or "good choice," no matter what other excellent features it may possess. Good environmental ratings can increase market share.
- Increased implementation of "responsible care programs" in many industries, resulting in more companies with experience in cleaner production. In cases where intense competition exists for a particular product, companies with a good environmental profile can have an "edge."

Trade/industrial organizations. These organizations often encourage member companies to take action on environmental improvement and/or may impose penalties on companies that do not take required action.

Organizations are expanding all existing norms and standards to include environmental issues. The ISO 14000 series will become the international standard for certifying environmental management systems. It is expected that product-related aspects, such as the obligation to collect and publish environmental data, will be incorporated into this standard.

Waste processing costs. Waste-processing charges, such as landfill and incineration costs, are likely to increase based on the principle of "polluter pays." The prevention of waste and emissions, reuse and recycling will consequently become more economic.

Environmental requirements for design awards. Several respected design competitions have now stipulated that participants must provide specific environmental information on their products.

DFE and the Product Life Cycle

Because the global market is undergoing continuous and rapid change, every company's ability to innovate and be flexible will be critical to its profitability.

The DFE strategies can play an important role in product innovation by:

- Offering new criteria for evaluating design, such as material options, production techniques, finishing technologies, and packaging methods. The new criteria can often lead to innovative product or service solutions.
- Considering the entire product life cycle - a process that can stimulate partnerships with suppliers/distributors/recyclers, open up new market areas, and increase product quality.

Products influence the environment at all stages of the product lifecycle. Key environmental factors include:

- Energy supply
- Raw materials acquisition
- Component/product manufacturing
- Transportation and distribution
- Product use
- End-of-life product disposal

DFE facilitates systematic evaluation of a product and continuous improvement goals for the entire product lifecycle. This lifecycle generally has five phases:

- Design
- Production
- Distribution
- Product use
- End-of-life

While most companies do not control the whole product lifecycle, their design decisions do have an impact both upstream and downstream, from the selection of materials to product service and end-of-life options.

For manufactured products like an office chairs or magazines, the lifecycle will include all five phases. For other products, such as computer software, or for services such as metal coatings, the product lifecycle may be more or less complex.

DFE and Sustainable Development

DFE is designed to help companies adopt environmental practices that will lead to a more sustainable and healthier society. Therefore, DFE both supports, and works within, the context of other environmental initiatives such as:

- Sustainable Development
- Industrial Ecology

- Pollution Prevention (PP)
- Environmental Management Systems (EMS)
- Occupational Health and Safety (OH&S)

Sustainable Development. In 1987, the World Commission on Environment and Development defined Sustainable Development as “development that meets the needs of the present without compromising the ability of future generations to meet their own needs.”

One of the fundamental assumptions underlying Sustainable Development is that environmental considerations must be entrenched in economic decision-making. Sustainable Development initiatives are increasingly widespread among individuals, communities, industry and governments around the world.

Industrial Ecology. This term encompasses the practices of scientists, engineers and manufacturers to achieve more sustainable industrial production and consumption for local, regional and international economies by:

- Examining the environmental costs of industrial production/consumption patterns.
- Addressing the effects of invisible and persistent toxic chemicals on the earth's ecological systems.

In a sustainable society, durability and recycling will replace planned obsolescence as the economy's organizing principle, and virgin materials will be seen not as a primary source of material but as a supplement to the existing stock.

Pollution Prevention (PP). PP focuses on process and product improvements in order to avoid environmental problems before they occur. It is economically and environmentally superior to traditional "end-of-pipe" controls or clean-up strategies.

DFE merges with PP by focusing on products and processes involved specifically in manufacturing. While many DFE strategies incorporate PP, DFE goes beyond PP practices by also examining product functionality and services.

PP during the manufacturing process saves costs with regard to:

- Disposal.
- Raw materials/consumables.
- Ventilation equipment.
- Maintenance-ducts, motors, balancing.
- Operations-internal "balancing."
- Pollution prevention equipment.
- Health-workers, protective equipment, training.
- Regulatory compliance-approval from the government.

A number of measures can be taken to prevent pollution during manufacturing:

1. Control pollution at the source
    - Substitute materials
    - Change form of material to reduce emissions
2. Enclose the process
    - Prevent release through sealed vessels and piping
3. Suppress emissions
    - Water sprays - dusty processes or liquids
    - Gaseous - gas blanket
4. Change the process entirely
    - Degreasing - from chlorine-based to high-pressure steam
    - Soldering - from traditional acid etching/fluxes/lead to different base materials, VOC-free fluxes, lead-free solder

DFE and Environmental Management Systems (EMS). EMSs, such as ISO 14001, are organizational approaches to facilitate environmental evaluation and management. Except in cases of legal compliance, an EMS does not set or demand specific levels of performance in relation to product or process design.

The core requirement for EMS is that an organization should have a reasonable amount of information on the environmental effects of its products and processes and, in turn, seek continuous improvement. Pollution prevention (PP) is typically part of EMS.

DFE is complementary to EMS. It enhances the organizational approach by including product-oriented environmental evaluations and improvements. Manufacturers using DFE strategies take into account the environmental aspects of a product's use and end-of-life and apply this information during its design, production and distribution.

EMS benefits include:

- Cost savings from greater efficiency in processes, waste reduction, materials and energy use.
- Increased ability to meet customer/supplier requirements.
- Greater competitive advantage.
- Regulatory compliance and reduced liability.
- Improved community relations.
- Greater company appeal for investors.
- Increased employee pride and morale.

Occupational Health and Safety (OH&S). The DFE strategies provide support for programs related to worker safety during production and worker health in terms of material selection and use. DFE helps reduce:

- Need for in-plant emission controls.
- Worker contact with physical or chemical hazards.
- Need for protective equipment.

Improving health and safety performance will help to:

- Reduce lost time due to injury and illness.
- Reduce insurance fees and liabilities.
- Improve employee morale.
- Increase productivity.

Design for Environment (DFE) is the systematic integration of environmental considerations into product and process design. Therefore, every company must adopt the cost-effective strategies of this product-focused environmental approach to benefit themselves and their environment.