Environmental Design

OVERVIEW

In the last two decades, the manufacturing sector has been undergoing changes to meet diverse requirements that include maintaining high quality at low cost, staying competitive in a global marketplace, and meeting consumer preferences and regulatory demands for reduced environmental impacts. As a result, environmental management is increasingly becoming proactive i.e., anticipating and preventing environmental problems. Designing for the environment or environmental design also contributes to proactivity. It is a strategy for effectively organising environmental issues. In this Unit, we will discuss the tools available for integrating environmental concerns in the process of designing industrial products, buildings and developmental planning. We will begin the Unit by introducing the concept and principles of environmental design (ED). We will then discuss ED for manufactured products and construction. We will also discuss ED in the context of developmental planning.

LEARNING OBJECTIVES

After completing this Unit, you should be able to:

explain the basic principles, objectives and potential of environmental design (ED);

discuss environmental design considerations in the context of manufactured products, construction and developmental planning.

ENVIRONMENTAL DESIGN (ED): AN EXPOSITION

Environmental design (ED) or designing for environment is a perspective in which environmental aspects of an existing or new product, process or facility, design/redesign are optimised systematically and continuously for minimal adverse impact on the environment. In other words, it helps in designing and developing environmentally benign products and processes that have the lowest life cycle environmental impact. Acting as a catalyst, ED helps provide businesses with information to make environmentally informed choices. Note that this approach is also referred to as life cycle design, eco-design, sustainable design or design for eco-efficiency.

Principles of ED

In order to provide a context for the discussion of the principles of environmental design (ED), we will first look into its basics. ED is a design of products to meet environmental as well as utilitarian objectives. The core environmental objective is sustainability of a product and process. As the environmental management tools evolved, it became evident that environmental benefits can actually be built into the plans and design, and in so doing, products and processes can contribute to the improvement of the environment.

To elaborate, the environmental issues relating to processes and products are addressed, generally, after their implementation, and this involves redesigning of the processes and products to the extent possible. However, such tasks are expensive and time consuming and rarely attain the required level of environmental improvements. It is, therefore, necessary to evaluate potential environmental impacts at the designing stage, and it is this principle that underlies the concept of environmental design. In other words, there is a need to shift the conventional focus of processes and products from utilitarian values to environmental values. This shift in focus results in processes and products that are environmentally sound as well as utilitarian oriented. The concept of ED is thus useful in the manufacturing of products and in the processes of developmental planning.

The genesis of many environmental problems is high population levels, rapid population growth and unequal population distribution. The natural systems are getting overloaded and are unable to provide resources to meet the basic minimum needs of the ever-growing population. The result is the vicious cycle of poverty, rapid population growth, environmental deterioration and more poverty. Contributing to this vicious cycle are the results of economic activities that were once perfectly acceptable and even desirable but are now considered unacceptable because of their impacts on the natural resource base. Till recently, humanity was concerned about the ill effects of development on the environment. But now, it is equally concerned about the ways in which environmental degradation can dampen or reverse economic development.

The WCED report of 1987, *Our Common Future*, emphasised that the size, density, movement and growth rate of population cannot be influenced, if population control efforts are being overwhelmed by adverse patterns of development. Since then, the concept of carrying capacity of ecosystem is being looked upon as a tool for enabling environmentally sound developmental planning. This is born out of the realisation that the preservation of ecosystems and of the productive potential of nature is a fundamental objective of all planning.

Against this backdrop, let us now discuss the key principles of ED below:

(i) The design of a project, process or product must incorporate environmental objectives, in addition to other objectives such as economic efficiency and practicality.

(ii) The core environmental objective is the overall sustainability of:

- the use of resources, including energy;
- the process used in the manufacturing of a product or constructing a project;
- the product or project in operation;
- the product or project at the end of its use or operation, i.e., the actions involved in discarding, recycling or dismantling the product or project.

(iii) While sustainability is the principal environmental concern, other environmental objectives that should be considered are:

- the restoration and enhancement of landscapes;
- the dignity, comfort and safety of workers in workplaces;
- the restoration and enhancement of ecosystem;
- fostering of human creativity and art.

(iv) Environmental objectives that refer specifically to a project, process or product should be stated explicitly, to a level of detail equivalent to those of the other objectives. These objectives are to be agreed upon at the outset by administrators, sponsors and designers.

(v) Since the environment is multi-sectoral and multi-disciplinary, design for environmental objectives is inevitably a multi-discipline exercise and multi-disciplinary activity must be considered within the environmental design.

(vi) The design of a project, process or product should proceed from its initiation by the conscious definition and integration of environmental and other practical considerations. This requires the consideration and statement of design process that is product- or project- specific.

Benefits of ED

ED offers businesses the opportunity to enhance environmental performance, while simultaneously improving their bottom line Companies that apply the concept of ED, for example, find that it:

- reduces environmental impact of products/processes;
- optimises raw material consumption and energy use;
- improves waste management/pollution prevention systems;
- encourages good design and drives innovation; cuts costs; meets user needs/wants by exceeding current expectations for price, performance and quality; increases product marketability.

ED can also provide a means for establishing a long-term strategic vision of a company's future products and operations. In essence, as an enabling force, ED helps shape sustainable patterns of production and consumption. In this context, consider the following:

(i) **Increased innovation:** By incorporating ED into product design/development, companies gain a fresh perspective on established practices, resulting in new ideas and solutions (e.g., new product/service concepts, alternate production techniques, increased employee participation and greater creativity).

(ii) **Greater ability to compete, add value and attract customers:** There is a growing global demand for environmental quality in products and services. Incorporating ED into product design can help companies:

- meet emerging market demands;
- differentiate their products in the marketplace;
- improve their image and win customer attention;
- attract investment.

(iii) **Become more cost-effective:** ED targets opportunities for cost-reduction at all stages of a product's life and ensures

the greatest reduction in environmental effects/releases per dollar invested. This results in:

- reduced production costs;

- increased product quality;
- elimination of compliance costs;
- increased return on environmental investments.

(iv) **Reduce environmental impacts and liability:** By decreasing a product's impact on the environment, ED helps companies:

- ensure compliance with environmental regulations;
- reduce uncertainty with respect to future environmental requirements;
- improve access to insurance and financing;
- achieve better community relations;
- contribute to a better local, regional and global environment.

(v) **Gain a systems perspective:** ED, which focuses on a product's life-cycle, helps companies create corporate links between product design, supply chain management and sales/marketing, thereby providing:

- an overall, systemic view of company operations;
- a mechanism for cross-functional teams to continuously improve products.

The three sample success stories listed below should attest to the benefits of ED:

Example 1

Interface Flooring Systems (IFS), a leading global supplier of floor coverings, fabrics, chemicals and interior architectural components, has been using product redesign and material formulation to eliminate targeted toxic elements and compounds in its production processes. Through its efforts, IFS:

eliminated costs of toxic substances;

improved product quality and performance;

reduced unsaleable materials from 5.4 to 0.4% since elimination of toxic substances was a factor in improving product quality.

IFS saved over $90 million USD from 1995 to 1999, as a result of its in-house, zero-waste initiative (Lorinda R. Rowledge, et al. *Mapping the Journey: Case Studies in Strategy and Action towards Sustainable Development*. Greenleaf Publishers, UK, 1999).

Example 2

Electrolux, the Swedish global appliance manufacturer, used a combination of design and life-cycle tools to improve energy and water efficiency in its product lines. As a result:

It expanded its market share in professional refrigeration equipment from 5% in 1997 to 14% in 1998 with its Explorer line, which was in the top range of energy-efficient appliances.

Its Master System for apartment washing machines optimised the use of electricity, water and detergents, reducing laundry costs in apartment buildings by 50 per cent (Electrolux, Environmental Report, 1998).

Example 3

IBM Sweden designed glassware made from recycled cathode ray tubes (CRTs). The face of the CRT comprises two thirds of the weight of the glass and does not contain harmful lead. The result is that the majority of glass can be recycled into glassware. The other parts, containing toxic materials, can be recycled into CRTs at IBM Holland in the Netherlands. The results are cost-savings in recycled materials and greater awareness among marketing staff regarding the value of recycled materials (Inga Belmane. *A Eco-innovation: cathode ray tube recycling at IBM Sweden*. @ Journal of Sustainable Product Design, Issue 9, April 1999. Centre for Sustainable Product Design, Surrey, UK).

The above discussion clearly illustrates the advantages that result in adopting DFE in companies. Let us discuss the key concept of DFE

Motivation for ED

Motivation to implement ED can come from either or both of the following:

(i) Within the company itself, referred to as *internal drives*.

(ii) Within the immediate surroundings, referred to as external drives.

Let us now discuss both of these drivers.

Internal drivers

The internal driving forces in ED should consist of:

(i) **Need for increased product quality:** A high level of environmental quality will raise product quality in terms of functionality, reliability in operation, durability and reparability.

(ii) **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 significantly.

(iii) **Need to reduce costs:** Companies can combine ED strategies with financial benefits by:

- purchasing fewer materials for each of its products;
- using energy and auxiliary materials more efficiently during production;
- generating less waste and lowering disposal costs;
- disposing of hazardous waste.

(iv) **Need to stimulate innovation:** ED can lead to radical changes at the product system level – the combination of product, market and technology. Such innovations can provide entry into new markets.

(v) **Employee motivation:** Employee morale, generally, increases when employees are empowered to help reduce the environmental impact of the company's products and processes. ED can also boost employee motivation by improving occupational health and safety.

(vi) **Sense of responsibility:** A growing awareness that business must play an important role in working towards sustainable development can provide a strong incentive for implementing ED.

External drivers

The external driving forces in ED should consist of:

(i) **Government policies:** Product-oriented environmental policy is growing rapidly in northern Europe, the United States and Japan. Some trends along these lines are given below:

- Legislation on extended producer responsibility and take-back obligation (e.g., 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.)
- Introduction of eco-labelling programmes for products or product groups.
- Requirement to provide environmental information on products and processes, requiring businesses to pursue more proactive environmental communication policies.
- Development of industrial subsidy programmes to stimulate ED activities and encourage companies to carry out research into potential environmental improvements.
- Termination of subsides on energy-intensive production methods and energy/raw material consumption.

(ii) **Market demand/competition:** The needs/wants of suppliers, distributors and end-users are powerful drivers for environmental improvement. The trends include the following:

- Requirements by some companies – generally large corporations – for environmental safeguarding declarations from suppliers. Some companies are systematically looking at their entire supply chain and imposing the new environmental standards or other measures of environmental performance.
- Boycotts or other actions by consumer organisations/environmental groups. For example, Green Peace successfully pressured industry to develop *Green Freeze*, 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.

(iii) **Trade/industrial organisations:** These organisations often encourage member companies to take action on environmental improvement and/or may impose penalties on companies that do not take the required action. As well, standardisation organisations 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 in this standard.

(iv) **Waste charges:** Waste-processing charges such as land-fill and incineration costs are likely to increase, based on the principle of polluter pays. The prevention of waste and emissions, re-use and recycling will consequently become more economic.

(v) **Environmental requirements for design awards.** Several respected design competitions have now stipulated that contestants must provide specific environmental information on their products. One example is the German Industry Forum (IF) Design Award, affiliated with the Hannover Messe, which has a five-year plan to obtain environmental information on aspects such as packaging materials used, re-usability and warranties. Other international design competitions now pro-active with regard to the environment are as follows:

- IDEA award in the United States.
- G-Mark award in Japan.
- Form Finlandia award by Nestle.
- Excellent Swedish Form by the Swedish Design Council.
- Brown Competition in Germany.
- ION award in the Netherlands.

ED and other environmental practices

ED is designed to help companies adopt environmental practices that will lead to a more sustainable and healthier society. It supports as well as works within the context of other environmental initiatives, some of which we will touch upon, next.

Sustainable development

One of the basic 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 organising principle, and virgin materials will be seen not as a primary source of material but as a supplement to the existing stock" (Lester R. Brown and Pamela Shaw. Six Steps to a Sustainable Society, World watch Paper No. 48. World watch Institute, Washington, 1982).

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. ED dovetails with PP by focusing on products and processes involved specifically in manufacturing. While many ED strategies incorporate PP, it 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, internal balancing operations, pollution prevention equipment, health-workers protective equipment and training, regulatory compliance-approval from governments, etc.

A number of measures can be taken to prevent pollution during manufacturing. These include controlling pollution at source (e.g., substitute materials and change form of material to reduce emissions), enclosing the process (e.g., prevent release, accomplished with sealed vessels and piping), suppressing emissions (e.g., water sprays – dusty processes or liquids and gaseous – gas blanket) and changing the process entirely (e.g., degreasing from chlorine-based to high-pressure steam and soldering from traditional acid etching/fluxes/lead to different base materials, VOC-free fluxes, lead-free solder.)

Environmental management systems (EMS)

EMS such as ISO 14001 is an organisational approach to facilitate environmental evaluation and management. Except in cases of legal compliance, a EMS does not set or demand specific levels of performance in relation to product or process design. The core requirement for EMS is that organisations have a reasonable amount of information on the environmental effects of their products and processes and, in turn, seek continuous improvement. Pollution prevention (PP) is typically a part of EMS. It is estimated that INR (Indian Rupee) 1 spent on prevention saves INR10 otherwise spent at end-of-pipe or INR 100 expended on environmental remediation.

ED is complementary to EMS. It augments the organisational approach by including product-oriented environmental evaluations and improvements. Manufacturers using ED 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.

The benefits of EMS 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 ED strategies provide support for programmes related to worker safety during production and worker health in terms of material selection and use. ED helps reduce the need for in-plant emission controls, worker contact with physical or chemical hazards and need for protective equipment.

Improving the performance of health and safety will reduce lost time due to injury and illness, reduce insurance fees and liabilities, improve employee morale and increase productivity.

Table 9.1 below illustrates the link between environmental design and OH&S elements:

Table 9.1
The ED-OH&S Link

ED Strategy	OH&S Elements
Strategy 1: Physical Optimisation Integrate Product Functions. Easy Maintenance and Repair. Modular Product Structure.	Ergonomics. Material handling. Safety.
Strategy 2: Optimise Material Use Cleaner materials. Reduce material usage.	Material substitution. Hazardous materials.
Strategy 3: Optimise Production Alternate production techniques. Fewer production steps. Less production waste. Fewer/cleaner production consumables.	Process substitution. Chemical substitution. Industrial housekeeping. Hazardous materials. Safety equipment. Ergonomics.
Strategy 4: Optimise Distribution Less/cleaner/re-usable packaging. Energy-efficient logistics.	Material substitution. Material handling/storage.

Source: Canadian Centre for Occupational Health and Safety, Hamilton, Ontario.

We will next discuss the applications of ED for manufactured products.

ED FOR MANUFACTURED PRODUCTS

Industrial production is responsible for a great deal of the adverse environmental impact that we experience in the world today. A product may cause adverse environmental impacts during its production, use and beyond. For example, in many instances, the most severe environmental disturbances may be due to the impacts of different means of transportation. The disposal of the product after its use may also be one of the reasons for serious soil and groundwater pollution (e.g., land filling) or air pollution (e.g., incineration). In addition, for many products, severe physical disturbances and pollution result from the extraction of raw materials. All of these environmental problems are largely decided (consciously or unconsciously) during the design of the product.

This points to the fact that the development of a new industrial product involves many decision-making situations where alternative solutions to a given design problem must be ranked, and priorities given, according to relevant criteria. Many different and very diverse criteria may be applied. Among the important demands on the new product may be:

Performance: The product should actually meet the need that has been recognised.

Appearance: The company may wish its products to have a certain common appearance or the product may belong to a series of products with a certain common look.

Manufacturing costs: The manufacturing costs are essential for determining the later consumer price of the product.

Durability: The company must seek some compromise between the customer demand for high durability and its own wish to be able to market and sell new products frequently.

Safety: The product should be safe to use, thus reducing the company's liability due to accidents.

Service: The product should be easy to service and maintain.

Ease of manufacture: The design of the product must consider the constraints of the manufacturing facilities and the capabilities of the company.

The environmental design of industrial product implies that the traditional product development criteria listed above must be extended to include criteria concerning the environmental impacts of the products throughout its entire life-cycle, and therefore, must be based on a life-cycle assessment of the product. Let us now discuss the importance of the stages of a product life-cycle in the design process

ED considerations in product life stages

The implications of the different life-cycle stages that need to be considered in the design process are many and varied. Consider the following:

Extraction of raw materials: Because the extraction of raw materials often takes place in scarcely populated regions remote from residential areas, there tends to be a slack concern about the environmental consequences. However, the impacts due to physical disturbances (e.g., destruction of habitats, extinction of species) and emissions (e.g., local pollution) may be severe for activities such as mining of minerals and extraction of mineral oil. Indeed, for many products, the most serious environmental impact may occur in the extraction of raw materials. These environmental effects should be considered as a consequence of the decisions made during the product design process when different materials are considered for the product.

Manufacture: Product developers decide what materials and processes should be used for the manufacture of the new product. They influence the environmentally relevant emissions, physical disturbances and output of solid waste and wastewater that occur during production. Apart from the external environment, their choice of processes and materials also influences the working environment in the production plant.

Distribution/transportation: The weight of the product is decisive for energy consumption and emissions due to transportation in the distribution of the product. For some consumer products, the use of packaging material is a substantial part of the total resource consumption and the disposal of the used materials causes some of the most serious environmental loadings of the whole product life-cycle. The packaging of the product will often be influenced by the product design. An example of serious environmental problems due to transportation early in the life-cycle (say, namely distribution of the raw materials) is the regularly recurring disasters involving marine and coastal oil pollution from wrecked oil tankers. This is an inevitable consequence of the use of mineral oil as a resource, be it for the supply of heating or electricity or for the production of polymers. It should, therefore, be considered a consequence of the selection of those types of materials in the product design process.

Use and maintenance: For most electrical equipment, the use stage gives rise to the most serious environmental impacts through the emissions occurring during the production of electricity. The same will generally hold true for products incorporating combustion engines (e.g., vehicles, various machine tools, etc.). The product design team must, therefore, focus on the basic reasons for the energy consumption of the product and aim for optimisation of its energy efficiency. Other possible emissions from the use stage that need attention in design are noise or wastewater. If the use of the product entails resource consumption, this will also be of interest in the environmental product design.

Disposal: Once the life of a product has ended, it must be disposed of. From an environmental and resource point of view, the best method of disposal will generally be to reuse or recycle the product or parts thereof. These methods save resources and reduce environmental impacts due to the extraction of materials. Furthermore, they reduce environmental loadings associated with land filling (i.e., a major source of soil and ground water pollution and the physical disturbances), incineration of wastes (e.g., serious air pollution and the combustion slag) and composting of applicable to biodegradable materials. The environmental design should, therefore, be one for disposal and for reuse or recycling. This means that consideration of the potentials for recycling and the possible effects of different forms of disposal should influence selection of materials. Furthermore, the construction of the product should facilitate its dismantling into reusable and recyclable parts.

ED tools for products

The decisions made early in the design process pertain to fundamental issues such as the technology concept behind the product and the need it satisfies. That is to say, such early decisions fundamentally determine how a product is to be constructed. Subsequent decisions, i.e., decisions made at later stages when environmental consequences can be predicted with some precision over the product life-cycle will often be restricted to minor details such as the choice between closely related materials or processes.

Designing for the environment will, in most cases, involve one or more of the following strategies:

Product life extension through better reliability, increased durability, improved serviceability and multi-functionality.

Material life extension by making the materials and components reusable or recyclable, making the separation of different materials quick and straightforward, labelling the components and materials to ease separation and collection and keeping potential contaminants, e.g., adhesives, away from recyclable materials.

Reduced use of materials by making products lighter or smaller while performing the same function.

Switch from non-renewable to renewable resources either in materials or in energy sources.

Energy efficiency in use as well as in production.

Pollution minimisation by minimising pollution arising from all stages of the life-cycle.

The tools available for environmental design of manufactured products include the following:

Checklists: The simplest tools in environmental design are checklists. Generally, checklists specify materials or substances to be avoided, and such checklists are referred to as negative checklists. For example, these checklists may indicate to us to eliminate CFCs, avoid mercury and cadmium, use lead-free pigments and so on. These may be extended to include reduction or minimisation requirements, e.g. for VOC's. Checklists can be developed in a number of ways. One approach is to develop one or more checklists that reflect the market needs (e.g., the requirements of customers and regulators in the countries where you sell). Another approach is to rely on standard lists of environmentally harmful substances.

Life-cycle assessment (LCA): Many of the tools available for environmentally beneficial product development or design have their origins in the process of life-cycle assessment (LCA), which we discussed in detail in Unit 6. As you know, LCA is a technique for estimating and assessing all of the environmental impacts (positive and negative) associated with a product or process from the extraction and acquisition of raw materials, through product manufacture, distribution and use to disposal or recycling. Carrying out a complete LCA on a particular product system is a time-consuming exercise, which requires a large amount of data and involves a certain amount of subjective judgement. It can also be very expensive. On the other hand, the data-gathering stage known as life-cycle inventory (LCI) often prompts many improvements on its own, without recourse to the more contentious impact assessment that follows. Detailed LCA and LCI studies have been carried out on a number of products for comparative purposes.

Matrices: Neither comprehensive LCA nor compilation of an LCI is a practical option for most firms when developing a new product or service, and wanting to improve their environmental performance at the same time. A structured approach to design or development, which considers the environmental impacts arising from each stage of a product's life-cycle is, however, possible for businesses of all sizes and within projects of all timescales. A simple, qualitative overview of the life-cycle can help to identify which of these approaches is likely to yield benefits. Matrix methods provide one such approach to assessing environmental impacts across the life-cycle. In one simple version, i.e., materials, energy and toxicity (MET) matrix, issues pertaining to materials, energy and toxicity can be identified for three stages of the life-cycle, i.e., production, use and disposal. Table 9.2 illustrates the entries that could be made in a MET matrix:

Table 9.2
MET Matrix: An Example

	Materials	**Energy**	**Toxicity**
Production	Plastics, metal for wiring and element.	Electricity, gas and fuel oil.	Pollution from metals extraction and refining. Pollution from oil extraction, petrochemical plants and energy sources.
Use	Water	Electricity	Pollution from power generation and distribution (SO_2, NO_2, CO_2 etc.).
Disposal		Diesel (fuel for transport).	Possible pollution associated with landfills in general.

Eco-indices: Having selected the ED approach for reduced environmental impact, it is necessary to identify performance indicators to monitor the progress. Examples of indicators that can be useful include percentage of recyclable content, energy consumption per year of typical use, weight of specified materials per product unit, etc.

Environmental design examples

Environmental design tools are under development in various countries throughout the world. In many cases, parts of a product are changed for a new version with a better overall environmental performance. However, projects evaluating and redesigning entire products according to environmental criteria are still rare. Consider now the following ED examples:

The Dutch eco-design project involves a scheme of regular visits by a consultation team with a designer and an environmental specialist to product design groups of companies. The consultation continues throughout the design period with a view to developing environmentally friendly products and changing the environmental attitude of the company. Among the products developed through this project are gas cookers, office chairs and trays for the transport and display of pot plants. The Dutch Ministry of Economic Affairs and the Ministry of Housing, Physical Planning and the Environment sponsor the project.

The Royal Philips Electronics N.V. have identified five focal areas for eco-designing products, and these are *mass reduction means* (i.e., less use of natural resources, less use of processing chemicals, less pollution during processing, less waste (including EOL), less packaging, less transportation pollution, etc.), *reduction/elimination of hazardous substances* (i.e., less health effects during the manufacturing, use and disposal of products), *energy efficiency means* (i.e., less greenhouse gas emission, less use of battery and less waste), *recyclables means* (i.e., extended material use, extended component/part use, reduction in depletion of resources, reduction in EOL waste and reduction in pollution) and *packaging mass reduction results* (i.e., reduced use of resources, reduced transportation pollution and reduced waste generation.) Some of the eco-designed products of Philips are *breakthrough in small signal* (BISS) transistor with reduction in mass (91%), hazardous substances (88%), energy (30 - 55%) and packaging (91%), *free power radio AE 1000* with reduction in Mass (61%), hazardous substances (no cadmium), energy (50%) and packaging (60%) and *S2 and S10 starter* with reduction in hazardous substance (no tritium and lead).

Countries such as Germany, England, Australia and Taiwan are preparing product take-back regulations. Many companies have already introduced take-back programmes.

Xerox reuses up to 75% of components and recycles up to 98% of materials from take-back products. Those components that meet criteria for new components are used again in the Xerox Eco-Series Copiers. The take-back programmes saved $50 million in its first year of operation.

As of 1997, IBM has saved over $70 million through machine parts reuse and over $7 million through use of recycled commodities.

Hewlett Packard created a worldwide Equipment Management and Remarketing Division to re-manufacture used products including PCs, printers and scanners. As a result, the company has saved millions of dollars in parts manufacturing, has improved its image as environmentally sensitive, and has gained a greater competitive edge in the global marketplace.

A large number of initiatives have been taken in India for promotion of environmental design. An overview of these initiatives is presented in Case 9.1. An Environmental Information Centre has been established in India for promotion of environmental design of products (see Case 9.2).

let us introduce you to a new concept under environmental design, viz., eco-labelling, which is receiving worldwide recognition and many countries have designed their own eco-label as a sign of their responsibility to the conservation of environment.

Concept of eco-labelling

Eco-labelling is a voluntary method of environmental performance certification and labelling that is practised around the world

An eco-label is a label, which identifies the overall environmental preference of a product or service within a specific product/service category based on life-cycle considerations. In contrast to *green* symbols or claim statements developed by manufacturers and service providers, an eco-label is awarded by an impartial third-party in relation to certain products or services that are independently determined to meet environmental leadership criteria. There are many different voluntary (and mandatory) environmental performance labels and declarations. The International Organization for Standardisation (ISO) has identified the following three broad types of voluntary labels, with eco-labelling fitting under the Type I designation:

(i) **Type I:** This represents a voluntary, multiple-criteria based, third party programme that awards a license that authorises the use of environmental labels on products indicating overall environmental preferability of a product within a particular product category based on life-cycle considerations.

(ii) **Type II:** This represents informative environmental self-declaration claims.

(iii) **Type III:** This represents voluntary programmes that provide quantified environmental data of a product, under pre-determined categories of parameters set by a qualified third party and based on life-cycle assessment and verified by that or another qualified third party.

The roots of eco-labelling can be found in the growing global concern for environmental protection on the part of governments, businesses and the public. As businesses have come to recognise that environmental concerns may be translated into a market advantage for certain products and services, various environmental declarations/claims/labels have emerged on products and with respect to services in the marketplace (e.g. natural, recyclable, eco-friendly, low energy, recycled content, etc.). These efforts have attracted consumers (i.e., those who are looking for ways to reduce adverse environmental impacts through their purchasing choices) as well as left them sceptical.

Without guiding standards and independent third party investigations, consumers may not be certain about the claims of the companies about eco-labels. This concern with credibility and impartiality has led to the formation of both private and public organisations providing third party labelling. In many instances, such labelling has taken the form of eco-label awarded to products approved by an eco-labelling programme operated at a national or regional (i.e., multi-countries) level.

Some examples of eco-labels:

ED FOR BUILDINGS

Environmental design of buildings involves adopting techniques that ensure that the structure is designed, built, renovated, operated or reused in an ecological and resource efficient manner. Environmental building design is called *green building* design.

A green building may cost more upfront, but saves through lower operating costs over the building. The green building approach applies a project life-cycle cost analysis for determining the appropriate upfront expenditure. This analytical method calculates costs over the useful life of the asset. These cost savings can only be fully realised when they are incorporated at the project's conceptual design phase with the assistance of an integrated team of professionals.

Green buildings

Traditional building practices often overlook the interrelationships between a building, its components, its surroundings and its occupants. Typical buildings consume more of our resources than necessary, impact the environment negatively and generate a large amount of wastes. It was observed that a standard wood-framed home consumes over one acre of forest and the wastes created during its construction averages from 3 to 7 tonnes. Often, these buildings are costly to operate in terms of energy and water consumption. And they can result in poor indoor air quality, which can lead to health problems.